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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

F. JEFFREY BELL, M.A.,

One of the Secretaries of the Society
and Professor of Comparative Anatomy and Zoology in King's College;

WITH THE ASSISTANCE OF THE PUBLICATION COMMITTEE AND

A. W. BENNETT, M.A., B.Sc., F.L.S., *Lecturer on Botany at St. Thomas's Hospital,*
JOHN MAYALL, JUN., F.Z.S.,
R. G. HEBB, M.A., M.D. (*Cantab.*),

AND

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

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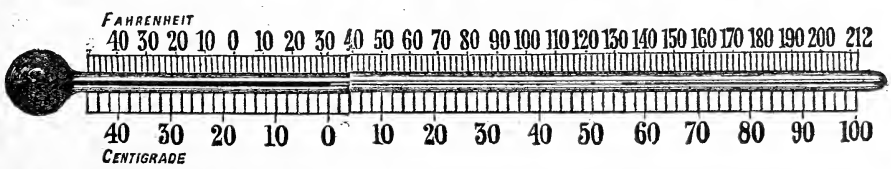
APERTURE TABLE.

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° 21′	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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JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

AUGUST 1890.

TRANSACTIONS OF THE SOCIETY.

VI.—*On some Methods of preparing Diatoms so as to exhibit clearly the nature of their Markings.*

By C. Haughton Gill, F.C.S., F.R.M.S.

(*Read* 19*th March*, 1890.)

Plate VII.

In a note communicated to the Society's Journal for December last I drew attention to the fact that certain diatoms when treated as therein shortly described, became so "charged" as to clearly demonstrate that their markings ("striæ," "dots," &c.) were hollows or cavities of some kind, as they were capable of being filled with foreign matter.

Having been asked to give more detailed particulars of methods and results I beg permission to submit the following.

Diatoms may have their "lacunæ" filled or partly filled by either of the methods described below, of which the third is by far the best as a general one.

(1) *Prussian-blue Method.*—Applicable only to such diatoms as have very coarse markings. The cleaned and ignited diatoms are boiled and soaked for several hours in a strong solution of ferric chloride (perchloride of iron); then to the cooled liquid is added a saturated solution of potassium or sodium acetate, whereby the ferric

EXPLANATION OF PLATE VII.

Fig. 1.—Inner surface of a Coscinodisc "charged" with mercurous sulphide. Some of the cells broken away, × 825.

„ 2.—Edge view of fragment of a Coscinodisc, showing the honeycomb structure of the valve, × 825.

„ 3.—Cell-cappings of a *Triceratium*. The perforations (secondary markings) filled with mercurous sulphide, × 825.

„ 4.—*Pinnularia major* (?). Striæ wholly or partially "charged" with mercurous sulphide, × 825.

„ 5.—*Stauroneis phœnicenteron* with lacunæ partially charged with mercurous sulphide, × 1750.

„ 6.—*Cocconema lanceolatum*, partially charged with mercurous sulphide, × 825.

„ 7.—*Epithemia turgida*, charged with mercurous sulphide, × 825.

„ 8.—*Pleurosigma angulatum*, charged with silver sulphide, × 1750.

„ 9.—*Surirella gemma* charged with silver sulphide, × 1750.

chloride becomes converted into the very dark red ferric acetate. The diatoms are now allowed to settle closely for two or three hours, and the excess of iron salt poured off as completely as possible. Next the test-tube with the moist diatoms is stood in a small vessel of boiling water till all the ferric acetate has passed into the basic state, as evidenced by its changing to an opaque buff colour. The diatoms, now "charged" with the insoluble basic ferric acetate, are shaken up with a few drops of water and acetic acid, and poured into not too great an excess of a solution of potassium ferrocyanide in acetic acid. After standing for some hours with occasional agitation, the excess of Prussian blue which has been formed among and around the diatoms can be removed (at any rate in great part), by repeatedly shaking up with fresh lots of distilled or rain water, as after elimination of the soluble salts this body assumes a form which settles very slowly indeed. Stirring the settled diatoms with a soft camel's-hair brush helps to remove the precipitate which may be clotted on their surface.

(2) *Platinum Method.*—Applicable to all diatoms, but apt to fail. To the cleaned and ignited diatoms contained in a small porcelain crucible add an alcoholic solution of sodio-platinic chloride, and evaporate with extreme slowness and without any approach to boiling. Finish the drying with the utmost care, to prevent the formation of bubbles of steam within the minute cavities, as this would result in ejection of the platinum salt and the consequent failure of the preparation. When *quite dry* raise the temperature very slowly till a low red heat is reached, and then throw a few crystals of oxalic acid into the crucible and immediately replace the cover. This completes the reduction of the platinum salt to metal and sodium chloride, and it now only remains to wash away the latter and as much of the unattached platinum as possible, and to select any required diatom from the residue.

(3) *Mercurous Sulphide Method.*—As stated above, this is the best method I have hitherto found for "charging" all diatoms except those having the finest markings. Take a cold saturated solution of mercur*ous* nitrate (*sub*-nitrate of mercury) and dilute it with its own bulk of water in a small test-tube. Add the diatoms and a drop of metallic mercury, and keep the whole standing corked up for as long a time as can be spared—days are better than hours, and weeks better than days. Shake the tube and withdraw the diatoms suspended in the liquid by help of a pipette, leaving behind any crystals of basic sub-nitrate of mercury which may have formed. Allow the diatoms to settle in a small test-tube, and draw off the supernatant liquid first by a pipette and then by a moistened thread or a very thin strip of filter paper till nothing but a slightly moist mass of diatoms remains. Now add several drops of a strong solution of ammonium sulphide which has been recently prepared, and which is practically free from dissolved sulphur (it should be almost colourless, not yellow), and shake. Fill up the tube with water, cork, and

allow the whole to stand for some hours. Wash and levigate as in the other methods. The mercurous sulphide thus formed is a black amorphous precipitate, which fills the "lacunæ" of the diatoms with an almost completely opaque stopping. Mercuric sulphide is apt to become red and crystalline; hence the necessity of the precautions to avoid the conversion of one into the other, which are detailed above. The only fault of this method is that the sulphide is somewhat apt to clot and become difficult to remove from the outside of the valves by washing. Perhaps this would be avoided by using weaker solutions than those I have worked with.

(4) *Silver Nitrate Method.*—A strong solution of silver nitrate (about 100 grains to the oz.) may be substituted for the mercurous nitrate, but on the whole does not serve so well except for those diatoms having the finest markings, e. g. *Pleurosigma angulatum.* The silver sulphide formed is brown and less opaque than the mercurous sulphide, but is not so apt to clot over the surface of the object.

By none of these methods will every diatom in a batch be equally well charged.

Diatoms treated by one or other of these methods exhibit very clearly that all "striæ," "dots," &c., are, as stated in the first paragraph, cavities of some kind, which, in default of a better name, might be called "lacunæ "or "pores."

Whether these lacunæ are complete perforations through the silicious test or mere pits or depressions on the inner or outer surface of the valve, or more or less flask-formed cavities communicating by one or more canals with the inner or outer surface, or with both, cannot at present be resolved with any degree of certainty in the case of those diatoms which have the finer markings. But in the case of some large Coscinodiscs it can be shown that the valve has a structure which may be described as cellular. Where the areolæ are widely separated from one another, a fragment of a charged valve viewed edgeways presents the appearance of a number of mammæform cells springing from the inner side of the outer face of the valve by their wider extremity, and terminating in a more or less conical perforated apex at the end facing inwards. Fig. 1 shows a valve of this description on the flat. All my edge specimens have spoilt themselves by rolling over.

Where the areolæ are very close together, so as to cause one another to assume the hexagonal form, the cells which constitute their prolongation partake of the same form, and their inner faces join together to form a perforated plate of considerable substance. The whole structure presents a close resemblance to a single layer of honeycomb cells with their cappings and bases complete but perforated. Fig. 2 exhibits an edge view of a fragment showing this structure.

The outer face or surface of these cells, very commonly if not universally, consists of a thin silicious membrane pierced with a

number of minute holes arranged in a symmetrical manner (constituting the so-called secondary markings), which differs in every species I have observed. Fig. 3 shows a portion of such a capping of one of them.

The cell-walls connecting the two surfaces are exceedingly thin and fragile, and are easily destroyed and lost sight of, while the two plates which they join are comparatively stout, and are often found separate and entire. The details of cell-form vary widely in different species.

In the case of the larger *Pinnulariæ*, e. g. *viridis* and *nobilis*, it can be easily seen that the striæ are pseudo-tubes contained in the walls of the valve, and which may be considered as formed by the lapping towards one another of the edges of a groove sculptured on the inner wall of the valve. I have observed indications of channels of communication between these pseudo-tubes and the outside of the valve, similar to those forming the secondary markings of the Coscinodiscs, but seek further confirmation. Fig. 4 shows a partly charged valve of *Pinnularia major* (?).

Of "dotted" diatoms, *Cocconema lanceolatum* (fig. 5), *Stauroneis phœnicenteron* (fig. 6), and the various *Pleurosigmæ* and *Naviculæ*, all that can be affirmed with certainty is that the dots are hollows. Further experiment is required to determine the point whether they have or have not the same cellular structure as the Coscinodiscs. Mr. Smith has shown that they have two skins or layers; is it not probable that these are connected in the same manner as those of the larger forms? Edge views of fragments of charged *Cocconema* and *Stauroneis* seem to show the black sulphide extending as a streak from one face to the other of the single valve, but in the case of such exceedingly minute structure, as is here in question, it is very easy to be misled by one's prepossessions, and it is therefore quite possible that on this point I have been deceived. What precise function these lacunæ or pores fulfil in the economy of the organism, is a question which I hope to study in the immediate future.

VII.—*On a Simple Form of Heliostat, and its Application to Photomicrography.*

By Thomas Comber, F.L.S.

(*Read* 21*st May*, 1890.)

Your Secretary has asked me to give your Society a detailed description of the apparatus I use for photomicrography, and of my method of working; but it appears to me that it will be simpler and shorter, and at the same time answer every purpose, if I merely explain those features in which my mode of working differs from that which I believe is generally adopted by others, and is probably sufficiently well known. The general nature of the arrangement will be apparent from the woodcuts.

The two main objects that I have endeavoured to attain have been, firstly, a means of sunlight illumination, easily applied, quickly adjusted, and simple in construction so as not to be liable to get out of order; and secondly, an arrangement which admits of convenient and comfortable eye-observation, for the purpose of arranging the object and adjusting cover-correction, before the camera is attached to the Microscope.

So far as my experience goes, for high magnification—other things being equal, both as regards objectives and manipulative skill—better results can be obtained by sunlight than by any other kind of illumination. The photomicrographs produced by Mr. Nelson and other of your members by oxyhydrogen light may be superior to what others have produced by sunlight; but this is due to their superior optical appliances and greater skill as microscopists, which more than compensates for what I cannot help regarding as inferior illumination. The same operator, using the same lenses, will, I am confident, produce better results by sunlight than by any artificial illumination.

The reasons sunlight has been so little used in this country are probably (1) the uncertainty of our climate; (2) the fact that many of our microscopists work chiefly in the evening; and (3) the complicated nature of the heliostats obtainable, which renders them very liable to get out of order, and so difficult to adjust that, when sunlight is available, much time is lost in setting up the apparatus; and, consequently, before everything is in working order, the sun may too often become clouded. The last objection is aggravated by the heliostat being usually placed a considerable distance from the Microscope, and sometimes even outside a window; and, as any error in the action of the heliostat is increased in proportion to the distance, it has been found almost impossible to keep the illuminating beam unchanged by the motion of the sun.

To avoid this difficulty, I place the heliostat inside the window,

and bring it quite close to the Microscope, so that it is within arm's length of the observer, and the sunbeam has so short a distance to pass before it reaches the substage condenser, that any slight error of the heliostat is of comparatively little consequence. The heliostat and all the accessories are fixed, once for all, on a wooden stand, so that they have not to be arranged each time they are used, but the stand has merely to be placed before the Microscope, and everything is in its proper relative position.

The heliostat itself is a brass time-piece A, fig. 47, to which is added an additional motion, causing the spindle, which need not be in the centre, to revolve once in twenty-four hours. It is mounted on a triangular brass plate, furnished with levelling screws, and is fixed at an angle to the horizon, corresponding to the latitude of the place in which it is to be used. When the point of the brass plate is directed due south, and the plate itself is levelled, by means of a spirit-level, in both directions, the clock is in the plane of the equator, and the spindle, at right angles to it, is parallel to the axis of the earth, and points to the North Pole of the heavens. The spindle is made slightly conical, and fitted to it, friction-tight, so as to be capable of easy rotation by the hand, is a small mirror B, with universal motion. The size of mine is two inches by one, which is ample. This mirror has to be set to reflect the light from the sun in the direction of the spindle, when the rotation of the spindle, corresponding exactly with that of the earth, only in the reverse direction, compensates for the apparent motion of the sun, and the reflected beam remains motionless. Where the reflected beam crosses the optic axis of the Microscope, there is placed a second fixed mirror C, inclined to the horizon at an angle equal to half the latitude, which reflects the beam in the axis of the Microscope. Between this fixed mirror and the condenser is placed an alum-cell D, to absorb the heat. In originally fixing the position of the mirrors, care has to be taken that the centre of the fixed mirror is truly axial with respect to the substage condenser and Microscope, and that, reflected in it when viewed through the Microscope, the spindle of the heliostat appears exactly end on, in the centre of the field. The heliostat will then be in its correct position, and the movable mirror can be placed upon it. All this may seem very complicated in the description; but once the position of the various pieces has been thus settled, all that has to be adjusted is the movable mirror, and its adjustment is no more difficult than that of the mirror which forms the ordinary adjunct of the Microscope. If the mirrors are of glass silvered at the back, the first gives a double reflection, which is again doubled by the second, and great loss of light is experienced. Glass silvered on the surface avoids this, but I found it tarnished quickly; so that I have had to adopt reflectors of speculum metal. These also are open to objection, for the light they reflect is distinctly reddish in tinge, and I believe there is considerable absorption of the rays of highest refrangibility.

The window at which I work faces about S.E., and has the sun from early morning until about two P.M., and, to ensure the apparatus

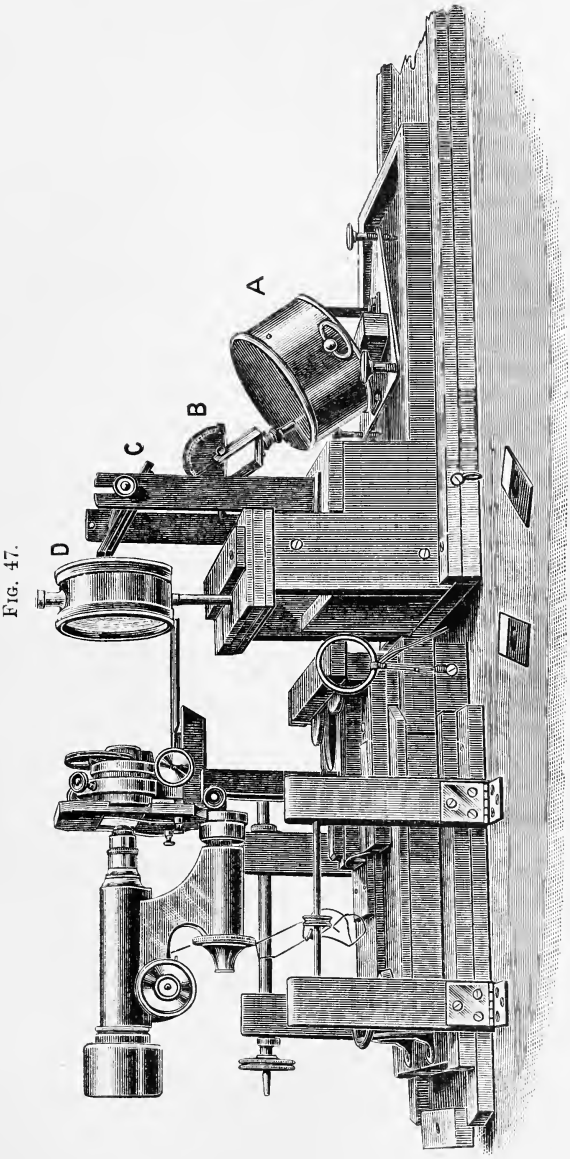

Fig. 47.

being placed due south, the end of the board upon which the heliostat stands is cut off at the angle corresponding to the glass of the

window, so that the table can be easily placed exactly in the required position.

The table itself (fig. 48) is heavy and solid, and stands upon three legs, so as to secure an equal bearing. It is at such a height that the horizontal Microscope-tube is at a convenient level for eye-observation, when the observer is seated, so that all the preliminary adjustments, as regards cover-correction, &c., can be comfortably made, and the illumination regulated, before the camera is attached. The base-board of the camera pivots on a steady tripod, and can, during this process of adjustment, be swung aside out of the way, but be brought round when required, and the anterior end of the base-board then fits to the edge of the Microscope table. The attachment of the camera to the Microscope is effected in the usual manner. For my own work, I find it most convenient to use a camera of fixed length, viz. one metre from eye-piece to sensitive plate; but a bellows body, capable of variable extension, can, of course, be substituted if desired. The focusing rod disconnects at the anterior end of the camera, sliding back off a square pin from the portion attached to the Microscope table. It works by means of a string, that passes round the milled head of the fine-adjustment (Fig. 49). The bar which carries the socket of the substage condenser has attached to it a small platform, upon which can be placed a screen of dark-blue glass, to subdue the glare for eye-observation, or a small cell containing ammonio-sulphate of copper or other solution, for producing monochromatic light.

So far, however, I cannot say that I have experienced any practical advantage from monochromatic light. It appears to me that when ordinary sunlight is used, the blue-violet rays are so prepotent in their actinic power that they do all, or nearly all, the work, and the other rays have not time to produce any material effect. The supposed advantages of monochromatic light are then practically attained without any special means, unless, indeed, some special method can be devised for working with rays of shorter wave-length than the blue-violet; and any suggestion for accomplishing this I shall be glad to receive, and to give it a trial.

The resolving power of our objectives depends not only upon their numerical aperture, but also upon the wave-length of the light used; and the high ultra-violet rays should therefore give a higher resolving power than the blue-violet; but I have not yet succeeded in making them operative in practice.

As regards general manipulation, the only special recommendations that I have to make are :—(1) That the cone of illumination should always be strictly axial. (2) That the image of the sun should be focused exactly in the plane of the object, so that it shows sharp and clear on the ground glass when the object is in focus. Clouds close to, or passing across the face of the sun, should be seen almost as if a landscape lens was being used. (3) That no unachromatized lens

should be introduced in any part of the system. I cannot, therefore, advise the use of a bull's-eye between the source of light and the sub-

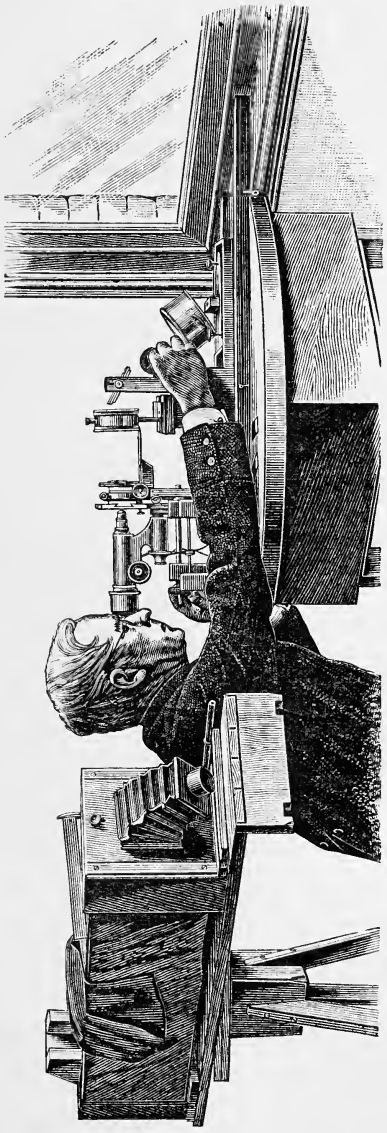

Fig. 48.

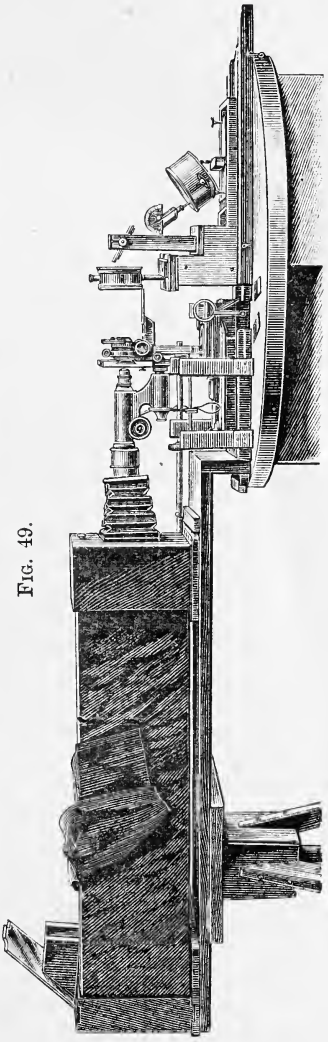

Fig. 49.

stage condenser. The angle of the cone of illumination which gives the best results, varies, I believe, not only with the object, but also with

the individual objective used. Too narrow a cone is apt to cause diffraction fringes, too wide a cone produces haze. I have not had much experience in photographing test diatoms, but so far as it goes, I find that my own 2 mm. Zeiss Apochromatic, 1·4 N.A., gives its best definition of such objects when about two-thirds of its back lens is filled by the dioptric beam.

I trust this description of my apparatus will enable others who may be desirous of using sunlight illumination to adopt it, and, I hope, improve upon it. I shall be pleased to answer any inquiries as to any point that may not have been made sufficiently clear.

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.†

Inheritance of Acquired Characters.‡—Dr. J. F. van Bemmelen has written a detailed history of opinions and theories in regard to heredity, with special reference to the problem of the transmissibility of individually acquired characters. After a brief sketch of Weismann's position, he reviews with great completeness the relevant literature. Beginning with Hippocrates and Aristotle, he passes to Buffon and de Maillet, Robinet, and Bonnet, and thence to Lamarck and the "Transformists." The opinions of modern naturalists are classified according to the predominance of anthropological, physiological, and pathological considerations. Scholarly as the record is, we find some serious omissions, as, for instance, of Brooks and Galton.

Studies in Mammalian Embryology—The Placenta.§—Prof. A. A. W. Hubrecht describes the placenta of *Erinaceus europæus*, and discusses the general history of placentation.

I. *Development of Yolk-sac and Allantois.*—The youngest blastocyst observed had the form of an oblong sac, and measured 1/10 mm. Its outer wall inclosed a few aggregated cells—the future hypoblast. The wall soon becomes more than single-layered, and exhibits an internal projection at the "anti-mesometrical" pole. Rapid growth thins out the wall of the blastocyst into a unicellular layer, with lacunar spaces containing maternal blood, and with numerous villiform processes from the columns intervening between the lacunæ. From the thickened polar epiblastic knob, the germinal area is formed by the separation of an

* 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.

‡ 'De Erfelijkheid van Verworven Eigenschappen,' 8vo, 'SGravenhage, 1890, pp. xiii. and 279. § Quart. Journ. Micr. Sci., xxx. (1889) pp. 283-404 (13 pls.).

internal bulging portion, which remains attached to the peripheral epiblast of the blastocyst along a circular line, until the amnion is formed. Soon after the establishment of the mesoderm, the separation of somatic and splanchnic layers is distinguishable, the former following the contours of the epiblastic disc, and folding up all along the circular attachment above mentioned. The epiblastic fold of the amnion is not double, but a single sheet, accompanying the double fold of mesoblast.

The germinal cell-mass bulges out gradually, leaving a central cavity, much in the same way as a morula becomes a blastula. The difference between this procedure and that described for the mole, rabbit, and opossum, is explained in reference to the fact that the cubic size of the hedgehog's blastocyst is many hundred times less than that of the others. As to physiological facts, Hubrecht maintains:—(1) That peculiar nutritive facilities are afforded by the didermic blastocyst before the formation of vascular areas on yolk-sac and allantois; (2) the "serous envelope," arising as a double layer of epiblast and mesoblast simultaneously with the amnion, does not as such take any important part in preparing the above facilities; (3) the outer cell-layer of the didermic blastocyst contributes very actively to bring them about; and (4) has an extensive and important rôle in perfecting the nutritive functions of the omphaloidean and allantoidean regions.

The author then introduces a series of new terms, by which he hopes to facilitate discussion. The trophoblast is the epiblast of the blastocyst so far as that has direct nutritive significance, as indicated by proliferating processes, and by immediate contact with maternal tissue, blood, or secreted material. The mesoblast, along with the trophoblast, forms the diplotrophoblast. That portion against which the vitelline circulation is applied is distinguished as omphaloidean from the mediodorsal allantoidean region. The omphaloidean placenta increases for a period, but retrogresses whenever the allantois begins to spread. Most important is Hubrecht's conclusion that both yolk-sac and allantois enter into very intimate interlocking, not with any maternal tissue, but with purely embryonic cell-material—the trophoblast—which has numerous lacunæ filled with maternal blood, and is connected with the maternal tissue long before the appearance of either vitelline or allantoidean circulation.

II. *The Histological Modifications in the Uterine Tissues.*—Where blastocysts are attached to the uterine wall, the lumina of the glands become occluded, the glandular epithelium gradually disappears, vascular channels and capillaries develope strongly. At first the blastocyst reposes at the bottom of a groove, in free communication with the lumen of the uterus, but the opposite walls of the depression fuse, a hæmorrhagic clot fills up the entrance of the cup thus formed, and the result is a capsule homologous with the *decidua reflexa* of the human subject. The blastocyst seems almost to eat its way into the maternal tissue, the uterine epithelium undergoing retrogressive metamorphosis. Round about the blastocyst, in the "vasifactive stroma" of the uterine mucosa, blood-spaces are formed in a unique fashion, and that region of mucosa undergoes proliferation and other changes, becoming the so-called "decidua." The zone of modified tissue with blood-cavities between the

blastocyst and the yet unaltered decidual stroma is named the trophospongia, while the embryonic trophoblast plus the maternal trophospongia, forming in *Erinaceus* a sphere shut off from the lumen of the uterus, is called the trophosphere. In this there appear certain specially large cells termed deciduofracts, the name suggesting their plausible function. While the author believes that trophospongia and deciduofracts arise from the endothelium of the blood-spaces of the decidual swelling, close to the blastocyst, he does not exclude the possibility that cells belonging to the decidual stroma may have a subordinate part in forming the trophospongia. The rest of this chapter is devoted to a consideration of the allantoidean trophospongia, the outer decidual layers, and the details of the mucosa.

III. *Physiology of Placentation.*—At a very early stage, the lacunæ of the blastocyst wall are filled with maternal blood, which contributes to growth and development. This primitive arrangement is succeeded by a very effective omphaloidean placentation, in which there is only a thin partition between the vitelline circulation and the maternal blood filling the trophoblastic spaces. This declines, however, as the final allantoidean placentation is established. The yolk-sac ceases to grow, and is folded up, although its circulation never wholly disappears; the trophoblast, against which it was applied, becomes membranous along with the rest of the omphaloidean trophosphere and the decidua reflexa. Of the vascular outgrowths of the allantois, as of those of the yolk-sac, it is true that they on no occasion penetrate or grow into maternal tissue. It is embryonic (trophoblastic) tissue that carries the maternal blood to them. The deciduofracts possibly act like phagocytes, with a direct destructive influence on the mucosa.

Prof. Hubrecht then reviews some recent contributions to the history of placentation, and urges against Sir William Turner, "that grand-master of placental research," four conclusions:—(1) In numerous orders (Carnivora, Chiroptera, Rodentia, Insectivora), the maternal epithelium disappears at a very early moment where the blastocyst adheres; (2) in the more primitive of the above orders, lacunar blood-spaces are in direct contact with the blastocyst long before the embryonic *area vasculosa* appears; (3) the connection between these lacunæ and the maternal blood-vessels is brought about in a more indirect way than by mere dilatation of capillary vessels; (4) in later stages, fœtal epiblast in varying thickness is present between the omphaloidean or allantoic villi and the maternal blood; in Insectivora, Chiroptera, Rodentia, this trophoblast is the only tissue so intervening. The author proposes to abandon the distinction between deciduate and indeciduate placentation, and maintains that the Insectivora furnish the natural starting-point for the placental series. After some observations on the ventral stalk (*Bauchstiel* of His), and other features in human placentation, Hubrecht concludes his elaborate memoir with a tabular comparison of the various names given by different investigators to placental structures.

Acquisition and Loss of Food-yolk, and Origin of the Calcareous Egg-shell.*—Mr. J. A. Ryder outlines his theory of yolk and shell. In primitive types which have ova almost wholly without yolk, surplus

* Amer. Natural., xxiii. (1889) pp. 928–33.

nutriment is elaborated into a multitude of small eggs, the number of which compensates for their unprotectedness. Unusual abundance of food might increase this number, or it might have the result of making the individual eggs larger, depositories for surplus oils and other hydrocarbons, buoyant like the pelagic ova of many fishes.

When the female parent becomes more highly developed, intelligent, circumspect, and alert, the ability to obtain food is doubtless increased, but as a matter of fact the ovary is reduced in size. The ova tend to be fewer and larger, and the circumspect parent retains them in the oviduct till their deposition is most convenient. When this retention is prolonged, as in Reptiles, a natural result is the deposition of albuminous or plasmic secondary deposits, or of secondary membranes, or even of a calcareous shell. But the secretory activity thus diverted from depositing surplus nutriment in the ovary would tend to diminish the fertility of the female and to starve the remaining ovarian ova.

Furthermore, if viviparous development occur, the embryo diverts all the spare nutriment to itself. The result is a diminution of fertility, a temporary check to the production of ova, but at the same time an increase in the chances of survival. This is most marked in cases of mammalian utero-gestation, when the claims of the fœtal parasite are strong, and when moreover the subsequent period of lactation tends to prolong the diversion of surplus nutriment from the ovary.

"It may be added, in conclusion, that the *membrana putaminis* of the eggs of birds and reptiles is a reticular, but cuticular, membrane, which is to be regarded as the homologue of the keratose cuticular secondary oviducal membranes of still lower forms, and that it would tend to take up calcareous matters in the same way as similar membranes in other parts of the body of a vertebrate."

Development of Proteus anguineus.*—Prof. R. Wiedersheim has had the opportunity of studying the development of *Proteus anguineus*. He finds that the external gill-orifices are ventral in position, and in young larvæ, as in Selachians, they are near the buccal cleft. The external gills first appear in the form of three papillæ set obliquely; later on they bifurcate and divide. The growing limbs have the form of buds, and call to mind the development of the paired fins of Teleosteans. The bend at the elbow-joint is to be seen in larvæ 16 mm. long. The position of the limb in relation to the wall of the trunk is such that the first finger is exactly ventral in direction, but the second dorsal. A short, broad tail is distinctly differentiated in larvæ 16 mm. long, and the fringe of fin that surrounds it is continued forwards, on the back, almost as far as the region of the neck. The organs of the lateral line are to be seen in larvæ 12 mm. long. The cœlom appears at 13 mm. in length, and the musculature is differentiated at the same stage.

The pronephros forms a compact coil of tubules which extends over three somites; it communicates with the cœlom by two infundibular orifices. The pronephros on either side and the ducts lie freely in wide venous blood-spaces which correspond to the system of posterior cardinal veins. Karyokinetic figures in the blood-cells indicate that division is going on in them. The enteric epithelium is capable of amœboid move-

* Arch. f. Mikr. Anat., xxxv. (1890) pp. 121–40 (2 pls.).

ments, by means of which the yolk-elements lying in the lumen of the enteron are actively taken up.

The rudiments of the semicircular canals and the endolymphatic duct appear very early; and the same is true of the lungs. The olfactory sac and the auditory apparatus are strongly developed in compensation for the rudimentary condition of the eyes. The teeth are developed very early, and before any other hard structures appear in the head; each tooth arises, like the placoid scales of Selachians, on a free papilla. The cartilaginous primordial cranium does not differ in its development from that of other tailed Amphibia. An indication of a fourth epibranchial may be made out in the visceral skeleton.

Pronephros of Amblystoma punctatum.*—Mr. J. L. Kellogg reports that the first portion to appear is the segmental duct which arises from the somatic mesoblast. The anterior end of the duct becomes constricted off from the peritoneal epithelium, except at two points, where the nephrostomes are to open into the body-cavity. As the organ becomes older and the openings into the body-cavity are acquired, the nephrostomes become more and more funnel-shaped in outline. These nephrostomes are segmentally arranged. The glomerulus in *Amblystoma* appears much later than in the frog.

Egg-membranes and Micropyle of Osseous Fishes.†—Mr. C. H. Eigenmann has examined the eggs of various osseous fishes, which he arranges thus:—

I. Eggs with a single membrane, the zona radiata.
  a. Zona radiata a single layer of uniform structure. *Notemigonus* and *Carassius*.
  a a. Zona radiata differentiated into an inner and outer layer. *Morone*, *Esox*, &c.

II. Eggs with a zona radiata and a thin homogeneous outer layer.
  b. Outer membrane without appendages. *Clupea*.
  b b. „ „ bearing filiform appendages. *Fundulus*.
  b b b. „ „ with short appendages. *Pygosteus*.

III. Eggs with a zona and a thick outer layer produced by a secretion from, and metamorphosis of the granulosa cells. *Perca*.

The author agrees with those who regard the zona as being derived from the yolk, and in some points confirms the statements of Kölliker.

Development of Serranus atrarius.‡—Mr. H. V. Wilson has a preliminary notice on the development of the Sea Bass, the egg of which is not difficult to rear. This egg is small and pelagic, and has one oil-globule; in almost all segmentation is strictly regular and bilateral as far as the sixteen-cell-stage. When thirty-two cells are formed the blastoderm is no longer bilateral. By a process of excentric thinning out one portion of the blastoderm becomes thicker than the rest, and it is round a small arc of this portion that the germ-ring first begins to form. This ring is everywhere formed as an ingrowth of cells from the edge of the blastoderm, in which the superficial layer takes no part.

* John Hopkins Univ. Circ., IX. (1890) p. 59.
† Bull. Mus. Comp. Zool., xix. (1890) pp. 129–55 (3 pls.).
‡ John Hopkins Univ. Circ., ix. (1890) pp. 56–9.

When the embryonic shield has reached its full size, the primitive endoderm is composed of two layers of cells distinctly marked off, except in the middle line, where there is a fusion. The streak of fused cells presently acquires a sharper lateral boundary, and becomes the notochord. On each side the under of the two lateral layers grows beneath the notochord and, uniting with its fellow, forms the endoderm proper. The upper lateral plate thickens by cell-division and forms on each side the mesoderm plate. In the extreme anterior region the whole of the primitive endoderm becomes transformed into the mesoderm of the head.

The alimentary canal is formed by a process of folding, essentially similar to that found in the Amniota. Kuppfer's vesicle is not formed in a manner essentially different from that of the rest of the alimentary canal. The peculiar features of the vesicle are the size and early appearance of the fold, and (in pelagic eggs at least) the fact that the periblast is here pushed down. The characters of this vesicle are discussed at considerable length.

The Wolffian duct arises as a fold of the body-cavity, and at no time has any connection with the ectoderm; Brook, in the author's opinion, probably mistook for it the rudiment of the lateral line.

The development of the sensory organs and of the lateral line is next described, and the history seems to show that the superficial sensory patch found in larval fish does not represent the condition of the primitive segmental or branchial sense-organ. The author's account of the development of the lateral-line organs is radically different from that of Hoffmann, and lends no support to Eisig's view of the homology between the lateral-line organs of fishes and those of certain Annelids.

Karyokinesis and Cleavage of Ovum.*—Mr. S. Watase agrees with Van Beneden and Boveri in holding that the achromatic spindle plays the most important part in the production of the karyokinetic phenomenon. It is the mechanism by which the chromatic substance of the spindle is divided among the daughter-cells. But he cannot find any evidence of the contractility of the achromatic fibrils; on the other hand, he finds that the achromatic threads are constantly lengthening, stretching, and pushing away from the centres of the asters from which they start. The achromatic spindle in its perfected form consists of two cones with their bases turned towards each other, with a sheet, as it were, of the achromatic substance of the nucleus interposed between them. Each cone is a part of a more general system of radiating fibrils forming one of the asters. The asters in a cell arise from the preceding single aster, as the new nuclei arise from the preceding nucleus. The old aster divides into two, each daughter-aster having a granular substance in its centre, and around it the achromatic rays extending in all directions. As the rays from each of the small asters grow longer the centres of the corresponding asters become more and more widely separated from one another. A small achromatic spindle is formed by the two groups of achromatic rays between the two centres. When the two asters become so widely separated as to have the whole nucleus between them, they apparently come to rest and begin their work on the nucleus by pressing on the more solid portion of the nuclear contents. The

* John Hopkins Univ. Circ. ix. (1890) pp. 53–6.

formation of the equatorial chromatin-plate is solely due to the pressure exerted by the two systems of rays from the opposite sides of the nucleus. The separation of the equatorial plate into two daughter-plates travelling in opposite directions, and the formation of the interzonal filaments are due to the continuance of the same action which has been going on before—the continuous growth of the achromatic fibrils. When each of two daughter-chromatin-plates approach the extremities of the spindle a new nuclear membrane is formed around each chromatin-plate, each plate thus forming a complete nucleus. The interzonal filaments consist of the same substance as the spindle filaments, but they do not in any way unite two daughter-chromatin-plates. In the interzonal filaments, therefore, there are two systems of filaments which run in opposite directions.

Looking at it in this way, the author considers that the whole phenomena of karyokinetic changes may be connected in one continuous series of activities of the cytoplasmic asters upon the nucleus. It follows that the rapidity of the cleavage process depends, in a great measure, upon the rapidity with which the cytoplasmic asters can migrate to two opposite poles of the nucleus. The presence, therefore, of inert, passive yolk-glanules imbedded in the cell-body of the ovum, necessarily interferes with rapid movement of the cytoplasmic asters. Such a view of the mechanism of karyokinesis suggests an explanation of the well-known fact, that the velocity of cleavage in any part of the ovum is, roughly speaking, directly proportional to the concentration of the protoplasm, or inversely proportional to the quantity of yolk-granules imbedded in the protoplasm.

The mechanism involved in the multiple nuclear division can be explained exactly in the same way as that in the binary karyokinesis. If, in a given stage of cleavage, say in the eight-cell stage, one blastomere on the right-hand side of the bilateral ovum shows multiple karyokinesis, the corresponding segment on the left half of the ovum shows exactly the same peculiarity.

β. Histology.*

The state in which the Water exists in Live Protoplasm.†—Prof. Marcus M. Hartog remarks:—One consideration on the structure of protoplasm, the question of the mode in which its water is combined with it, has been somewhat neglected of recent years. Even Berthold, who in his 'Protoplasma-mechanik'‡ has put forth a masterly exposition of the reasons for regarding living protoplasm as an emulsion, seems to have overlooked the need of explaining the condition of what may be termed the substratum or base of the emulsion in which the droplets lie.

Yet there is one phenomenon which ever confronts the histologist and sheds considerable light on this question, and which, from its very obviousness, has hitherto escaped full investigation; this is the change of optical behaviour of the protoplasm after death. Living protoplasm, in which I include even such specialized forms as striated muscular fibre, is transparent, with a refractive index not far above those of water, cell-sap, or the liquids that lave the cavities of the Metazoa. The difference

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

† Read at the British Association, 1889. ‡ Leipzig, 1886.

is so slight as to make small animals transparent, a very obvious phenomenon in the case of rounded pelagic animals, freshwater or marine. It is only by *slight* differences of refractivity, often requiring accentuation by oblique illumination, that we show up the different structures and cavities in these, in optical sections under the Microscope. Exner has recently determined the refractivity of striated muscle in *Hydrophilus* at $\mu = 1{\cdot}363$, in the frog at $\mu = 1{\cdot}368$,* while that of water is $\mu = 1{\cdot}333$, that of the liquid of an ovarian cyst is $\mu = 1{\cdot}365$, synovia $\mu = 1{\cdot}348$, egg-albumen (fresh) $\mu\, 1{\cdot}359$–$1{\cdot}364$. †

Immediately on death, however, this transparency disappears, and dead protoplasm is notably opaque. Now opacity can only be due to one of three causes: reflection at the surface, as with metals; absorption in the substance, as with ink; or scattering of light due to optical heterogeneity, like spun glass in the skein, silicate wool, filter-paper, &c. The two former causes are excluded by the nature of the case; and the last, *optical heterogeneity*, is left to us as the only possible explanation. Now we can make the paper transparent by greasing it, and so replacing the air in its interspaces by a medium approaching cellulose in refractivity; just so do we "clear" or restore the transparency of our dead protoplasm by replacing the aqueous medium that permeates it (and which can be expelled by pressure), with one of higher refractive index such as glycerin ($\mu = 1{\cdot}462$), or Canada balsam ($\mu = 1{\cdot}52$).‡ Yet even the latter falls below that of the dead protoplasm, as is very obvious in balsam mounts of transverse sections of muscle, or the spores of Saprolegnieæ, and I think their index is not much under $1{\cdot}55$.

It is obvious that the watery liquid which permeates dead protoplasm (consisting of water + small quantities of soluble salts) exists in a separate liquid condition in the interstices of a solid material, and that these interstices are too fine to be directly visible by the highest powers of the Microscope. This solid material has lost the power which it possesses in life of taking water into its substance. Exner has shown that living muscular fibre can excrete part of its liquid with corresponding increase of refractivity, and he cites the observation of Künckel that it can take up an additional 20 per cent. of water.

It follows that the water in living protoplasm must exist in a state of perfect physical combination, like the water of a solution of gum or of jelly. Now the phenomena of protoplasmic motions, as studied in the Rhizopods and in the vegetable cell, seem to me absolutely to preclude the jelly supposition; and for these cases we must admit that living protoplasm is a viscid liquid, whose refractivity is probably the mean of the two constituents separated by death, the one solid, the other a watery solution; and death is for us essentially a phenomenon of precipitation.

I may summarize these conclusions in the following theses:—

I. Live protoplasm is transparent and of low refractivity ($\mu < 1{\cdot}38$).

II. Dead protoplasm is opaque from optical heterogeneity.

III. The transparency of dead protoplasm is restored by replacing the liquid that permeates it by a medium of higher refractive index.

* In Pflüger's Arch., xl., "Ueber optische Eigenschaften lebender Muskelfasern."

† Exner in Arch. f. Mikr. Anat., xxv., "Ein Mikro-Refractometer," p. 111.

‡ This explanation of clearing was first given in part by A. B. Lee ('Microtomist's Vade-Mecum,' 1st ed., p. 213).

IV. The substance so permeated is solid and of high refractivity ($\mu > 1 \cdot 53$).

V. In death the solid substance forms a sort of reticulum too fine for resolution by our Microscopes,* the interstices of which are permeated by the watery liquid; in life the two are physically combined in the form of a viscid liquid. Hence death is essentially a phenomenon of precipitation.

For the more exact solution of the points discussed above, I propose making a full research on the refractivity of various proteids, solid and in solution, and of living and dead structures, animal and vegetable. The method I shall follow is that adopted by Exner in the papers cited above, consisting in immersion in liquids of known refractivity, and examination under the Microscope with the micro-refractometer which he invented.

It may be of interest to add that the above ideas were suggested to me in elaborating a technique for the convenient study of the Saprolegnieæ.

Peculiar Polycentric Arrangement of Chromatin.†—Dr. O. vom Rath calls attention to a peculiar polycentric arrangement of chromatin which he noticed in some large gland-like cells of *Anilocra mediterranea*. These cells were found in various parts of the head, and the author is inclined to believe that they have a salivary function. The cells varied considerably in size and form. The cell-protoplasm has in most cases the appearance of a finely granular coagulation, in which a very fine multireticulate plexus may occasionally be made out. In most cells there are several nuclei, and they may be of very different sizes. Some are round, others oval, others sausage-shaped, biscuit-shaped, or constricted. The chromatic star-figures exhibit a polycentric arrangement of the chromatin of the nuclei; each of these figures consists of an intensely coloured centre and a number of radially arranged, somewhat brightly-coloured chromatin-rods. The centre generally appears to be homogeneous, while in very thin sections it has not rarely the form of a dark ring with a clear central internal space. All the chromatin-rods are considerably thinner at the end which is turned towards the centre than at the other, which is somewhat swollen. At first sight there does not seem to be a direct connection between the chromatin-rods and the centre, but the use of higher powers (Seibert's apochromatic homog. immers. N.A. 1·35, oc. 8) shows distinctly that the club-shaped chromatin-rod is continued, at its central end, into a thin, pale filament which extends to the dark centre. The chromatin-rods surround the centre in all directions like the spines of a sea-urchin.

In nuclei with one star the centre of the nucleus and of the star fall together; but when there are several stars the centre of each is about the length of the radius of a star from the periphery of the nucleus. From the peripheral end of the several chromatin-rods, very pale, fine filaments pass out; these unite the chromatin-rods of the same star with one another, and with those of the neighbouring stars; in this way a plexus is formed which traverses the whole nucleus.

* Of course this is quite distinct from the much coarser reticulum or sponge directly visible under the Microscope.

† Zool. Anzeig., xiii. (1890) pp. 231–8 (1 fig.).

The unusual size and the forms of the nuclei, and especially the presence of figures of direct nuclear development, together with the presence of several nuclei in one cell, are all characters which have been noted in cells which have an intense secretory or assimilating function; the peculiarity of the present case is the arrangement of the chromatin. In the absence of any knowledge of similar cases it is difficult to suggest what this means. One is inclined to regard the chromatic centres of the star-figures as themselves nucleoli, around which the chromatin has, from some cause, become radially arranged. It has long been known that a large number of nucleoli may be found in gland-cells, and, indeed, in some other kinds of cells too. It is possible that the phenomenon has something to do with multipolar indirect cell-division; we might imagine that each centre was a centrosoma, and regard the division of the centres as divisions of centrosomata; but to this supposition it is easy to raise objections, and, at present, the best way of finding an explanation is to multiply examples of this peculiar mode of arrangement.

Micrometric Study of Red Blood-corpuscles.*—Prof. M. D. Ewell has made an elaborate micrometric study of blood, which is one of the few methods of identifying that fluid which is worthy of discussion. No reliance can, however, be placed on the micrometric test unless the errors of the micrometer used, with reference to some authentic standard, are known. When the subject continues during a short period in substantially the same condition of good health, there appears in the hands of the same observer to be an average size of the fresh corpuscles, provided at least one hundred are measured. As several tables given by the author show, there are such large discrepancies between the averages obtained from the measurement of the fresh blood-corpuscles of animals of the same species, and between measurements of the same objects by different observers, as to throw doubt on published results. There is no advantage in using very high powers in these investigations. The drying of blood-corpuscles in a clot multiplies the difficulty of identification; it has never been proved that dried corpuscles can be restored to their normal proportions. The mean size of the red corpuscles of very young animals is larger, and their size varies between wider limits than in adults. Many diseases alter the size of the red corpuscles, and fasting and various drugs diminish both their size and number. It is impossible, therefore, in the present state of science to say more of a given specimen of blood, fresh or dry, than that it is the blood of a mammal.

Histology of Central Nervous System.†—Prof. A. Kölliker, in his first communication on this subject, deals with the minute structure of the cerebellum. He finds that the granular layer contains a few glia-cells, and a large number of multipolar nerve-cells—the small and large granular cells. The former are very numerous, and have short protoplasmic processes, which divide at the end into small tufts. The very fine nervous process generally arises from a protoplasmic process, passes into the molecular layer, and then divides into two horizontal and longitudinal unbranched fibrils, the termination of which is unknown. There

* North Amer. Practitioner, ii. (1890) pp. 99-107, 173-86.
† Zeitschr. f. Wiss. Zool., xlix. (1890) pp. 663-89 (4 pls.).

are a large number of them, and they give the appearance of an extremely close parallel striation to vertical longitudinal sections. The large granular cells are more scattered and rarer; they have numerous ramified protoplasmic processes, which pass into the molecular layer, and also into the medullary lamellæ. The nervous processes of the cells of Purkinje give off a moderate number of fine lateral branches, some of which return to the molecular layer. The smaller cells of the molecular layer are external or internal; the former have richly branched protoplasmic processes, which often extend for a considerable distance, and a nervous process, the exact relations of which are unknown. The latter have very long and well-branched protoplasmic processes, some of which reach to the outermost parts of the molecular layer. The nervous process is very long, and extends as a transverse fibre over the bodies of the cells of Purkinje, and gives off, from time to time, vertical processes which pass inwards; these divide and surround the cell-body like basketwork.

The medullated fibres of the cerebellum of adult animals divide in the molecular layer only; they form a thick plexus in the granular layer. In the brains of embryonic and young mammals the medullary lamellæ of the cerebellum exhibit a certain number of undoubted nerve-fibres, which divide and become lost in the two layers of the grey substance, where they form anastomosing arborescent divisions. None of the fibrous structures revealed by Golgi's methods give certain indications of anastomoses, and as yet there is no fact that justifies us in believing in the presence of a nervous network in the grey substance.

Does a Magnet affect Karyokinesis? *—M. L. Errera, like many other observers, has been impressed by the resemblance between some karyokinetic figures and magnetic curves. He was led to try whether an electromagnet had any influence on the dividing nuclei in the staminal hairs of *Tradescantia virginica*. But the currents of protoplasm persisted, and the karyokinesis proceeded quite normally, so that the result of the experiment was distinctly negative.

γ. General.

Origin of Nerve-centres of Cœlomata.†—M. L. Roule discusses this question, and comes to the conclusion that in the Trochozoa (Mollusca and Annelida), and, without doubt, in the Chordata also, the nerve-centres of the adult, which are arranged in a bilaterally symmetrical manner, are always derived from simple and median rudiments, which are subsequently divided into two lateral symmetrical halves, and that they are not formed from the junction of two primitively distinct rudiments. When the larva has a proper nervous system, this is sometimes arranged radially (Trochozoa), and sometimes longitudinally (Chordata). In the former case the greater part of the system disappears, while what remains becomes the rudiment of the nerve-centres of the adult, or put themselves into relation with rudiments formed directly by the ectoblast; in the latter case the nervous system is preserved entire, or parts disappear, as in the tail of the caducichordate Tunicata.

* Bull. Soc. R. Bot. Belg., xxix. (1890) pp. 17-24.

† Arch. Zool. Expér. et Gén., viii. (1890) pp. 83-100.

"British Area" in Marine Zoology.*—Canon A. M. Norman has an interesting paper on this vexed question. He defines it as bounded on the south by 49° 30′ N., terminating at 5° 0′ W.—that is, midway between the Land's End and Brest. The mid-channel should be the boundary round the south and south-east coast, until, nearly opposite the Naze, we obtain a mid-channel at 2° 30′ E., and that longitude may be taken as the boundary through the North Sea and past Shetland. The northern boundary is more complex; it may start from the west at 60° N., and proceed eastwards till a point about midway between Cape Wrath and Faroe is met at 5° 0′ W.; thence a line should be taken due north-east past Shetland, until 1° 0′ W. is reached, whence the line should go due east to 2° 30′ E. The western boundary has no limits; it is the slope of that part of the continent of Europe of which our islands are the outliers, and descends to the base of the continent at 1500 fathoms. The author details his reasons for suggesting these boundaries, and criticizes the report of the British Association (1888) Committee, of which he was chairman, but to which at the time he was not able to give the necessary attention.

B. INVERTEBRATA.

Marine Invertebrate Fauna of the Gulf of Manaar.—In a report on the Pearl and Chank Fisheries,† published by the Government of Madras, Mr. E. Thurston gives a preliminary account of the marine fauna of the Gulf of Manaar; the sponges, echinoderms, Crustacea, and Mollusca have been worked out by specialists; there is also a list of the Cœlenterata.

New Invertebrates from the Coast of California.‡—Mr. J. W. Fewkes gives descriptions of various new genera and species of Invertebrates, which he collected off the coast of California; especial attention was directed to the Medusæ.

Heliotropism of Nauplii and Movements of Pelagic Animals.§—Mr. T. T. Groom and Dr. J. Loeb have made a number of experiments on the Nauplii of *Balanus perforatus* with the object of testing their heliotropism and of investigating the causes of the migrations of pelagic animals to or from the surface of the sea. They come to the conclusion that the periodical daily migrations of pelagic animals are due to heliotropism, or, in other words, are directed by the rays of light; this heliotropism is in the evening (in faint light) positive, and in the morning (in strong light) negative. The directive influence of a source of heat is slight in comparison with that of a source of light, so that the heating of the surface by day and its cooling by night do not play any essential part in the periodical migrations of animals.

Mollusca.

Revision of British Mollusca.‖—The Rev. Canon Norman has commenced the publication of a revision of British Mollusca. In the present paper the Cephalopoda are dealt with, and a new arrangement of the group is proposed. It is based primarily upon sexual distinctions. The

* Ann. and Mag. Nat. Hist., v. (1890) pp. 345-53 (1 map).
† Madras, 1890, 8vo, pp. 69-89.
‡ 'Zoological Excursions,' i., Boston, 1889, 8vo, 50 pp., 7 pls.
§ Biol. Centralbl., x. (1890) pp. 160-77; 219 and 20.
‖ Ann. and Mag. Nat. Hist., v. (1890) pp. 452-84.

Mesarsenia have the third arm of the male hectocotylized, while some of the suckers of the other arms are in that sex much larger than those of the female, in certain genera; in others the tips of the arms undergo modification; here come the Octopoda. The Decapoda are divided into the Chondrophora, Sepiophora, and Phragmophora; the first of these groups consists of two suborders—the Ophistharsenia (= Sepiolidæ), in which one of the first or dorsal arms is generally hectocotylized, and the Prostharsenia (= Cranchiidæ, Chiroteuthidæ, Ommastrephidæ, and Loliginidæ), in which there is hectocotylization of one of the fourth, i.e. ventral arms. In the Sepiophora (= Sepiidæ) and the Phragmophora (= Spirulidæ), the hectocotylization is on the basal portion of the fourth or ventral arm. The synonymy and distribution of twenty species are given.

Terrestrial Air-breathing Molluscs of United States.*—Mr. W. G. Binney has published a third supplement to his fifth volume on these Molluscs, in which the eastern province species are given as well as other addenda which bring the subject down to the first day of this year. *Arion foliolatus* Gould has been rediscovered, after fifty years' disappearance.

γ. Gastropoda.

Nudibranchs collected by the 'Blake.'†—Dr. R. Bergh gives an account of the seven, all new, Nudibranchs collected by the U.S. steamer 'Blake' in the Gulf of Mexico and the Caribbean Sea. Opportunity is taken to revise or make additions to the characters of the genera. *Chromodoris scabriuscula* is remarkable for the hard warts on the back and the development of the cutaneous spicules, as well as for its strong median tooth-plates. A species which is called *anceps* is, with some doubt, assigned to the genus *Phlegmodoris*. The anatomy of all the species is very carefully detailed.

The "Opaline Gland" of Aplysiidæ.‡—To a previous report § of Sig. G. F. Mazzarelli's investigation of the "opaline," "poison," or "grape-like" gland of Aplysiidæ, the following facts from the completed memoir may now be added:—The gland of Bohadsch, as the author prefers to call it, usually receives an arterial trunk directly from the aorta, and is always innervated from the right pedal ganglion. It may consist of odoriferous, chromatogenous, and giant mucous cells, derived from a gradual increase and modification of ectodermic elements which sink into the subjacent connective and muscular mesoderm. According to the nature of the component cells, the gland may emit a white and odoriferous, a violet, or a mucous section, of which the first and third are usually combined in all the species, while the second is only known in *Aplysia limacina* and *A. punctata*. There is, however, great variability in the character of the secretion. The products of the gland are regarded by Mazzarelli as excretory, while he believes that their odour and their power of clouding the water have a defensive value. Morphologically, the organ is probably comparable to a glandular sac recently described in *Oscanius* (*Pleurobranchus*) by A. G. Bourne.

* Bull. Mus. Comp. Zool., xix. (1890) pp. 183-226 (11 pls.).
† T. c., pp. 155-81 (3 pls.).
‡ Mem. Estr. Atti R. Accad. Napoli, iv. (1890) pp. 26 (2 pls.).
§ This Journal, 1890, p. 164.

δ. Lamellibranchiata.

Two new Hermaphrodite Lamellibranchs.*—M. P. Pelseneer justly directs attention to the rare condition of hermaphroditism exhibited by two Lamellibranchs. In some species of *Pecten* there is hermaphroditism, but one part of the gonad is male, and another female; *Pandora* and *Aspergillum* have on each side two distinct gonads, one male and one female, and each with its own duct. In *Lyonsiella* there are two ovaries and two testes, and the same is the case with *Poromya*, though the arrangement of the ducts is different.

It is remarkable that all the Lamellibranchs which have the sexes united belong to groups in which there is a good deal of specialization, such as the Pseudolamellibranchiata, the Eulamellibranchiata, and the Septibranchiata; on the other hand, the more primitive forms are all dicœcious. As this is true also of Gastropoda, we may conclude that in the ancestors of the Mollusca the separation of the sexes was the normal arrangement, and that hermaphroditism is a sign of specialization.

Molluscoida.

α. Tunicata.

Anatomy of the Cynthiidæ.†—Profs. H. de Lacaze-Duthiers and Yves Delage publish some preliminary notes on the anatomy and systematic relations of the Cynthiidæ. The pyloric gland is present in all members, whether there be a liver, as in the Cynthiineæ, or no such definite organ, as in the Styelineæ. The authors believe that the pyloric gland has a special digestive secretion, but with this an excretory function is possibly combined. They leave the last point to be worked out by Kowalevsky. The classification of Cynthiidæ requires revision, and in distinguishing Cynthiineæ from Styelineæ the chief emphasis should be laid on the alimentary system.

The Cynthiineæ have a distinct liver. The stomach is unswollen, without distinct limits, without marked internal projections, without a stomachal gutter, without an intestinal-pyloric ligament conducting the excretory duct of the pyloric gland, which opens directly on the wall of the digestive tube. The digestive loop is very large, extending almost to the level of the inhalent aperture; it consists of two portions almost vertical and parallel throughout the greater part of their length. The species are always armed with spicules. The dorsal raphe bears languets, or a continuous lamella.

The Styelineæ have no distinct liver. The stomach is swollen, definitely limited from œsophagus and intestine. It bears marked internal projections, and a deep gutter ending in a *cul-de-sac*, in which the excretory canal of the pyloric gland opens, after following the course of the intestinal-pyloric ligament. The intestinal loop is almost transverse, and hardly extends above the level of the cloacal aperture. The species are usually unarmed, though sometimes slightly. The dorsal raphe always bears a simple continuous lamella.

* Comptes Rendus, cx. (1890) pp. 1081-3.
† Arch. Zool. Expér. et Gén., vii. (1889) pp. 519-34 (1 pl.).

β. Bryozoa.

Synonymic Catalogue of Recent Marine Bryozoa.*—Miss E. C. Jelly is to be congratulated on the completion of this most valuable work. Though it is not to be expected that her fellow-workers will in all cases agree with her in her views of synonymous names, they are all greatly indebted to her for the long and patient labour necessary for a work of this kind; in many cases a single species occupies more than a page, and sometimes nearly two. When a recent form is also known in the fossil state, references to the fossil specimens are given. Only a systematist will fully appreciate the service Miss Jelly has performed for students of the Marine Bryozoa.

South Australian Polyzoa.†—Mr. P. H. MacGillivray in presenting a list of sixty-four species of South Australian Polyzoa, four of which are new, points out that the Australian seas are peculiarly rich in Polyzoa, more than 360 having been recorded from Victoria. Other parts of South Australia are, probably, equally rich.

Arthropoda.

Migration of Retinal Area in Arthropods.‡—Mr. G. Watase discusses the migration of the retinal area and its relation to the morphology of the simple ocelli and the compound eyes of Arthropods. He defines an ocellus as a visual organ in which the sensory nerve-end cells are segregated into definite groups called retinulæ, a group of retinulæ being again characterized by possessing a single dioptric apparatus in common. The author has already pointed out that a single retinula is morphologically a pit-like invagination of the skin. In his present paper Mr. Watase proposes to show how, granting the homology of the retinulæ in both the compound and simple eyes, a group of such retinular invaginations becomes again invaginated as a whole.

An area of primitive pit-organs which probably occupied the level of the general body-surface may migrate, under certain circumstances, inwards into the body in an embryonic stage. Since a slight difference in the level of a sense-area, in reference to the level of the surroundings, introduces a fundamental difference in the formation of the dioptric mechanism of an Arthropod, and, therefore, presumably a difference in functions, two organs serving different purposes may easily be formed out of the common type from a circumstance comparatively insignificant at first. The composite mode of origin of the visual organ in Arthropods culminates in the remarkable phenomenon of migration of the sensory area of the eye first observed by Brookes and Bruce in the larva of *Limulus*. Strictly speaking, the early stage of the lateral eye of *Limulus* represents a structure which is neither a compound eye nor a simple eye, but the initial stage for both. The author does not look favourably on theories which derive the compound from the simple eye. Both types are considered to have been derived from a common source—a group of pit-organs arranged on the level of the surface of the body.

* 8vo, London, 1889, 322 pp.
† Trans., Proc. and Rep. Roy. Soc. South Australia, xii. (1889) pp. 24–31 (1 pl.).
‡ John Hopkins Univ. Circ., ix. (1890) pp. 63-5 (2 figs.).

"They are the differentiations into two different directions from a common starting-point, the initiating factor for this divergence being the relative differences of the levels of the primitive sense-areas, in reference to the level of the surrounding skin."

a. Insecta.

Eyes of Caterpillars and Phryganid Larvæ.*—Herr O. Pankrath has examined the eyes of the caterpillars of *Gastropacha rubi*, and of the larvæ of the Phryganida. As is well known these eyes do not, as a rule, survive in the adult, for they disappear during the pupal stage, and are replaced by perfectly new organs. It may be supposed, *à priori*, that the same components are found in both sets of eyes, and a simple eye of a larva may well be compared with a facet of an adult's eye. This facet consists of a cornea-lens, a crystalline cone, and a retinula, which, as a rule, consists of seven parts; there are just the same components in the eye of a caterpillar; the fact that there are also seven rods in the retinula is probably not an accident, but indicates the close connection between the two kinds of eye.

Notwithstanding this resemblance there is a great difference in the vision of the caterpillar and the butterfly. In the latter a number of facets act in conjunction, and the eye is adapted for the perception of movements; in the caterpillar each eye acts independently, and is rather adapted for the perception of bodies. The powers of such an eye are, in consequence of the small number of nerve-endings, very small, but it is probable that they can do more than distinguish between light and darkness, and are able to perceive bodies, though not to distinguish them.

Intermediate stages can be easily detected between the two extremes; if the eye of a caterpillar be more closely approximated and covered by a continuous cornea, we get the eye of the Phryganid larva; while, if the separate eyes in this organ be multiplied and set closer together, we get the facetted eye, for this last is nothing more than a complex of a number of separate eyes.

Diminution in Weight during Pupation.†—Herr F. Urech shows, by means of curves, the gradual diminution of weight throughout the pupal stage of *Pieris* (*Pontia*) *brassicæ*. The various curves express the influence of the different temperatures at which the pupæ were kept, in the open air or within doors. They show very vividly that the weight diminishes with great rapidity towards the end of pupation, and also that dry air shortens the length of the period. The loss is of course due to the internal metabolism of the pupal reconstruction which goes on without recuperative income. Of the water given off along with carbonic dioxide, part is directly associated with the continual oxidation, the rest forms a large proportion of the secretion exuded before the emergence of the imago. Herr Urech also gives a table showing the rapidity with which the wings grow after emergence.

Tracheal Endings in Sericteria of Caterpillars.‡—Dr. C. v. Wistinghausen has investigated the mode of termination of the tracheæ

* Zeitschr. f. Wiss. Zool., xlix. (1890) pp. 690–708 (2 pls.).
† Zool. Anzeig., xiii. (1890) pp. 254–60.
‡ Zeitschr. f. Wiss. Zool., xlix. (1890) pp. 565–82 (1 pl.).

in the sericteria (spinning-glands) of caterpillars. The tracheal capillaries do not, he finds, end in the sericterial cells, but pass into a fine plexus—the so-called tracheo-capillary plexus. This is a system of fine tubes which, like the tracheal capillaries, consist of a peritoneal layer and an intima, which is probably chitinized; the tubes anastomose with one another, and the capillaries of various tracheal areas are connected with one another. The plexus lies beneath the membrana propria and between it and the sericterial cells, and broadens out over the whole cell; it does not, however, lie in the plasma of the cell, but is separated from it by a thin membrane.

Secretion of Silk by Silkworm.*—Prof. G. Gilson is of opinion that the silk of the silkworm is a regular secretion product. He bases this view on the facts that—the glandular tube is covered internally, through its whole length, by a transparent membrane; this contains circular threads, and the spaces between them are filled with a network-formation. As the silk is always separated from the cells by a membrane, it cannot be the result of the direct transformation of the protoplasm. In the next place, the silk is not, as a rule, to be detected by any reagents in the body of the cell, but in some cases it becomes really visible. At the end of larval life, certain shining spherules were found in the cells, and the reactions of these were just the same as those of silk. If one impedes the excretion of the silk at the end of larval life, the cell-body becomes quite burdened with silk-spherules. It seems that the silk is made up within the protoplasm, and cast out through the meshes of the netlike membrane. A selection is probably made by the membrane itself among the several substances that are mixed with the liquid part of the protoplasm and the silk, and the substance that becomes the silk is cast out. The special apparatus of the silk-duct seems to regulate the diameter of the thread, which is often very irregular before it has passed through it, and probably also to regulate the thickness of the thread.

Development of Hydrophilus piceus.†—Dr. V. Graber has a critical notice of Dr. K. Heider's memoir on the development of *Hydrophilus piceus*. Objection is raised to the statement that the primitive segments in Insects never enter into any relation with the rudiments of the extremities, and *Stenobothrus* is cited as a case. In other cases Dr. Heider is stated to have reported on what happens in *Hydrophilus* as if the facts were noted by him for the first time.

Development of Chalicodoma muraria.‡—Dr. J. Carrière has published a full account of the development of this bee. The egg is sausage-shaped, and the concave side is the dorsal. It is particularly well adapted for study, not only because of its transparency, but because the whole process of development is effected on the future ventral side. Several periods may be distinguished during development within the egg; the first closes with the formation of the germinal membrane, the second contains the changes which occur from the commencement of the formation of the germinal layers till the complete closure of the embryo

* Rep. Brit. Assoc., 1889 (1890) pp. 628–9.

† Zool. Anzeig., xiii. (1890) pp. 287–9.

‡ Arch. f. Mikr. Anat, xxxv. (1890) pp. 141–65 (1 pl.). See this Journal, *ante*, p. 322.

and its regular segmentation, while the third begins with the appearance of the rudiments of the gnathites, and ends with the formation of the anus; the fourth includes the rest of the intraovular development.

It should be noted that all of the so-called yolk-cells do not come to the surface in the formation of the blastoderm; much remains behind in the yolk. It is quite easy to see distinctly in *Chalicodoma* that, later on, there is neither a migration of yolk-cells into the already formed blastoderm or into the meso- or endoderm, or, on the other hand, a return of the cells of these layers into the yolk.

The Poison and Sting of the Bee.*—Dr. G. Carlet finds that in Hymenoptera with toothed stings there is in addition to the well-known "acid-gland" another with an alkaline secretion which renders the poison fatal. In Hymenoptera with smooth stings, which benumb their victims without killing them outright, this extra "alkaline gland" is rudimentary or absent. He describes the piston which makes the sting a double syringe, and shows how the cistern of poison feeds the syringe in such a way that the secretion does not flow out unless the whole apparatus is brought into action. The articulation of the stilets is the same in principle as the cabinet-maker's sliding dovetail. Of the detailed parts of the sting, the author claims to have given a more exact account than heretofore, of the truth of which Mr. Cheshire can judge.

The Genus Prosopistoma.†—M. A. Vayssière begins a monograph on this interesting Ephemerid, which has received such varied treatment at the hands of naturalists. Of the European species *P. foliaceum*, the male adult is still undiscovered, while the Madagascar forms (*P. variegatum*) are known only in the "larval-nymphal" stage. The young forms of the European species live in rapid rivers, such as the Seine and Rhône, under stones, in company with small insect larvæ. They swim rapidly, avoid the light, and probably feed on Protozoa and organic débris. Making a sort of sucker of their body, they also adhere firmly to the surface of stones. In swimming they use chiefly the three hairy bristles at the posterior end, while the head seems to be directive. The habits and the frequent moults of the "larval-nymphal" forms were studied by M. Vayssière on captive specimens. So far, the author describes the tegumentary, muscular, alimentary, and vascular structures, but the general results may be reserved until the completion of the monograph.

Anatomy of Thysanura.‡—Mr. H. T. Fernald gives an abstract of his studies on Thysanuran anatomy. *Anurida maritima* has been fully examined, and in some points *Lepisma saccharina*. The structure which Sommer called the "Excretionsorgan" in *Macrotoma* is present in *Anurida*, and is regarded by the author as the homologue of the fat-body of higher insects; its connection with the hypodermis is only secondary. Near the origin of each of the main nerve-trunks there lies a very large nucleus, which is more than twice the size of the nuclei of nerve-cells, but the author has not been able to ascertain its significance. Tactile bristles are scattered over the surface of the body, and are especially abundant on the antennæ and round the mouth. On the terminal joint

* Ann. Sci. Nat. (Zool.), ix. (1890) pp. 1–17 (1 pl.). † T. c., pp. 19–64 (1 pl.).
‡ John Hopkins Univ. Circ., ix. (1890) pp. 62–3.

of each antenna there is a small trilobed organ, which is similar to the bilobed organ described by Kingsley in *Campodea;* it probably aids in the determination of the form of the objects touched by the antenna. There are five eyes on each side of the head, and each of these consists of a nearly spherical mass of protoplasm containing four nuclei and covered externally by the cuticula, which is here smooth, though bearing small protuberances elsewhere. Immediately below the protoplasm is a dense layer of pigment. The different eyes of each side are entirely independent, and lie some little distance apart. No structure resembling an ommatidium could be found.

The post-antennal organ described by Laboulbène is situated between the eyes and the base of the antenna, on each side of the head. It is a rosette-like structure, and consists of from seven to nine ovoid bodies radiating from a centre. At the central end of each is a sort of pedicel or stalk joining the ovoid portion to the head. Both parts of the organ are filled by a pigmented protoplasm continuous with the hypodermis, but no nerve-connection was observed.

The abdominal vesicle is cleft longitudinally, and the hypodermic cells lining the cleft are glandular in appearance and are larger than on the outer sides of the vesicle. A small tube, in the formation of which both hypodermis and cuticula take part, passes forward in the ventral line to a median cleft in the lower lip. From the salivary glands a duct, which soon fuses with its fellow, passes forwards, but, instead of emptying into the mouth, it joins this ventral tube.

In *Lepisma* each eye consists of twelve facets, and each ommatidium consists of a large cornea, beneath which are two corneagen cells; the crystalline cone has the form of a concavo-convex lens, and at its sides are the four cells of the vitrella. The rhabdomere is pyramidal, and its base rests against the internal face of the crystalline cone; the four retinulæ which surround it are densely pigmented, and their proximal ends, which perforate the basement membrane, become optic nerves. *Lepisma* seems to represent the highest grade of differentiation yet attained by the Thysanura, while *Anurida* seems to have undergone a differentiation perhaps even greater, but followed by a degradation which is probably correlated with a change of habits and food.

β. Myriopoda.

Anatomy and Histology of Digestive Tube of Cryptops.*—M. E. G. Balbiani gives a detailed account of the general and minute anatomy of the digestive tract of this Myriopod. He was led to study it by remarking that the œsophagus, and not the intestine, is the region chiefly selected by the parasites which infest it. The author enters into a very minute account of the object of his investigation.

γ. Prototracheata.

Australian Species of Peripatus.†—Mr. A. Dendy has come to the conclusion that only one species of *Peripatus—P. leuckarti*—has as yet been found in Australia. Owing to the very distinct and definite mark-

* Arch. Zool. Expér. et Gén., viii. (1890) pp. 1–82 (6 pls.).
† Proc. Roy. Soc. Victoria, 1889 (*sic*), pp. 50–62.

ings in two specimens found by himself in Victoria, he was at first inclined to think that he had discovered a new species.* The close and critical examination of the colour markings which he has since made has shown him that this is not the case.

δ. Arachnida.

Lung of Arachnida.†—M. L. Berteaux has made a study of the lungs of Arachnida. He describes the upper surface of the pulmonary plates of the dipneumonous forms as being covered with chitinous tigella with free ends; these tigella are united at their base by a plexus with polygonal meshes which is formed by the cuticle. In *Mygale* the tigella anastomose at their tops, and the whole constitutes a trellis-work.

The free edge of the plates of the Dipneumona has a "marginal palisade" formed of anastomosed tigella. In *Euscorpius flavicaudis* the structure of the pulmonary plates is almost exactly like that of the dipneumonous spiders. In *Buthus europæus* the two lamellæ which form a plate carry the same chitinous processes; in *Scorpio indicus* the plates are divided into two zones, one of which is naked, while the other carries spines which are analogous to those of the Dipneumona. The walls of the pulmonary cavity carry various chitinous processes. All the varied kinds of processes found on the plates or in the walls are analogous. The straight bars with free ends, which are borne by the pulmonary plates of *Epeira diadematа*, appear in the embryo in the form of protuberances of the cuticle, and, in the course of development, become enormously elongated.

The two chitinous lamellæ which form a pulmonary plate are, in both Spiders and Scorpions, united by cells; these cells are separated by large spaces, in which blood circulates, and they reach, more or less, to the surface of the cuticle. These interlamellar cells are capable of contraction, and their alternate contraction and dilatation results in the movement of the blood which is contained in the lamellæ. The movements of the cells may also allow of the entrance and exit of a small quantity of air into the lung, but they are insufficient to account for the ventilation of the organ, which is due to other and as yet unknown causes.

The author regards the pulmonary plates of Arachnida as similar to the branchial plates of various Crustacea, and especially of the Pœcilopoda.

Embryology of Pycnogonida.‡—Mr. T. H. Morgan thinks that the evidence afforded by the developmental history of the Pycnogonida points to their affinities with the Arachnida. The process of multipolar delamination to form the endoderm seems to be common to the two groups; it is represented in its greatest simplicity in the majority of the Pycnogonida, while *Pallene* furnishes an analogy to the changes which an accumulation of food-yolk will cause in this process, and renders a comparison with the Arachnida quite possible. Other common points are the formation of an opaque area (*Pallene*) at the place where the

* This was called *P. insignis* in a preliminary account published in the 'Victorian Naturalist' for April 1890 (*sic*). † La Cellule, v. (1890) pp. 255–317 (3 pls.).

‡ John Hopkins Univ. Circ., ix. (1890) pp. 59–61.

stomodæal invagination appears, and the early formation of mesoderm at this point; the general mode of appearance of ganglia and appendages; the body-cavity of the appendages, and the early appearance of mesoderm; the formation of endodermal pouches into the appendages from the mid-gut, which pouches contain yolk in the embryo. The large "upper lip" of *Chelifer* suggests a homology with the proboscis of the Pycnogonida. As the first (chelate) appendages appear at the sides of the stomodæum, and subsequently move forwards, and are innervated from part of the supra-œsophageal ganglia, they may be closely compared with the same parts in Arachnida. In Pycnogonids the lumen of the invagination of the stomodæum is triangular in outline and Schimkewitsch describes a similar triangular invagination in Spiders. The absence of brain invaginations seems to be the only good objection brought by embryology against the hypothesis of the relationship of Pycnogonida to Arachnida.

ε. Crustacea.

Development of Homarus Americanus.*—Mr. F. H. Herrick has found considerable resemblance between the mode of development of the American lobster and of *Alpheus*, but in the earlier stages there are some interesting differences. The eggs of the lobster have an average diameter of about 1·6 mm., and are invariably of a deep olive-green colour. The period of hatching in the summer at Woods Holl is nearly one hundred days. The initial stages of segmentation were not observed. The typical yolk pyramid structure is not present, but the entire egg divides into a large number of subspherical segments of irregular size. There appears to be a continuous migration of protoplasm from the central to the peripheral parts of the egg. The gastrula-phase commences with a small patch of cells which makes its appearance on the side of the egg where the cells are thickest; a minute circular depression in it (which may be called the blastopore) marks the point where numerous cells at the surface pass into the yolk, and spread out on all sides. At the time of gastrulation, the great central yolk-mass is destitute of protoplasm, whereas in *Alpheus* there is a migration of cells from the surface into the yolk before gastrulation begins. Later on, the position of the blastopore is marked by a solid, deeply-staining core of cells from which the cells gradually thin out on all sides. The anterior side of this cell-mass, which the author calls the keel, is marked by the more crowded condition of the cell-nuclei; this forms the proper embryonic area.

The naupliar appendages appear nearly simultaneously in the embryonic area at a considerable distance in front of the keel; they are at first widely separated, but after a short interval the embryo undergoes a marked contraction. The optic discs are represented by a single tier of columnar cells. The anterior portion of the keel enters into the abdominal plate; the invagination of the stomodæum occurs at a point between the first and second pairs of antennæ. The labrum soon begins to grow down over the mouth, the proctodæum is established as an ingrowth of ectoblast on the surface of the thoracic-abdominal process

* John Hopkins Univ. Circ., ix. (1890) pp. 67–8.

and the thoracic-abdominal fold can soon be distinguished. The stomodæum is a tube which is bent forwards and flattened antero-posteriorly; its wall consists of a single layer of cells; it is surrounded by degenerating nuclei, yolk, and cells derived either from the abdominal plate or from the epiblast. The appendages are chiefly filled with yolk which is not absorbed until a comparatively late period.

The spores form a marked characteristic of the early stages of the lobster, and throw light on similar bodies which have been observed in *Alpheus* and other Crustacea. They are small, deeply-staining masses of chromatin, and correspond to the granules or nucleoli of ordinary embryonic cells. It seems that we have here to do primarily with a remarkable case of cell-degeneration. The cells go to pieces, for some unknown reason, and the chromatin particles are gradually degraded into a substance resembling yolk. It is possible that these dissolving cells act as yolk-digesters. The spores disappear at a later stage, when five to six pairs of appendages are formed. The heart is represented by a space between the proximal end of the hind-gut and the body-wall; this is filled with plasma, blood-corpuscles, and mesoderm cells, derived from the thoracic-abdominal process.

In embryos of this stage there is a conspicuous circular patch of cells behind the heart, which probably represents one of the structures described under the name of "dorsal organ." The endoblast appears as a definite layer when eight to ten pairs of appendages are present; its cells are derived from the yolk, and thus we see that it is not till a later stage that the germinal layers are established. In the egg-nauplius we can only recognize an ectoblast and an internal layer which consists of yolk-cells, proliferated ectoblast, and cells derived from the abdominal plate and mesoblast. The keel probably represents the endodermal disc of the Crayfish. The structure and development of the nervous system, fore and hind guts, and various organs seem, so far as they have been studied, to agree essentially with those of *Alpheus*.

Developmental History of Brachyura.*—Mr. J. Lebedinski had for the chief object of his investigations *Eriphya spinifrons;* the female of this crab carries a large number of eggs attached to the hairs of its abdominal appendages. The egg is about 0·5 mm. in diameter, and is quite spherical. It is invested by a chorion and a vitelline membrane. The earliest stage observed was that in which the already developed blastoderm covered only one pole; at this stage some of the blastodermal cells unite to form a thick cylindrical epithelial germinal disc which gives rise to all three layers. The disc sinks down and exerts a mechanical compression on the underlying mesoendoderm; this latter takes on a regular arrangement, for just below the cylindrical epithelium there is a row of elongated cells, internally to which there are amœboid cells scattered in the yolk. The proliferating cells give rise to the ectoderm, the elongated to the mesoderm, and the amœboid, which multiply actively, to the endoderm.

While these processes are going on two new thickenings of the blastoderm are formed in front of, and independently of the disc; these, which have a bilaterally symmetrical arrangement, are the cephalic

* Biol. Centralbl., x. (1890) pp. 178–85.

lobes, from which the eyes and brain are, later on, formed. These lobes converge in the direction of the ventral median line, touch, and give rise to a considerable thickening, which is the rudiment of the labrum. The lobes and the disc together give rise to a germinal stripe, which corresponds to the ventral side of the embryo. The changes in the germinal disc are next described, and this is followed by an account of the changes in the cephalic lobes, and the formation of the nervous system.

In the Nauplius-stage the egg is completely invested by the continuous blastodermal layer. The rudiment of the eye is now separated on either side from the optic ganglion, and later on constricts off from the ectoderm a complex of ectodermal cells, which gives rise to the median elements of the eye. The ganglionic rudiments cease to be solid cell-aggregates, for each becomes hollowed as the ganglion-cells and dotted substance begin to be differentiated. This dotted substance appears to be the result of a direct conversion of some of the true ganglion-cells. The ganglion-cell elongates, becomes spindle-shaped, and finally breaks up into separate fibrils. Though the three pairs of appendages characteristic of the Nauplius-stage are somewhat developed, they are not yet jointed. The divisions of the digestive tract become apparent. The abdomen appears as an elongated process, which runs parallel to the ventral surface; the rectum is continued into it in the form of a cylindrical tubule, the blind end of which extends into the mass of amœboid cells, which are here arranged in two rows. The mesodermal cells become connected with those which have been given off from the germinal disc and the lateral ectodermal thickenings, and give rise to two mesodermal bands on either side of the median line. These bands become metamerically jointed, and, later on, give rise to the body-cavity, splanchnopleure, and somatopleure.

The rudiment of the heart appears in the form of a rounded solid mass of mesodermal cells, and lies between the thorax and abdomen; its cells have a coarsely granular protoplasm, and stain very strongly with borax-carmine. Later on, the peripheral cells elongate and form a unilaminate membrane, when the heart appears as a completely closed cavity. In its interior there are a few mesodermal cells, and some blood-corpuscles. It now begins to beat, but the regular rhythmical contractions are seen only in the inner mesodermal membrane, while the outer ectodermal wall, which has no muscular elements, plays only a passive part. Later on the mesodermal cardiac membrane is further differentiated, and in the zoea-stage the heart has the form of an elongated spindle-shaped tubule, the wall of which is everywhere delicate.

The first rudiments of the segmental organs are found in embryos shortly before the zoea-stage; they appear as a paired evagination of the somatopleure. They are ventral in position. The elongated lens-like cells of the somatopleure in their neighbourhood become cubical and cylindrical. Each cell of the evaginated wall has in its outer part a nucleus and some protoplasm, while the rest is free of protoplasm and highly cuticularized. The distal end of the evagination passes into a blind tubule, which elongates and soon forms a canal which, after several coils, ends blindly beneath the skin. Here the ectoderm becomes invaginated and forms a short tubule, the blind end of which

unites with the blind end of the canal. The resemblance between these organs and the segmental organs of Annelids, the organ of Bojanus in the Mollusca, and the pronephros of Selachians is sufficiently striking.

The author's observations concluded at the zoea-stage.

Stenorhynchus longirostris.*—Mr. D. Robertson has an interesting note on this common Crustacean. He has had occasion to doubt its carnivorous habits, and he has often seen it picking about its limbs (particularly the second pair, which are generally most invested with sea-weed), and conveying the produce to its mouth. "If other observations confirm the view that this animal is a true vegetarian, we shall have one example at least of an independent agriculturist who is not only superior of his lands, but carries them with him when he removes."

The Stalk of Barnacles.†—M. R. Koehler devotes the first part of his memoir on the structure of Cirripedia to a description of the stalk of Lepadidæ. While there is no doubt that the Cyprid larva fixes itself by its antennæ, there is some divergence as to the morphology of the stalk. For, according to Darwin, Claus, Willemoes-Suhm, and others, it is due to an elongation of the frontal region of the larva, while, according to Lang, it arises from an enormous increase of the anterior part of the cutaneous fold which lines the internal surface of the bivalve Cyprid carapace, the posterior part of the same fold forming the future mantle. This view is corroborated by the histological homology between stalk and mantle. The stalk consists of an external epithelium covered by a chitinous cuticle, of three layers of unstriped, peculiarly ramifying, muscle fibres (oblique, transverse, and longitudinal), and of a central mass of connective tissue, which is prolonged between the muscle-fibres on to the epithelium. This connective tissue in the proximal region of the stalk incloses the ovaries and cement-glands, while in the distal region, where it is less developed in consequence of the extension of the muscle-fibres, it only incloses the ducts of the cementing (possibly excretory) organs. Along its length the stalk exhibits a canal of large calibre, bordering on the rostral surface, and lying in a kind of gutter, which corresponds to a depression of the longitudinal layer of muscles. This canal branches towards its distal end, and opens at the other extremity into the general cavity of the barnacle. The oviducts, when formed, lie along its internal margin, and accompany it till it enters the body. Furthermore, on the sides there lie two large nerves from the sub-œsophageal ganglion, but these leave the canal and branch to form three principal pairs within the longitudinal layer of muscles. All these structures are described and figured in detail.

Vermes.

a. Annelida.

Perichæta.‡—Mr. F. E. Beddard has published some observations upon a South American species of Perichæta, together with some notes on the genus. He discusses the proposed divisions, and suggests that

* Proc. and Trans. Nat. Hist. Soc. Glasgow, ii. (1890) pp. 218–9.
† Arch. de Biol., ix. (1889) pp. 313–402 (4 pls.).
‡ Proc. Zool. Soc. Lond., 1890, pp. 52–69 (2 pls.).

the name *Megascolex* be applied to such forms as have the line of setæ interrupted, and the clitellum occupying more than three segments, while *Perichæta* will apply to those in which the line of setæ is continuous, and the clitellum consists of three segments only. The following new genera are proposed for species already described: *Diporochæta*, *Anisochæta*, and *Hoplochæta*. With regard to the distribution of the setæ in Chætopods the evidence afforded by the Oligochæta favours the view that a continuous circle of setæ is the archaic condition. Notes are added on the nephridia, the spermathecæ, and the glycogenic organs, additions are made to our knowledge of *Perichæta biserialis*, while *P. forbesi*, from New Guinea, and *P. vaillanti*, from Manila, are described as new.

Segmental Organs of Hirudineæ.*—M. H. Bolsius gives an account of the segmental organs of the Leeches. In all, the cavities of these organs, with the exception of the vesicle at the lower end, are intracellular cavities. In *Hirudo* and *Aulastomum* the organs consist of a glandular and of a collecting part; the former contains a network of anastomosing canals, and these canals receive the chief trunks of a system of intracellular vessels, which groove the cytoplasm of most of the cells. The network itself communicates with the collecting canal by an apparently small number of branches. This collecting canal, which is formed of perforated cells placed end to end, does not extend as far as the superior part of the gland which abuts on the testicle. It opens below into a urinary bladder which is lined by epithelium. This vesicle has a sphincter; its orifice pierces a cell—"the cellule-porte"—which forms the boundary between the intercellular and epithelial system of the bladder, and the intracellular system of the segmental organ.

In *Nephelis* and *Clepsine* the segmental organ has the form of a ribbon made up of a single chain of cells. This chain is perforated by three canals of unequal length; they arise in the cytoplasm of certain cells by a system of branching analogous to that of *Hirudo* and *Aulastomum*. The three canals appear to unite, and the single canal opens, as in *Hirudo*, by an orifice in a single cell. The urinary bladder is greatly reduced, especially in *Clepsine*; this bladder has no sphincter.

In the structure of the cells, attention may be drawn to the nuclei, which contain an abundance of caryoplasm, much reticulated; they contain a nuclear nucleolus which often possesses a distinct membrane, when it may be known as a "nucleole-noyau." In *Clepsine* the nuclei are often morula-like, and bear prolongations which are often cylindrical. The membranes of the cells and nuclei are dotted, as is also the wall of the internal canaliculi; the trabeculæ of the cytoplasm are inserted into these membranes in such a way as to establish an intimate relation between the canals and the reticulum. The trabeculæ of the cytoplasmic reticulum do not start from the nucleus as their principal centre, but from all the canals and internal canaliculi. In some of the canals there is a striated plate on the inner surface.

The cells are very intimately connected with one another. In the glands of *Hirudo* and *Aulastomum* they communicate by the system of

* La Cellule, v. (1890) pp. 369-436 (3 pls.).

anastomosing canals. At the level of their surfaces of contact, one does not, ordinarily, perceive two membranes, but one very delicate lamella, which perhaps represents a primary membrane. However, in old individuals, and above all in the case of *Aulastomum*, a complete fusion appears to be established, and this is particularly the case with the cells which form the collecting canals and the adjacent glandular cells. Similar relations are to be found in the segmental ribbon of *Nephelis*. In *Clepsine* there is a peculiarity in the mode of union of the segmental cells, for it is effected by very delicate prolongations of adjacent cells. In most cases the prolongations are equal in number to the canals of the region, and each gives passage to a single canal.

Body-cavity Liquid of Sipunculus Gouldii.*—Dr. E. A. Andrews reports that a specimen of this Gephyrean of average size contains about 1 ccm. of a saline liquid which contains a larger percentage of sodium chloride than sea water, and is rendered turbid and reddish by the presence of definite solids. There are red, white, and giant corpuscles, with spermatozoa in the male, and eggs in the female. The liquid clots quickly on removal from the body, and when washed, the clot resembles vertebrate fibrin in appearance and many reactions. The colouring matter of the red corpuscles is hæmerythrin, which is probably colourless when reduced, and seems to have iron associated with it. The presence of large amounts of proteid and saline material in the liquid is connected with its use as the only nutrient internal medium as well as the chief and ultimate respiratory liquid. The presence of iron perhaps indicates a genetic connection between hæmerythrin and the hæmoglobin of *Phoronis* and the Echiuridæ, while the other characters favour the separation of the Sipunculids from the rest of the Gephyrea.

New Phoronis.†—Dr. E. A. Andrews has a short note on a new, American species of *Phoronis*, which he calls *P. architecta*. It was found at Beaufort, N.C., inhabiting slender tubes which stand upright in rather impure or muddy sand. The tubes are isolated, and are formed by a clear, firm, chitin-like membrane, the upper part of which is covered with a layer of sand. The animal is about 50 mm. long and 1 mm. in its greatest diameter. There are about sixty tentacles which are arranged in a simple crescent. The lophophore is distinguished by the presence at either end of the crescentic bar of a large spoon-shaped organ which opens by a wide longitudinal slit into the extra-branchial or anal space; the cavities of the organs are ciliated and lined by a peculiar glandular epithelium. At the base of each there is a spherical "sense-lobe" which appears to correspond to the "glandular pit" described by Benham in *P. Kowalevskii*. The organ may be supposed to play a part in collecting or fixing sand-grains to the chitin-like tube. The longitudinal muscles are greatly developed, the sexes appear to be separate, and there is a ciliated groove in the digestive tract. In the first stomach intracellular digestion is effected by irregular ridges of epithelium rising up around one or more large diatoms and inclosing them within a syncytium-like mass.

* John Hopkins Univ. Circ., ix. (1890) p. 65.
† Ann. and Mag. Nat. Hist., v. (1890) pp. 445–9 (3 figs.).

β. Nemathelminthes.

Lemnisci of Nematodes.*—Dr. O. Hamann has come to the conclusion that there is a complete homology between a whole series of organs in Nematoda and Acanthocephala. The lemnisci of the latter, the history of which is so obscure, are to be found in Nematodes, where they have been called cephalic or cervical glands. These so-called glands are, in *Dochmius duodenalis* and all Nematodes which possess them, continuations of the dorsal and ventral longitudinal lines, just as the lemnisci of *Echinorhynchus* are continuations of the skin. The history of their development has shown that the subcuticula of Nematodes with its four outgrowths (so-called lateral or longitudinal lines) represents the epidermis, and is formed from the cellular ectoderm of the larva. The water-vascular system of *Echinorhynchus* is homologous with that of Nematodes. In both groups it lies in the skin (ectoderm), and has two longitudinal vessels, which, in the Nematodes, run in the dorsal and ventral longitudinal lines. There are also in the epidermis of Nematodes afferent canals of very various kinds, as well as structures which call to mind the lacunæ in the skin of *Echinorhynchus*.

The gigantic spherical nucleus, nearly 0·1 mm. in size, found in the lemnisci of Nematodes, is seen in *Echinorhynchus clavæceps*, and somewhat modified in *E. clavula*, *E. tænioides*, *E. spira*, and others. In both groups the lemnisci arise as projections from the epidermis into the body-cavity; they grow backwards and become finger-like and saccular organs, which in the simplest case merely contain a cavity or sort of canal. The lemnisci are, then, direct continuations of the skin, and there is no question as to the absence of an orifice. Not only can the ectodermal vascular system be shown to be homologous in the two groups, but the same is true of the body-cavity. In both there is a true cœlom lined by an epithelium. The polyhedral cells of this layer may, in either group, give rise to muscular fibrils, but in most members of both groups the epithelium disappears. On the whole, there is good reason for supposing that the Acanthocephala, of which *Echinorhynchus* is the representative, are not to be separated from the Nematodes.

New Nematode from a Galago.†—Prof. P. J. Van Beneden gives a description of a new Nematode, which he calls *Strongylus otolicni*, found in the cæcum of *Otolicnus peali*. It is about 15 mm. long, and 0·75 mm. thick; males and females were found in about equal numbers, and the latter do not appear to be viviparous.

Development of Strongylus strigosus and S. retortæformis.‡—Prof. A. Railliet has made some experiments on rabbits which prove that these two nematoids follow Leuckart's law, and develope without any intermediate host. The former is found in the stomach, the latter in the stomach also, but chiefly in the small intestine.

* Zool. Anzeig. xiii. (1890) pp. 210–2.
† Bull. Acad. Roy. de Belgique, lx. (1890) pp. 389–93 (1 pl.).
‡ Bull. Soc. Zool. France, xiv. (1889) pp. 375–7.

γ. Platyhelminthes.

Helminthological Studies.—Prof. M. Stossich describes the numerous species which make up the genus *Trichosoma** Rudolphi. Thirty-one forms with a smooth, unarmed penial cirrus are distinguished as Gymnothecæ from sixteen Echinothecæ in which the same structure bears spines or bristles, while one form (*Trichosoma crassicauda*, *Trichodes crassicauda* according to Linstow) has no copulatory organ at all. Twenty-three species insufficiently defined bring up the total to seventy-one. Of these, twenty-three were found in mammals, thirty-nine in birds, three in reptiles, and the same number in amphibians and in fishes.

In a seventh report on Tergestine helminthology,† Stossich notices over a score of parasitic worms, and figures *Scolex polymorphus*, *Heterakis spumosa* and *fusiformis*, *Echinorhynchus lesiniformis* and *rubicundus*, and four species of *Distomum*.

In a third communication,‡ he catalogues fifty-six parasites from a collection made by Dr. A. P. Ninni, and briefly describes *Distomum crassiusculum*, *Tænia emberizorum*, and *Heterakis compar*.

The Skin of Ectoparasitic Trematodes.§—Herr M. Braun concludes from observations on *Polystomum integerrimum*, *Nitzschia* (*Tristomum*) *elongata*, and *Epibdella hippoglossi*, that the outer layer on the body of ectoparasitic Trematodes is a modified epithelium, which in certain conditions of altered function, e. g. in forming the hooks of *Polystomum* or the lateral suctorial pits of *Nitzschia*, retains its original epithelial character.

Anatomy of Amphiptyches urna.‖—Prof. W. Baldwin Spencer gives an account of the structure of this parasite. It was first observed by Wagener in *Chimæra monstrosa*, and Prof. Spencer has found it in the southern representative of that fish—*Callorhynchus antarcticus*. When alive it is of a creamy white colour, and the sides of the body and one end are crenate; this end the author, in opposition to Wagener, believes to be the anterior, and not the posterior. The opposite end of the body is characterized by a rosette of folds, and is pierced in the centre by a small tubular space which leads into the body; this space soon turns dorsalwards and opens to the exterior by a slight proboscis-like structure; the proboscis is capable of protrusion or retraction. It is difficult to assign any function to this curious structure, or to homologize it with anything present in other Cestodes, or, in fact, in other Vermes.

The most prominent feature of the body-wall is the presence of very distinct and numerous spines, which are generally distributed over the body-surface. The spines are somewhat elongate and are each composed of concentric layers of a transparent material. The epidermis consists of long, thin, columnar cells which pass internally into a layer of apparently homogeneous material; some of the cells are glandular, and they possibly secrete a sticky material which enables the parasite to adhere to the walls of the alimentary canal of its host.

* Boll. Soc. Adriat. Sci. Nat., xii. (1890) pp. 3–38.
† T. c., pp. 39–47 (1 pl.). ‡ T. c., pp. 49–56.
§ Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 594–7.
‖ Trans. Roy. Soc. Victoria, i. (1890) pp. 138–51 (3 pls.).

The nervous system consists of a pair of strongly developed longitudinal cords, which extend on either side of the body from one end to the other. They give off branches on either side. No nerve-cells can with certainty be detected. The excretory organs consist of a network of tubes, the larger of which contain cilia. Each vessel is lined by a clearly outlined membrane-like layer which, in appearance, more resembles a fine cuticular structure than anything else. From one side a tuft of cilia projects into the lumen. In longitudinal section these cilia are seen to form a continuous line along one side of the vessels, and are apparently connected at their bases with cells, the nuclei of which can be detected. There are no structures to be found resembling the "flame-cells" of other Cestodes or of Trematodes, and another point of distinction is to be found in the position of the vessels which are for the most part placed in, and not superficial to the central core of connective tissue. After long search the author found, what Wagener failed to see, the external openings of the excretory system; they are on the ventral surface, one on either side of the body, and slightly in front of the external opening of the uterus. It is possible that there is more than a single pair of orifices.

Amphiptyches is hermaphrodite, and only one set of organs is present. It is doubtful whether it is self-fertilizing, as with the single exception of *Caryophyllæus*, it alone among Cestodes possesses a definite receptaculum seminis, a structure characteristic of not-self-fertilizing hermaphrodite animals. Wagener regarded this receptaculum as the testis. The real testes are a series of somewhat globular saclike structures which are scattered about irregularly in the posterior part of the body. Fine ducts, very difficult to distinguish, and probably only fully developed when the spermatozoa are actually in the act of transit to the exterior, pass from the testes into a common duct on each side, which again opens into a coiled tubular organ; this last is to be regarded as a vesicula seminalis. The tube into which it opens is probably eversible.

The coiled tubular uterus is the most prominent structure in the body. The ovary consists of a series of somewhat small grapelike ovaries, whence ducts pass into a central somewhat saccular organ filled with ova, which appears to hold the same relationship to the ovaries as the vesicula seminalis does to the testes. Each little ovary, when the ova are not fully formed, has the structure of a multinuclear mass of protoplasm which only subsequently becomes divided into a number of distinct cells. The yolk-glands consist of innumerable dark brown small spherical masses; they are distributed plentifully along the sides of the body. There do not appear to be any definite shell-glands.

Larvæ of Bothriocephalus in the Salmon.*—Dr. F. Zschokke describes five larval forms of *Bothriocephalus* sp. from the salmon of the Rhine. These seemed referable to several different species, but not in any case to *B. latus*. Two infection experiments with two different larval forms yielded no result. The larvæ are by no means frequent in Rhine salmon, for only three fishes out of ninety-three examined con-

* Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 393–6, 435–9 (5 figs.).

tained the parasites in question, while among seventeen salmon from the Baltic, four were infected. As to *B. latus* the author has found its larvæ in *Trutta lacustris*, perch, and pike.

δ. Incertæ Sedis.

Indian Rotifers.*—Mr. H. H. Anderson gives a first account of the species of Rotifers he has been able to find in the Calcutta tanks, and enumerates forty-seven, several of which are new. He looks, however, on this list as a mere instalment, for the weedy tanks teem with Rotifers. *Floscularia unilobata*, *Œchistes* [*sic*] *stephanion*, which differs from most of its congeners in having a very small corona, *Rotifer mento*, which seems to inhabit a tube, *Actinurus ovatus*, which does not possess all the generic characters ascribed to *Actinurus* by Dr. Hudson and Mr. Gosse, *Stephanops dichthaspis*, *Metopidia torquata*, *M. angulata*, *Pterodina intermedia*, *Brachionus longipes* and *B. bidentata* are the new species. Of the last but one, we are told that the foot is of extraordinary length, for in a dead specimen in which the lorica measured 1/100″, the foot, which was wrinkled, measured 1/75″ ; in living specimens the foot is often extended so as to be three times as long as the lorica.

Three new Rotifers.†—Mr. A. Pell states that, during the past winter, he found seventy species of Rotifers, sixty-four of which he was able to identify with forms described by Dr. Hudson and Mr. Gosse; three he was uncertain about, and three appear to be undescribed. *Mastigocerca bicuspes* is easily distinguished by the two spines on the back, one on each side of the median line of the body; it resembles *M. carinata*, but the ridge continues almost to the foot. The body is 1/200″ long, and the height of the body and ridge 1/300″. *Cathypna Stokesii* is easily distinguished by the two flattened points which terminate the lorica; it is not so broadly ovate as *C. luna*, and it has spines which are a continuation of the dorsal plate. It is 1/144″ long. *Copeus americanus* has a general resemblance to *C. labiatus*, but is distinguished from it by the absence of the large lip; it is more slender than that species, and it is 1/50″ in length.

Echinodermata.

British Deep-sea Echinoderms.‡—Prof. F. Jeffrey Bell has a note on some Echinoderms collected in deep water off the S.W. coast of Ireland, supplementary to his report already published.§ The most noticeable fact in this collection is the extension of the depths at which some of the more common shallow-water species—such as *Asterias rubens*, *A. glacialis*, *Stichaster roseus*, and *Spatangus purpureus*—were found.

Cœlenterata.

Actinida of North Sea.‖—The latest of the beautifully illustrated reports on the Zoology of the Norwegian North Sea Expedition is one

* Journ. Asiat. Soc. Bengal, lviii. (1889) pp. 345–58 (3 pls.).
† Microscope, x. (1890) pp. 143–5 (3 figs.).
‡ Journ. Marine Biol. Assoc., i. (1890) pp. 324–6.
§ *Ante*, p. 44.
‖ 'Den Norske Nordhavs Expedition,' 1876–8, xix. (Zoologi) 1890, 184 pp., 25 pls., 1 map.

by Dr. D. C. Danielssen, on the Actinida. All those which were collected came from deep water, and mostly from the cold area. As the author was a member of the expedition, he was able to keep these animals alive and sketch them with tentacles expanded and in characteristic attitudes. While following the classification proposed by R. Hertwig, which is chiefly based on anatomical characters, Dr. Danielssen has also made use of external points.

The forms described are thus arranged:—

Tribe Hexactiniæ, Fam. Amphianthidæ; *Korenia margaritacea* g. et sp. n.: Fam. Paractidæ; *Kadosactis rosea* g. et sp. n., *Kyathactis hyalina* g. et sp. n.: Fam. Sideractidæ; *Sideractis glacialis* g. et sp. n.: Fam. Sagartidæ; *Stelidiactis Mopseæ* g. et sp. n., *S. tubulariæ* sp. n., *Allantactis parasitica* g. et sp. n., *Anthosactis Jan Mayeni* g. et sp. n., *Sagartia repens* sp. n., *S. abyssicola* K. & D., *S. splendens* sp. n., *Calliactis Krøyeri* sp. n.: Fam. Bunodidæ; *Bunodes abyssorum* sp. n., *Actinauge nodosa* Fabr.: Fam. Tealidæ; *Tealiopsis polaris* and *Kylindrosactis elegans* gg. et spp. nn.: Fam. Madonactidæ; *Madonactis lofotensis* g. et sp. n.: Fam. Phelliidæ; *Phellia flexibilis*, *Ph. margaritacea*, *Ph. arctica*, *Ph. crassa*, *Ph. bathybia*, *Ph. norvegia*, *Ph. violacea*, *Ph. spitsbergensis* spp. nn., *Kodioides pedunculata* and *Cactosoma abyssorum* gg. et spp. nn.: Fam. Andvakiidæ; *Andvakia mirabilis* g. et. sp. n.: Fam. Halcampidæ; *Halcampoides abyssorum* g. et sp. n.

Tribe Edwardsiæ, Fam. Edwardsidæ; *Edwarsioides vitrea* g. et sp. n., *Edwardsia Andresi* sp. n.

Tribe Zoantheæ; Fam. Mardoellidæ; *Mardoel Erdmanni* g. et sp. n.: Fam. Zoanthidæ; *Epizoanthns arborescens*, *E. glacialis*, *E. roseus* spp. nn.

Tribe Cerianthеæ; Fam. Cerianthidæ; *Cerianthus Vogti* sp. n.

Tribe Ægireæ; Fam. Ægiridæ; *Fenja mirabilis*, *Ægir frigidus* gg. et spp. nn.

This enumeration will give some idea of the wealth of new forms collected and described by Dr. Danielssen; of the last two "new genera" we gave some account when the preliminary notice regarding them was published.* The importance, however, of this possession of a cœlom is so great that we will transcribe the remarks which the author finally makes on this question:—

"If we make the cœlom the decisive feature, it is then evident that my two species must be removed from the ranks of the Cœlenterata, but where they should then be placed I can really not indicate. It may, however, be the case that too much stress has been laid on the so-called gastrovascular apparatus as a systematic feature in naming the whole of the animal group that Cuvier called Zoophytes, Cœlenterata. What is called gullet-tube in Actinida is possibly a rudimentary intestinal formation, and those at the sides of the adjoining chambers may perhaps be considered as a beginning formation of the cœlom. This is still more distinct in the Ctenophora, where the gullet-tube has not only the form of an intestine, but also the function of a real digestive canal, even though anus is wanting, and is placed in direct communication with the gastrovascular cavity. In any case there is, here, in reality, no great step to a complete separation between the intestine and the body-cavity. Probably, even in the group of the Actinida, it may be

* This Journal, 1889, p. 230.

possible to show a different development of gullet-tube, and, in connection with it, a more or less complete separation of the so-called gastrovascular cavity; thus leading the relation in the genera *Ægir* and *Fenja* to be regarded as the final stage of a process that has already begun in other Actinida. But certain knowledge in respect of those relations will scarcely be obtained except by investigations of embryons, as then it will be seen whether they develope themselves as genuine Cœlenterata, or whether they possibly show themselves to belong to either Pseudocœlia or Enterocœlia. In the meantime I am satisfied with their assignment to the great division Actinida, but have, however, found it necessary to form a new race (tribus) for them."

The family Sideractidæ contains Actiniaria with numerous perfect septa; there are a few series of short non-retractile tentacles, the innermost of which contains eight mesodermal circular muscles; *Sideractis* in some respects approaches Gosse's genus *Bolocera*. *Atlantactis* has been placed with the Sagartiidæ, though it does not possess acontia, which R. Hertwig, though not Andres and others, regards as distinctive of the family; the same is true of *Anthosactis*.

The Madionactidæ are defined as Hexactiniæ with few principal septa, acontia, and a prominent endodermal circular muscular system. *Kodioides* has a pyriform body, with a long bare stem which terminates in a pedal disc; suckers are developed on the encrusted portion of the body. *Cactosoma* has a claviform body with an encrusted covering, the uppermost part being bare; the surface of the body is furnished with suckers. The Andvakiidæ are Hexactiniæ, elongated, set loose in the sand, without any real pedal disc, and the greater part of the body encrusted; the uppermost bare part of the body, the oral disc, and the tentacles are completely retractile; the septa are few. *Andvakia* is, in many points, a transitional form; in its internal structure it has several points in common with the Sagartiidæ and Phelliidæ, while in the external it differs considerably; in these last it seems to approach *Edwardsia*, its body being divisible into three parts.

The Mardoellidæ are Zoanthidæ which form colonies which, by means of a common rounded basal part, live freely in or upon the sand. *Mardoel* is allied to, and is perhaps identical with, a generic type characterized recently by Dr. Erdmann, but not named by him.

Special notice must be taken of the beautiful plates which adorn as well as illustrate this important memoir.

The Position of Sympodium coralloides.*—Prof. G. v. Koch describes *Sympodium coralloides* Pallas as a genuine Alcyonid, which by adaptation to a special substratum (Gorgonid axes) has acquired an apparent approximation to the Cornulariidæ. As an accurate comparison shows, it is really in close agreement and alliance with *Alcyonium palmatum* Pallas, and the author proposes to rename it *Alcyonium coralloides*.

Marginal Sense-organs in Pelagiidæ.†—Mr. R. P. Bigelow has a preliminary notice on this subject. He finds in the adult *Pelagia cyanella* a well-marked dorsal sensory groove, but no trace of the paired

* Zool. Jahrb., v. (1890) pp. 76-92 (10 figs.).
† John Hopkins Univ. Circ., ix. (1890) pp. 65-7.

folds of ectoderm in the sensory notch, while in the *Pelagia*-stage of the *Chrysaora* the rudiments of the folds have appeared, and in this species and *Dactylometra quinquecaria* the dorsal groove does not appear until the second set of tentacles begins to form. The *Chrysaora*-stage in the *Dactylometra* has the paired folds more developed than in the beginning of the adult stage in the *Chrysaora*, and different from what they are in the fully-formed adult of that species. Of the adult sense-organs in the three species, those of *Dactylometra* are the most highly developed. It appears, then, that in *Pelagia*, *Chrysaora*, and *Dactylometra*, there is, with increased complexity of general characters, an increase, both phylogenetically and ontogenetically, in complexity of the sense-organs; but the steps in the ontogeny of these organs are not strictly identical with the condition at the corresponding points in the phylogeny of the species.

Portuguese Man-of-War.*—Mr. R. P. Bigelow has had the opportunity of making some observations on the physiology of *Caravella maxima* Haeckel—the Portuguese Man-of-war. This Medusa feeds almost entirely on small fish, which are caught by running against its tentacles. The tentacle is immediately firmly attached to the fish, probably by the nettle-cells, and it is very soon temporarily paralysed by the poison from them. Before, however, the fish succumbs it manages to give a pretty vigorous pull on the tentacle. This acts as a stimulus to cause the tentacle to contract, the impulse apparently coming from the base. If the fish offers no resistance the tentacle does not contract. By the contraction of the tentacles the fish is brought into contact with the mouths of some of the siphons, the feeding members. These mouths are spread out over the fish until they completely envelope it. It is there finally killed and digested. The products of digestion with indigested fragments are taken into the stomachs of the siphons until they are gorged; digestion is completed in the stomachs, and the nutrient fluid is conveyed by the hollow pedicels to the rest of the corm. A siphon will attach itself with equal alacrity to a piece of fish or to a small stone, but does not remain attached to the latter very long.

The beating of wind or rain against the float causes its muscles to contract, so as to erect the crest, which normally lies flat on the water. It seems to require a good deal of effort to keep the crest erect.

The secretions observed were a mucous secretion on the surface, a gluey substance at the mouth, a digestive fluid, a poison in the nettle-cells, and, probably, the gas in the float.

The nervous system seems to be very poorly developed. There is some indication of a motor centre at the base of each tentacle, and impulses may be transmitted from one part to another. No correlation of movement was seen. There are no traces of any sense of sight, hearing, or smell; and it is doubtful whether there are any special senses.

Tetraplatia volitans.†—In the fourth of his memoirs on the lower animals of the Bay of Algiers, Dr. C. Viguier treats of this rare and interesting Cœlenterate. So far as is known it is pelagic, but it is

* John Hopkins Univ. Circ., ix. (1890) pp. 61-2.

† Arch. de Zool. Expér. et Gén., viii. (1890) pp. 101-42 (3 pls.).

possible that the pelagic and free state are but phases in the course of its existence. Its form is best understood by speaking of it as a regular octohedron, formed of two elongated pyramids with square base, and all the angles rounded. When alive, however, the creature is so contractile in every direction that it presents the most varied forms.

The supporting lamella which separates the endoderm from the ectoderm has been pretty satisfactorily described by Claus; the author gives his own account of the parts of which it is composed. For the greater part of the body the ectoderm consists of a single layer of thick cells with very short cilia; they have no muscular processes connected with them, and it is to their own contractility that we must ascribe the contractility of the body. Among the large ectodermal cells are the glandular cells and the cnidoblasts. The former are easily divisible into two parts—the true cell with its nucleus, and the gland, which is quite peripheral and has a very small excretory orifice. Claus did not distinguish the glandular cells from the vibratile cells which cover them. Some of the cnidoblasts are small and almost spherical; others, two and a half or three times as large, are still more spherical than oval. The former are found all over the surface of the body, while the larger are limited to a few placed on the median lines of the surfaces of the aboral pyramid, and are found in large number on the longitudinal ridges. After a lengthened description on the action of stinging cells, the author passes to an account of the sense-organs, on which various authors have expressed their opinions, but the mode of action of these bodies still remains a matter for conjecture.

While venturing to criticize some of Claus' expressions, the author can only "imitate his wise reserve as to the definite position which *Tetraplatia* ought to occupy in our classifications."

Histology of Hydra.*—Herr K. C. Schneider has investigated the histology of *Hydra fusca* with special reference to the nervous system of Hydropolyps. In the ectoderm we may distinguish epithelial and subepithelial cells according to their position; the epithelio-muscular and stinging cells are epithelial; the former are divided into investing and secreting cells, while the latter are only a modification of the former. The investing cells possess a cuticle, the peculiar property of which is indicated by the fact that the very delicate alternate with thicker areas; stinging cells are deposited in them, and they multiply by indirect division. The secreting cells give off granules which are arranged in parallel cords on the protoplasm; they contain no stinging cells, and their mode of multiplication has not been observed. All the muscle-cells give off basally long contractile fibres which are invested by protoplasm for their whole length; the direction of the fibres is longitudinal, but they seem to be somewhat sunk into the supporting lamella, into which they send processes. The stinging cells only reach the surface by means of the cnidocils which traverse the cuticle of the covering cells. Centrally they contain a stinging capsule, around which in most (and perhaps all) cases there is a muscular layer; this often, especially in the tentacles, passes into a muscular tubular stalk, within

* Arch. f. Mikr. Anat., xxxv. (1890) pp. 321-79.

which are the nucleus and protoplasm. The stalk is connected with the supporting lamella.

The subepithelial tissue consists of ganglionic, sexual, and indifferent cells, the last of which give rise to the others and to the stinging cells. The ganglionic cells have a small nucleus, but no nucleolus, a small quantity only of protoplasm and long branching processes, which become varicose on treatment with acetic acid. These processes become connected with one another, with the epithelio-muscular cells, and probably also with the stinging cells. The spermatozoa have a cylindrical head, a transversely flattened middle piece, and a long, thin flagellum. The indifferent cells are rounded, cubical, or somewhat cylindrical, and have a nucleus of medium size, together with a nucleolus.

The stinging cells are derived from the indifferent by the central secretion of an alkaline product which is first surrounded by the inner wall, and by the outer only when the formation of the filament ceases. The filament is probably formed by the surrounding protoplasm growing into the secretion-cavity. The ganglionic cells are formed from the indifferent by the using up of the central part of the cell at the expense of the peripheral, which takes on a semilunar form and grows out into processes. The spermatozoa are formed by repeated indirect division of the indifferent cells.

The endoderm is likewise formed of epithelial and sub-epithelial cells. The former are epithelio-muscular, or nutrient, glandular, and sensory cells; in some of the first there are stinging-capsules. The epithelio-muscular cells have two (rarely three or one) flagella. They excrete basally a contractile fibre, which takes a circular course, and is less well developed than in the ectoderm. The processes into the supporting lamella are also more delicate. In the interior there are nutrient bodies, and brownish or reddish pigment; they multiply by indirect division. The glandular cells have two or three flagella; are shortly oval, and are rarely provided with a prolongation at their basal end; they have in their interior a highly refractive secretion which fills the protoplasm in the form of rounded balls. The sensory cells are filamentar, but somewhat thickened peripherally; they have an elongated nucleus and a short hair on the surface; at their base they break up into varicose processes; they would appear to be derived from epithelio-muscular cells. The stinging capsules appear to have no nucleus, and we cannot, therefore, suppose that they are directly derived from the nutrient cells. The ganglionic cells agree exactly with those in the ectoderm. They are derived from the sensory cells, as intermediate stages between them may be observed. The indifferent cells are like those of the ectoderm, but are much rarer.

The supporting lamella is a homogeneous intermediate layer between the ectoderm and endoderm, but is much more closely connected with the former.

In an appendix Herr Schneider deals with some of the histological elements of *Eudendrium ramosum* and *Tubularia larynx*. Their ganglionic cells correspond in form and position almost exactly with those of *Hydra fusca*, but the number of processes is smaller and the processes themselves are finer; the nucleus has a nucleolus; the processes of the cells were not observed to be connected with one another or with epithelial cells. The

stinging cells have a muscular investment, to which is attached a pretty long, thin, solid stalk which passes to the supporting lamella.

Heliotropism in Hydroids.*—Dr. H. Driesch has observed heliotropic phenomena in the growth of *Sertularella polyzonias*. The stolons produced in unfavourable conditions instead of persons, are at first positively, and after the production of daughter-stolons, negatively heliotropic. They arise on the side of the mother-stolon turned towards the light.

Porifera.

Pseudogastrula Stage in Development of Calcareous Sponges.†—Mr. A. Dendy has had an opportunity of studying the development of *Grantia labyrinthica;* while within the maternal tissues the embryo lies in a cavity; as the embryo increases in size the capsule in which it lies becomes correspondingly enlarged; the side of the capsule next to the adjoining layer of spicules becomes flattened, while the opposite side bulges out into the flagellated chamber and forms a kind of blister over which the delicate wall of the chamber becomes tightly stretched. The embryo obviously receives nutriment from the mother sponge, probably through the medium of the endothelial cells. The granular cells of the embryo absorb nutriment from the maternal tissues, increase in size, proliferate rapidly, become invaginated mechanically, and when they have done absorbing nutriment become arranged in a hemispherical mass of large ovoid cells, highly charged with food-granules and an investing epithelial layer. The embryo is now ready to lead an independent existence, and the internal mass of granular cells seems to be a supply of food which enables it to wander for a long distance before becoming fixed. By degrees this food is absorbed and used up, and then the invagination of the ciliated cells takes place and the embryo becomes attached. It is for this reason that in the gastrula stage the internal granular mass of cells is no longer visible. This mass does not seem to have anything to do with the formation of mesoderm.

Anatomy of Hircinia, a new Genus of Sponges.‡—M. H. Fol brings forward some evidence to show that those authors have been in error who have regarded the fibrils of *Hircinia* as the work of an unknown parasite; these fibrils are, on the contrary, an integral part of the sponge. The family Filiferæ ought, therefore, to be re-established, as it is the most certain and best characterized of all the proposed divisions of Horny Sponges.

The name of *Sarcomus Georgi* is given to a large blackish sponge which is found in abundance near Nice, and is about the size of a man's head. A short description is given of it from which it appears that it is intermediate between *Spongelia* and *Aplysina*, which it resembles by the characters of its skeleton, and *Hircinia* and *Euspongia*, which it approaches in the disposition of its canalicular system.

Key to the Nomenclature of Sponge Spicules.§—Dr. R. von Lendenfeld calls attention to a "nomenclator spiculorum" prepared by Prof.

* Zool. Jahrb., v. (1890) pp. 147–56 (3 figs.).
† Proc. Roy. Soc. Victoria, 1890, pp. 93–101 (1 pl.).
‡ Comptes Rendus, cx. (1890) pp. 1209–11.
§ Biol. Centralbl., x. (1890) pp. 131–5.

F. E. Schulze and himself; it is, of course, impossible to abstract the contents of such a key, which, in the present state of confusion, cannot but be of value.

Protozoa.

Notes on Infusoria.*—Herr R. v. Erlanger gives accounts of a few Infusoria. *Actinobolus radians* Stein is the first dealt with; when swimming it has a pyriform shape, the thicker end being the hinder; this is contrary to Entz's statement. When at rest the form is often spherical; as the change in form is effected very slowly, the author supposes that there is no myoneme present; this again is contrary to Entz's view. The characteristic tentacles are arranged by twelves in the ciliated grooves, where they are separated from one another by regular distances. In swimming, the tentacles are retracted, while when the animal is quite still they are longer than the axis of the spherical body. When a tentacle is highly magnified three parts may be made out in it. The proximal part is thick, and conical in form, the next part is longer and half as thick, and both are transparent; the distal third is shorter, highly refractive and thinner; at its end is a capitulum which is much smaller than the terminal knob of the tentacles of the Acineta. There is a terminal trichocyst which completely distinguishes the tentacle of *Actinobolus* from that of the Suctoria. Since the discovery of this organism by Stein no other observer than Entz has given an account of it. Herr Erlanger gives a full account of it. *Chlamydodon mnemosyne* Stein, which the author found at Deauville, is next carefully described; it, again, has been noticed by but few observers. *Phascolodon vorticella* Stein is little known; it has a very peculiar form, the anterior end being broad and rounded, and forming an obtuse angle on the left side; posteriorly the animal becomes gradually smaller and ends in a blunt caudal tip; on the right and left of the ventral surface there is a longitudinally directed elevation; the median part is also convex, though not so high as the ridges. There are twelve longitudinal rows of cilia, the arrangement of which is fully described, as are other parts of the creature. *Hastatella radians* g. et sp. n. is a free-swimming Vorticellid, characterized by two parallel circlets of spines; these spines are simple outgrowths of the protoplasm of the body which are pretty thick at their base, and taper gradually. After describing its organization, the author compares the characters of this new genus with those of some other Vorticellids; in some points it resembles *Gerda* and *Astylozoon*, in others *Epistylis umbellaria* and *Vorticella microstoma*, and in others, possibly, *Cyclochæta*.

Structure of Distephanus (Dictyocha) speculum.†—Herr A. Borgert comes to the conclusion that the Dictyochidæ are independent organisms, and that, consequently, their tests are not—as R. Hertwig and Haeckel suppose—the isolated skeletal parts of Phœodaria. Haeckel's Dictyochidæ are primitively a skeletal species of Phœodaria. The Dictyochidæ must be separated from the Radiolaria, and be placed with the Mastigophora.

The protoplasmic body of *Distephanus speculum* consists of a small rounded soft structure which fills the cavity of the siliceous test, but

* Zeitschr. f. Wiss. Zool., xlix. (1890) pp. 649-62 (1 pl.).
† Zool. Anzeig., xiii. (1890) pp. 227-31.

does not send out fine pseudopodia; in the place of these there is a long delicate, hyaline flagellum, by means of which the organism is capable of effecting lively swimming movements. The brownish-yellow colour by which living examples of *D. speculum* are distinguished, is due to numerous small rounded bodies which fill the protoplasm of the body; after the death of the organism these become of a greenish hue, in consequence of chemical decomposition; but it could not be satisfactorily determined whether one has to do with small symbiotic algar cells or with endogenous chromatophores. The nucleus, which lies in the middle of the body, is ellipsoidal and vesicular, and is surrounded by a delicate membrane; it consists of a vacuolated cortical layer and a central chromatin-body, and has, consequently, a certain resemblance to the central capsule of a very small Radiolarian.

The Dictyochidæ are, however, sharply separated off from the Radiolaria by the complete absence of pseudopodia, and by the possession of a flagellum. The appearance, also, of double individuals is a point of importance, as conjugation has never yet been observed in the Radiolaria, while it is very common among the Flagellata. The possession of a siliceous skeleton is an important point of distinction, and it is necessary to make a special order of the Mastigophora for the Dictyochidæ; this may be appropriately called the Silicoflagellata.

Colouring-Matter of the Peridinieæ.*—Dr. F. Schütt finds in the chromatophores of the Peridinieæ three distinct pigments, viz.:—

(1) *Phycopyrrin*; obtained as a dark reddish-brown fluid by crushing the Peridinieæ in a very small quantity of distilled water. The spectrum is nearly related to that of chlorophyll; it exhibits the strong absorption-band I, as well as, with a certain concentration, the band II; the end-absorption begins in the green. Phycopyrrin is readily soluble in alcohol, ether, carbon bisulphide, and benzol; the solution in the last three solvents is yellow, but has essentially the same spectrum as the aqueous solution. Its chief distinction from chlorophyll is in its solubility in water; its chemical properties seem to indicate that it is a connecting link between this substance and the phycoerythrin of the Florideæ; it is quite distinct from the diatomin of diatoms. In addition to this α-phycopyrrin, the author describes a β-phycopyrrin, differing from it in unimportant particulars, and probably a derivative from it.

(2) *Peridinin;* obtained by digesting for a short time in alcohol the Peridinieæ which have already been extracted with water; a wine-red solution is thus obtained, presenting a very different spectrum from that of chlorophyll; the band I is but faintly indicated, while a moderately sharp band appears between λ 64 and 63. Peridinin is readily soluble in alcohol, ether, chloroform, benzol, carbon bisulphide, and glacial acetic acid; it appears to represent in the Peridinieæ the xanthophyllin of flowering plants.

(3) A substance was further obtained identical with, or very nearly related to, the chlorophyll of plants.

Foraminifera of Faroe Channel.†—Mr. F. G. Pearcey gives a revised list of the Foraminifera found in the Faroe Channel. He dis-

* Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 9–32 (2 pls.).

† Proc. and Trans. Nat. Hist. Soc. Glasgow, ii. (1890) pp. 163–79 (1 pl.).

tinguishes these from the "warm-area" from those from the "cold-area," and gives a note of the quantity of each species that is found. In all, 228 species and varieties are recognized, 180 of which are found in the warm and 120 in the cold area. A description is appended of *Hyperammina palmiformis* sp. n., which is most interesting on account of its arborescent distal extremity.

Foraminifera of Older Tertiary of Australia.*—Mr. W. Howchin reports that the Muddy Creek beds contain one of the richest local faunæ known, either recent or fossil; no one locality in the British area of the rich Suffolk Crag has yielded more than 62 species, while the lower bed at Muddy Creek has yielded 163, and the Upper Bed 76 species. There is a close resemblance in the number of species noted by Mr. Brady from the remarkably rich dredging made by the 'Challenger' in Torres Straits and that of Muddy Creek, while many of the rarer forms are common to both.

* Trans. Proc. and Rep. Roy. Soc. South Australia, xii. (1889) pp. 1–20 (1 pl.).

BOTANY.

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

a. Anatomy.

(1) Cell-structure and Protoplasm.

Structure of Living Protoplasm and Cell-membrane.*—Herr V. Fayod asserts that all living protoplasm is composed of delicate usually spirally twisted hollow threads, or "spirofibrillæ," composed of a hyaline unstainable somewhat toughly gelatinous substance, which easily swells up, generally coiled together in such a way that they themselves form the walls of spirally-twisted hollow cylinders, the "spirosparts." The cavities of both threads and cylinders are normally filled up by the so-called granular protoplasm, in which the streamings of protoplasm take place. The spirofibrillæ and spirosparts are the true morphological and physiological units, not limited to one cell, but passing from one to another, and traversing the whole plant.

These bodies are invisible in ordinary fluids, such as water, glycerin, Canada balsam in turpentine, oils, &c., in consequence of the great capacity for swelling of their walls; but their cavities can be injected with mercury under a pressure of two atmospheres; they may then be examined in longitudinal section in a 0·75–5·0 per cent. solution of sodium chloride, or in a mixture of equal parts of water and a saturated alcoholic solution of lead acetate.

Nature of Reserve-cellulose and its absorption in germination.†—Herr R. Reiss has investigated the nature of the so-called "reserve-cellulose" in the endosperm and other parts of the seed of a number of plants, and its mode of absorption on germination, and finds that it differs in most cases from true cellulose in its optical properties. The hydrolytic decomposition of ordinary cellulose gives a dextrose belonging to the group of grape-sugars, which reduces Fehling's solution, and to which the author gives the name *seminose*. The reserve-cellulose, on the other hand, consists of a substance which, on hydrolytic decomposition, yields a sinistrose carbohydrate, which is possibly a compound, and which the author calls *seminin*; it cannot, therefore, be identical with ordinary cellulose. The thickening layers, which are composed of this substance, are completely absorbed during the germination of the seed in six different ways, which are described in detail.

Non-nitrogenous Reserve-substances in the Seeds of Leguminosæ.‡—Referring to the observations of Nadelmann,§ but conducting his researches in a macroscopic instead of a microscopic method, Herr E. Schulze confirms his statement that one constituent of the thickenings of the walls of the cells of the cotyledons in *Lupinus* acts as a reserve-material; but this substance is, he states, not cellulose, but paragalactan.

* Naturwiss. Rundschau, v. (1890) pp. 81–4. See Bot. Centralbl., xli. (1890) p. 359.
† Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 322–9.
‡ T. c., pp. 355–9. § Cf. this Journal, 1889, p. 773.

In the seeds of the same plant were found also two other non-nitrogenous reserve-substances, viz. β-galactan and a fatty oil.

Cellulose-formation and Growth of Protoplasm without a Nucleus.*—In opposition to the statement of Klebs,† Herr E. Palla finds that the formation of cellulose and growth in length are not necessarily associated with the presence of a nucleus. Pollen-tubes, as those of *Leucojum vernum*, *Galanthus nivalis*, and other plants, the apices of which with their nuclei have been destroyed, still form a cap of cellulose round the protoplasm, or the protoplast breaks up into separate portions, each of which surrounds itself with a cell-wall. Protoplasm which has exuded may even sometimes clothe itself with a cell-wall and develope into a pollen-tube. Similar observations were made on leaves of *Elodea* and on root-hairs.

Intercellular Substance.‡—M. L. Mangin endeavours to show that in Phanerogams and Cryptogams (Fungi and many Algæ excepted) the tissues with soft elements are built up of cells united together by means of a cement formed of pectic acid in the state of insoluble pectates. The author calls this cement the intercellular substance, and its chemical nature may be shown in the following manner. Fragments of various organs (roots, leaves, flowers, &c.) must be allowed to macerate for twenty-four hours in alcohol, to which a fourth or fifth part of its bulk of hydrochloric acid has been added. The tissues are then washed and placed in an alkaline solution, and shortly, when the fragments of tissues have had time to become impregnated with the solvent, a slight agitation will dissociate them. If the liquid be now filtered and acid added, a gelatinous mass will be obtained which shows the characters of pectic acid. In order to examine tissues microscopically, thin sections of adult organs must be taken and coloured with phenosafranin or methylene-blue, after having been acted on by alcohol and hydrochloric acid. The insoluble pectic acid is coloured more strongly than the pectic compounds associated with the cellulose in the thickness of the membrane.

The author concludes by stating that intercellular substance formed of insoluble pectates is separated at an early period in merismatic tissues; its partial transformation into soluble pectates allows of lamellation of the cell-wall, and the formation of passages in adult tissues; by a sort of exudation, it forms bodies which strengthen the surface of union of the cells, and increase the solidity of the tissues.

Action of Oxidized Solution of Green Vitriol on living Cells.§—Herr T. Bokorny finds that a very dilute solution of iron sulphate (1 : 5000 to 1 : 10,000), when oxidized in the air, does not kill the protoplasm of *Spirogyra*. While turgor, the chlorophyll-band, and the nucleus remain unchanged, an excretion of granules (active albumin) takes place in the parietal protoplasm. From these facts he argues in favour of his previous conclusion as to the presence of hydrogen peroxide in the living cell.

* Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 330–1.
† Cf. this Journal, 1888, p. 758. ‡ Comptes Rendus, cx. (1890) pp. 295–7.
§ Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 274–6.

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

Chlorophyll in the Embryo.*—Mr. C. B. Atwell states that chlorophyll occurs in the embryo of *Tilia americana* and *Ipomœa purpurea*. In the latter species the chlorophyll appears as soon as the first traces of the cotyledons can be recognized in the cross-sections of the seed. It is abundant in the pod while the seeds are developing.

Colouring Matter of the Buds of the Horse-chestnut.†—Prof. L. Macchiati finds this to be an uncrystallizable substance resembling the phycoerythrin of Kützing and Cohn, but differing from that substance in being unaffected by light. It is soluble in water, but insoluble in alcohol, benzin, chloroform, ether, and other solvents. When dissolved out by boiling water and evaporated, it has a dark cherry-red colour.

Colouring Matters in the Integument of Seeds.‡—M. L. Claudel states that the researches of M. Poisson have established that the seat of the colouring matter in the integument of the seed is very variable. It is nearly always a protecting layer in the integument, the walls of which become thickened, and often coloured. The author now describes the following variations:—

In Cruciferæ it is the third layer which becomes the protecting layer, while it is the fourth in *Cistus*, and the fifth in *Tilia*. In *Phlox Drummondii*, *Gentiana germanica*, and *Scabiosa arvensis*, it is the superficial tissue that becomes coloured. Finally, it may be said that spermodermic colouring matters are formed only in living cells. There are a certain number of seeds in which the localization of colouring matter does not take place in the protecting layer (e. g. *Acanthus mollis*).

Colouring Matter of Grapes.§—M. E. Laurent finds in fruits two distinct layers of colouring substances, one of which depends absolutely on light for its production, while the other does not. The composition of the red colouring matter of grapes corresponds nearly to the formula C_2H_2O. It may be derived from glucoses by a process of dehydratization which takes place in the fruit during the last period of its ripening.

Calcium-salts and Silica.‖—In a very important and exhaustive work, Dr. F. G. Kohl treats of the mode of occurrence of these substances in vegetable cells and tissues, and of their physiological significance.

Calcium oxalate occurs in five different forms—as monoclinic and quadratic crystals, as concretions (Drüsen), as sphærites, as raphides, and as crystalline sand. By a long series of experiments he arrived at conclusions (which our space prevents us from going into) of the conditions under which these various forms are assumed. The lime may, under certain conditions, become again separated from the oxalic acid and act as a carrier of carbohydrates; while the excreted calcium oxalate plays a not unimportant part in the mechanical strengthening of the tissues.

* Bot. Gazette, xv. (1890) p. 46.

† Nuov. Giorn. Bot. Ital., xxii. (1890) pp. 76-8.

‡ Comptes Rendus, cx. (1890) pp. 298-300. Cf. this Journal, *ante*, p. 196.

§ CR. Soc. R. Bot. Belg., xxix. (1890) pp. 71-6.

‖ 'Anat.-phys. Unters. d. Kalksalze u. Kieselsäure in d. Pflanze,' Marburg, 1889, xii. and 314 pp. and 8 pls. See Bot. Centralbl., xli. (1890) p. 69.

Cystoliths the author regards as reserve-structures for calcium carbonate, which may again serve for the transport of carbohydrates. Silica he finds, in opposition to earlier observations, to be excreted in young parts of plants in process of formation, as well as in the mature organs.

A detailed description is given of the structures known as "cover-cells" (Deckzellen) or "stegmata," which occur in the interior of the tissue in certain groups of plants, viz. in the Palmæ, the Scitamineæ (except Zingiberaceæ), and some families of Orchideæ; in the Pandanaceæ they are replaced by crystals of calcium oxalate. They are cells which contain within them a free mass of silica of varying form, and are always more or less in connection with the intercellular system. The author believes that they play an important part in promoting a current of air through the tissues, and also serve as temporary reservoirs for water. The main function of silica in plants is, however, one of mechanical strengthening.

(3) Structure of Tissues.

Morphology and Anatomy of the Axis.*—M. P. A. Dangeard adopts Gaudichaud's terminology of "phyton" for the leaf, which constitutes a distinct individual, and consists of two parts—a cauline portion or rachis and an appendicular portion. The root is an ordinary axis which has undergone metamorphosis by the loss of its leaves, and the centripetal development of its protoxylem, which shows a close analogy with the central cylinder of Vascular Cryptogams. These phenomena are then studied in detail in two special genera.

In *Pinguicula* there is, in all the species examined, a strongly differentiated endoderm in the stem; it frequently displays thickenings on its lateral wall, and sometimes punctations on its other walls; the cells of this layer often contain a violet sap. Where the foliar vascular bundle enters the stem it divides into two halves, each of which becomes a sympode, right and left; these sympodes form a network, the size and form of the meshes of which vary according to the phyllotaxis. These sympodes may vary in two different ways. In the root of *P. vulgaris* the woody bundles may join in the centre or on the sides, and form a closed woody cylinder.

In *Acanthophyllum* a woody genus of Caryophyllaceæ, in which the leaves are more or less transformed into spines, the wood displays a great complexity of structure, recalling that of certain species of *Bauhinia*. In one section the leaf shows all transitions from the spiny to the ordinary form, in the diminution of the stereome, the reduction of the median bundle, the disappearance of the dorsal and increase in number of the lateral bundles, and the development of wings and of palisade-parenchyme.

Comparative Structure of the Nodes and Internodes in the Stem of Dicotyledons.†—M. A. Prunet states that at the nodes the epidermal cells are frequently of larger dimensions, and an increase in the thickness of the cortical parenchyme may also be noticed, this being due rather to the enlargement of the cortical cells than to their multiplication in

* Le Botaniste, i. (1889) pp. 175–207 (2 pls.).
† Comptes Rendus, cx. (1890) pp. 592–5.

number. Generally the pericyclic fibres become less numerous at the nodes; at the same time their walls are thinner and their size increases. These modifications are especially noticeable in the neighbourhood of emergent bundles; but it is in the xylem of the fibrovascular bundles that the greatest change takes place. The vessels diminish in diameter and become more numerous; the medullary rays also become more numerous and larger. The pith also increases, but in a smaller ratio than the cortex.

Sap-periderm.*—By this term Herr J. Wiesner designates a tissue found in aerial, but more often on underground parts of plants. It is distinguished from ordinary periderm by both its cell-wall and its contents being in a living condition, serving as an absorption-tissue for the storing up of water. It is always the tissue from which the ordinary periderm is formed. In the tuber of the potato it occurs as a stratum, often from six to ten cells in thickness, between the dead periderm and the phellogen, already passed into a permanent condition, cell-division having ceased in it; but the cells contain remains of protoplasm, and frequently a nucleus. As long as the potato remains in the soil this sap-periderm only is formed; the dead periderm, the cells of which are empty, is produced subsequently as a result of desiccation. This tissue occurs also in young twigs of the maple and lime, and may persist through the winter, but soon becomes covered by ordinary dead periderm.

Change of Shape exhibited by turgescent pith in water.†—Miss Anna Bateson calls attention to the fact that when turgescent pith is placed in water it increases greatly in length, but we have no accurate knowledge of any changes occurring in the transverse dimensions. The general results of a series of experiments directed to this question fall into two classes:—(1) The case of the sunflower, elder, and rhubarb, in which transverse contraction of the pith is the final result; (2) *Impatiens Sultani*, in which no contraction occurs; transverse extensibility is here so great that transverse expansion is not only clearly apparent from the first, but is never overcome by longitudinal expansion, the pith continues to expand transversely, and never exhibits a subsequent contraction.

Passage from Stem to Root.‡—M. P. A. Dangeard has studied the phenomena presented by the tissue at the point of passage from stem to root in Dicotyledons. He finds a constant relationship between the type of venation in the cotyledons and the number of vascular bundles in the root—pinnati-veined cotyledons are associated with a root of the diarch type, palminerved cotyledons with a root of the tetrarch type. The phloëm-bundles behave in the same way as the xylem-bundles, but their fusion does not necessarily take place at the same level. The term "collar" should be reserved for the spot where the epiderm of the tigellum unites with the outer piliferous layer of the root. It is almost impossible to determine the exact level at which the union of the tissues of the two organs takes place. The author asserts that the pericycle of the stem is of a different nature from that of the root, belonging, in the former, not to the conjunctive tissue,

* Oesterr. Bot. Zeitschr., xl. (1890) pp. 107-11.
† Ann. of Bot., iv. (1889) pp. 117-25.
‡ Le Botaniste, i. (1889) pp. 75-123 (2 pls.).

but to that of the bundles, or, more exactly, to the phloëm-region of the bundles outside the group of sieve-elements. For the pericycle of the stem he proposes the term *periphragm*.

In Gymnosperms * the number of cotyledons may vary even within the same species. When the number of cotyledons is either two or three, then the number of fibrovascular bundles in the root corresponds to the number of cotyledons, the xylem-bundles alternating with the phloëm-bundles. But when the number of cotyledons is more than three the number of bundles in the root is only half that of the cotyledons.

Unlignified Elements in the Xylem.†—Dr. R. Raimann states that unlignified thin-walled cells frequently occur near the primary vessels in Dicotyledons. They have been observed in *Æsculus*, *Tilia*, *Aristolochia Sipho*, and *Fagus*. He proposes for these elements the term *interxylary cambiform*, since they resemble the cambiform in the soft bast in their origin, form, and structure. Their function he has at present been unable to determine.

The author further states that the formation of the innermost xylem-zone takes place at a later period than that of the outer zones which follow the protoxylem. The elements of the protoxylem do not form a closed tissue, but proceed either without any definite order or in radial rows out of the inner portion of the protoxylem. It is the elements of the innermost xylem-zone immediately surrounding the first vessels, or lying in rows between the rays of protoxylem, which remain for a time unlignified, forming the interxylary cambiform; and even if they subsequently become lignified, their walls remain thin and they retain their cambiform character.

Growth of the Cystoliths of Ficus elastica.‡—A careful examination of the structures has led Herr C. Giesenhagen to the following conclusions. The stalk of the cystoliths consists of cap-shaped lamellæ of uniform structure which also cover one another on the sides. Their body is composed of homogeneous nearly concentric lamellæ of cellulose, in and between which there is a deposition of calcium carbonate. The radial strings in the body are tubular cavities filled with lime. The stratification, both in the stalk and in the body, arises from the successive deposition of homogeneous lamellæ of cellulose formed from the cell-protoplasm. The lamellæ of cellulose in their body continue to increase considerably in size and density after their deposition, this depending nearly or exclusively on the subsequent importation of calcium carbonate. The calcium carbonate is believed by the author to be present, both in a state of combination with the cellulose and also free between the surfaces of contact. The growth of the cystoliths of *Ficus elastica* appears, therefore, to take place partly by apposition and partly by intercalation.

Recent observations in Anatomy.§—Dr. D. H. Scott gives a very useful *résumé* of the most important publications since the appearance of De Bary's 'Comparative Anatomy of Phanerogams and Ferns,' published in 1877, which have added to our knowledge of the anatomy of plants.

* Comptes Rendus, cx. (1890) pp. 253-4.
† SB. K. Akad. Wiss. Wien, xcviii. (1889) pp. 40-75 (2 pls.).
‡ Flora, lxxiii. (1890) pp. 1-30 (1 pl.). § Ann. of Bot., iv. (1890) pp. 147-61.

(4) Structure of Organs.

Structure of the Olive.*—Sig. A. Bottini gives a detailed description of the structure of the ripe drupe of the olive, distinguishing the characteristics of several Italian varieties. The minute warty excrescences found on the surface of the ripe fruit are lenticels, each of which was originally a stomate; the passage from one to the other can be readily followed by examining the fruit at different stages of development. The mesocarp consists of a spongy parenchyme, the cells of which have very thick walls; interspersed among these are sclerotized cells, with greatly thickened and hardened cell-walls, the proportion of which to the thin-walled tissue varies greatly in different varieties. The oil is found in the whole of the mesocarp except the lenticels and the sclerenchyme, almost filling up the cell-cavities. The pigment of the olive is dissolved in large quantities in the cell-sap.

White Bilberries.†—In opposition to the view of Woronin,‡ Herren P. Ascherson and P. Magnus maintain that the white variety of the bilberry, *Vaccinium Myrtillus* var. *leucocarpum*, is distinct from the diseased berry caused by the attacks of *Sclerotinia baccarum*, and that it is an example of the albinism which is not uncommon in fruits, as, for example, in the white currant.

Fruit of Aurantiaceæ.§—Sig. L. Savastano has determined that the splitting which is so common a phenomenon in the fruits of the Aurantiaceæ, especially in the orange, and in those of some other fruits, such as stone-fruits, the pear, fig, pomegranate, &c., is the result of the excessive absorption of water by the protoplasm, and of the small resistance offered by the cell-walls to compression from the tissue of the sarcocarp.

Seed of the Hemp.‖—Prof. L. Macchiati gives a minute description of the anatomical structure and the phenomena of germination of the seeds of *Cannabis sativa*. The points to which he calls special attention are the great inequality in the size of the two cotyledons, which becomes more conspicuous after germination, and the entire absence of starch from the embryo, the cells of which are filled with oily substances and grains of aleurone; the proteid crystalloids of these aleurone-grains are insoluble in cold water, but dissolve readily in water slightly acidulated.

Pitchers of Insectivorous Plants.¶—Referring to the observations of Dr. Macfarlane,** Prof. F. O. Bower adduces additional reasons for regarding the lid of the pitcher of *Nepenthes* as resulting from the coalescence of the only pair of pinnæ formed on the winged phyllopode; and for concluding that in *Sarracenia* the leaf is throughout a simple phyllopode, the lid being merely its flattened terminal portion, and the

* Nuov. Giorn. Bot. Ital., xxi. (1889) pp. 369–81 (2 pls.).
† Ber. Deutsch. Bot. Gesell., vii. (1890) pp. 387–400 (1 fig.).
‡ Cf. this Journal, 1889, p. 263.
§ Boll. Soc. Nat. Napoli, iii. (1889) pp. 273–88.
‖ Nuov. Giorn. Bot. Ital., xxii. (1890) pp. 58–63.
¶ Ann. of Bot., iv. (1890) pp. 165–8 (3 figs.). ** Cf. this Journal, 1889, p. 779.

flap an outgrowth in a radial plane, somewhat similar to that of the leaf of *Iris* or the phyllode of *Acacia*. There is no evidence here of coalescence of pinnæ.

Modifications of Leaves in Maritime Plants.*—M. P. Lesage draws the following conclusions as the result of his investigations on this subject:—(1) Plants living near the sea have thicker leaves than those inland; but there are certain exceptions to this rule. (2) The palisade-cells are generally much developed and the lacunæ reduced in maritime plants. (3) Chlorophyll is generally less abundant in the cells of plants living near the sea. This conclusion is not quite so constant as the preceding. (4) The fleshiness of leaves, the development of the palisade cells, the reduction of the lacunæ, and the diminution of the chlorophyll, can be effected by experimental cultures where salt is the variable element.

Structure of the Margin of Leaves.†—Herr R. Hintz describes in great detail the various modes in which the leaves of plants are mechanically protected against tearing, whether by local mechanical thickening, or by the special arrangement of the marginal veins. These he classifies under three types, and the connection between these special structures and the arrangements for storing up water in the margins of the leaves are further detailed.

Fall of Hairs.‡—Herr W. Kärner describes the conditions favourable to the formation of hairs on leaves and other parts of plants, and the causes which lead to their subsequent disappearance. This latter may result from the amount of water in the cells, from changes of temperature or moisture in the air, from the formation of a coating of silica on the surface, from rain, wind, and other causes. The amount of water in the cell-wall also influences the durability, as well as the stiffness or brittleness of the hairs. The mechanical arrangements by which the hairs are detached are also described.

β. Physiology.

(1) Reproduction and Germination.

Pollination and Distribution of the Sexual Organs.§—Herr A. Schulz continues his researches on this subject, recording a very large number of observations on plants belonging to a great variety of natural orders. A few general remarks are appended.

In the family Sileneæ of Caryophyllaceæ, the proterandry is in many species so marked as to render self-fertilization impossible. Only two observed species, *Tunica prolifera* and *Vaccaria parviflora*, were homogamous. In the family Alsineæ, on the other hand, the proterandry is

* Rev. Gen. de Bot. (Bonnier), ii. (1890) pp. 55–65, 106–21, 163–75 (3 pls. and 1 fig.). Cf. this Journal, *ante*, p. 363.

† Nova Acta K. Leop.-Carol. Akad. Naturf., liv. (1889) pp. 97–214 (3 pls.). See Bot. Centralbl., xlii. (1890) p. 50.

‡ Nova Acta K. Leop.-Carol. Akad. Naturf., liv. See Bot. Centralbl., xli. (1890) p. 294.

§ Biblioth. Botan. (Luerssen u. Haenlein), Heft 17, 224 pp., 1890. Cf. this Journal, 1888, p. 612.

not nearly so decided. Female flowers occur in almost all the species except *Mœnchia erecta* and *Mœhringia trinervia*. In the Umbelliferæ, with only a few exceptions, male flowers occur in addition to the hermaphrodite, less often female flowers. The various forms are described in detail for *Euphrasia Odontites* and *E. officinalis*, and the long and short-styled forms of species of *Primula*. Lists are appended of those species in which unisexual flowers or individuals occur at different periods in the time of flowering; of species normally hermaphrodite, which occasionally produce unisexual flowers; of the insects which are in the habit of biting through the corolla to obtain the honey; and of the species of flower the corolla of which is pierced in this way.

Fertilization of Ficus Roxburghii.*—Dr. D. D. Cunningham describes the remarkable phenomena connected with the development of the fruit of this species of fig in Calcutta. The receptacles or inflorescences are male and female, and the species is dicœcious. The male receptacles contain true male flowers which produce pollen, and modified or atrophied female or "gall-flowers," which never produce seed, but within the ovaries of which the eggs of an insect are deposited and undergo evolution. The female receptacles contain true female flowers, in which the eggs of insects are never found, and which produce fertile seeds. The ostiole or opening of both male and female receptacles is so obstructed by a covering of bracts, that the receptacles are almost closed chambers. But the perfect development of both male and female flowers is dependent on the access of the "fig-insect" to the interior of the cavity of the receptacle, without which neither of them attain functional condition. The insect most commonly found is a species of *Eupristis*.

Although the development of embryos in the female receptacle is essentially connected with the access of the insects to the receptacular cavity, yet Dr. Cunningham believes that it is independent of the introduction of pollen by their agency. The nearly entire closure of the ostiole by bracts presents an almost insuperable obstacle to the introduction into the female receptacles of a sufficient quantity of pollen for the impregnation of every one of the ovules in the exceedingly numerous female flowers by a separate pollen-grain; and but very few pollen-grains could be found within the female receptacles. Although it is possible that in some instances ordinary pollination may occur, yet the author asserts that the embryo is ordinarily formed independently of any such process, and arises as an outgrowth of the nucellar parenchyme outside the embryo-sac. Up to the period of insect-access, and of the initial development of the embryo, the embryo-sac retains its character of a simple uninucleate cell without oosphere, synergidæ, or antipodal cells. The full development of both male and female flowers appears to be dependent simply on hypertrophy of all the tissues of the receptacle resulting from stimulation caused by the access of the fig-insects. This stimulation is the result of the female insects laying their eggs within the ovary of the "gall-flowers" in the male receptacles, and of their persistent attempts to do the same within the flowers of the female

* 'On the Phenomena of Fertilization of *Ficus Roxburghii* Wall.,' Calcutta, 1889, fol., 37 pp. and 5 pls.

receptacles, although these attempts are here frustrated by the great strength and thickness of the ovary-wall.

Fertilization of Scrophulariaceæ.*—Prof. E. Warming describes the mode of fertilization in the Greenland species of Scrophulariaceæ, especially those belonging to the genera *Veronica*, *Pedicularis*, *Rhinanthus*, *Bartsia*, and *Euphrasia*. In *Pedicularis* we find every gradation between species with horizontal lower lip to the corolla, like *P. flammea*, adapted for self-fertilization, and species with oblique lower lip, like *P. lapponica*, adapted for cross-fertilization. All the Greenland and Iceland species of *Euphrasia* are self-fertilized.

Fertilization of the Grape-vine.†—Dr. M. Kronfeld states that, although the cultivated grape-vine is usually anemophilous, yet that, under certain conditions, it is fertilized by honey-bees, especially when there is in the same neighbourhood an abundance of other plants which are visited by bees.

Trimorphism of Scabiosa succisa.‡—Mr. A. Turner points out the existence of three distinct forms of this common British plant, viz.:—(1) hermaphrodite; (2) and (3) two different female forms, differing from one another remarkably in the size of the capitula and of the flowers, the arrangement of the flowers on the receptacle, the colour of the corolla, and the presence or absence upon it of stellate hairs, and especially in one having a perfectly straight and the other a much bent style. He further describes the mode in which this trimorphism assists in crossing by insects.

Pollination of Eryngium and Cakile.§—Herr P. Kunth describes the mode of pollination of *Eryngium maritimum* and *Cakile maritima*. Both are habitually cross-fertilized, though the latter may also be self-fertilized. The former is strongly proterandrous, and is effectively protected against the visits of intruding insects by its spiny foliage and involucre. The pollinating insects are Hymenoptera, Diptera, and Lepidoptera, and to a large extent the same species in the case of both plants.

Fertilization of Phyllis.‖—Prof. F. Delpino describes the mode of pollination of *Phyllis Nobla*, endemic in the Canary Islands, belonging to the Rubiaceæ, which is strictly anemophilous. He proposes to limit the tribe Autospermeæ of the order to genera which are strictly anemophilous.

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

Parasitism of Thesium.¶—M. O. Lignier finds that the nature of the soil has no influence on the production of the vegetative organs of *Thesium divaricatum* var. *humifusum*, and that it is parasitic on a considerable number of species. It derives its nourishment from the host

* Bot. Tidsskr., xvii. (1889) p. 202.

† Ber. Deutsch. Bot. Gesell., vii. (1889) Gen.-Versamml.-Heft, pp. 42–4. Cf. this Journal, *ante*, p. 208.

‡ Nature, xl. (1889) pp. 643–4.

§ Bot. Centralbl., xl. (1889) pp. 273–7 (5 figs.).

‖ Malpighia, iii. (1889) pp. 348–9.

¶ Bull. Soc. Linn. Normandie, iii. See Morot's Journ. de Bot., iv. (1890) Rev. Bibl., p. x.

by means of a number of haustorium-tubercles, of which the largest attain a diameter of 5 mm.; it attacks the stem, leaves, and root in the underground zone of the host, but not the root-tubercles of *Lotus* or *Medicago*.

Transpiration-current in Plants.*—Herr T. Bokorny finds the most convenient method of tracing the course of the ascending current in a plant to be by causing it to absorb small quantities of iron sulphate (not more than 0·1 per cent.), and then precipitating by potassium ferricyanide.

By this method he has determined that the elements through which the greater part of the conduction of water takes place are the vessels (and the tracheids of Conifers), a current being always perceptible in the cell-cavity; whether there is also any considerable conduction through the walls, he leaves undetermined. A current through the walls appears to take place in some cases, but not in others. The pith often gives strong lignin-reactions, and is therefore quite incapable of conducting water. The water also appears to rise through the prosenchymatous cells of the xylem, through those of the sclerenchyme, through the thin-walled bast, and through the collenchyme. The ascent through the sclerenchyme and collenchyme appears to tell against Sachs's imbibition-theory. In the upper portions of the stem of *Nicotiana* and *Cucurbita* the walls of the vessels alone were found to contain iron. In *N. rustica* the water had risen to the extent of 1 metre in three-quarters of an hour.

Passage of Gases through Plants.†—Prof. J. Wiesner and Dr. H. Molisch give the following as the chief results of a series of experiments on this subject.

Gases subject to pressure are unable to penetrate by filtration either through the cell-wall, whether living or dead, whether dry or saturated with water, or through the protoplasm or watery cell-sap. The movement of gases from cell to cell can take place only by diffusion when the tissue is a close one, or also through the intercellular spaces where these occur; the rapidity of diffusion is in proportion to the quantity of water imbibed by the cell-wall. Dialysis of dry air cannot take place to any determinable amount through cell-walls when they are neither lignified nor suberized; but it can take place through lignified or suberized cell-walls. Carbon dioxide diffuses through cell-walls more rapidly than hydrogen, oxygen, or nitrogen, the rapidity of diffusion being proportional to the absorption-coefficient and the density of the gas. Carbon dioxide passes out of vegetable cells by diffusion more rapidly into air than into water. Periderm is more hygroscopic, and imbibes water more rapidly, than had previously been supposed.

(3) Irritability.

Movements of Nutation.‡—Dr. A. Hansgirg distinguishes several kinds of nutation, especially in connection with petals and leaves, viz.:—

The ephemeral and periodical nutation-movements of petals, which

* Jahrb. f. Wiss. Bot. (Pringsheim), xxi. (1890) pp. 469–503.
† SB. K. Akad. Wiss. Wien, xcviii. (1889) pp. 670–713.
‡ Oesterr. Bot. Zeitschr., xl. (1890) pp. 48–53.

have for their object the protection of the sexual organs and of the honey, and the promotion or prevention of foreign pollination; these may be termed *gamotropic* movements, in contrast to the nyctitropic movements, which serve merely for protection from injurious radiation at night.

Movements of the bracts, sepals, and petals, and of the flower-stalks for the protection of the ripening fruit, or for the dissemination of the fruit or seeds—*carpotropic* movements.

The author gives also numerous instances of *photo-cleistogamic* flowers, in which the opening of the flower is prevented by the rapid growth of the outer side of the petals, the result of photo-hyponasty; of the nutation-movements of leaves and petals which are caused not only by changes in light and temperature, but also by variations in turgidity, and of such as are caused by variations in temperature and turgidity only; and of the movements of nutation and irritation in stamens, styles, and stigmas.

The leaves of *Marsilea* exhibit movements of irritation under the influence of concussion, in addition to the more conspicuous sleep-movements. The leaves of many Papilionaceæ exhibit more considerable paraheliotropic movements in southern than in northern latitudes, for the protection of their chlorophyll from intense sunlight.

Influence of Heat on the Movements of the Flowers of Anemone stellata.*—According to Herr H. Vöchting, the flower-stalk of this plant, which, before the unfolding of the flower, is bent downwards, becomes erect immediately on its opening, bending towards the sun, and following its course through the day; in the evening the plant takes up a sleep-position, the perianth closing, and the flower-stalk again bending downwards. A careful series of observations convinced the author that these successive movements were in no way due to changes either in the light or in the degree of moisture, but entirely to changes in temperature. Contrary to what takes place in *Papaver*, the movements of the flower-stalk of *Anemone stellata* are not directly dependent on the flower, since they continue even after this has been cut off.

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

Formation of Starch from Organic Substances by Leaves.†—As the result of a series of experiments with a number of different carbohydrates and other organic substances, Herr G. Nadson finds that the chlorophyllous cells of various plants (Dicotyledons, Monocotyledons, Vascular Cryptogams, and Algæ) can in nearly all cases form starch out of cane-sugar, dextrose, and dextrin, less uniformly out of milk-sugar, glycerin, mannite, and melamprite, never out of inulin, quercite, glycogen, gum-arabic, calcium saccharate, or out of tartrates, oxalates, or malates. As a general rule, starch can be formed out of substances which contain the two radicals of alcohol, CH_2OH and CHOH, but not out of those which contain only one of these elements.

* Jahrb. f. Wiss. Bot. (Pringsheim), xxi. (1889) pp. 285-97.

† Arb. Petersburg Naturf. Ver. 1889, 50 pp. See Bot. Centralbl., xlii. (1890) p. 48.

γ. General.

Special Characters of Plants at high altitudes.*—M. G. Bonnier finds that, when plants are cultivated in alpine regions—other conditions except those of climate remaining the same—the aerial stems become shorter and prostrate; the flowers more highly coloured; the leaves thicker and of a deeper green; the protecting tissues of the stem more strongly developed; and, in consequence of the greater development of the palisade-tissue and the abundance of chlorophyll, the assimilation in the leaves becomes more energetic in proportion to the surface.

Myrmecophilous Plants.†—Mr. W. Trelease describes the extra-floral nectaries for the entertainment of ants in *Calycanthus*, and for the colonies of Aphides in *Andromeda*. Ritter R. v. Wettstein ‡ gives a useful bibliography of the phenomenon of myrmecophilism.

Herr K. Schumann § treats generally of the structures for the accommodation of ants in stems, branches, and leaves; and describes in particular the bladders on the branches of *Duroia hirsuta*, the entrances into the tuberous stem of *Myrmecodia bullata*, the bladders on the under side of the leaves of *Tococa lancifolia*, and on the upper side of the leaves of *Duroia saccifera*, and Müller's bodies in *Cecropia*.

Nanism in the Vegetable Kingdom.‖—Dr. D. Clos discusses the conditions under which plants exhibit nanism, or the dwarfed condition,—its causes, whether internal or external, and the various modes in which it manifests itself.

Relationship between Snails and Plants.¶—Herr F. Ludwig describes the mode in which the gigantic leaves of *Petasites officinalis* and those of other plants are destroyed by snails, especially by *Succinea putris*, leaving nothing but a skeleton of vascular bundles. As previously described in the case of the hop, the snails appear to have a special liking for the patches of parasitic fungi, e. g. *Coleosporium Sonchi* and *Puccinia Poarum*, which frequently occur on the leaves.

Use of Micrography in Botany.**—M. P. Vuillemin discusses the use of micrographic characters in descriptive botany. He concludes that their employment may be recommended from three points of view, viz. (1) to determine incomplete plants, or plants altered in their form, and species of minute size; (2) to corroborate or to rectify classifications based on other characters; (3) for the determination of certain questions relating to the genetic relationship of plants, which are unapproachable by other modes of research.

* Comptes Rendus, cx. (1890) pp. 363–5.

† Psyche, 1889, pp. 171–80. See Biol. Centralbl., x. (1889) p. 44. Cf. this Journal, *ante*, p. 212.

‡ See t. c., p. 44. § See t. c., p. 45.

‖ Mem. Acad. Sci. Toulouse, 1889, pp. 375–406.

¶ SB. Gesell. Naturf. Freunde Berlin, 1889, p. 197. See Bot. Centralbl., xli. (1890) p. 295. Cf. this Journal, 1889, p. 548.

** Bull. Soc. Bot. France, xxxvi. (1889) Actes du Congrès de Bot., pp. xc–xcix.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Anatomy of Vascular Cryptogams.*—M. P. A. Dangeard classifies the very numerous species of *Selaginella* into two primary sections, dependent on the arrangement of the leaves,—*Homotropæ*, in which the leaves are of one kind only, and are opposite or arranged in various phyllotaxes, 3/8, 5/13, &c.; and *Dichotropæ*, in which they are of two kinds, and are arranged in four longitudinal rows. These are then divided into a number of groups, according to the structure of the stem and leaves.

In the stem of *Lycopodium* we find a collection of cauline bundles, corresponding in their origin and structure, and in their relationship with the leaves, with those of *Selaginella;* they are united into a central cylinder either by their metaphloëm only, or also by their metaxylem. *Tmesipteris* possesses a rhizome entirely destitute of leaves, which presents a transition to a true root. In the vascular bundles of the stem the metaxylem is not simply centripetal, it surrounds the protoxylem, which gradually disappears, leaving a lacuna.

In the stem of *Salvinia* the central cylinder is large; the endoderm has here and there a tangential septum; scattered through the central parenchyme are a few vessels, the largest of which are replaced by a lacuna; the phloëm is external, but passes insensibly into the central parenchyme which contains the vessels. In the Marsiliaceæ the fibrovascular system is more complicated, and the leaf attains a great development; the vascular bundles of the leaves are surrounded by an endoderm. The structure is very similar in the Filices.

In the Equisetaceæ we appear to have an approach to the structure of Phanerogams. In several species a lacuna makes its appearance on the internal face of the bundle, and this leads directly to the ordinary collateral bundles of the Dicotyledones.

Anatomy of Marattiaceæ.†—The following are given by Dr. R. Kühn as the more important results of a fresh examination of the anatomical structure of the stem of Marattiaceæ, the species examined being chiefly *Kaulfussia æsculifolia* and *Marattia fraxinea*.

Kaulfussia has a creeping dorsiventral stem, while that of *Marattia* is, when young, radiar and erect, passing over gradually into a fleshy tuberous stem. The vascular bundles of the stem and leaves of *Kaulfussia*, *Marattia*, and *Angiopteris* are really concentric, not bicollateral like those of leptosporangiate ferns, the phloem-portion surrounding the xylem-portion; there is no bundle-sheath. In the leaf-stalk of *Marattia fraxinea* is a peculiar joint which appears to serve as a motile organ, the sclerenchyme-fibres within it passing over into collenchyme. The mucilage-passages are of lysigenous origin, from the absorption of the cell-walls of adjacent cells; the mucilage itself originates from the disorganization of the protoplasm of these cells; there are no epithele-cells. The peculiar masses in the roots of Marattiaceæ are the result of an infection by a fungus, similar to that of the Orchideæ, and the

* Le Botaniste, i. (1889) pp. 211–70 (3 pls.).

† Flora, lxxii. (1889) pp. 457–504 (2 pls.), and lxxiii. (1890) pp. 147–50.

same is the case with the Ophioglossaceæ, and with *Lycopodium inundatum*.

The following particulars are added with regard to other classes of Vascular Cryptogams:—No mucilage is found in the Ophioglossaceæ, while, on the other hand, it is more widely diffused in the Lycopodiaceæ than has been supposed. *Osmunda regalis* and *Todea barbara* have, in connection with the vascular bundles of the leaf-stalk, cells which produce a mucilage containing tannin, and similar cells are found in many Cyatheaceæ. The vascular-bundle-cylinder in the cortex of the stem of *Struthiopteris germanica* belongs to the stem, and not to the leaf. The stem of *Botrychium* has a secondary growth in thickness, but limited to the new formation of a few tracheïdes.

Danæa alata corresponds with other Marattiaceæ in the anatomical structure of the stem (or root-stock) in all essential points. There are no sclerenchymatous elements, it contains mucilage-passages and tannin-cells, and the vascular bundles are concentric. It presents, however, a peculiarity in the root, in the presence, as in the leaf-stalk, of a closed ring of sclerenchymatous fibres, two or three rows of cells in thickness, a few layers below the epiderm.

Muscineæ.

Peristome.*—M. Philibert now describes the structure of the peristome in various genera of Splachnaceæ. In *Splachnum* the interior cells are thickened along the whole length of their walls, the adherence of the two peristomes is complete, and the internal membrane divides into sixteen segments. In the three other European genera of Splachnaceæ the ordinary diplolepideous type is found. The author then describes the peristome of *Splachnobryum Boivini*, a member of a genus composed entirely of exotic species. The teeth are composed of two membranes joined together by a complex mass of cells arranged in several rows in the upper part, the internal peristome only remaining; this is exactly the converse of what is found in *Dissodon*, *Tayloria*, and *Tetraplodon*, where the external peristome alone remains.

The author then proceeds to point out the differences between the Nematodonteæ and the Arthrodonteæ, and especially describes the Discelieæ and Leptostomeæ. The family of the Discelieæ, which consists of a single genus and single species *Discelium nudum*, does not differ greatly from *Funaria* in its aspect and vegetative system, the capsule and spores being analogous. The peristome is composed of sixteen regular teeth, in which the two layers can be easily distinguished. The curious family of Leptostomeæ differs from all other known genera in the peristome, which is reduced to a single uniform and undivided membrane, representing the primitive framework from which is derived the double peristome of the Arthrodonteæ. The author concludes by describing the peristome of *L. macrocarpum* and *L. inclinans*.

Fibres in Medullary cells of Sphagnum.†—M. F. Gravet records the presence of fibres in the medullary cells, or cells of the central zone of the stem, in a small number of specimens of the immersed form of *Sphagnum cuspidatum*, and also in a form of *S. recurvum*.

* Rev. Bryol., xvii. (1890) pp. 8–12, 25–9. Cf. this Journal, *ante*, p. 68.
† Rev. Bryol., xvii. (1890) p. 21.

Stem-leaves of Sphagnaceæ.*—Dr. J. Röll adduces a variety of examples to demonstrate his statement that the stem-leaves may vary considerably in the same species of *Sphagnum*, and that trustworthy specific characters cannot in all cases be drawn from them.

Algæ.

Algæ as a cause of the Impurity of Water.†—Mr. G. W. Rafter publishes the results of a series of observations on Freshwater Algæ, and their relation to the purity of public water supplies. He finds that a number of algæ (and Schizophyceæ) may contribute to render drinking water unpotable, producing a nauseous or "fishy" smell, generally due to the decomposition of their mucilaginous envelope, or of the starch or oil contained in their cells. In addition to the Schizomycete *Beggiatoa*, which has the property of withdrawing the sulphur from sulphates in solution, the following may be mentioned:—*Cladophora*, *Vaucheria*, *Batrachospermum*, *Draparnaldia*, *Chætophora*, *Volvox*, *Eudorina*, *Pandorina*, *Hydrodictyon*, *Palmella*, *Crenothrix*, *Oscillaria*, and the diatoms generally, especially *Meridion circulare*. The desmids appear mostly to be innocuous.

Inferior Algæ.‡—M. P. A. Dangeard dissents from Bütschli's classification § of the Eugleneæ, Cryptomonadineæ, Peridinieæ, Chlamydomonadineæ, and Volvocineæ with the Flagellata, considering them to be true Algæ, as is determined by their mode of life.

Among the special forms described is *Anisonema viridis* [*e*] sp. n., belonging to the Palmellaceæ, and nearly allied to *Palmella hyalina*. Among the Polyblepharideæ, *Pyramimonas tetrarhynchus* is described in detail, characterized by having four projecting lateral wings and four cilia. To the same family belong *Chloraster agilis* and *C. gyrans* with five cilia. Among the Chlamydomonadineæ a new genus and species *Corbieria vulgaris* is described, distinguished from all the other genera of the family by the posterior position of the nucleus and by the red-brown colour of the oosperm, which has also a double instead of a single membrane.

Among the Volvocineæ, *Pandorina* is stated to have a *Gonium*-like early stage, which rapidly changes into a sphere. In *Eudorina* he finds green as well as yellow antherozoids. Under the Tetrasporeæ, a new species and genus, *Schrammia barbata* is described, consisting of two- to eight-celled colonies inclosed in a cellulose-gelatine, rapidly becoming incrusted in calcareous water. The contents are blue-green, and it may belong to the Cyanophyceæ; it appears to be allied to *Glœochæte* Lagerh.

In the non-sexual Pleurococcaceæ we have a new genus and species *Hariotina reticulata*, apparently derived directly from the Volvocineæ, resembling a *Pandorina* in the act of division. It consists of a number of green spheres, each consisting of from four to sixteen spherical cells, irregularly united together into a network by stout threads. It multi-

* Bot. Centralbl., xli. (1890) pp. 241–5, 273–8.

† Trans. Amer. Soc. Civil Engineers, 1889, pp. 483–557 (9 pls.). Cf. this Journal, 1889, p. 677.

‡ Le Botaniste, i. (1889) pp. 127–74 (2 pls.). Cf. this Journal, 1889, p. 95.

§ Cf. this Journal, 1889, p. 776.

plies by repeated division. Another new genus and species belonging to the same family is *Placosphæra opaca*, consisting of spherical or somewhat elliptical cells 24 μ in diameter, with a thick calcareously incrusted membrane, a central pyrenoid, and lateral nucleus. It is reproduced by repeated division, and appears to be most nearly allied to *Nephrocytium*.

The author regards the Hydrodictyeæ as derived from the Volvocineæ, the colonies having lost their motility; under unfavourable vital conditions they may become encysted. *Polyedrium trigonum* Näg. is not a stage in the development of a *Pediastrum*, but is an independent organism; it breaks up, on germination, into new individuals. This genus and *Scenedesmus* may be considered as abnormal Hydrodictyeæ, in which the production of zoospores and sexual reproduction are suppressed.

Hybrid Desmid.*—Mr. A. W. Bennett describes a possible hybrid desmid between *Euastrum humerosum* and *E. crassum*.

Trentepohlia.†—M. E. de Wildeman recurs to several critical points in determination of the species of this genus, and dissents from its division into two classes by De Toni and Hansgirg, dependent on the colour and odour, characters which vary with the conditions of growth and of drying. Species, he states, which have been separated and placed in the two classes ought to be united. He proposes an alternative classification into two groups, the first with the cells cylindrical, or rarely irregularly elliptical, the second with the cells oval, elliptical, or irregular, never cylindrical. The species in both groups vary as to colour and odour.

M. P. Hariot ‡ gives a complete monograph of the genus, which he considers as nearly allied to *Cladophora*, differing in its terrestrial habit, its more or less bright coloration, and its mode of fructification. The family Trentepohliaceæ is divided by him into two groups, Cephaleuroideæ and Chroolepideæ, the latter being made up of the two genera *Trentepohlia* and *Nylandra*. He classifies the species of *Eu-trentepohlia* under two groups, the first with cylindrical cells (11 species), the second with torulose or moniliform cells (6 species). One new species is described, *T. Wainoi*. A second sub-genus, *Heterothallus*, intermediate between *Eu-trentepohlia* and the Phycopeltideæ, has the primary filaments ramifying in a single plane, and forming a circular horizontal rosette. It comprises three species, including *T. depressa*, hitherto included under *Cœnogonium*, and a new species, *T. Leprieurii*, from Cayenne.

The new genus *Nylandra*, comprising only a single species, *N. tentaculata*, is distinguished from *Trentepohlia* only by the cells of the thallus producing setiform appendages.

Movements of the Protoplasm in Caulerpa.§—Dr. J. M. Janse has investigated the nature of the energetic movements of protoplasm within

* Ann. of Bot., iv. (1889) pp. 171-2 (1 fig.).

† Bull. Soc. R. Bot. Belgique, xxviii. (1889), Pt. ii., pp. 67-70, 95-100, 125-7. Cf. this Journal, 1889, p. 420.

‡ Journ. de Bot. (Morot), iii. (1889) pp. 345-50, 366-75, 378-88, 393-405; iv. (1890) pp. 50-3, 85-92, 178-80, 192-7 (24 figs.).

§ Jahrb. f. Wiss. Bot. (Pringsheim), xxi. (1889) pp. 163-284 (3 pls. and 1 fig.).

the unicellular sac of *Caulerpa prolifera*. He finds that the phenomenon bears no relation whatever to that of rotation in the higher plants, such as the familiar examples in *Nitella* and *Hydrocharis*, and but little to that of circulation such as is seen in the hairs of *Tradescantia* and *Cucurbita*. The parietal protoplasm of the mature "leaves" contains an uninterrupted layer of chlorophyll-grains, in which no motion whatever could be detected. The motion is observed mainly in the strings of protoplasm which pass from one to another of the beams of cellulose which occur in such large numbers in the interior of the cell; these strings form a continuous mass of protoplasm with the protoplasmic layers which invest the cellulose-beams. The beams increase in number from the base towards the apex of the "leaf." The protoplasmic strings inclose chlorophyll-grains which are carried along in the current. Branches of these strings run into the prolifications.

No similar movement of the protoplasm, or only a very feeble one, was observed in *Valonia*, *Bryopsis*, or *Codium*; in *Acetabularia mediterranea* it was much more apparent.

Injury to the leaves of *Caulerpa* is speedily remedied, first by accumulation of the protoplasm which escapes from the wound, followed by copious formation of cellulose. The protoplasmic phenomena in the rhizome and in the rhizoid correspond, in general terms, with those in the leaf.

The familiar beams of cellulose are outgrowths from the inner side of the cell-wall. Their main function appears to be to preserve the form of the organ in which they are found under different degrees of turgidity; if they are cut through, the leaf increases very greatly in thickness. They also aid, through their protoplasmic envelope, in guiding the currents of protoplasm within the cell which serve for the transport of the food-materials.

Fungi.

Nucleus of Peronospora.*—Mr. H. W. T. Wager has investigated the structure of the nuclei in *Peronospora parasitica*, a common parasite on cruciferous plants, and their behaviour during the formation of the oosperm. The following is a summary of the results.

Mycele, antherids, oogones, and gonids (spores) contain numerous deeply-staining nuclei which exhibit a very clear nuclear structure. The division of the nucleus takes place by a process of karyokinesis similar to that which occurs in the higher plants. This can be most satisfactorily observed in the nuclei of the oogone. These are, at an early stage, spherical or slightly oval vesicular bodies, each of which contains a large mass of chromatin, forming a peripheral layer on its wall. All the nuclei of the oogone divide, and the process of division is accompanied by complicated changes in the protoplasm, leading to the formation of the oosphere. At an early stage the protoplasm of the oogone appears to be a homogeneous granular mass, containing numerous nuclei. A number of vacuoles appear in the centre of the oogone, and cause the greater part of the protoplasm to be restricted to the

* Ann. of Bot., iv. (1890) pp. 127-46 (1 pl.).

periphery. At the same time the nuclei swell up, and exhibit a thread-like structure; they assume a very regular arrangement, and form a single layer in the parietal protoplasm. The chromatic threads next arrange themselves in the equatorial plane of the nucleus, and then divide into two groups of threads, each of which forms a daughter-nucleus. The daughter-nuclei again divide, and then two, or perhaps more, pass towards the centre of the oogone, and soon afterwards the cell-wall of the oosphere begins to form on the inner side of the parietal layer of protoplasm, leaving this, together with the remainder of the nuclei outside, to form the periplasm. From this mass of protoplasm and nuclei both the endospore and the exospore are formed.

One or more antherids are developed in connection with the oogone. The antherids send out fertilizing-tubes, swollen at the ends, which pass to one side of the oosphere, come into close contact with it, and appear to open into it by a small aperture. The passage of a nucleus from the antherid into the oosphere has not been directly observed, but it is probable that fertilization does take place, as two nuclei have been seen in the oosphere at about the time when the nucleus or nuclei from the antherid appear to pass through the fertilizing-tube.

The nuclei of the mycele divide in a similar manner to those of the oogone, but they do not become so large, nor exhibit the details so clearly. The gonids or zoosporanges contain numerous nuclei, differing in structure from those in the other parts of the plant. They consist of a central mass of protoplasm, surrounded by a layer of nucleoplasm, with a firm outline. They are spherical or slightly oval bodies, a little larger than the nuclei of the mycele.

Smut of Wheat and Oats.*—Mr. J. C. Arthur states that *Ustilago fœtens* B. & C. (*Tilletia lævis* Kuhn) may be recognized by its strong fœtid odour, which is especially noticeable in the evening, or when the air is moist. If the spores of *U. fœtens* are placed under the Microscope, the black powder will be found to consist of an infinite number of round corpuscles, in the middle of which delicate ramifying filaments will be perceived, to which the spores are attached. The reproduction of this fungus is very simple. The spores forming the black powder are transformed, under certain conditions of temperature and humidity, into short branched tubes, and from these escape other minute spores.

Endothlaspis.†—Prof. N. Sorokine, in his description of the materials for a Cryptogamic flora of Central Asia, gives the diagnosis of a new genus of Ustilagineæ, *Endothlaspis*. The filaments of the mycele destroy the ovary of the host. On the surface of the pistil the filaments divide by transverse septa and form the tissue. Each cell of this tissue is transparent and colourless, and is provided with a nucleus. In the interior of this pseudo-periderm the filaments of the mycele change into a mass of black or blackish spores. The author describes and figures two species:—*E. Melicæ*, parasitic on the pistil of *Melica ciliata;* and *E. Sorghi*, parasitic on *Sorghum cernuum*.

* Bull. Agricult. Exper. Station, Indiana, Sept. 1889, 32 pp. See Rev. Mycol., xii. (1890) p. 90.

† Rev. Mycol., xii. (1890) p. 4.

"Pourridié" of the Vine.*—M. P. Viala has followed out the life-history of *Dematophora necatrix*, the cause of the disease of the vine known as *pourridié*, and the mycele of which constitutes various kinds of "rhizomorph." It produces its conidial form only on the organs of the vine which it has destroyed, and on which it carries on a saprophytic life. In addition, the author was able, by varying the method of culture, to produce the peritheces which had not previously been observed, and which are formed only on dry soil at least six months after the formation of the conids. The asci are filiform, and contain eight ascospores. M. Viala regards *Dematophora* as forming a distinct genus of Tuberaceæ, the first genus of the order in which the formation of conidiophores has been observed.

New Disease of Pine Trees.†—M. E. Mer has had his attention called to a large number of fir trees, in which the last four or five shoots of some of the branches had completely dried up or perished. This was due to the attacks of a fungus, the pycnids of which show considerable resemblance to those described and figured by Saccardo under the name of *Dothiorella pythia*. The author hopes to meet with spermogones or peritheces in a state of maturity in order to give a more exact determination and a complete description of the parasite.

Sphæropsideæ and Melanconieæ.‡—Herr A. Allescher describes a large number of fungi from South Germany belonging to these orders, including six new species belonging to the genus *Actinonema*, all found on the leaves of various trees and shrubs, usually in a fallen but still living condition; also two new species of *Pestalozzia*.

Podaxis.§—From an examination of specimens of *Podaxis indica*, from South Africa, Mr. G. Massee assigns this genus of Fungi to the Ascomycetes, removing it from the family Podaxineæ of Gastromycetes. It closely resembles in appearance a long-stalked puff-ball. The glebe is, however, destitute of the sinuous cavities and well-defined tramal plates characteristic of the Gastromycetes, presenting from its earliest appearance a sponge-like structure. The thin-walled colourless hyphæ which form the irregular walls of the glebe put out numerous long lateral branches, which are the ascogenous hyphæ. The asci are lateral outgrowths from these, at first papillæform, but afterwards cut off by a septum, and are densely crowded; each contains a single ascospore, or less often two, which escape from the ascus through a lateral slit. Some species (*P. Emerici*) appear also to produce basidiospores homologous with the normal asci. The different species further present a differentiation in the presence or absence of a capillitium.

The author regards the entire group of Gastromycetes as having sprung from the Tuberaceæ, one line of evolution having been through the genera *Elaphomyces, Podaxis*, and *Tulostoma*.

Nutrition of Oidium albicans.‖—MM. G. Linossier and G. Roux find that free oxygen is absolutely indispensable to the growth of this

* Comptes Rendus, cx. (1890) pp. 156–8.

† Bull. Soc. Bot. France, xxxvii. (1890) pp. 38–48.

‡ SB. Bot. Ver. München, March 10, 1890. See Bot. Centralbl., xlii. (1890) pp. 42 and 74. § Journ. of Bot., xxviii. (1890) pp. 33–9, 69–77 (2 pls.).

‖ Comptes Rendus, cx. (1890) pp. 355–8. Cf this Journal, *ante*, p. 220.

fungus; the more abundantly it is supplied with atmospheric air, the more luxuriantly it grows; when immersed, the growth is feeble in proportion to the depth below the surface. The rarity of the air appears to favour its filamentous form of development. Of food-materials the carbohydrates are those which are most favourable to its growth, and in proportion to their high molecular equivalent. Slightly alkaline media are more congenial than neutral or acid.

Lily-disease.*—Mr. A. L. Kean has investigated a disease which is exceedingly destructive in Bermuda to a variety of *Lilium longiflorum*, and finds it to be due to a species of *Botrytis* growing upon or within the leaves or flowers, in all probability identical with that described by Prof. Marshall Ward † as attacking *Lilium candidum* in this country.

Production of Varieties in the Saccharomycetes.‡—More than a year ago Dr. C. C. Hansen succeeded in rearing varieties of Saccharomycetes which since this time have been cultivated without interruption in beer-wort, also in other liquid nutritive media and on solid media, or, in other words, they have been cultivated under very different conditions, and, nevertheless, have not regained their original faculty of spore-formation. In beer-wort especially, innumerable generations have been produced every fourteen days, and frequently new cultivations have been oftener effected. The transformation which the cell-protoplasm has undergone has therefore been of a nature so profound that it has been transmitted from generation to generation, and there does not seem any likelihood that it will disappear as long as the cells are cultivated in wort. Hence, in general terms, the principal result of the author's experiments has been the production of varieties, the new characters of which are retained in the most diverse cultivations.

About the methods whereby he has effected these changes the author gives only general indications. These are that cultivations were made from a low yeast at a temperature just below that which prevents budding. The cultivation-medium was beer-wort. Although the cells had lost their power of developing spores, they were still actively reproductive, and capable of exciting alcoholic fermentation.

Action of Alcoholic Ferments on various kinds of Sugar.§—The examination, by Prof. E. C. Hansen, of the action of forty kinds of yeasts on saccharose, maltose, lactose, and dextrose, showed that, with the exception of the endosporous *S. membranifaciens*, all species of the genus *Saccharomyces* possess the power of forming invertin and exciting alcoholic fermentation in saccharose and dextrose. On the other hand, *S. marxianus*, *exiguus*, and *apiculatus*, like the Torulæ, were unable to ferment maltose, although this is decomposed by the rest of the Saccharomycetes, by *Monilia candida*, and the Mucor yeasts. *Monilia candida* is, moreover, the only yeast which decomposes saccharose directly without the previous formation of invertin. *Mucor erectus* excites fermentation in saccharose solution, but not in that of dextrose. Only a single alcoholic yeast, that discovered by Duclaux in 1887, fermented lactose.

* Bot. Gazette, xv. (1890) pp. 8–14 (1 pl.). † Cf. this Journal, 1889, p. 265.
‡ Annales de Micrographie, ii. (1890) pp. 214–21.
§ Op. c., i. (1888). See Bot. Centralbl., xxxix. (1889) p. 160.

The facts adduced by the author are of importance to the analytical chemist if he have to examine a mixture of several kinds of sugar.

Peridium and Spores of Uredineæ.*—Mr. H. J. Webber suggests that the size and form of the cells of the peridium, which he regards as being developed from æcidiospores, may be useful characters in determining the species of Uredineæ. He further describes peculiar spores in several species of Uredineæ. In *Puccinia flaccida* the teleutospores, though often one-celled, are also frequently two-celled, and the septum may then be in almost any position, from nearly horizontal to vertical; the author regards this species as more resembling a *Uromyces* than a *Puccinia*. In *P. Sporoboli* the teleutospores are one-, two-, or three-celled, the different forms occurring either in the same or in different sori. The teleutospores of *P. Tanaceti* are equally variable in structure. In *Uropyxis Petalostemonis* the author has also observed a three-celled teleutospore.

New Parasite on the Vine.†—Under the name *Uredo Vialæ* Prof. G. V. Lagerheim describes a new species, exceedingly destructive to the vines in Jamaica. The uredo-form alone is known, appearing as minute pustules, which cover more or less completely the under side of the leaves.

Trichophyton tonsurans parasitic on Cervus elaphus.‡—Dr. K. Eckstein finds the hairs of a specimen of *Cervus elaphus* attacked by this fungus, the mycele of which causes the disease of man and other animals known as "Herpes tonsurans." It causes disorganization of the cells of the hair, the entire pith passing over into a uniform granular mass, and the hairs finally falling off. Infection may be brought about by the carriage of the spores of the fungus by animal parasites.

"Bladder-rust" of the Weymouth Pine.§—In addition to the well-known *Peridermium Strobi* and *Pini*, Dr. H. Klebahn now describes a third species, *P. Cornui*, parasitic on *Pinus sylvestris*, and probably on allied species. Its teleutospore-form is *Cronartium asclepiadeum;* and the author gives a *résumé* of the genetic connection between the various teleutospore-forms *Coleosporium* and *Cronartium*, and the æcidio-forms *Peridermium*.

Parasitism of Tremella Dulaciana on Agaricus nebularis.‖—M. C. Roumeguère describes a new fungus parasitic on *Agaricus nebularis*, to which he has given the name of *Tremella Dulaciana*. The parasite measures 5 mm. in length and 1 mm. in height. The head consists of a gelatinous globular whitish mass, showing to the naked eye a number of threads forming tortuous circles, and somewhat recalling *Peziza Tamaricis*.

Thelephoreæ.¶—Mr. G. Massee publishes a monograph of this order of Fungi, prefixed by a description of its general characters. There occur within the order all the types of hymenium characteristic of the

* Amer. Natural., xxiv. (1890) pp. 177–80 (1 pl.).
† Comptes Rendus, cx. (1890) pp. 728–9. ‡ Zool. Anzeig., 1890, pp. 40–1.
§ Hedwigia, xxix. (1890) pp. 27–35. Cf this Journal, 1889, p. 564.
‖ Rev. Mycol., xii. (1890) pp. 1–3.
¶ Journ. Linn. Soc. (Bot.), xxv. (1889) pp. 107–55 (3 pls.), and xxvii. (1890) pp. 95–205 (3 pls.).

four principal groups of the Hymenomycetes, the Agaricineæ, Polyporeæ, Hydneæ, and Clavarieæ; and the author regards it, therefore, as constituting the base and starting-point in the evolution of the Hymenomycetes, excluding the Tremellineæ, which are more nearly allied to the Uredineæ. Two types of hyphal structure are met with in the order:—(1) Having thin walls, with little or no tendency to become gelatinous externally, numerous transverse septa, and usually much branched; and (2) walls very thick, with a decided tendency to become gelatinous or mucilaginous outside, not septated. Transitional forms connect the two extremes.

The following two new genera are described:—*Heterobasidium:* Resupinato-effusum, secernibile; subiculo compacto arido; basidia bimonospora; sporæ septatæ, fuscidulæ. The lowest member of the order, and intermediate between the Hymenomycetes and Hyphomycetes. *Asterostroma:* Resupinato-effusum; subiculo fibrilloso arido; hyphis stellatis brunneis immixtis; sporæ albæ, hyalinæ. Separated from *Corticium*, to which it is nearly allied, by its brown stellate hyphæ in the subiculum, and the dry minutely pulverulent not waxy hymenium. A diagnosis follows of the three genera *Hymenochæte*, *Corticium*, and *Stereum*, and of all their known species, among which several new ones are described.

British Gastromycetes.*—Mr. G. Massee reviews the structure and systematic position of this family of Fungi. He disagrees from De Bary's idea of the derivation of the Gastromycetes from the Polyporeæ, and suggests rather that they are descended from the Ascomycetes through the Tuberaceæ, by the gradual conversion of asci into basids, the Hymenogastreæ being regarded as the primitive stock of the Gastromycetes. The group is divided into the orders—Hymenogastreæ, Sclerodermeæ, Nidulariceæ, Podaxineæ, Lycoperdeæ, and Phalloideæ, diagnoses being then given of the twenty-one genera and seventy-four species at present known in Great Britain.

Protophyta.

a. Schizophyceæ.

Classification of Diatoms.†—Dr. G. B. De Toni proposes a new classification of the Diatomaceæ, of which the following are the primary divisions:—

I. Evolutio valvarum bilateralis, i. e. systema striarum v. costarum circa lineam medianam longitudinalem (raphem v. pseudoraphem) dispositum.

A. Valvæ nodulis medianis instructæ (*Noduliferæ* Deby); raphis genuina præsens (*Rhaphideæ*). (Naviculaceæ, Amphitrophidaceæ, Cymbellaceæ, Cocconeidaceæ, Gomphonemaceæ, Achnanthaceæ.)

B. Valvæ utræque nodulo mediano genuino carentes v. ob absentiam v. abbreviationem striarum costarumve spatium longitudinale raphem simulans (pseudoraphem) nodulosque et medianos et terminales (pseudonodulos) præbentes

* Ann. of Bot., iv. (1890) pp. 1–103 (4 pls.).
† Notarisia, v. (1890) pp. 885–922.

(*Pseudoraphideæ*). (Nitzschiaceæ, Cylindrothecaceæ, Amphipleuraceæ, Surirellaceæ, Diatomaceæ, Meridionaceæ, Trachyspheniaceæ, Plagiogrammaceæ, Licmophoraceæ, Striatellaceæ, Entopylaceæ, Eunotiaceæ.)

II. Evolutio lateris valvaris centricus ita ut sculptura radialiter e puncto mediano oriens disposita sit (*Araphideæ* v. *Cryptoraphideæ*.)

A. Valvæ non orbiculari-rotundatæ, sed 3-multi-angulatæ v. elliptico-constrictæ, sæpe processus varios gerentes, zona seu facies connectivalis sculptura ab ea faciei valvaris diversa et analoga ornata. (Biddulphiaceæ, Hemiauliduceæ, Isthmiaceæ.)

B. Valvæ orbiculari-rotundatæ, nonnunquam processibus aciculis v. spinis instructæ; zona seu facies connectivalis plerumque exstria, subrectangularis v. nonnunquam undulato-constricta. (Melosiraceæ, Xanthiopyxidaceæ, Coscinodiscaceæ, Eupodiscaceæ, Heliopeltaceæ, Asterolampraceæ.)

C. Valvæ tum æquales tum inæquales, imperfecte siliceæ, cornubus spinis setisve instructæ, zona connectivalis plus minus turgida, singula, breviter cylindracea. (Chætoceraceæ.)

D. Valvæ conoideæ v. acuminatæ, sæpius calyptra v. stylo terminatæ, per laminas parce siliceas numerosas apparenter imbricatas striatas conjunctæ. Frustula subinde per stylum calyptramve consociata. (Rhizosoleniaceæ.)

Pleurosigma angulatum.*—Dr. H. Van Heurck describes a series of preparations of this diatom, accompanied by photograms, made with an objective of 2·5 mm. focal length and a numerical aperture 1·63. The alveolæ or "pearls" exhibit themselves under the form of minute points, each surrounded by a crown of six secondary pearls, really intermediate between the primary ones. A careful examination of the photograms shows that the cause of this appearance is that the alveolæ are not really round, but hexagonal, the "secondary pearls" being the result of imperfect focusing of the angles of the network. This view is confirmed by a comparison with the structure of *Coscinodiscus excentricus*. It is further shown that the valve of *Pleurosigma* consists of two layers, and that the alveolæ are hollowed out in the substance of the valve.

Fossil Diatoms of Japan.†—Prof. J. Brun and J. Tempère describe the numerous new and marine species of diatom found in the argillaceous calcareous deposits of Sendaï and Yeddo; the most noticeable peculiarity of which is that they have been fossilized not by silica but by calcium carbonate, which has filled all the valves in the crystalline state, accompanied by small crystals of black oxide of iron.

β. Schizomycetes.

Structure of Bacteria and allied Organisms.‡—Prof. O. Bütschli deals with the finer structure of Bacteria in a monograph, the object of

* Bull. Soc. Belge Microscopie, vi. (1890) pp. 10–2 (5 photograms).

† Mem. Sci. Phys. et Hist. Nat. Genève, xxx. (1890) 75 pp. and 9 pls.

‡ 'Ueb. den Bau d. Bacterien und verwandter Organismen,' 1890, 37 pp. (21 figs.).

which is to demonstrate the proposition that these organisms are nucleated bodies. The ultimate structure of these minute bodies is divided into two parts, an outer harder layer and an inner softer part, the central body. The former is further distinguished from the central body by being less stainable with the ordinary pigments. In both a reticulated appearance is discoverable with high magnifying powers, and on section this reticulation or network imparts a honeycombed appearance to the object. At the points of intersection of the network are frequently seen red globules of variable size. These red globules, which are very frequent in the sulphur bacteria, are supposed to consist of sulphur in some viscid condition. Their exact significance seems doubtful. One point on which the author expresses himself confidently is that when a flagellum is present it is continuous with the outer layer. The central or chromatic part of the micro-organism is to be regarded as the nucleus.

Micrococcus versatilis.*—This micro-organism, which Dr. C. Delgado and Dr. C. Finlay presume to have some direct connection with the appearance of yellow fever, has been obtained by the usual methods, not only by these authors, but also by Dr. Sternberg and others from the juices and tissues of persons affected with or dead of yellow fever. The authors have obtained it from the serum of artificial blisters, and Sternberg from the skin of healthy but unwashed persons living in places where the fever is endemic. The name originally given to this micrococcus by Delgado and Finlay was "Tetragenus febris flavæ," but they now accept the new name proposed by Sternberg.

The best procedure for obtaining *M. versatilis* is to inoculate peptonized gelatin and keep it in the incubator at a temperature of 30°–32°. When a deposit forms at the bottom of the gelatin, gelose in Esmarch's tubes is inoculated therewith, and the tubes kept at a temperature of 30°–32°. Colonies began to appear in from two to six days, according to the season of the year and the activity of the germs cultivated. The colonies are round, with smooth edges, transparent, of a straw-yellow colour, but become opaque as they grow older. The colonies below the surface are more fusiform and deeper coloured.

The name *versatilis* was suggested by the different appearances presented by the colonies, their variable colour, and the diverse sizes of the micrococcus, which is chromogenous, and developes in true tetrads.

Bacillus of the Olive Tubercle.†—Dr. L. Savastano, who in 1887 announced that this disease of olive trees was due to a specific bacillus, now communicates some further characteristics of the micro-organism. Successful cultivations are made from commencing tumours; when these are older it is necessary to take the internal parts near the regeneration area. The bacillus is of medium size, and three or four times longer than broad. It is usually single, but may be in pairs. The ends are slightly rounded. The colonies are variable in shape, but usually round to oval. The cultivations succeeded well on the usual media, and slowly liquefied gelatin in May and June, but not from January to April. Spore-

* Journ. Anat. et Physiol., xxv. (1889) pp. 223–4.

† Atti Reale Accad. Lincei—Rend., v. (1889) pp. 92–4. Cf. this Journal, 1887, p. 286.

formation was not observed. The microbes were easily stained with the usual anilin dyes. The same micro-organism was detected in material sent from the olive plantations of Puglia, Calabria, about Vesuvius, and Sorrento.

Three series of inoculation experiments were made, and their results were that healthy olive plants raised from seed and not from cuttings, showed tumours in four or five weeks, while the control plants were unaffected. Secondly, that other kinds of plants inoculated with this bacillus never showed any kind of tumour. Thirdly, that olives inoculated with micro-organisms pathogenic to other plants were unaffected. Hence the author concludes that the *Bacillus Oleæ tuberculosis* is the specific cause of this disease of olive trees.

Influence of the kind of Nutriment of a Bacillus on the Diastase secreted by it.*—M. W. Vignal has found, from a series of experiments which he has made from some bouillon cultivations of *Bacillus mesentericus vulgatus*, that up to a certain degree the nutrient media exert a definite influence on the quantity of the excretory products secreted by this bacillus. This influence made itself appreciable to a slight degree on the addition of sugar or starchy material, and to a significant extent on the addition of casein. The excretory products always quickly disappeared from the cultivation fluids.

Bacillus mesentericus vulgatus.†—In a long monograph, M. W. Vignal treats exhaustively of the potato bacillus. He discusses its wide diffusion in water, in air, in the digestive system, its morphological, biological, and cultivation characters, and the way in which it is propagated and multiplies. The author then passes on to the influence which warmth and antiseptic media exert on the potato bacillus, and describes the changes which the bacillus induces in albuminous substances, gelatin, casein, sugar, starch, and vegetable matter, and concludes with remarks on the products of metabolism.

Existence of Micro-organisms in the Tissues of the higher Plants.‡—M. E. Laurent, in reviewing the connection of bacteria and the higher plants, points out that while there are few bacterial affections among plants, there are a great number in the animal kingdom. In animals, the bacteria overcome the resistance of the living cells by the production of toxic matter, which is rapidly diffused throughout the organism by the blood, while in plants the migrations of these parasites and their secretions is more difficult. The author sums up the results of his own experiments, and also those of others, as to the existence of foreign organisms within vegetable tissues, by denying the possibility of their existence under normal conditions. But although this statement is to be regarded as true for most cases, exceptions to the rule are pointed out. Thus several Nostocaceæ live within the tissues of various living plants, while a more remarkable example of symbiosis between vascular plants and microbes is offered by the Leguminosæ.

* Archiv de Méd. Experiment. et d'Anat. Pathol., 1889, p. 547. Cf. Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) p. 61.

† 'Contributions à l'étude des Bactériacées,' Paris, 1889. Cf. Centralbl. f. Bakteriol. u. Parasitenk., vii (1890) pp. 61–2.

‡ Bull. Soc. Roy. Bot. de Belgique, xxviii. (1889) pp. 233–44.

The author further gives a short notice * of some experiments which prove that bacteria are absent from the vessels of plants. He regards the theory of Béchamp as "the result of a lively imagination altogether devoid of experimental control."

ADAMETZ, L.—**Ueber einen Erreger der schleimigen Milch.** (On a micro-organism, the cause of viscous milk, *Bacillus lactis viscosus.* *Milchzeitung*, 1889, p. 941.

BUCHNER, H., AND OTHERS.—**Untersuchungen über die bakterienfeindlichen Wirkungen des Blutes und Blutserums.** (Investigations on the destructive influence of blood and blood-serum on Bacteria.) 1. Vorbemerkungen (Preliminary remarks), von H. Buchner. 2. Ueber den bakterientödtenden Einfluss des Blutes (On the fatal influence of blood on Bacteria), von H. Buchner u. Fr. Voit. 3. Welchen Bestandtheilen des Blutes ist die bakterientödtende Wirkung zuzuschreiben? (To what constituents of the blood is the fatal influence on Bacteria due?), von H. Buchner u. G. Sittman. 4. Versuche über die Natur der bakterientödtenden Substanz im Serum (Experiments on the nature of the fatal substance in the serum), von H. Buchner u. M. Orthenberger.
Arch. f. Hygiene, X. (1890) Heft 1, 2, pp. 84–173.

CELLI, A., ET G. GUARNIERI.—**Sulla etiologia dell' infezione malarica.** (On the etiology of malarial infection.) *Archivio per le Scienze Mediche*, XIII. p. 307.

DAEHLE.—**Beobachtungen über einen Antagonisten des Milzbrandes.** (Observations on an antagonist of charbon.) Thesis, Kiel, 1889.

FOKKER, A. P.—**Die Grundlagen der Bacteriologie.** (The foundations of Bacteriology.) Rede, gehalten beim Niederlegen des Rectorats der Universität Groningen. Leipzig, 8vo, 1889.

HANSGIRG, A.—**Ueber neue Süsswasser- und Meeresalgen und Bakterien, mit Bemerkungen zur Systematik dieser Phycophyten und über den Einfluss des Lichtes auf die Ortsbewegungen des *Bacillus Pfefferi* nob.** (On new freshwater and marine Algæ and Bacteria, with remarks on the systematic position of these Phycophyta, and on the influence of light on the locomotor movements of *Bacillus Pfefferi* nob.
Sitzber. d. Kgl. Böhmischen Ges. d. Wissensch. in Prag, Prag, 1890, 8vo, 2 pls.

LEWEK, THEODOR.—**Ueber den Wachsthumseinfluss nicht pathogener Spiltpilze auf pathogene.** (On the action exercised by some non-pathogenic Bacteria on the growth of pathogenic Bacteria.)
Ziegler's Beiträge zur pathol. Anatomie und zur allgemeinen Pathologie, VI. p. 3.

LORTET.—**Des microbes pathogènes des eaux potables.** (The pathogenic microbes of drinking waters.) *Lyon Méd.*, 1890, No. 13, pp. 450–4.

MANDRY, GR. D.—**Zur Kenntniss des Friedländerschen Bacillus und einer Abart desselben.** (Contribution to our knowledge of the bacillus of Friedländer, and on a variety of this micro-organism.) *Fortschritte der Medicin*, VIII. p. 201.

METCHNIKOFF, E.—**Étude sur l'immunité.** (On immunity.) 3e mémoire.
Annales de l'Institut Pasteur, IV. p. 194.

PLEHM, Dr. F.—**Beitrag zur Lehre von der Malaria-infection.** (Contribution to the knowledge of malarial infection.) *Zeitschrift f. Hygiene*, VIII. p. 78.

WAGNER, K. E.—**De l'action de quelques substances médicinales sur la croissance des cultures du bacille de la tuberculose.** (On the action of some medicinal substances on the growth of cultivations of the bacillus of tuberculosis.)
Wratsch, 1889, No. 42 (Russian).

ZIMMERMANN, O. E. R.—**Die Bakterien unserer Trink- und Nutzwasser, insbesondere des Wassers der Chemnitzer Wasserleitung.** (The Bacteria of our drinking and service waters, and especially those of Chemnitz.)
1st series, Chemnitz (Martin Bülz), 1890, 8vo, 106 pp.

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* Bull. Acad. Roy. de Belgique, lx. (1890) pp. 468–71.

MICROSCOPY.

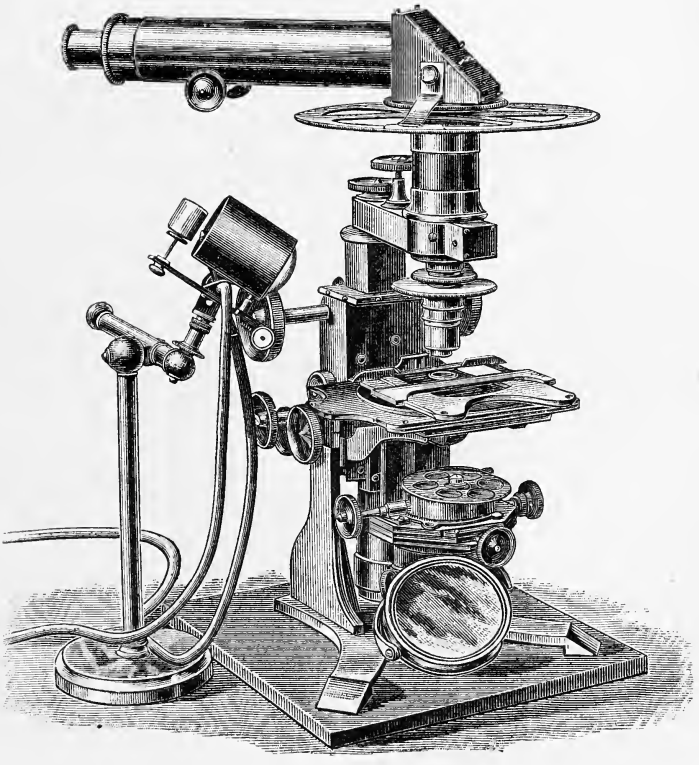
a. Instruments, Accessories, &c.*

(1) Stands.

Braham's Universal Microscope.—The following description has been communicated to us by Mr. Philip Braham, of Bath:—

"The original design of the instrument was based on the most improved Microscope, devised by the late Andrew Ross: but the modi-

Fig. 50.



fications I have made with a view to facilitating special investigations are considerable.

Fig. 50 shows my application of a rectangular prism, giving the

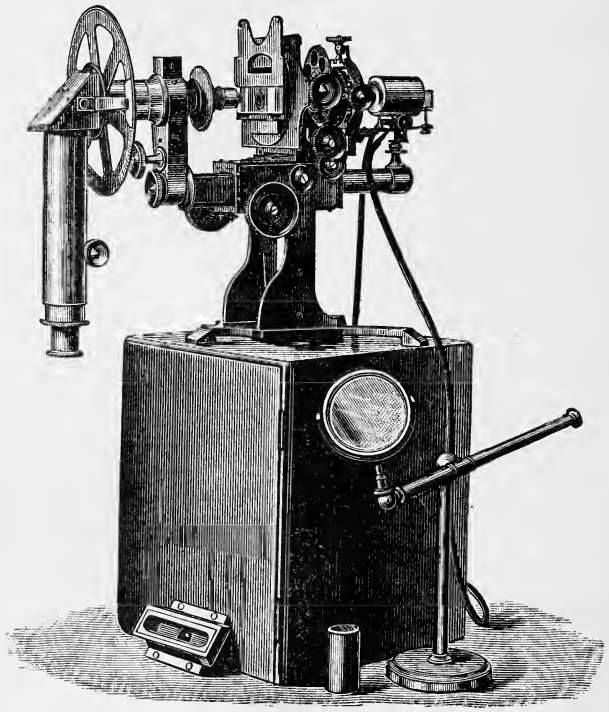
* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

observer an easy position for examining objects in liquids, and the means of measuring the angles of crystals.

The angles of crystals are measured by cross-wires in the focus of the eye-lens, a divided circle attached to the body of the instrument, and a Vernier attached to the side of the brasswork, carrying the rectangular prism, which is adjusted by three screws, so that the hypothenuse is exactly at an angle of 45° with the optic axis. The adjustment is made by placing on the stage a slip of glass, ruled with fine cross-lines, which are made to coincide with the cross-wires in the eye-piece.

The divided circle can be turned by rotating the tube at right angles

FIG. 51.



to the optic axis. The magnified image of the crystal also rotates, the angles being measured by the coincidence of the sides of the crystal with the cross-wires in the eye-piece.

This arrangement is also useful in observing phases in polarization, the tube carrying the polarizing prism on the substage being rotated by clockwork, and four pins making electrical contact and ringing a bell,

by which every quarter revolution is marked, and attention called to the changes visible.

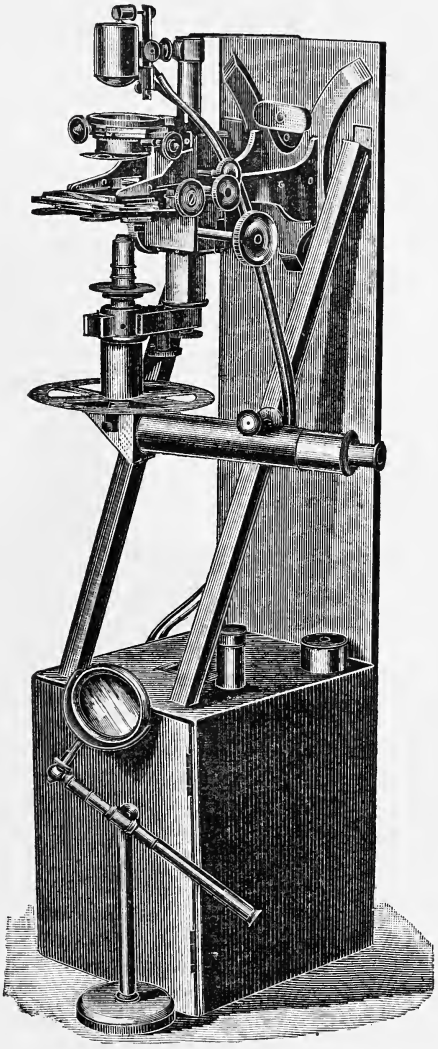
The limelight illuminator is shown in position for illuminating opaque objects, and a light from the mirror through coloured glass gives a good background for a variety of objects.

The limelight apparatus shown is conveniently clean and devoid of smell, and gives out very little heat. It can be used for oblique, opaque or transparent illumination, and can be varied in intensity. It consists of a diminutive limelight on a condenser stand, with an adjustable plano-convex lens in front. By varying the distance of the plano-convex lens in front of the limelight either convergent, divergent, or parallel rays can be obtained and projected in any direction.

Fig. 51 shows the instrument in position to project an image of an object on a sheet of paper on the table for sketching; the limelight being attached in the place of the mirror.

Fig. 52 shows the adjustment of the instrument in an inverted position. A board is attached to the box, and two struts are applied; the Microscope is then clamped to the upper part of the board, the feet fitting into corresponding notches in the board. This enables the observer to examine objects from beneath, whilst objects in liquids and tubes are seen free from cylindrical aberration by immersing the tubes in a cell shown on the table in Fig. 51.

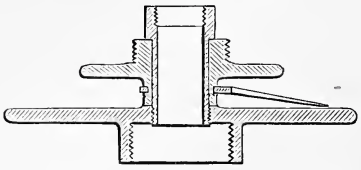
Fig. 52.

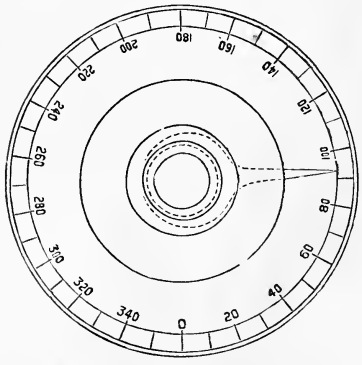


The interior of crystals or gems can be microscopically explored by immersing them in equally refractive liquids.

Fig. 53 shows my rotating nosepiece, consisting of a screw fitting to the objective end, and a divided circle fitting to the objectives and rotating. An index pointer sprung on to the nozzle shows the angle of rotation; the other end of the rotating tube is adapted to receive the analysing prism or a double-image prism, which can be used for measuring the angles of crystals by rotating the magnified extraordinary image round the ordinary. It can also be used in testing objectives."

Fig. 53.





Dumaige's "New Model of Microscope." *—M. Fabre Domergue describes and figures what he calls "un nouveau modèle de Microscope," constructed by M. Dumaige of Paris. We cannot, however, discover anything new in the instrument, and the only points to remark on are:—(1) the teeth of the rack are of ovoid section, and are set obliquely (a plan we believe not previously adopted in a French Microscope); (2) the carrier for the Abbe condenser is of reduced size, so as not to require the stage to be raised too much above the base; and (3) the pivot on which the condenser carrier turns is fixed to a slight prolongation from the right posterior corner of the stage, which the author considers to be "a very great advantage; it constitutes for the hand that works the micrometer-screw a kind of natural support, and allows the fingers much ease and suppleness in using the screw."

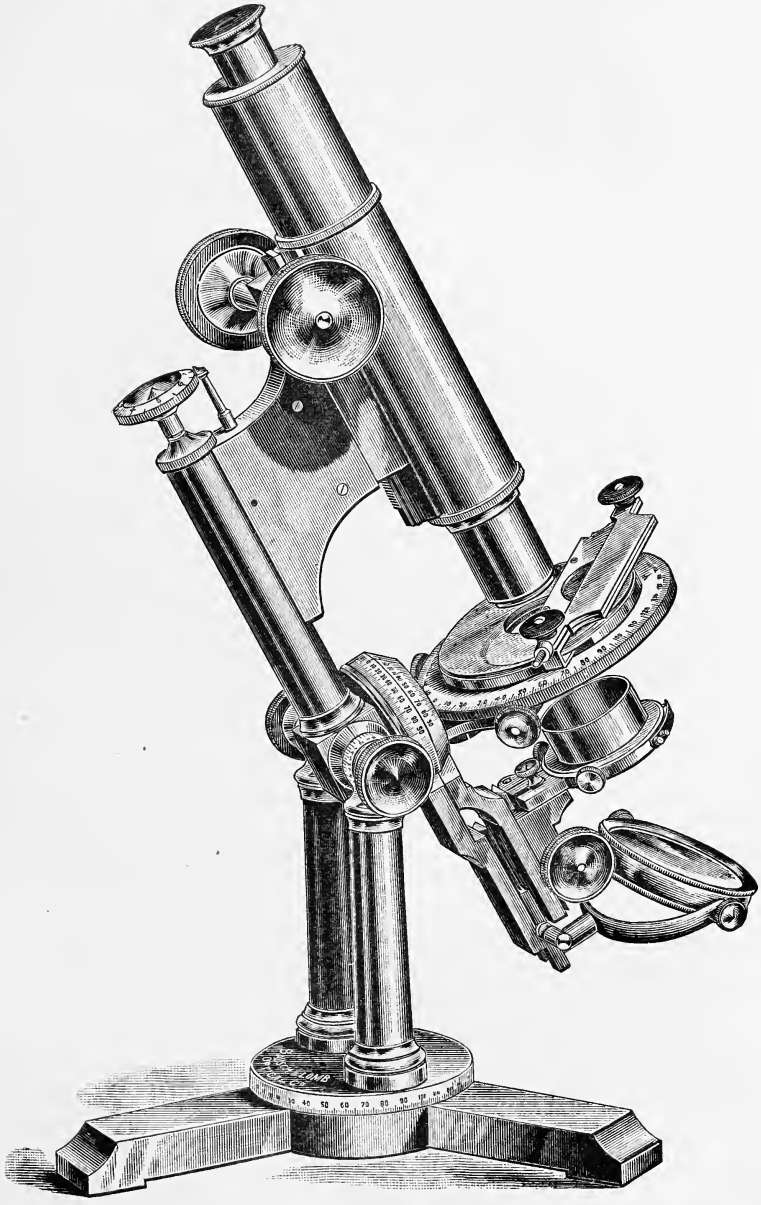
M. Fabre Domergue refers to condensers as having been "completely neglected ten years ago!" The introduction of the Abbe condenser, he says, imposes upon constructors the necessity of modifying the old models of stands so as to allow of the introduction of condensers beneath the stage.

Hart's Microtome-Microscope.†—The following is the abstract of a paper by Dr. C. P. Hart, as printed in the Proceedings of the American Association for the Advancement of Science, under the title of "*A new, cheap, useful, and quickly constructed adjustable Microtome.*"

"This instrument is nothing more nor less than a Bausch and Lomb "Microscope-stand, converted into a microtome by the following changes: "—Having removed the substage, the slide-carrier clips, the objective "adapter, and the draw-tubes, a suitable razor-blade is permanently fixed "to the slide-carrier, so as to have a corresponding universal lever move-

* Ann. de Micrographie, ii. (1890) pp. 164–7 (1 fig.).
† Proc. Amer. Assoc. Adv. Sci. for 1885 (1886) p. 356.

FIG. 54.



HART'S MICROTOME-MICROSCOPE.

"ment parallel to the glass stage. The imbedded substance is then carried "down the main tube of the instrument (which is placed in a horizontal "position) until it presses gently against the microtome-knife, when it is "fixed in position within the tube by means of the main draw-tube, the "diaphragm of which, either directly or by means of a small wooden "cylinder, is brought in contact with the distal extremity of the substance "to be divided, and this acts as a plug or follower to retain it in position "within the tube. Then, having moistened the knife, and, if necessary, "the substance to be operated on also, the slide-carrier, and with it the "microtome-knife, is made to pass through a sort of revolving cutting "motion, by which the sections are made. These sections may be made "of any degree of delicacy by means of the micrometer-screw attached to "the instrument."

The notion of converting such a Microscope into such a microtome seemed to be so unique in the novelty of its originality (it is difficult to hit on the exactly appropriate designation) that we imported the instrument from the United States, and give an illustration of it in fig. 54, which shows the razor-blade and slide-carrier in the form designed by Dr. Hart.

Alterations in Nobert's Microscope.*—Herr Kayser describes some alterations made on a Nobert Microscope. He particularly mentions the simple reading arrangement constructed by him, which is just as serviceable as a microscopical one composed of eye-piece and objective, but it does not invert the image. This arrangement consists of a small tube, containing only a thread and a plano-convex lens. Close to the eye comes the thread stretched horizontally, and then the lens, with convex side in front, at such a distance that the image of the thread is distinctly seen by the passage of the rays through the lens, and reflection at its plane silvered surface. A narrow strip of the silvering is removed in a direction passing through the centre, and at right angles to the thread. Consequently, when the distance of the tube is suitably adjusted, the eye can see a division through this central space. In order to have the division, but not the thread, more strongly magnified than in this, the simplest case, a second plano-convex lens of suitable focal length can be added immediately on the plane silvered face of the lens. Here two equal lenses of 10 mm. diameter and 25 mm. focal length are combined. On the thread end of the tube a white paper screen inclined at 45° with central aperture is fitted for the illumination of the thread. This small reading arrangement is fastened to the object stage, while an ivory rod with a range of 80 mm. divided into half millimetres, and fixed vertically on the Microscope-tube, can be displaced with the tube. A screw with large drum divided into 50 divisions serves to raise or lower the stage by slow degrees. Since the tenth of the division can be easily read, an arrangement is thus attained which, over a very large interval (80 mm.), gives an adjustment and a measurement which is exact up to 1/1000 mm. This is of importance, for instance, for microscopical measurements of the refractive indices of transparent plates. By means of the fine screw, the error of the divisions on the scale can be tested, and it is especially serviceable in

* Schrift der Naturforsch. Gesells. Danzig, vii. (1890) pp. xi.–xii.

adjusting objectives of short focal length and immersion systems, which must otherwise be done by testing, and consequently with danger to the apparatus. In determining the refractive index of a transparent plane parallel plate, Herr Kayser proceeds as follows. The refractive index is $= \frac{D}{D - d}$ where D and d are given by three readings on the scale, when the adjustment of the Microscope is made :—1. On the support of the plate. 2. On the upper face of the plate, after it has been put on the stage. 3. On the support as seen through the plate. The readings 1 and 2 give D, the readings 1 and 3 d. This method is, however, not sufficiently precise. Another and more exact method, with experimental proof, will be given later.

(3) Illuminating and other Apparatus.

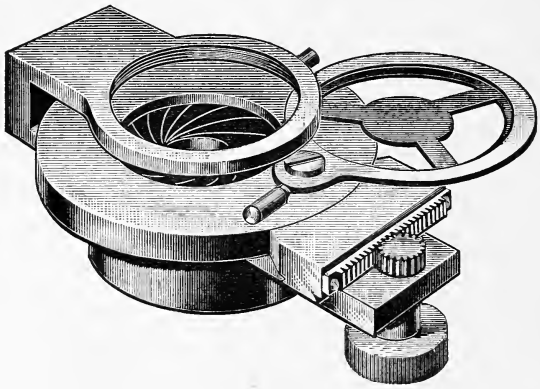
Mayall's "Jewelled" Fine-adjustment.—At the April meeting of the Society, Mr. J. Mayall, junr., referred to an improved form of fine-adjustment constructed and exhibited by Messrs. Powell and Lealand, for the production of which he was himself chiefly responsible. He said that during the past ten or twelve years, several forms of fine-adjustment had been brought to the notice of the Society, but the principal aim in most of them had been economy of production or lowness of price, without regard to improving on the best existing forms. In the new form exhibited the chief aim had been to construct a fine-adjustment that should combine extreme sensitiveness of action with accuracy and probable durability, beyond what had previously been attained. With this view he had carefully considered every known form of fine-adjustment, and had selected that of Messrs. Powell and Lealand, as representing the highest type of construction yet devised, with which to test the possibility of improvement. The essential feature in the improvement was the application of what watchmakers would term a "jewelled movement." The whole of the contact surfaces by which the fine-adjustment was actuated consisted of polished steel and agate, the intention being to reduce the friction as much as was consistent with steadiness of motion. The perfection and durability of jewelled mechanism was a great feature in the highest class of clocks and watches; the most delicate parts of Nobert's ruling machine were jewelled, as were also the bearings in Dr. Hugo Schröder's feeling level for testing the accuracy of plane surfaces. Those who were familiar with Powell and Lealand's fine-adjustment, as previously constructed, would understand the extreme difficulty of improving the mechanism substantially, for it was the outgrowth of long experience and of the most conscientious devotion of expert mechanicians to the task of providing a perfect focusing movement. No other fine-adjustment had reached the same high standard of construction, which was probably due to the fact that during the fifty years that had elapsed since its first production, the makers had kept steadily to the same system, only varying the minor details of the mechanism as experience critically suggested in the direction of improvement.

The application of polished steel and agate bearings throughout the mechanism was intended to reduce the friction, and thus render the

action more sensitive without introducing unsteadiness. The result attained was undoubtedly an improvement on the whole system, though the cost would probably limit the application to the few instruments required for very special and difficult investigations in microscopy. For high-class photomicrographic work, or where preparations had to be retained under observation for long periods of time, the new mechanism should be particularly useful, for the greater solidity of the general construction clearly pointed to greater precision of action and increased stability.

Messrs. Bausch & Lomb's Condenser Mounting.*—We give a figure of a condenser mounting with iris diaphragm recently designed by Messrs. Bausch and Lomb. This mounting provides a movement for the

Fig. 55.



diaphragm by rack and pinion. It has in addition a recess for receiving central stops and blue glass.

It can be attached to an adjustable substage or to a substage fixed to the stage, and may be used with the high and low angled Abbe condenser.

New Stage Micrometers.—At the May meeting of the Society, Mr. E. M. Nelson called attention to a new stage micrometer, produced by Messrs. Powell and Lealand, and so excellently ruled as to be worthy of remark:—"It comprises 100ths and 1000ths of an inch, and 10ths and 100ths of a mm., there being 10 divisions of each set; the finer divisions of ·001 in. and ·01 mm. being placed in the centre, the ·01 in. being on the one side, and the ·1 mm. on the other, respectively, a guiding line being ruled at right angles to them. The lines are fine, 1/30,000 in., and are blackened in, and mounted in balsam. The lines are straight, and evenly ruled. With regard to the spacing, I have made exhaustive comparisons with fine micrometers by Rogers and Zeiss, and some others not quite so perfect. Upwards of 240 screw micrometer

* Amer. Mon. Micr. Journ., xi. (1890) pp. 25-6.

measurements were made, and the work carried on under hypercritical conditions. An account of these may be of interest. First, a magnification of 1200 diameters by means of a suitable immersion lens was employed for the finer ruling, and for the coarse a dry 1/6 × 600 diameters; the screw micrometer was on an independent mounting. Care being taken with regard to the illumination, &c., a critical image of the lines was obtained. The order in which the lines were taken was from left to right, as seen in the instrument; each interval was then designated by consecutive letters of the alphabet. The intervals were then most carefully wired, and each value set down under its corresponding letter; when the ten spaces were finished they were meaned.

It was then easy to see which interval differed from the mean, and to calculate how much. In the same way comparison can be made with any other scale, it matters not whether it is ruled in inches or mm. It is most important that both the instrument and the observer be tested. To this end I proceeded as follows. The screw value of 20 intervals on a badly ruled scale was written down as above, the paper was then put away, and the operation performed again.

On comparing the two papers, the screw values of seven intervals were identical, 12 different by one division, and one by two divisions. This error of two divisions occurred in the interval H, the first reading being 1033, and the second 1031. On careful re-examination of this interval, I came to the conclusion that the first reading was the bad one, and that the true value was 1031 or 1032. On substituting this last value in both sets of readings, the 20 intervals meaned precisely alike, viz. 1038. As this forms a suitable illustration of the work, I append the two columns. With the exception, therefore, of the interval H, the screw readings may be taken as true to ± 1. The point, therefore, we have to determine, is the value of ± 1. The mean 1038 being the value in divisions of the screw-head, for 50 μ, the value of one division consequently = ·000001897 in., or less than 1/500,000 in.

This might be called 'the constant of the instrument, and observer.' We next have to find the greatest errors of the intervals from the mean; G is the greatest, and S the least. Calculation shows that G is 1/20,000 in. too large, and S 1/40,000 in. too small.

But, on returning to Powell's scale, we find a much closer agreement than this. Taking the ·001 in. first, we find the mean to be 628·0. Three out of the ten intervals agree to that mean to ± 1: this being 'the constant of the instrument and observer,' they are without sensible error. Four intervals agree to ± 2, which is less than 1/300,000 in.; two lines B and H agree to ± 3, which is less than 1/200,000, and one interval G is + 4, viz. 1/157,000 in., too large. Now, as we found that ± 1 was the limit of observation, we may say that the scale, with the exception of B, G, and H, has no sensible error. Practically speaking, G is the only interval that is out, and its error is small in comparison with other scales.

The next scale is the 1/100 mm.

The ·01 mm. is too small a quantity to treat in the above way; it must be left until we have objectives as perfect as those we have at present, but of double their power.

All that can be done is to take several of the divisions. Eight sets

of three each were measured on Powell's new scale: the variation from the mean was less than 1/200,000 in. Rogers' is a very well ruled scale; it is, however, difficult to observe, the lines being without pigment, and it is mounted dry. The lines under these circumstances present the usual black and white diffraction images. It is, on that account, very difficult to maintain an equable focus during measurement. In Rogers' scale, the greatest error is in interval G, where it amounts to four divisions, or somewhat less than 1/100,000 in. Thirteen out of twenty intervals have practically an insensible error. One cannot speak with the same certainty with regard to this plate as to the others, because of the focal difficulty. Different readings gave discordant results; therefore, in this case, more must be allowed for the 'constant of the observer and instrument.' With regard to the 1/10ths of a mm. on Powell's scale, they were examined by a power of 600 diameters by a dry lens. The mean was 987; six intervals had no sensible error, but C and G had an error of three divisions, which is equivalent to 1/100,000 in.

Rogers gave a very similar result.

The error of the interval D, in the Zeiss scale, was 1/30,000 in.

I next compared the length of the mm. on the three scales, that is Powell's, Rogers', and Zeiss', with each other. I detected a slight but insensible difference of $\pm$ 1. All that now remains to be done, is to compare the inch and the mm. scale on Powell's plate. By measurement, we found that 30 μ gave a screw value of 741·25; therefore, the value for ·1 mm. would be 2470·8, and the value for 1/1000 in.

$$\frac{\cdot 001 \times 2470\cdot 8}{\cdot 003937} = 627\cdot 59.$$

The value actually measured was, as we saw above, 628·0; here again there is no sensible discrepancy. In conclusion, I feel sure that such an accurately ruled micrometer, and one so clear to read, will prove extremely useful to microscopists at large.

Before closing, I would like to bring to your notice a screw micrometer made for me by Mr. Powell, which contains some slight modifications from the usual forms, which practical experience has suggested to me.

First, with regard to the lens portion, I have substituted a compensating positive for the old form of Huyghenian or Ramsden. This yields far better images when making measurements with apochromatic and ordinary objectives. I have so arranged it that the compensating eye-lenses of different foci are interchangeable. In fact, no special lens is required, you use your ordinary working eye-piece, whatever that one may be. This is, of course, a great advantage: bacteria, for instance, require a high-power eye-piece micrometer, while such a power would be useless on an ordinary object.

Therefore, the ability to regulate your eye-piece power to the object to be measured, will meet a long felt want.

Next let me say that I entirely disapprove of having two movable threads; at the outset 'the constant of the instrument' would be doubled; moreover, I am confident that a movable zero is a mistake.

I have, therefore, considerably altered this portion of the instrument by making the screw portion, together with the fixed zero thread, movable in the other part, which might be aptly termed 'an eye-piece

adapter.' By this we secure the advantage of the double movable thread, without the additional error of the double movable thread, and this, moreover, without losing the convenienee of a fixed zero.

This enables you to span your object at equal distances on either side of the optic axis, without disturbing the centricity of the eye-piece. A guiding line has been added, because an error might creep in unless measurements are made with precisely the same portion of the wires.

The divisions on the screw head have been made white on a black ground, on account of their being easier to read in a darkened room. A cap to protect the threads from dust and injury, &c., is provided, as the threads are no longer inclosed between the lenses, as in the Huyghenian form.

An iris diaphragm is placed below the threads and as close to them as possible.

In spanning the stage micrometer, it will be found better to take the readings from centre to centre of the lines, by doing which you avoid the diffraction which is always present at edges.

The measurement of all objects should be performed under a wide angled cone of illumination, so that the diffraction at the edges may be minimized as much as possible."

Two Readings of Scale 50 μ.

				diff.
A	1038	A	1038	0
B	35	B	36	+ 1
C	37	C	36	− 1
D	36	D	37	+ 1
E	30	E	29	− 1
F	37	F	37	0
G	65	G	64	− 1
H	32	H	32	0
I	29	I	30	+ 1
J	48	J	48	0
K	34	K	33	− 1
L	29	L	30	+ 1
M	40	M	40	0
N	45	N	45	0
O	38	O	37	− 1
P	44	P	43	− 1
Q	39	Q	39	0
R	40	R	41	+ 1
S	24	S	24	0
T	40	T	41	+ 1
20	760		760	0
	1038		1038	

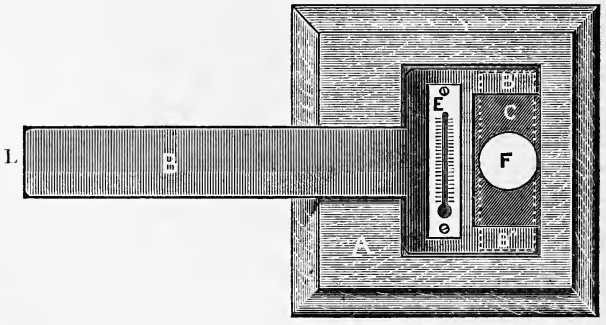
H H altered from 33 and 31 respectively.

An easily constructed Hot-stage.*—A very simple and convenient hot-stage was exhibited by Dr. Robert Reyburn at a recent meeting of

* Amer. Mon. Micr. Journ., xi. (1890) p. 1 (1 fig.).

the Washington Microscopical Society. This form is adapted from the more complicated and expensive forms used by microscopists, and is claimed to be especially useful from the fact that it can be made at a trifling cost by any one possessing a little mechanical skill. In fig. 56, A represents the wooden block or stage which is fastened upon the brass stage of the Microscope. A space is cut from the upper surface of this block, as shown by C, into which is fitted a piece of copper plate (B, B′, B″). A round hole is also cut at F, the opening of the brass stage, to allow of the illumination of the object to be examined. The slide is placed on the copper bed with its ends resting at B′ and B″, as indicated by the dotted lines. The heat is applied by a spirit-lamp at the end L of the copper plate B which

Fig. 56.



gradually transmits the heat by conduction to the slide. The temperature is registered by the thermometer E, which is screwed fast to the copper plate.

Application of Apertometer to the Microscope.*—Herr Kayser remarks that the narrowest perceptible distance of a wave-length stated by Fraunhofer and Nobert, is not the extreme limit which the newer Microscopes with oil-immersion systems have reached in the resolution of the structure of diatoms. The smallest recognizable distance ϵ approximates to the expression established theoretically by Helmholtz

$$\epsilon = \frac{\lambda}{2 \sin \alpha},$$

where λ denotes the wave-length and α the angle of divergence under which the extreme rays from the axis of the object fall upon the objective system. Since this angle can with an immersion lens be nearly a right angle, the numerical expression for the limit, taking $\lambda = 0 \cdot 00055$ mm. in the most general case, will amount to the half wave-length $0 \cdot 000275$ mm. According to the practical investigations of Abbe and Dippel, the resolving power of an objective system stands in very close relation to the magnitude of the angle of divergence. On this account makers are

* Schrift. der Naturforsch. Gesells. Danzig, vii. (1890) pp. xiii.–xvi.

obliged to have regard to the greatest possible angle of aperture or to the highest "numerical aperture" of Abbe, of which the expression is $a = n \sin u$ (where u is the refractive index). Accordingly they give in their price lists with dry systems the angle of aperture or the numerical aperture, and with immersion systems the latter. Whether these data correspond to the facts must be subjected to experiment. Herr Kayser received from a well-known firm an oil-immersion (1/16 in.), which he had required to be capable of resolving *Amphipleura pellucida* in oblique light. The system supplied did not answer to the requirements. The maker having ascribed the non-resolution to "badness of the preparation, defects in means of illumination, stand, &c.," it remained for a time doubtful whether these circumstances were really to blame. Herr Kayser was at that time engaged on the construction of apertometers. The apparatus resulting from his investigations, which serves for the examination of dry systems, has the following arrangement. Round a horizontal divided circle a vernier can be turned, and an upright, on which is fixed a Microscope directed horizontally, is set up in the centre. In front of the objective of the latter is a ring attached by a pin to the same upright. This ring can be rotated about the axis of the upright by means of side pieces which reach to the horizontal scale and carry a second vernier. With the plane of the ring at right angles to the axis of the Microscope, which passes through its centre, the reading on the second vernier is 90°, when the direction of the Microscope corresponds to the reading 0°. The system whose aperture is to be tested is placed in the ring. The Microscope is then displaced along its axis until the combined optical apparatus, which acts as a non-inverting telescope, shows the images distinctly. When by suitable turning of the whole apparatus the cross wires of the Microscope have been adjusted on an object not too near, the first vernier is displaced, without moving the second, both to right and left, until the image in each case just vanishes on the edge. The sum of the two angles read off is the angle of aperture. The angle thus given for an objective system, No. 7, of about 4 mm. focal length, was greater than the value given for it and found by the Abbe apertometer, in which the identity of an optician's systems of equal members is assumed. The author, attributing the magnification to his apparatus objective, tried the apertometer objective of Zeiss, specially made for the Abbe apertometer; but even with this the result remained unaffected.

The second apertometric apparatus constructed by Herr Kayser can be used for both dry and immersion systems. It consists simply of a glass plate of which one face is silvered and has scratched upon it a system of concentric circles which come into observation according to the dimensions of the apertures to be determined. The plate is laid on the stage with the silvered side downwards, and carries on its upper face in the middle of the rings, a small cover-glass, on the under side of which is a small mark. The Microscope containing the objective to be tested is first adjusted on this mark. Then without moving the body-tube the eye-piece is withdrawn, and again replaced in the tube when combined with the apertometer objective. The eye-piece is then adjusted so that the rings near the edge appear quite distinct; the extreme ring is counted, and if it does not exactly coincide with the edge, an estima-

tion in tenths of the following ring interval is made. A central portion of the silvering is removed and illumination by a mirror used in order to make the mark on the cover-glass visible. For the illumination of the rings, however, a white paper screen above the objective, and set obliquely to the incident light, is sufficient. The rings then appear dark on a white ground, and it is not necessary to have light incident from a mirror below. When an immersion system is to be tested, the observation is made in the same way except that, in this case, a drop of the liquid is first inserted between lens and cover-glass. To fix the diameter of the rings of this apparatus before they are actually scratched on the plate, a determination of the exact thickness of the glass plate and its refractive index must first be made. As found by the microscopical method, the first was 6·13 mm., the second = 1·525. The rings are arranged at intervals of 5/100 of the numerical aperture. The data, for example, for an aperture of 0·80 are as follows:—

$$0{\cdot}80 = 1{\cdot}525 \sin \chi,$$

whence the angle in the glass $\chi = 31^\circ\ 38'$, but

$$\tan \chi = \frac{r}{6{\cdot}13},$$

from which is deduced the radius of the ring in question $r = 3{\cdot}777$.

The angle of divergence α in air, since

$$n \sin \chi = \sin \alpha$$

is

$$\alpha = 53^\circ\ 7'.$$

The double amount 106° is therefore the angle of aperture corresponding to the numerical aperture 0·80 mm. The radii for the numerical apertures up to 1 would be as follows:—

0·80	3·777 mm.
0·85	4·115
0·90	4·481
0·95	4·881
1·00	5·324.

The plate contains in this way rings increasing in diameter up to the aperture

1·40	18·820 mm.

For greater distinctness, at certain intervals, two circles close together are drawn instead of one.

In testing the oil-immersion system previously referred to, the fifth reckoned from the ring corresponding to the aperture 0·80 fell on the edge of the field of view. It has, therefore, at most, the numerical aperture 1·00, whereas in the price list of the firm it was called 1·25. This was a great discrepancy, for if the system had really possessed the latter aperture, five more rings ought to have been seen. The numerical apertures necessary for the resolution of different diatoms are given in Dippel's text-book of general microscopy in the tables of comparison which have been established by exact scientific observations. On

reference to these tables, the data referring to 1·00 were found to be *Nitzschia curvula* and *Navicula rhomboides* (*Frustulia*) var. *saxonica* 36 striæ in 1/100 mm., while for the resolution of *Amphipleura pellucida* with 40–42 striæ, a system of 1·10–1·15 was found to be necessary.

Long before the use of the apertometric process, Herr Kayser had informed the maker of the system that he fixed the resolving power at 34 striæ from the fact that *Nitzschia curvula* was not resolved, and that *Frustulia* showed striæ first on the edges. The maker, ascribing the non-resolution to the mounting of the preparation, at the same time sent preparations which really were resolved. The striation of these, however, only amounted to 26 and 24 to 30 respectively, while *Amphipleura pellucida* was not forthcoming, because they were "at present not of good quality."

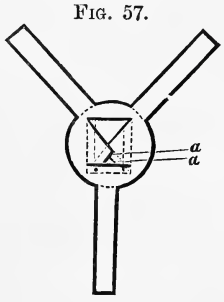
Dippel's work shows with what exactness the productions of microscopical forms can be apertometrically rated, in a way quite analogous to the determination of size by the scale. The action of an optician therefore who sells an objective system having a less aperture than it professes to have, must be compared to the behaviour of a tradesman who supplies goods deficient in quantity.

An advantage is now to be considered which the apertometer ring method possesses over that of Abbe. In the latter method a pointer is turned round on a polished glass cylinder until it appears to come on to the edge of the aperture. In this way the aperture is tested only in a certain diameter. By the author's method the whole range is seen at a glance, and any defects can also be noted. It is interesting that in the present dry system No. 7, the rings do not appear to be exactly concentric, but in a certain diametral direction on one edge there are broad intervals, on the opposite narrow ones, so that for the clear definition of the first, a further pressing in of the eye-piece is necessary. This asymmetry can be also recognized by the first method in the change in adjustment of the eye-piece, and out of the difference of the horizontal angle.

PLAXTON, J. W.—**A Camera Lucida for nothing.**

["The other day, after a morning's work, something went wrong with the prism of my camera lucida, and, do what I would, I could not bring it back to usefulness. At a loss for the moment, I cast about for a substitute, and in half-an-hour, with penknife and pencil, out of a piece of stiff paper and a square of thin glass, had turned out a fragile but efficient substitute for what is known in catalogues as 'Beale's Neutral Glass Reflector,' price 6*s*.

FIG. 57.



"This is how I did it—Describe a circle by standing the eye-piece of the Microscope on the paper and running a pencil round it; inscribe a square in the circle already drawn by drawing the pencil along the edges of the square of thin glass you intend to use; now lay down the diagonals of the square; draw three other lines within the square, each one parallel with a side of the square, and each, say 1/8 inch from the side; draw two other short lines (*a a* in the diagram, fig. 57) parallel to the diagonals.

Take the penknife and, following the continuous lines of the diagram, cut through the paper: you will have in paper what resembles a three-spoked

wheel without tire. The upper triangle of the four within the square falls away as useless; the lateral triangles open outwards, and stand at right angles with the plane of the circle; the little flanges on their lower edges are made by creasing the paper to support the thin glass. The base of the lower triangle answers the same purpose.

"Put the eye-piece in the Microscope, the circle of paper to the end of it; turn the spokes of the wheel back along the tube, and slip a tiny elastic band over them, or tie them with a thread; a little manipulation with the fingers, the thin glass is in place, and the thing is done.

"Need I say that any one can see that it would be almost as easy to use a piece of thin sheet brass or other metal as to use paper?"]

Journ. of Microscopy, III. (1890) pp. 40-1 (1 fig.).

(4) Photomicrography.

Some Experiences in Photomicrography.*—"More than a dozen years have now elapsed since I made my first photomicrograph; at that time the successful workers in this country could be counted on one's fingers, and the old messy wet process and expensive appliances were regarded as indispensable for good results. The development of amateur photography following the general introduction of dry plates could not fail to influence photomicrography, since few microscopists viewed with indifference the placing at their doors of a ready means of recording observations. The experience gained during ten years of continuous work, covering almost every class of subjects, with amplifications ranging from four to four thousand diameters, has, naturally, emphasized many facts; the possibility that a brief statement of these conclusions may aid younger workers in this field must be my apology for the egotism of these remarks.

While appreciating fully and endorsing heartily the efforts of those working with no greater responsibility than their individual enjoyment, it is rather to those seriously engaged in endeavouring to produce the best and highest class of this work, that these suggestions are offered.

The three essential conditions for success in photomicrography are:—(1) Satisfactory apparatus; (2) Good illumination; (3) Suitable preparations.

Satisfactory apparatus by no means implies elegant appliances, but adaptation to purpose; so that the Microscope be very solid and firm, and supplied with a substage to which a condenser can be attached and satisfactorily adjusted, and that the camera be of sufficient length, it matters little as to exact form or detail; for high powers the mechanical stage is a convenience, and for extreme amplifications (2000 and over) well nigh a necessity. The most complete photomicrographical outfit to be had is, undoubtedly, the one made by Zeiss, of Jena. . . . Of greater importance, however, is the quality of the objectives, for only those of the most perfect correction will stand the severe test of photography. While there are many others, which personal use has shown to answer well, my experience would lead me to select the following as being especially satisfactory:—3 in. Crouch, 1½ in. Beck, 3/4 in. Bausch and Lomb, 4/10 in. (BB) Zeiss, 1/4 in. "Photographical" Bausch and Lomb, 1/6 in. (DD) Zeiss, 1/12 in. oil-immersion apochromatic Zeiss. The 3 in. Crouch and the 4/10 in. (BB) Zeiss deserve especial mention,

* By George A. Piersol, M.D., of Philadelphia. Amer. Annual of Photography, 1890.

as for crisp definition over an entire perfectly flat field they are unsurpassed; for high amplifications the new apochromatic oil 1/12 Zeiss is superb.

The question, whether to receive the image directly from the objective on the plate, or to employ some means to project the image, has received of late much attention. While fully appreciating the theoretical objections to the direct image, I confess that for low and medium powers I continue to use it by preference, as the photographs so obtained fully equal in every respect any which I have ever seen made by the indirect mode. With high amplifications (1000 diameters and over), the conditions are greatly changed by the approach to the limit both of the shortness of the focus of the objective and of the length of camera which can be advantageously used; my experience leads me to adopt the 1/12 in. objective as the one, and not over four feet as the other limit, since any given high amplification, say 2000 diameters, can be more satisfactorily and more conveniently obtained with a superior 1/12 in. connection with suitable optical means to increase the initial magnifying power of the objective than with an unaided 1/25 lens and the plate removed to a great distance. Until quite recently the various amplifiers offered the best means of increasing the power of an objective, but the introduction of the "projection-oculars" of Zeiss has given us an accessory for this purpose far superior to the older devices. These projection-oculars resemble the ordinary microscopical oculars, or eye-pieces, only in general form and in name, being optically a projection-objective in connection with a collecting lens. The new oil-immersion apochromatic lenses, in combination with these projection-oculars, form, undoubtedly, the most efficient equipment for high-power work, and have but one drawback—their cost. It is, unfortunately, as true for high-power photography as for microscopical observation in general, that the best results are to be obtained only with fine, and necessarily expensive, optical appliances. If for the satisfactory study of the intimate structure of a cell, or of a micro-organism, the most improved immersion lenses are necessary, it is to be expected that for the successful photographing of the same, tools at least as good are needed. The complicated mechanical arrangement for controlling the focusing adjustments from a distance, may usually be replaced with advantage by the simple contrivance of cords and weights, devised by the writer more than a dozen years ago, which has been so generally adopted in this country; during the extended continued use of this little device, it has never been found wanting, responding perfectly to the severe demands of the highest amplifications. A modification for the coarse-adjustment, having pulleys and very heavy weights, serves equally well when very low (2 to 5 in.) lenses are used. A very stiff spring in the fine-adjustment may sometimes require increased friction to prevent the cord from slipping, the necessary traction being obtained by heavier weights, or by taking an extra turn of the cord about the milled head of the micrometer screw.

My conclusions regarding the second of the necessary conditions—good illumination—are briefly stated; after many experiments with various kinds of artificial illumination, and after the examination of innumerable specimens of the best work of acknowledged experts, while, of course, admitting that good photographs can be made, under suitable

conditions, by these means, yet I am fully pursuaded that sunlight is by all odds the best, and, for high powers, the only really satisfactory illumination by which to make photomicrographs that are satisfactory as photographs, as well as records of microscopical observations. That even by good lamplight fair impressions of objects under extreme magnification can be obtained, no one questions, but the negatives produced by such illumination seldom, if ever, possess the characteristics of a really good sunlight negative, where the sharpest details are combined with an exquisite softness and harmony of half-tones. That a photomicrograph should be a silhouette of deep shadows and chalky whites, is a proposition to which I could never subscribe. Sharpness and vigour are, of course, the first essentials in a photomicrograph, but there seems to be no reason that in such a picture all the qualities of a good photograph should not be represented. An almost identical opinion regarding the advantages of sunlight, has been reached by Dr. R. Zeiss,* after a most exhaustive series of experiments with artificial illuminations of all kinds, stimulated by the hope of finding a satisfactory substitute for sunlight, the uncertainty of which, during the greater part of the year, is even a greater inconvenience in Germany than with us.

The third condition for good work—suitable preparations—though last, is by no means least, for all apparatus and illumination avail but little when proper preparations are wanting. Thanks to our present microscopical technique, these are readily obtained, since extremely thin and well-stained preparations of vegetal and animal tissues are now matters of everyday production. The thinness with which sections are now usually cut (·005–·01 mm.) often renders them, when stained with the staple carmine dyes, too actinically transparent to photograph well with very low powers. The interposition of some ray-filter readily overcomes this; during the last three years a screen of yellowish-green glass has been in constant use, with the most satisfactory results, yielding plucky pictures of objects entirely too transparent to produce sufficient contrasts in the negatives; the exposure, however, is increased about three to five times, but this, even when thus lengthened, seldom exceeds 20–25 seconds, on Carbutt's "B 12" plates. Where great differences of colour are present in the same preparation, or where certain unfavourable tints, as deep brown, prevail, the orthochromatic plates offer decided advantages; for, however, ordinary preparations with but one stain, the colour-screens, when judiciously selected, will yield equally good pictures, with a gain in economy, convenience, and certainty. The modified hæmatoxylin stains, producing browns and slate-blues, are very valuable for special purposes, but require some considerable technical experience for their successful production.

What has been written may appear to discourage the undertaking of this most fascinating branch of photography, where the primary object of instructive entertainment does not warrant the acquisition of the class of appliances above recommended; this should not be so, as the full force of these suggestions applies only to those whose work in this line necessitates the use of the higher amplifications, with the view of producing the highest possible results."

* 'Special-Catalog über Apparate für Mikrophotographie,' Jena, 1888.

To the amateur, who has been using but lamplight for his exposures, it is suggested that he avail himself of some bright "off-day" to give sunlight a trial. If the mirror of the Microscope be of good size, it will be only necessary to make an arm on which to support the removed mirror outside some southerly exposed window, since it is desirable to have much more distance between the mirror and the stage than would be possible were the mirror attached in its usual place. Where the Microscope mirror is too small to be satisfactorily used, a rectangular wood-framed looking-glass is readily mounted with the aid of a few strips of wood, so as to turn about both axes.

The rays from the plane side of the mirror are passed through a condensing lens (of 8–10 in. focus, if possible), so placed that they are brought to a focus before reaching the plane of the object. The exact position of the condensing lens is a matter of experience; usually, however, the most favourable illumination is obtained at that point where the field is still *uniformly* illuminated, just before the rays form an image of the source of light; the nearer the rays are focused, the less disturbance from diffraction rings. Ordinary objectives will require the employment of monochromatic light—produced either by a deep blue solution of ammonio-sulphate of copper, or by the green glass screen already mentioned—since the optical and actinic foci do not usually coincide. Powers up to the 3/4 in. will require no further condenser; with the 1/4 or 1/6 objectives, the low power (1 or 3/4 in.) serves with advantage as an achromatic condenser, when attached to the substage. The Abbe condenser, although so important for refined microscopical investigation, is not adapted to photography unless a very wide cone of light is desired, which, for the majority of preparations, is a decided disadvantage; a low-power objective, used as a condenser, will generally be found more satisfactory than the Abbe with a small diaphragm.

The simple apparatus indicated, when properly handled, will produce excellent work with such powers as the amateur is likely to employ; focusing the image by the monochromatic light, and avoiding over-exposure, being the points especially requiring experience. When it is remembered that seconds, with very slow plates, usually suffice for the minutes with rapid ones of an exposure by lamplight, the intensity of the actinic power of the sunlight will be somewhat appreciated. Some simple arrangement, by which the rays from the mirror may be cut off with sufficient rapidity, will suggest itself; an effective one is a small shutter, turning at one end on a screw and covering a circular opening in a board, through which the rays from the mirror pass; the rapidity with which the sun's image from a fixed mirror becomes decentered necessitates a readjustment of the light just before each exposure, but the patience thus exercised will be more than repaid in the character of the resulting negatives.

Microphotographs of Wood Sections.—An interesting communication on this subject was recently made by MM. Thil and Thouronde to the French Photographic Society. Microphotographs to the number of about four hundred were executed to the order of the Minister of Agriculture. M. Thil, Inspector of Government Forests, has, in very precise language, pointed out the reach of this application of photography, which permits of the classification of woods in families

and species, thanks to the comparison alone of the intimate structure of the fibres and cellular network. By this means we are enabled, with the help of simply thin cuttings, to give, so to say, a complete anatomy of each species, and to notice easily the essential differences which exist between woods of different species, although belonging to the same family; all the more, therefore, can we recognize classification in families. Microphotographic pictures, projected by the lantern, served to demonstrate clearly the truth of the propositions affirmed. This is a new example of the numerous services that photography may render to the sciences.

The Coloured Screen in Photomicrography.*—The following is an abstract of a paper by Professor Romyn Hitchcock :—

An ordinary gelatino-bromide plate is sensitive to the spectrum of sunlight from a point between the Fraunhofer lines E and F to about K. The maximum photographic action is about G. By considerably prolonging the time of exposure the limit of photographic action at the red end of the spectrum is greatly extended. In practice the light below the green of the spectrum may be regarded as quite inactive when we take photographs with ordinary plates.

By introducing a coloured screen—a plate of yellow glass for example —in the path of the light, we may absorb the more active rays, and prolong the time of exposure until the yellow rays have time to act upon the sensitive plate. In practice, however, it is found that there are two difficulties about this method of procedure; first, in obtaining a satisfactory screen, and second, in the long exposure necessary when working with the comparatively inactive rays.

With colour-sensitive plates, such as are now in general use abroad and gradually being introduced in this country, the range of photographic action towards the red is greatly extended. With such plates the yellow screen can be used with great advantage.

A few years since it was customary to work with monochromatic blue light in photomicrography, and the ammonio-sulphate of copper blue cell was much in use. When colour-sensitive plates were introduced yellow screens took the place of blue, because it was found that many specimens had yellow and red and brown parts which were not well photographed with blue light.

The colour and thickness of the screen both require attention. If it be too thin the blue light is not sufficiently cut off. In particular cases an almost monochromatic yellow light is desirable, as when it is desired to obtain sharp outlines of deeply stained objects regardless of structural details. But generally a rather broader spectrum range is desirable, for the light employed should correspond to the different colours or shades of colour of the object. It is owing to neglect of this consideration that we often see photomicrographs which are mere silhouettes, while the objects show much more structure to the eye. This is frequently observed in photographs of such structures as the tongue and sting of a bee, and legs of insects. In other preparations, in which the colour is a stain, brown or red for example, the fault lies partly in the exposure, which, in many cases, is insufficient to give more than

* Amer. Mon. Micr. Journ., xi. (1890) p. 8.

outlines and blank interiors. This is frequently noticeable in photographs of bacteria.

By a proper choice of a screen, if a screen is required, a photograph should show any object as clearly as we can see it in the Microscope.

Colour-sensitive plates may be said to be indispensable in the photography of rock-sections with polarized light.

The yellow solution devised by Professor Zettnow, of Berlin, is used with much favour by many workers. It is composed as follows:—Copper sulphate, 175 grm.; potassic bichromate, 17 grm.; water, 1000 ccm.

The true function of the colour-screen should be to give definition and detail, not to increase contrast between the object and the field, as many observers seem to believe.

(5) Microscopical Optics and Manipulation.

Amplification in Micrometry.*—My attention has quite recently been drawn to this subject in connection with the celebrated Dr. Cronin case. It may be taken for granted that one cannot measure what he cannot see. But how high an amplification is necessary in a given case is a matter of much importance. In the measurement of blood-corpuscles in medico-legal cases the late Dr. Richardson advocated the use of a very high power, viz. a 1/25 or 1/50 objective. In my own measurements of blood-corpuscles I have, out of respect to authority, always used a high power, from 1500 to 1800 diameters. Recent experience has, however, qualified my views upon the subject, and in the case of the comparison of the ultimate subdivisions of a micrometer, ruled on metal, I am now of opinion that practically the same result may be obtained by the use of a 1/4 objective as with a 1/18 or 1/25.

In December 1885, I commenced the investigation of the 1/100 mm. spaces of "Centimeter A"; but was unable to finish it. Two series of measurements were then made with a Bausch and Lomb opaque illuminating objective, and a Bulloch filar micrometer. Recently I have measured the same spaces with a Spencer 1/10 and 1/25, and with a Zeiss 1/18. The results of these measurements are given in the table below, each correction being the mean of from three to twelve readings of the filar micrometer at each end of the measured space.

It will be observed that the agreement between the several series of the writer, and the results obtained by Prof. Hilgard is quite close, the discrepancy being practically insensible.

Provided the amplification is sufficient to render the object to be measured of a sensible size, and to render the difference between the sizes of two objects visible, my own judgment is that little, if anything, is gained by the use of a power so high as to impair the definition, even though such impairment be but slight. Quite as much, in other words, is lost by impairment of definition as is gained by increase of amplification. The practical conclusion then is that no higher power should be used than is consistent with perfect definition.

Diffraction Rings and Diffraction Spectra.—There appears to be still some confusion between the diffraction "spectra" of the Abbe theory and the diffraction bands or fringes and spurious lines seen

* By Hon. Marshall D. Ewell, LL.D.

surrounding the outlines of all objects in the field of the Microscope, when the illumination is obtained by somewhat narrow but sufficiently bright beams of light, especially with high powers or deep eye-pieces.

The latter are true diffraction bands, originating from the diffraction of the light at the object, but the difference between the two phenomena is that the spectra represent the diffraction effect of the object at a very distant plane, conjugate to the posterior focus of the objective, whilst the "bands" or "fringes" show the diffraction effect of the same objects in a plane close by, i. e. in the neighbourhood of the objects themselves. Nägeli and Schwendener, it is true, deny that these fringes are diffraction phenomena, and explain them as interference phenomena in a somewhat complicated manner, but Prof. Abbe considers that he has established the incorrectness of their views on this point, except so far as they assert that the phenomena cannot be due to the diffraction effect of the lens opening, as had previously been assumed by Helmholtz and others.

(6) Miscellaneous.

The 300th Jubilee of the Microscope.*—"B. C." writes:—Natural science enters this year on a memorable anniversary, the 300th Jubilee of the Microscope, one of the most powerful of its resources. To this instrument is due in great measure the wonderful impulse given to science in the second half of this century. The importance to which the Microscope has attained in scientific investigations is well known. It has become an absolutely indispensable instrument to the zoologist and botanist, to the mineralogist and geologist, to the astronomer and the physician. The Microscope has effected a complete revolution, and has diverted the direction of study into the most varied channels. In fact it has created a new method of research, such as histology. On the healing art the Microscope has exercised a most beneficent influence; for while it explained the changes undergone by the finest tissues in the various diseases—it was on microscopic observation alone that Virchow founded his renowned system of cellular pathology—it pointed out at the same time the means of healing them. The Microscope has also been of wonderful service in technical matters. Before attaining its present high degree of perfection, the Microscope had to pass through a number of intermediate stages which it is of great interest to look back upon on this its 300th jubilee. . . .

It is strange how slowly the Microscope found its way into learned circles. It was only when Leeuwenhoek had by its aid discovered the infusoria that it became generally used in the scientific investigations of anatomists and physiologists. What it has accomplished since that time constitutes the glory of the natural sciences. The Microscope soon passed from the workshops of the spectacle-makers to those of the optician, by whose skill it has undergone, little by little, numerous changes, corrections, and improvements. Not to mention all of these, it will suffice to point out the arrangement of the transmitted light (1685), of the reflecting illuminating mirror (1715), and the use of achromatic and aplanatic objective lenses (1824). In more recent times the Microscope has received further improvements, which have cast into the shade all conceivable expectation; and unless appearances deceive us the finer

* Central-Ztg. f. Optik u. Mechanik, xi. (1890) pp. 69–70.

mechanics of Microscope construction have not yet reached the limit of their capabilities. The latest acquisition of medical science, the bacteria, has put the greatest demands on the Microscope, and reveals to this instrument the deepest secrets of nature. Let it be the aim of science to gather in a still richer harvest by the aid of the Microscope!

The Microscope banished.—The following appears in the *Daily News* of the 9th April:—"An interesting paper by Mr. Bothamley in *The Photographic Quarterly* reminds us of the important part now played in education by the optical lantern which in the memory of so many among us was a mere toy for the entertainment of juvenile parties. The initiation and growth of the system is mainly due to Professor Miall, of the Yorkshire College, Leeds, in which important institution almost every department has its lantern, and such widely different subjects as biology and engineering, ancient history and textile industries are alike illustrated by this convenient means. In the biology lectures *the lantern is said to have well nigh banished the Microscope, thereby effecting a great saving both in cost and time* (!) The production of lantern slides is found to be most easily and rapidly done by photography. Original objects, drawings, large photographs, illustrations in text-books, can all be reproduced in the same way. At the Yorkshire College the number of slides required by the various departments is stated to be so large that the whole time of a special photographic assistant is occupied with their production, although the work is much facilitated by the ingenious copying camera devised by Professors Barr and Stroud. But perhaps the most remarkable fact in connection with this subject is Professor Miall's discovery of how the lantern may be used in illustrating lectures in a room illuminated by daylight."

Miss V. A. Latham, F.R.M.S.*—This lady has recently been elected to the chair of Demonstrator in Pathology in the University of Michigan. Professor Latham is the first lady who has held any office in the Medical Department of the University, and has our congratulations and best wishes for her success.

β. Technique.†

Böhm, A., u. A. Oppel.—**Taschenbuch der mikroskopischen Technik.** (Handbook of microscopical technique.)
München (Oldenbourg), 1890, sm. 8vo, 155 pp.

Goronowitsch, —.—**Kurze Uebersicht über die Fortschritte in der mikroskopischen Technik im Jahre 1888.** (Short review of the progress in microscopical technique in 1888.) *Medizinsk. Oboscrenije*, 1889, No. 8 (Russian).

Kahlden, C. von.—**Technik der histologischen Untersuchung pathologisch-anatomischer Präparate.** Für Studirende und Aerzte. Ergänzungsheft zu Dr. E. Ziegler's Lehrbuch der allgemeinen und speciellen pathologischen Anatomie. (Technique of the histological examination of pathological-anatomical preparations. A supplement to Dr. E. Ziegler's Handbook for the use of Students and Physicians.) 6th ed., Jena (Fischer), 1889.

Poli, A.—**Note di microtecnica.** (Notes on microtechnique.)
Malpighia, III. (1889) June, August, December.

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* Amer. Mon. Micr. Journ., xi. (1890) p. 10.

† 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.

(1) Collecting Objects, including Culture Processes.

Procuring and Preparing Protista found in the Stomachs of Ruminants.*—To obtain Protista from the stomachs of oxen, says Dr. A. Fiorentini, it is merely necessary to open that viscus with a knife, and gather some of the gastric juice in test-tubes. In order to keep the animals alive it is advisable to keep the tubes immersed in water at a temperature of 30°–35°. To examine these Protozoa alive, it is necessary to make use of Schultze's or Ranvier's hot-stage, so that the slide may be kept at 35°. But the following method has the advantage of simplicity. Heat the slide over a spirit-lamp until it becomes warm. Then place thereon a drop of the fluid containing the animals to be examined, and cover with the cover-glass. Next with a pipette take some boiling water and drop it in lines on the slide, taking care, however, that it does not mix with the fluid under the cover-glass. This device will keep the preparation warm sufficiently long to examine the Protozoa alive. When cold a new preparation must be made.

For fixing the animals, the author used a 1 per cent. osmic, and for staining the nuclei and nucleoli fuchsin, alum-carmine, and alum-cochineal. Glycerin and Canada balsam were used for clearing up the preparations when osmic acid had blackened them or made them obscure.

Useful Collecting Device.†—Mr. J. Walker finding his collecting bottle, a modified Wright, somewhat cumbersome, "decided to use a smaller bottle, and have the strainer (I use bolting silk 10,000 to the inch) outside instead of inside. I therefore procured a bottle holding about 4 oz. A square bottle with a wide mouth is preferable, though a round one will answer well. I bored four holes opposite each other, 1 in. above the bottom and about 3/8 in. in diameter, and enlarged the openings in a direction parallel with the length of the bottle, until within an inch of the neck. Over these four oblong apertures I cemented fine bolting silk or other desirable material with shellac, and when dry, the bottle was ready for use. To those not having the tools needed for drilling glass, I would recommend a small tin can or box, such as that in which Colman's mustard is sold, or the common round pepper-box obtainable from the grocery stores, the lid making a good coarse strainer.

In working with it, the currents of water passing through the meshes of the strainer will cause fine debris to collect on the inside, which in this case is easily kept clean with a small brush, a piece of wood, or a stalk of grass. The concentrated material will be found at the bottom of the vessel, and can be transferred to another small bottle carried for the purpose."

Collecting-bottle for Rotifers.‡—Mr. A. Pell remarks, "Here is the 'boss' collecting implement at last. Take one of the new lard bottles which hold a quart, the mouth being about 4 in. across, with a metal cover that screws to the neck, and a handle by which it is readily carried. Make a tube of muslin or of linen, in any desirable

* Journ. de Micrographie, xiv. (1890) pp. 15–6.

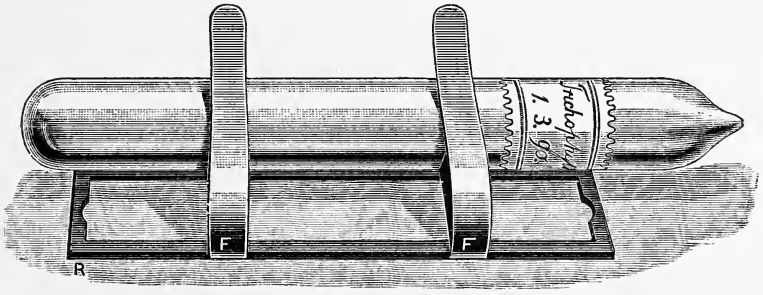
† The Microscope, ix. (1889) pp. 372–4.

‡ Op. c., x. (1890) p. 151.

fineness, and about 2 feet long, 4 in. in diameter at one end, and 2 at the other. Fasten a tin ring to the small end and attach the large end to the mouth of the bottle. Then put on your rubber boots and go to the pond. There pour the water into the small end of the muslin tube, holding it up for that purpose, the bottle hanging below. It will rapidly strain out the Rotifers, &c., which will finally get down into the bottle, and as the muslin tube has so large a surface the water will run through quickly, all solid matters collecting in the bottle. Less is lost by the use of the muslin tube than by a funnel-shaped strainer, and the cloth will not become clogged."

Test-tube Holder for Microscopical Investigations.*—Dr. D. von Sehlen has invented a test-tube holder, the advantages of which are mainly its stability and simplicity. Hence it will be found of great use in the cultivation of the various forms of Fungi, and also for photo-

Fig. 58.



graphic purposes. The apparatus consists of a flat oblong frame R which supports two uprights, placed equidistant from the ends of the frame. In these uprights a triangular piece is cut out in order to put the test-tube in, and the latter is kept in position by the two spring-clamps F. The distance between the two spring-clamps is enough to allow sufficient space for the objective to work in, and the length of the frame such that it is easily clamped to the Microscope-stage. It is hardly necessary to explain that the test-tube is easily moved round its short axis, and pushed up and down, so that when on the Microscope-stage it is easily illuminated from below.

Preparation of Nutritive Agar.†—Dr. V. A. Moore writes:—"The extent to which nutritive agar is employed in the cultivation of Bacteria renders it of much importance that its method of preparation should be made as perfect as possible. When it is prepared after the method recommended in works on bacteriology (which is practically the same as that first formulated by Koch for the preparation of solid culture media), a medium is obtained that favours the growth of most germs. In this respect the method is desirable, but in regard to the other

* Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 17–20 (2 figs.).
† Amer. Mon. Micr. Journ., xi. (1890) pp. 115–7.

requisites of a satisfactory solid medium it is quite deficient. The objections to the method with reference both to the process itself and the character of the resultant agar are three in number. (1) The difficulties attending the filtration of the agar. This process alone often requires a very considerable length of time besides the use of a hot filtering apparatus that must be provided especially for this purpose. (2) The presence in the sterile agar of a flocculent precipitate that is invariably thrown down during the process of its sterilization, and which greatly interferes with its usefulness, especially in making roll and plate cultures. (3) The variation in the consistency of the agar. It is impossible to obtain this material of the same consistency, as the agar is only partially dissolved, even after long boiling, in the simple beef-infusion. The coagulation of the albumen ensheaths the stems of agar, floats them to the surface where they remain imbedded in the firm, albuminous coagulum. This property of the agar is worthy of consideration, for with the varying consistency of the medium a consequent change follows in the character of the growth of most germs.

For the purpose of securing a process for the preparation of nutritive agar that was free from the above mentioned difficulties I have reviewed carefully the method of Jacobi,* Von Freudenreich,† and Cheesman,‡ in all of which I found difficulties that were equally as objectionable as those possessed by the original method.

The use of a solution of beef-extract in distilled water, instead of the simple beef-infusion made directly from the fresh meat, was also tried, but the agar thus prepared did not favour as vigorous a growth of many germs as when prepared from the fresh meat-infusion. So feeble was the growth of many germs upon this agar that the method was abandoned, although very satisfactory in other respects.

In the course of this experimental work it was found that when the stems of agar were cut into small pieces and boiled in a fluid containing no coagulate material, that it was entirely broken up and the soluble portion dissolved. The insoluble particles that remained suspended in the liquid were easily and completely removed by the addition of egg albumen, and subsequent boiling and filtering. From these facts a method for the preparation of nutritive agar was derived, which consists in first preparing the neutralized beef-infusion-peptone, and thus getting rid of all coagulable material before the agar is added. This process is effective in greatly diminishing the time and attention required for the preparation of this medium. The medium can always be made of the same consistency, as all of the agar that is added is dissolved. It remains free from precipitates when sterilized, and its nutritive qualities are as favourable to bacterial growth as when it is prepared after the original method.

(1) *The preparation of the beef-infusion-peptone.*—The method of preparing this liquid is practically the same as that already in use in most laboratories. Finely chopped or ground beef (freed from fat) is macerated in distilled water for from 12 to 18 hours in a cool place. The distilled water is added in the proportion of 200 ccm. to each

* Centralbl. f. Bacteriol. u. Parasitenk., iii. (1888) p. 538. † T. c., p. 797.
‡ American Naturalist, xxii. (1888) p. 472.

100 grams of beef. On the following day the liquid is separated from the meat by straining it through a coarse linen. The simple beef-infusion thus obtained should be equal in quantity to the amount of water added; if it is not the deficiency can be restored by the addition of distilled water. To the beef-infusion is added 1 per cent. peptone, 1/2 per cent. sodium chloride; and if it is desirable to make it alkaline, a sufficient quantity of a normal solution of sodium carbonate to give it a weak alkaline reaction. The liquid is then boiled for thirty minutes in a water-bath, cooled, filtered, and distributed in Erlenmeyer flasks plugged with cotton-wool. If only a small quantity of agar is to be made at once, 250 ccm. is found to be a very convenient quantity to put in each flask. It is then sterilized by boiling for one hour each day for three consecutive days. It need not be sterilized if it is desirable to prepare the agar at once. As the beef-infusion-peptone is also employed as a liquid medium in the cultivation of bacteria, very little time is lost in preparing an extra quantity of this liquid to be used in making the agar.

(2) *The preparation of the agar.*—To an Erlenmeyer flask (a glass beaker or agate or iron vessel may be used) containing beef-infusion-peptone, as prepared above, 1 per cent. of *very finely chopped* agar is added. The flask is then placed in a water-bath and boiled vigorously for two hours. At the end of that time the agar is dissolved, and the liquid is allowed to cool. When a temperature of 40–45° C. is reached, the white of egg is added in the proportion of one egg to 250 ccm. of the liquid. After the albumen is *thoroughly* mixed with the liquid agar it is returned to the water-bath and again boiled for two hours. It is of much importance that the albumen is evenly distributed throughout the mass before it is coagulated. It is now ready to be filtered. The egg albumen is coagulated in very firm masses, leaving the liquid perfectly clear. The coagulum is removed by filtering the liquid through fine Japanese filter-paper or a layer of absorbent cotton, as a 1 per cent. solution of the agar does not pass readily through ordinary filter-paper. Should a weaker solution of the agar (1/2 to 3/4 per cent.) be desired, its filtration can be accomplished by the ordinary method. A hot filtering apparatus is not necessary. The clear filtration is now ready for distribution in sterile cotton-plugged tubes.

The agar is sterilized by discontinuous boiling in a closed water-bath for three consecutive days. If small tubes have been used containing not more than 7 ccm. each, five minutes' boiling each day is sufficient. If larger tubes are used, they should be boiled for a longer time. Or it may be sterilized by steaming each day for from five to ten minutes after the agar has become liquefied for the same number of days. After its sterility has been tested by allowing it to stand in an incubator for several days, it is ready to be stored until required for use. It has been customary in this laboratory, in order to prevent the evaporation of the agar by long standing, to dip the lower end of the cotton-plugs in hot sterilized paraffin, and to store the tubes in a cool, moist chamber."

(2) Preparing Objects.

Preparation of Crustacea.*—Dr. O. vom Rath gives an account of the method he adopted in his investigation into the structure of the Cymothoid Crustacean *Anilocra mediterranea*. The heads were cut off with a sharp pair of scissors and immediately placed in picric-nitric acid, picric-sulphuric acid, warmed absolute alcohol or chrom-osmic-acetic acid; the first of these reagents gives especially good results. The hardened heads were stained *in toto* in alum-carmine or borax-carmine. Paul Meyer was quite right in urging that the mere preservation in alcohol of Crustacea or other Arthropods with a strong chitinous membrane is quite insufficient.

Modes of Studying Segmental Organs of Hirudinea.†—M. H. Bolsius did not learn much by dissecting out the segmental organs and mounting them entire. It is better to cut sections of the entire animal, or, when it is large, of parts. Transverse, vertical, longitudinal, or horizontal longitudinal sections should be made. To prevent contraction of the body, large specimens should be anæsthetized before being killed. Small specimens should be placed in a 1 per cent. (or even weaker) solution of chromic acid. Passable results in the way of fixation were obtained by bichromate of potash, but bichloride of mercury is much more efficient. A saturated aqueous solution or Gilson's liquid may be used. In either case small individuals are placed in them for 15 to 30 minutes; larger pieces must remain a proportionately longer time. Excellent preparations were also obtained with a 2 per cent. solution of nitrate of silver; in this case staining reagents were not used, but with the others a picro-alum-carmine, the formula for which has not yet been published, but which is used at Louvain, was found to give excellent results.

Mode of Investigating Hydra fusca.‡—Herr K. C. Schneider recognizes that it is only possible to study the nervous system of Hydroids by maceration-processes. It is scarcely possible to recognize in sections the cell-boundaries of the ectoderm, to say nothing of distinguishing them from the separate subepithelial elements. The structure of the cells is considerably affected by the use of paraffin. As a maceration-medium, the author first used pure acetic acid from 1 to 10 per cent; but as this caused deformation of the elements, chloride of sodium was used, and was followed by various strengths and quantities of osmic acid. After some experiments, a mixture of one part 0·02 per cent. osmic acid with four parts 5 per cent. acetic acid was found to give excellent results. Pure osmic acid was found to give very different results from the mixture of osmic and acetic acids. Animals placed for eight days or more in glycerin were very useful in the study of the nervous system. Picrocarmine was found to be the best staining medium, but Beale's carmine and safranin were also of use.

Microscopical Sections of Tooth and Bone.§—It was with great satisfaction that we read Mr. J. Howard Mummery's notes on the prepa-

* Zool. Anzeig., xiii. (1890) p. 232. † La Cellule, iv. (1890) pp. 374-6.
‡ Arch. f. Mikr. Anat., xxxv. (1890) pp. 322-3.
§ Trans. Odontol. Soc. Great Britain, xxii. (1890) p. 207.

ration of microscopical sections of tooth and bone, in which he gives an account of some new and important discoveries in the structure of these tissues, for it was from this Journal,* he tells us, that he obtained an account of Dr. L. A. Weil's method of carrying out the balsam process. "I prepared," says Mr. Mummery, "some sections according to these directions, and was so pleased with the results that I have since cut nearly two hundred specimens in this way." It should not be forgotten that this portion of the Journal is of great assistance to those who, like Mr. Mummery, have little time for searching the literature of microscopical technique.

Preparing Sections of Teeth.† — Mr. W. A. Hopewell-Smith remarks:—

"(1) The most satisfactory method, in my opinion, of preparing sections showing odontoblasts *in situ* is as follows:—The jaw, preferably the lower, of an embryonic mammal, such as kitten or pup, taken while still in a fresh condition, is carefully stripped of all the tissues covering it, except the oral epithelium and flange of gum, and is placed in the usual standardized solution of Müller's fluid, in order to harden its soft structures, the volume of fluid being about twenty or thirty times the bulk of the immersed tissue. The fluid must be changed every day for four or five days, and then every third or fourth day. The hardening process is to be completed by removing the specimen—which has remained in the Müller's for a fortnight—to alcohol or rectified spirit; and this is to be renewed occasionally until all the colouring matter has disappeared from the specimen and fluid. Vertical sections are then cut by means of a thin sharp knife, and these placed longitudinally on the stage of a Cathcart or Williams freezing microtome, and cut in the ordinary way. Best results are obtained from sections in the canine and bicuspid regions, as here the parts are less likely to be disturbed in the manipulations with the microtome. Imbedding in paraffin and wax, or celluloidin, is of little service. The advantages claimed for this method are:—(*a*) The simplicity of its performance. It will be seen that the hard tissues are not softened by any decalcifying agent, which would materially affect the delicate soft tissues. The knife cuts quite easily the thin cap of semi-calcified dentine and bone, and the elements of the pulp are in no way disturbed in their relation to each other. (*b*) The odontoblasts are of large size, and easily observable at this period, as their formation of dentinal fibrils is at its highest stage of development. They can be isolated, if thought necessary, by separating with the point of a needle from the surface of the dentine papilla the cap of dentine to which in places they adhere. (*c*) This method affects little, if at all, the relative positions of dentine, odontoblasts and pulp; and I have found it to be extremely successful.

(2) I should advise your correspondent not to grind down sections of teeth of fishes *in situ;* but to decalcify the jaw and teeth with a 5 per cent. solution of chromic acid or 10 per cent. solution of HCl. After sections have been cut and stained they should be washed well in distilled water, dehydrated for three minutes in absolute alcohol, "cleared" in oil of cloves or xanthol, and mounted in Canada balsam.

* 1888, p. 1042. † Journ. Brit. Dental. Assoc., xi. (1890) pp. 310–2.

Carmine is the best stain for fishes' teeth. If it is used, however, it is necessary before transferring to distilled water to pass the section quickly through weak $HC_2H_3O_2$ as this "fixes" the stain. If gold chloride is used the specimens must be mounted in glycerin-jelly. . . .

(5) It is unnecessary to cut sections of enamel to demonstrate the prisms. After having softened enamel by immersion in 10 per cent. solution of HCl, remove by means of a needle-point or fine brush a small portion to a slide; put a drop of normal salt solution on to the top of the enamel, and press down cover-glass. Then run a solution of carmine or orange-rubine beneath the cover-glass, and draw off the excess with a little blotting-paper. Wash the stain away further by irrigation with weak HCl, or $HC_2H_3O_2$, and mount in this solution or acidified glycerin after Beale's plan.

Examining Nuclei of White Blood-corpuscles.*—The ordinary notion about white corpuscles, viz. that the majority are polynucleated, is, says M. Mayet, quite erroneous. By this the author does not mean that polynucleated corpuscles are not demonstrable, but that this condition is extremely rare.

To ascertain exactly the shape of the nucleus, glacial acetic acid must be intimately mixed with the blood in the proportion of three to one.

By this means the red corpuscles are rendered almost invisible, while the extra-nuclear part of the white is more or less dissolved, so that the nuclei are isolated and become very visible.

The nucleus then is found to be of very variable shape, and it is owing to this irregularity that various optical effects are produced, so as to give the appearance of more than one nucleus. The nucleoli are always multiple, there being one for each swelling of the nucleus.

When a white corpuscle is really polynucleated, it is just in the act of division, nucleus and extra-nuclear plasma as well, but this condition is rare.

Studies in Cell-division.†—Prof. D. H. Campbell recommends the following subjects as specially well adapted for showing the various stages of division in the plant-cell, and its modifications; the paper is accompanied by very good figures:—For cell-division where there is no definite nucleus—*Nostoc*. For division of a multinucleate cell, and division of the nucleus independently of cell-division—*Cladophora*. For cell-division accompanied by the division of the single nucleus—*Spirogyra*. If exposed to cold during the night, and brought into the laboratory in the morning, some of the cells will probably begin to divide almost immediately. An interesting modification of the process is shown by many desmids. For following the process in the living cell—the hairs on the filaments of *Tradescantia virginica*. It is well shown by removing the stamens from the young buds, and mounting the attached hairs in water or in a 3 per cent. solution of sugar. They may be stained without killing them by a weak aqueous solution of methyl-violet, dahlia, or mauvein. For easy demonstration of the process of karyokinesis—the final divisions of the pollen-mother-cells,

* Comptes Rendus, cx. (1890) pp. 475-7.

† Bull. Torrey Bot. Club, xvii. (1890) pp. 113-21 (2 pls.).

especially of Monocotyledons as *Allium canadense*, or among Dycotyledons *Podophyllum peltatum*. The latter is especially favourable for showing the early stages, because of the small number (about ten) of the nuclear segments.

Dehydration and clearing up of Algæ.*—The following method, described by Dr. E. Overton, neither requires complicated apparatus nor demands a great expenditure of time, in obtaining a result more favourable than is usually expected when dealing with such delicate objects as Algæ, which shrivel or crumple up when transferred from one reagent to another.

The object, previously fixed and stained, is placed in a not too large quantity of 10 per cent. glycerin. Here it remains in an open vessel until the glycerin has given off nearly all its water. The objects are then transferred to absolute alcohol. Their further treatment depends on the nature of the clarifying medium. If turpentine, oil of cloves, or the like is to be employed, the object should be placed in a watch-glass, containing a 10 per cent. solution of the oil in absolute alcohol. The watch-glass is placed in a large covered vessel, on the floor of which are some pieces of calcium chloride to absorb the alcohol. In this way the objects are gradually impregnated with the pure oil, whereupon they may be transferred to dilute balsam. If before the objects be placed in the ethereal oil and alcohol mixture, they be passed through chloroform, this step will avoid the too great extraction of the staining by the spirit.

Should xylol be preferred for clearing up, then in the larger vessel pure xylol is placed as well as in the watch-glass. By a process of diffusion the inner vessel will ultimately contain almost pure xylol. By means of this method the most delicate algæ may be mounted in balsam without crumpling.

Amplification required to show Tubercle Bacilli.†—When properly stained and prepared, the bacillus tuberculi can be readily recognized with a good 1/5 objective and a 2-in. eye-piece, normal tube-length, or, roughly speaking, an amplification of 250 diameters. We do not think that it could be done much below this amplification, though the sharpness of vision of the observer, his acquaintance with the object, and the excellence of his objective would be important factors in settling the question. A 1/4 objective with a 2-in. eye-piece, normal tube-length, gives an approximate amplification of 200 diameters.

To be seen and diagnosed for certain, the bacillus tuberculi in urine or water must be prepared for examination by following the well-known technique in such cases (fixing, staining, bleaching, and mounting). No person who has any regard for his reputation as a microscopist would undertake to diagnose for certain bacilli of tubercle from other similar forms existing in water, urine, or any other medium whatever, whether with a magnification of 200 or 2000 diameters. The property of taking certain aniline stains, and retaining them so firmly that even nitric acid, diluted with only three volumes of water or alcohol, will not bleach them, is one peculiar to the tubercle bacillus, and shared, as far as we know, by the bacillus of leprosy only. This test, along with

* Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 11–13.

† Amer. Mon. Micr. Journ., x. (1889) pp. 277–8; from 'National Druggist.'

isolation and pure culture, alone makes the recognition of bacillus tuberculi certain.

For search of tubercle bacilli and study of the same, we have found a 1/10 homogeneous-immersion objective with a 2-in. eye-piece (approximately 500 diameters) the most satisfactory and least tiring to the eye. A good 1/8, however, with the same eye-piece, should be quite sufficient.

GRANDMAISON, F. DE.—**De l'emploi des solutions de chlorure de zinc pour la fixation des éléments anatomiques.** (On the use of solutions of chloride of zinc for fixing anatomical elements.)
Comptes rend. hebdom. Soc. de Biol., I. (1889) No. 39.

HOYER, H.—**Ueber ein für das Studium der directen Kerntheilung vorzüglich geeignetes Object.** (On an object particularly suitable for the study of direct nuclear division.) *Anat. Anz.*, V. (1890) No. 1, p. 26.

(4) Staining and Injecting.

Practical Notes.*—Mr. H. M. Wilder writes:—*Picric Acid Staining.*—Picrocarmine is very easily washed out with water, at any rate the picric acid. I prefer for that reason to stand the slide on edge, in order to let it drain off, and finally touch the section (or what else) *on the edge* with blotting-paper or filtering-paper, but I do *not* put the blotter *on top;* even the best, and handled most carefully, will always leave fibres. I then allow the section to dry a little, and finally put on the medium. If in balsam I let the section dry thoroughly; the benzole balsam will soon clear it, without any alcohol or oil of cloves. That is for vegetable tissues.

To mount Powders.—In mounting powders I much prefer to breathe on the slide, press it on the dry powder, provided the firmness of the powder is tolerably uniform, give a few smart raps with the edge of the slide on the table, in order to get rid of superfluous powder, put on the cover-glass, with a pencil-brush dust off the surrounding powder, and let the medium *run under* by capillary attraction in the well-known way with a couple of drops on the side of the cover-glass. In this way I seldom have any air-bubbles to contend with.

Silicate of Sodium (soluble glass, water-glass) I would strongly recommend as a medium for vegetable sections and powders. It "sets" quickly, less than fifteen minutes after a mount is made; the slide can be cleaned with a nail-brush without fear of the cover-glass coming off. It clears well, and acts as its own cement, no ringing being necessary. Its disadvantages are: it does not agree with alcohol, ether, volatile oils, mucilage, acids (not even very weak), collodion; being alkaline it will colour lignified tissue yellow, and alter the shades of stains more or less (the bluish-purple colour of hæmatoxylin is turned sepia-brown). After some time it deposits "crystals," that is flakes, which, while they detract from the beauty of the slide, cannot well mislead any one; this tendency may, however, be largely obviated by using a mixture of four or five fluid parts of the silicate and one part of glycerin. This mixture is, of course, slow in drying.

Note.—Mucilage and water-glass do not well mix, because mucilage is always more or less acid; water-glass is very intolerant of acid.

* Micr. Bull. and Sci. News, vii. (1890) p. 17.

Staining of Vegetable Nuclei.*—The following is the method employed by Mr. H. W. T. Wager in staining the nuclei in *Peronospora parasitica*, parasitic on the shepherd's purse (see p. 491). The sections were made by the Cambridge ribbon-section-cutting microtome. The fresh infected tissues of the host-plant were cut up into small pieces, and placed at once either in absolute alcohol or in chromic acid solution, where they were kept until thoroughly penetrated, and were then prepared for imbedding in paraffin-wax. The chromic acid specimens were thoroughly washed in 70 per cent. alcohol, then transferred to methylated alcohol, and finally to absolute alcohol. The pieces of tissue may then be stained *en bloc*, or the separate sections may be stained, when cut, on the slide. The latter gave the best results.

After being thoroughly dehydrated by alcohol, the pieces of tissue were transferred to turpentine for about forty-eight hours, and were then placed in soft melted paraffin-wax for about twenty-four hours, and finally transferred into hard melted paraffin-wax for about two days. They were then imbedded in small square blocks of paraffin, and very thin sections cut by the microtome. These sections were cemented to the slide by a solution of white of egg and glycerin, and the paraffin-wax melted by heating the slide on a water-bath, and washed off in turpentine. The slide was next placed in absolute alcohol, and afterwards transferred to a dilute solution of Kleinenberg's hæmatoxylin in water, made by adding a few drops of the strong hæmatoxylin solution to a beaker of water, until the whole was decidedly coloured. The sections were left in this until they were considerably over-stained, and were then placed in a dilute solution of acid alcohol, made by adding a few drops of strong hydrochloric acid to a beaker of 70 per cent. alcohol for a short time to reduce the stain. They were then washed successively in 70 per cent., 90 per cent., and 100 per cent. alcohol, and were next transferred for a few minutes to turpentine until quite clear and transparent, and were finally mounted in Canada balsam. The preparations thus obtained, which were in many cases only about 1/8000 in. in thickness, exhibited the structure of the nucleus clearly and distinctly.

Nessler's Ammonia Test as a Micro-chemical Reagent for Tannin.†—Mr. S. Moore writes: In most cases the presence of tannin is immediately shown by all the ordinary reagents used by the botanist for its discovery. This does not happen sometimes, however, as, for instance, in the tannin-cells found in the epidermis on the dorsal side of the leaves of some plants. As a good typical example the common primrose may be cited. Of all the ordinary tests, including iron salts, potassium bichromate, Möll's test (copper acetate and iron acetate), ammonium molybdate, and osmic acid in 1 per cent. solution, the latter alone acts immediately upon the tannin in the primrose leaf's epidermis. It may hence be worth while recording the discovery of a second reagent capable of acting rapidly and effectively; and one which is easily made and will keep for some time should be especially valuable. Such a reagent is Nessler's test for ammonia.

Nessler's test is made, as all the world knows, by saturating a solution of potassium iodide with mercuric iodide, and adding an excess

* Ann. of Bot., iv. (1890) p. 131.

† Nature, xli. (1890) pp. 585-6.

of caustic potash. Ammonia gives with this a reddish precipitate; tannin a brown, and when in considerable quantity a deep black one; but if little tannin be present, the brown may tend towards purple. It goes without saying that much experiment must be undertaken before one can be sure of the substance giving the brown precipitate being really tannin. To be conclusive, such experiment should be carried out in four different directions:—

(1) The reaction ought to be given in all cases when the ordinary reagents make their presence immediately felt.

(2) Cells which will not immediately give the tannin reaction with ordinary tests, but which will do so with Nessler's test, must also do so under the former conditions if time be allowed.

(3) Tissues, which will not yield the reaction with Nessler's test, must not give it with any other reagent, even after the lapse of some time.

(4) Solutions of tannin must give a brown precipitate with Nessler's test.

Under the first of these headings may be mentioned growing shoots of the garden rose. On laying a radial longitudinal or a tangential section of this in Nessler's fluid, a copious black-brown precipitate is obtained, and the same thing occurs with the beautiful tannin-sacs of *Musa sapientium*. In all other instances, where tannin has betrayed its presence by the use of ordinary reagents, the brown colour has been obtained upon treatment with Nessler's test.

The primrose leaf may be again cited as an example of the time sometimes necessary to show up tannin with the usual reagents, of which it must here suffice to particularize ammonium molybdate. On laying in the molybdate a small piece of epidermis torn off the lower side of the leaf, one first sees a cell here and there coloured the characteristic and beautiful yellow given by this test: these coloured cells are usually situated among the elongated more or less rectangular cells overlying the vascular bundles. Re-examination after half an hour or so shows several more of the cells similarly coloured, but it is usually not till after a couple of hours that one can safely declare all the tannin-containing cells to have been stained. With variations in respect of time, and with the sole exception of osmic acid, all the other tests act in precisely the same way; even Möll's, preferred to all others by some of our Continental *confrères*, being as unsatisfactory as the rest. But sooner or later its characteristic colour is imparted to these cells by every reagent, thus proving tannin to be present.

For the negative experiment the absence of the brown colour from tissues treated with Nessler's fluid, and its absence from the same tissues when acted upon by ordinary tannin reagents, recourse was again had to epidermis. The experiment succeeded in all cases; among these may be cited *Fatsia japonica*, wallflower, box, *Stellaria media*, and *Pelargonium zonale*. In none of these did tannin show up, although twenty-four hours were allowed to elapse before the preparations were destroyed.

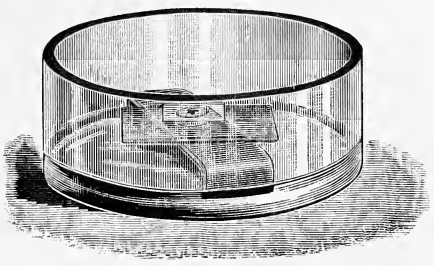
Lastly, Nessler's fluid gives a rich brown precipitate with solutions of tannin. Moreover, with gallic acid a grey-green one is thrown down, thus affording an easy means of distinguishing between these bodies.

For these reasons, therefore, viz. the rapidity, certainty, and distinctness of its action; the ease with which it can be made; its permanence when made; and lastly, the difference in its behaviour towards tannin and towards gallic acid—for these reasons I am bold enough to anticipate the time when, to adapt a hackneyed expression, Nessler's fluid will be regarded as a reagent which no botanical laboratory should be without.

Staining and Imbedding very Minute Objects.*—The preparation of microscopically small objects is usually a very unsatisfactory procedure, but very good results may be obtained, says Dr. E. Overton, by adopting the following method:—Suppose the material is a hanging-drop cultivation on a cover-glass, as for example unicellular algæ, Flagellata, pollen-tube, or the like. When the cultivation has reached the desired stage of development, the cover-glass is removed and iodine vapour allowed to stream over it. Iodine vapour is easily obtained by putting some crystals in a test-tube and warming them. Instead of iodine, osmic acid or its vapour may be used, but then manipulation is extremely difficult, not to say unsatisfactory.

By this method the objects are fixed at once, and then the iodine is removed by heating the preparation up to about 40° for 2-3 minutes. It is sometimes necessary to add a drop of distilled water during the evaporation of the iodine. The cover-glass, with the moist side still uppermost, is then put on a piece of elder-pith, about 3 mm. thick, and with a diameter rather less than the cover-glass. This, in its turn, rests upon a slide (Giessen size), which is placed in a glass capsule, the sides of which are about 2 cm. high. The slide does not lie on the bottom of the capsule, but is placed on a sort of little stool made of metal (see fig. 59).

Fig. 59.



To the preparation is added a drop of 20 per cent. alcohol and absolute alcohol in the capsule, the layer reaching half-way up the stool. The capsule is covered over and sealed up with vaselin. The vessel must be kept at an equal and moderate temperature, and not exposed to the sunlight. In a few hours the alcohol will have acted sufficiently upon the preparation. It is then removed and covered with a drop of collodion, or a solution of celloidin. When the celloidin has set a little, it is immersed in 80 per cent. spirit, wherein it becomes firmly set in about two minutes, so that the preparation may now be placed in any staining solution without fear of damage. The celloidin solution must be quite thin; the author uses the commercial solution diluted with six to ten parts of a mixture of equal parts of alcohol and ether.

* Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 13-16 (1 fig.).

The best stains are carmine and hæmatoxylin, or eosin, iodine-green, and fuchsin. Other anilin dyes, as gentian-violet, are not suitable. The preparations should be dehydrated in 80 to 85 per cent. spirit, and then cleared up with creosote, or with a mixture of equal parts of 90 per cent. alcohol and creosote. They are then mounted in balsam, after having first passed through xylol.

Although this method may appear complicated, in reality it saves a great deal of time.

Surface Deposits in Golgi's Method.*—Sig. P. Samassa, in criticizing Sehrwald's method for preventing surface deposits in sections treated by Golgi's method,† points out that in the original method of Golgi these surface deposits are considerably less. Hence, as in the latter no cover-glass is used, it is an obvious inference that the pressure of the glass sets up diffusion currents, whereby the precipitate is scattered over the section, and renders it often quite useless. The diffusion process is aided by the evaporation of the solvent. In the uncovered method, owing to the large area exposed to evaporation, these diffusion currents are not so likely to occur with such violence as when confined between two rigid layers.

Staining Elastic Fibres and the Corneous Layer of Skin.‡—Herr A. Köppen, in a continuation of the technique of staining elastic fibres,§ recommends a double staining, which may be either diffuse or nuclear.

For diffuse staining the following solution is used:—Carmin optim. 1·0 is dissolved in 50 ccm. cold water, then 5 ccm. liq. ammon. caust. is added, and the whole allowed to stand for two days. It is then filtered, and of the filtrate 1 drop is used to 20 ccm. water. The sections remain therein for twenty-four hours, and are then stained a diffuse red.

Staining of the nuclei and protoplasm.—(1) Weigert's picrocarmine stain is made by adding to the above solution 50 ccm. of a saturated aqueous solution of picric acid. This solution, which should be filtered before and after use, stains in from two minutes to several hours. (2) Grenacher's alum-carmine is made by boiling together for 15 minutes, and then filtering, carmine 1·0; alum 5·0; water 50·0.

The advantage of using these preliminary stains is that the subsequent decolorizing is extremely rapid.

Decolorizing Preparations over-blackened by Osmic Acid.‖—The method of decolorizing objects over-blackened by osmic acid by means of peroxide of hydrogen was, says Dr. E. Overton, first introduced by Fol, but is so little practised that it merits a word in its favour. The following solution, which should be prepared every time, is recommended by the author:—Commercial peroxide of hydrogen 1 part; alcohol (70–80 per cent.) 10–25 parts. The removal of the osmium is completed in a few minutes, and the preparations stain excellently.

Staining Sections of Botanical Preparations.¶—Dr. A. Zimmermann gives a short description of some methods for staining botanical pre-

* Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 26–8. † See this Journal, *ante*, p. 410.
‡ Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 22–5. § See this Journal, *ante*, p. 410.
‖ Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 10–12. ¶ T. c., pp. 1–8 (1 fig.).

parations, which he has found useful in the examination of chromatophores, crystalloids, and various cytoplasmic elements.

(1) Picro-fuchsin stain.—The sections are fixed to the slide, and the paraffin and its solvent xylol having been removed, are placed in a solution of acid-fuchsin, which is made by dissolving 20 grm. of the pigment in 100 ccm. of anilin water. In this solution, which should be gently warmed, the sections remain for 2–5 minutes, and are then washed in a mixture of 1 part of a saturated alcoholic solution of picric acid and 2 parts of water until no more dye is given off. After this the picric acid is to be extracted in absolute alcohol; then the sections are passed through xylol and mounted in xylol balsam.

(2) Acid-fuchsin staining, with subsequent washing out in flowing water.—This method is serviceable for staining thick sections made from living tissue and then fixed. After the fixative is extracted the sections are placed in a 0·2 per cent. watery solution of acid-fuchsin, in which they remain for 24 hours or longer. The excess of stain is then extracted in flowing water, and this is best done by means of Steinach's glass filter capsules.* The capsules are placed in a receiver, over which is a pipe with a number of small taps, from which the water can be made to flow into the capsules. In adopting this method it is advisable to manipulate a large number of sections at once, and to examine them from time to time to ascertain the proper degree of decoloration.

(3) Iodine-green for staining chromatophores.—The sections are made from tissue previously fixed with an alcoholic sublimate solution, and then immersed for half an hour in a saturated aqueous solution of iodine-green. They are then washed in water and examined in glycerin or Hoyer's mounting fluid, or in balsam. If balsam be used, then dehydration must be effected by merely drying the preparation. Then xylol is added, and, when saturated with this, the xylol balsam. As a contrast stain for the rest of the tissue, a watery solution of Bismarck brown may be used.

(4) Ammonia-fuchsin for staining the chromatophores.—This stain is prepared by adding chemically pure ammonia to an alcoholic solution of fuchsin until the fluid assumes a bright yellow colour. The solution may be used at once, but will only keep a few weeks. The sections are fixed to a slide and some of the solution poured thereon and allowed to remain for some few minutes. They are then washed and examined in water or glycerin. Hoyer's mounting medium may be used, or even balsam. If the latter, then the sections must be dehydrated by drying them in the air.

Staining Human Retina with Acid Hæmatoxylin.†—Dr. J. Schaffer has been able to differentiate the outer and inner segments of the rod and cone layer of human retina by staining the tissue with the acid logwood recommended by Kultschitzky.

The sections, imbedded in celloidin, are taken from the Müller's fluid or alcohol in which they have been fixed and hardened, and left during the night in a 1 per cent. solution of chromic acid, which acts as

* This Journal, 1888, p. 850.

† SB. K.K. Akad. Wiss. Wien, xcix. (1890) pp. 110-20 (1 pl.).

a mordant. After having been washed they are placed in the logwood solution for about twenty hours. The overstaining is removed by decolorizing with Weigert's borax and ferrocyanide of potash solution. The proper degree of differentiation is attained when the rod and cone layer alone remains of a dark colour, the rest of the layers having a brownish hue to the naked eye. The sections are then washed in water and mounted in balsam in the usual manner.

Hæmatoxylin as a means for ascertaining the Alkalinity or Acidity of Tissues.*—Prof. F. Sanfelice has found that the acid or alkaline reaction of tissues may be recognized by staining with Boehmer's hæmatoxylin (alkaline), or with the author's iodized hæmatoxylin (acid).†

In using this method as a test, two principal precautions must be observed. First it is necessary that the normal reaction of the tissue must not be interfered with, hence reagents such as chromic acid and its salts, Müller's fluid and Flemming's solution are unsuitable fixatives. The author used chiefly absolute alcohol for hardening and fixing, and also corrosive sublimate, the excess of which must always be carefully extracted with spirit. The second precaution is that the hæmatoxylin solution must have only a feeble reaction.

Among the instances of differential staining obtained by this method it is mentioned by the author that the protoplasm masses in the ovary and testicle of Selachians are coloured red when the whole of the tissue is treated with the alkaline solution—a fact which proves that the elements undergoing this form of necrobiosis acquire an acid reaction. Goblet-cells in the intestinal mucosa become coloured blue, while the rest of the tissue remains red. Hence the reaction of goblet-cells is alkaline, and this method might be usefully employed to ascertain the reaction of tissues or elements, and their products.

New Method of Staining Central Nervous System, and its Results.‡—Prof. P. Flechsig recommends the following method for staining the nerve-cells of the cerebral cortex and their prolongations. By means of it it was shown that the axis-cylinder process was the only prolongation from the cell which was in connection with a nerve-fibre; that the axis-process, which is not at its commencement medullated, divides like a T, i. e. dichotomously at a right angle. In the occipital lobe a trichotomous subdivision was the rule, although frequent subdivision was also remarked. In the neighbourhood of the central fissure some axis-fibres did not subdivide.

These results were obtained by hardening pieces in 2 per cent. aqueous solution of chromate of potash, and then making sections not exceeding 5/100 mm. in thickness.

After soaking in 96 per cent. spirit, the sections are kept for 3–8 days in a solution of redwood extract at a temperature of 35° C. The sections having been washed in distilled water are then decolorized in the following manner:—Each section is placed in 3 ccm. 1/4–1/5 per cent. solution of permanganate of potash until the solution have lost its

* Journ. de Micrographie, xiv. (1890) pp. 21–2.

† See this Journal, 1889, p. 837.

‡ Berichte ü. d. Verhandl. K. Sächs. Gesell. Wiss. Leipzig, 1890, pp. 328–30 (1 pl.).

bluish colour; it is then immersed in the decolorizer (distilled water 200, oxalic acid 1, hyposulphite of potash 1), until all traces of yellowness have departed from the section.

The redwood solution is made as follows:—1 gram of the pure extract of Japan redwood is dissolved in 10 grams of absolute alcohol, and then diluted with 900 grams of distilled water. To this are added 5 grams of a saturated solution of Glauber's salt and a similar quantity of a saturated solution of tartaric acid.

If this redwood method be combined with Golgi's sublimate staining, the sections, having been stained as above, are placed in a mixture of 20 ccm. absolute alcohol and 5 drops of 1 per cent. solution of chloride of gold and potash, until the sublimate precipitate have become quite black, and the red nerve-fibres have assumed a bluish tone. They are then washed in 10 grams of distilled water, to which 1 drop of a 5 per cent. solution of cyanide of potash has been added, then dehydrated in absolute alcohol, cleared up in oil of lavender, and mounted in balsam.

Burchardt, E.—**Eine neue Amyloïdfärbung.** (A new amyloid stain.) *Virchow's Arch.*, CXVII. (1889).
Cf. *Fortschr. d. Med.*, VII. (1889) No. 23, p. 901; *Centralbl. f. Klin. Med.*, XI. (1890) No. 4, p. 74.

Dekhuyzen, M. C.—**Ueber das Imprägniren lebender Gewebe mit Silbernitrat.** (On the impregnation of living tissues with silver nitrate.) *Anat. Anz.*, IV. (1889) No. 25, p. 789.

Nickel, E.—**Die Farbenreactionen der Kohlenstoffverbindungen. Für chemische, physiologische, mikrochemische, botanische, medicinische und pharmakologische Untersuchungen.** (The colour-reactions of carbon-compounds. For chemical, physiological, micro-chemical, botanical, medical, and pharmacological investigations.) 2nd ed., Berlin (Peters), 1890, 8vo, 134 pp.

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

Finishing Balsam Mounts.*—Mr. F. N. Pease finishes balsam mounts as follows:—The object is mounted on the slide, applying the cover-glass in the ordinary manner, using either balsam, hardened balsam, balsam and benzol, storax or dammar. The slide is then heated to drive off the solvent or more volatile constituents, either gently in a water-bath or at a higher heat, even boiling carefully over a spirit-lamp when the nature of the object will permit. When cold, the superfluous mounting medium is carefully removed, then a narrow ring of paraffin-wax is heated in a capsule until it is melted and quite limpid. With the aid of a very small camel's hair pencil, the melted paraffin is applied at the edge of the cover-glass, covering the exposed medium and instantly solidifying. It is now necessary to apply a finishing cement. For this purpose Bell's cement has been found excellent. If this cement does not work satisfactorily the admixture of some chloroform makes it work smoothly. This cement ring is finished at one application, and in a few hours the slide is ready for the cabinet.

This method is intended to protect the mounting medium from becoming discoloured owing to atmospheric influences.

A new Diatom Mounting Medium.†—Mr. F. W. Weir writes, "$C_{10} H_7 Br$ + Resin of Tolu.—Dissolve 3 oz. of commercial balsam tolu

* Amer. Mon. Micr. Journ., xi. (1890) pp. 66–7.
† Micr. Bull. and Sci. News, vii. (1890) pp. 23–4

in 4 fluid drachms of benzine (C_6H_6) at a temperature of about 45° C., and strain. Add 4 fluid oz. of carbon bisulphide, agitate thoroughly, and allow to cool, when the tolu solution will separate and the carbon bisulphide with cinnamic acid in solution can be decanted. Add another portion of the carbon bisulphide and treat as before. Finally pour the tolu solution into a glass tray and evaporate the benzine.

Place in a 1/2 oz. glass-stoppered phial 1 fluid drachm of naphthaline monobromide, and add gradually about three times its volume of the resin of tolu, or sufficient to make the mixture quite stiff when cold. The solution will be effected slowly at about 45° C. The above constitutes a mounting medium which is rather easier to use than Canada balsam.

Warm the medium at 40° to 45° C. until quite fluid, take up a minute quantity on a warm needle, place on centre of cover-glass and invert on slide. Use no pressure whatever, but warm the slide gently, when the medium will flow to edge of cover.

After a few days ring with a non-alcoholic cement. This method of treating balsam tolu does not remove an atom of resin, and does not allow an atom of cinnamic acid to remain.

The subsequent solution in naphthaline monobromide produces a medium of higher index (1·73) than the resin alone, permanent in structure and volume, and free from objections to which any medium in a volatile solvent is subject."

Tolu and Monobromide.*—Mr. H. L. Smith writes to the Editor of the 'Microscopical Bulletin':—

"I meant to reply to your letter before. The bromide medium will keep if *tightly sealed*, but almost all cements, and some coloured waxes, decompose it. I must say I am not satisfied, and would not advise any one to use it. The yellow medium can be made to keep, but I don't like the colour.

Mr. Weir, of Norwich, Conn., sent me a compound of monobromide of naphthaline and tolu, which is best of any of the high mediums yet—no crystals, easy to use, and very satisfactory.

He is about publishing the formula. I wish somebody—you or some one—would make it for sale, as he does not intend to do this. It has full as high index as monobromide, and none of its disadvantages.

It has consistency of ordinary balsam, and is used like that. It can be hardened by careful heat; or better, mount without heat, and in a day or so it will harden to allow asphalting, or in a few more days will need no ring. It is going to do the thing, I *guess*.

Nothing could please me more than to have you make the bromide medium if I could advise it. It keeps perfectly well in the bottle. I have it two and three years old. No decomposition at all, but it acts so powerfully on all cements, that *this* prevents its usefulness. The index is considerably above monobromide, but the latter is high enough, and I am pretty well pleased with it."

Fixing Sections with Uncoagulated Albumen.†—Dr. J. Rabinovicz has found that albumen may be used for fixing sections to the slide by

* Micr. Bull. and Sci. News, vii. (1890) p. 24.
† Zeitschr. f. Wiss. Mikr., vii. (1890) p. 29.

adhesion as well as by coagulation, and the method is as follows:—The sections are laid on the slide, covered with albumen, and pressed down with a brush. The slide is then put straight into toluol until the paraffin is dissolved. The time required for this varies with the quantity of paraffin (from one to five minutes). The specimen may then be mounted in balsam. If there be any glycerin, however little, mixed with the albumen, this must be removed by immersion of the slide in absolute alcohol for five to ten minutes.

This method has the advantage over others in that it is shorter, and that the albumen is not coagulated by heat or spirit.

(6) Miscellaneous.

New Reaction for Albuminoids.*—Herr C. Reichl proposes the following test for albuminoids, which, though not so sensitive as Millon's reagent, may yet be of service in micro-chemico-botanical investigations. Two or three drops of a dilute alcoholic solution of benzaldehyd, a moderate quantity of dilute sulphuric acid (equal parts of acid and of water), and a drop of solution of ferric sulphate, give a dark blue colour with an albuminoid. A light blue colour is brought out by the first two substances, which becomes deep blue by the action of the ferric sulphate. Concentrated hydrochloric acid may be used in place of the sulphuric, and a different soluble iron salt, for example the chloride, in place of the sulphate.

WHEATCROFT, W. G.—**Presidential Address to the Bath Microscopical Society.** *Journ. of Micr.*, III. (1890) pp. 48–52.

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* SB. K.K. Akad. Wiss. Wien, Monatsheft f. Chemie, 1889, p. 317. See Bot. Centralbl., xlii. (1890) p. 367.

PROCEEDINGS OF THE SOCIETY.

MEETING OF 18TH JUNE, 1890, AT 20, HANOVER SQUARE, W.,
FRANK CRISP, ESQ., B.A., LL.B., V.P.L.S., IN THE CHAIR.

The Minutes of the meeting of 21st May last were read and confirmed, and were signed by the Chairman.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Specimens of *Patella pellucida*	*Mr. W. B. Strugnall.*
Flint-glass slide of mixed Diatoms	*Dr. H. Van Heurck.*

Mr. J. Mayall, jun., said the flint-glass slide received from Dr. H. Van Heurck, Director of the Botanical Garden, Antwerp, had been forwarded to replace the slide received from Prof. Abbe with the new 1/10 objective of 1·6 N.A., which slide had unfortunately become so deteriorated by partial crystallization of the extra-dense mounting medium that it had not been possible to test the objective satisfactorily. The new slide was stated by Dr. Van Heurck to contain several fine specimens, and it was hoped that it would facilitate the preparation of the report on the objective.

Mr. Mayall mentioned in explanation of the delay in bringing forward the report on the new objective, that before the committee—consisting of Dr. Dallinger, Mr. E. M. Nelson, and himself—met officially to examine the objective, it had been agreed to support the report by the production of photomicrographs of the various objects used as tests. With this view, Mr. Nelson and himself met, and after devoting several hours to the examination of sundry diatoms, on some of which the definition was remarkably good, it was decided to photograph the best fractured valve of *P. angulatum* observed on the slide. They were, however, disappointed to find that the visual and actinic foci were not coincident, which fact was demonstrated (1) by the visual image that had been accurately focused appearing in the photographs wholly indistinct; (2) by Mr. Nelson's guessing what focal allowance to make, so that the out-of-visual-focus-image came out very nearly sharp in the photograph; and (3), in further proof of the point, a coarsely marked diatom, as to the focus of which there could not be a doubt, was first accurately focused, then photographed, the photograph appearing wholly indistinct. The focus was then altered by Mr. Nelson by an amount which he roughly estimated would suffice. The visual image was then wholly indistinct, but the photograph produced of it was very nearly sharp—very nearly as sharp as the image could be seen in the Microscope when accurately focused. Under these circumstances the possibility of producing critically good illustrative photographs with the objective as it then was seemed very doubtful; it was therefore decided, with Dr. Dallinger's consent, to communicate the facts to Prof. Abbe, and by his request the objective was returned to Jena. After the lapse of

several weeks Dr. Czapski replied that he had not found any trace of a "chemical" focus non-coincident with the visual focus, and the objective was again forwarded to London. The committee then met, and the same fractured valve of *P. angulatum* was focused accurately and then photographed, and it appeared quite sharp in the photograph. The transit of the objective from London to Jena had somehow got rid of the "chemical" focus. Unfortunately, as he had already stated, the slide had become seriously deteriorated, so that the critical tests which they intended to photograph could no longer be tried. They were therefore compelled to wait the arrival of another slide, which Dr. Van Heurck had most kindly sent; but which the committee had not yet been able to examine. He trusted the matter would be dealt with satisfactorily during the recess, though he must express his regret that the trials would necessarily be limited to the one slide, the diatoms on which had undergone very rough treatment in being imbedded in the surface of the flint glass by melting, and by the addition of the dense mounting medium, which, according to Dr. Van Heurck's statement, required a temperature of 400–500° Centigrade for its preparation whilst actually on the slide.

Mr. Andrew Pringle's letter was read, in which he expressed his regret at not being able to attend the meeting to describe the new photomicrographic apparatus recently made to his instructions, by Messrs. Swift and Son, for the Royal Veterinary College.

Mr. Mayall said Mr. Pringle's letter had reached him only a few minutes before the Council meeting; but as he had had an opportunity of examining the apparatus before it was brought to the Society, he would endeavour to call attention to the principal points. From the very early days of photography the Society had been kept well informed of the progress of photomicrography, and had from time to time received a great number of photographs representing the progress made. They had also received many communications describing the apparatus and methods employed. The most notable, from every point of view, were the photomicrographs produced by the late Dr. J. J. Woodward, of Washington, who had been most careful and exact in describing his methods and in figuring the installation of his apparatus, which was, without doubt, the most perfect of its date. In Dr. Woodward's work every branch of microscopy extant in his time had been dealt with, so that his successors were bound to rate their progress by comparison with his work, which was, however, wholly produced before the days of the modern "dry-plate" processes of photography. The simplification of the manipulations due to the dry-plate photography had greatly popularized photomicrography, so that nearly every microscopist who had tried his hand at producing a few photographs, considered himself justified in devising some special form of apparatus, as evidenced by the enormous mass of appliances that had been figured and described in the Society's Journal.

Hitherto it might be said that the inventors had generally limited their efforts to the application of some form of camera to an existing type of Microscope, the latter being the particular instrument with which they were most familiar. Even Dr. Woodward, who had practically unlimited means at his disposal, contented himself with combining his favourite Microscope (Powell and Lealand's No. 1 model) with a

substantially-made camera, or movable screen, using such precautions as he could devise to give the whole apparatus the greatest possible steadiness. Chevalier, Hartnack, Nachet, and other opticians, including Zeiss, who had devised photomicrographic apparatus, had never, so far as he knew, attempted to plan a Microscope specially for the work; they had all adapted some form of camera to the ordinary Microscopes constructed by them. Mr. Pringle had, however, made a new departure. Having devoted much attention to the photographic processes, he became interested in photomicrography, and in his recently published volume on that subject, he frankly acknowledged that he was indebted to Mr. Nelson for all his best experience in the use of the Microscope; he was, therefore, familiar with Mr. Nelson's apparatus and his methods of work. With the experience thus gained, he considered it essential to have sundry modifications made in the Microscope itself with a view to attaining greater general stability, especially as the instrument was intended principally for high-class work, and no expense was to be spared to make it as efficient as possible. He explained his plans to Messrs. Swift, giving them general instructions to produce the best mechanism they could make. The result was the apparatus exhibited at the meeting. Of the photographic arrangement—the extensible camera and the oxyhydrogen lamp—little need be said beyond noting that it seemed very well and conveniently devised. He should himself have preferred a solid wood box-camera made in sections like Mr. Nelson's; but that was by no means a vital point. He had no doubt that with an extensible bellows camera quite as good work could be done as with a box-camera; the preference, then, was a matter of individual choice—the essential matter was that the apparatus should be accurately made, and as free as possible from vibration. With a solid wood box-camera made in sections, weights could be conveniently applied to stop vibration at the end where the sensitive plate was placed; in the bellows arrangement clamp-screws were relied upon—in either way no appreciable vibration need occur. The oxyhydrogen lamp required a great number of adjustments to be made readily; the lime cylinder had to be raised, or lowered, or turned, or it had to be brought nearer to or slid further from the Microscope; for effecting these movements rapidly and accurately substantial mechanism was applied.

As to the Microscope, he supposed that Mr. Pringle had instructed Messrs. Swift to provide a substantial extra support at the eye-piece end to insure steadiness when the instrument was in the horizontal position, and had left all the other details of the construction to be carried out by them on their own plans. But that involved a new departure, for the addition of the support at the eye-piece end was a point essentially novel, and as it gave additional stability, he thought it would probably be adopted, with more or less modification, as an adjunct to all the best photomicrographic arrangements henceforth, for its merits were unquestionable; moreover, the plan was easily applicable to any form of Microscope. Messrs. Swift had adopted the "Jackson" form of limb, modifying the usual modern construction by making it long enough to support the whole length of the body-tube, both when high or low powers were in use, thus reverting in principle to Jackson's original design, which had been rather neglected in recent times. The Jackson form of Microscope, as usually made by the American and English

opticians, was defective in the matter of the fine-adjustment—a most vital point in an instrument intended for critical work. Some five years ago, Messrs. Swift worked out a new and special system of fine-adjustment applicable to the Jackson model, which he had noticed at the time as being the most important improvement in that form of Microscope made up to that date. At that time the action of the mechanism was upon the nose-piece only, within the body-tube; but later on it was found that the bearings, &c., could be more exactly fitted by arranging the mechanism to act on the whole body-tube, and that was the system adopted in the new Microscope. The great length and breadth of the bearing slides secured steadiness, at the same time providing ample space for the screw and long-lever action which could thus be made unusually strong and yet sensitive. The stage and substage supports were shaped as recommended by the late Mr. Tolles, of Boston, so as to be strengthened at the parts where they were attached to the stand. The mechanical movements of the stage seemed very elaborate, and whilst admitting the great convenience of having such movements, he thought the microscopist would do well to learn to manipulate without them; or if that were too severe a task, then he thought his own mechanical stage—which moved the object about on the surface of the stage proper, without the intervention of moving plates—would be more serviceable, especially if strong clamping stage springs were brought to bear upon the slide when once got into the position required. The base and trestle supports of the Microscope were of unusual strength; the two brass trestles supporting the trunnion axis were held together by a V-piece after the manner of some of Troughton's small transit instruments; a third brass trestle supported the eye-piece end of the body-tube, the three trestles being screwed to an oblong brass base-plate pierced in the centre for the application of a clamping screw. The base-plate itself was fixed to a strong disc of mahogany—a sort of turn-table—having a tail-piece to carry the oxyhydrogen lamp, the whole rotating in or out of the axis of the camera, a stud-piece stopping it when in the axis, and the clamp-screw fixed it. The intention was that the microscopist would be seated, and would adjust the Microscope by rotating the instrument away from the camera, and then swing it in a line with the camera and clamp it. At the eye-piece end the trestle-support had a screw arrangement for collimating the optical image in the vertical direction on the centre of the focusing-screen. The frame carrying the focusing-screen was also provided with a small range of motion for centering the image. For photographic work the fine-adjustment screw was actuated by a system of pulleys and a silk cord kept at moderate tension by two straight springs; a long rod on fittings at the side of the camera had an indiarubber ring on the cylindrical head, which engaged by friction on a large milled head connected with the silk cord. The motion was very smooth and regular.

Without pledging himself to approve of every detail of the design, as being the best known arrangement, he thought Mr. Pringle was to be congratulated for his share in the production of the apparatus. Messrs. Swift had had a difficult task before them in constructing such an instrument, and they had accomplished their work in a most creditable manner. His own testing had been limited to the Microscope, especially the fine-adjustment, and he was glad to be able to say he found the

action extremely accurate and sensitive when severely tried. He had suggested to Messrs. Swift the advisability of clamping the body-tube, and the mechanical stage when the adjustments were made, and he understood the matter would be dealt with.

Mr. E. M. Nelson said, as regarded the general stability of the whole apparatus, he could endorse all that Mr. Mayall had said about it; but he thought it was obtained at too great a sacrifice, as the Microscope would have to be kept specially and wholly for photomicrographic work. He did not like the rotation of the Microscope with the wooden turn-table, for that seemed to him a lazy way of working; he much preferred the standing position for making the adjustments. He knew of nothing more ridiculous than the picture in Zeiss's catalogue of photomicrographic apparatus of a man sitting and adjusting the horizontal Microscope: such a position for work was quite absurd. There must be a rest for the arms, and unless a person was utterly decrepit, he should stand up to do work of that sort. He disapproved of Messrs. Swift's arrangement of the focusing cord tightened by pressure of springs with pulley wheels. The cord should not be regulated by springs, but should be drawn quite tight by a screw arrangement; he estimated the proper degree of tightness in his own apparatus by its emitting a shrill note when tried by the finger. In this way he was certain of his focus. The plan of using indiarubber in contact with the milled head was quite a mistake, he had tried that and many other similar things, but they were all radically bad. The only really certain way of focusing from a distance was to use the tight cord he had mentioned. Another fatal objection was that the Microscope was not adapted for the use of Zeiss's projection eye-pieces. He also criticized sundry points of detail in the arrangement of the camera, &c. He thought that with the springs taken away, and the other matters he had spoken of put right, the apparatus would be greatly improved. It was beautifully designed, and beautifully made, as all Messrs. Swift's work was.

Mr. T. F. Smith quite agreed with Mr. Nelson's views.

Mr. J. Swift said all the minor points referred to by Mr. Nelson as to the arrangement of the camera, the focusing screens, and sensitive plate-holders, really had been met, although he had not thought it necessary to bring everything forward at the meeting. He thought Mr. Nelson was mistaken in supposing there was only one way of arranging the focus from a distance successfully. He believed the plan adopted would be found efficient in practice. As to Mr. Nelson's preference for a standing position in making the adjustments, it was not a matter for argument. The collimating arrangement at the end of the Microscope would be found useful, as it acted very readily and accurately where placed. Mr. Nelson was in error in supposing the tube had not been arranged to take Zeiss's projection eye-pieces. Mr. Pringle brought him Zeiss's achromatic condenser, and a projection eye-piece, so that there might be no mistake about their fitting properly on the instrument.

Mr. Mayall observed that the collimating screw, as devised, moved the Microscope in relation to the lamp, so that it would require to be adjusted before the condenser was centered. He thought Mr. Nelson's contention in favour of the standing position was hardly serious. He had worked with the Microscope for upwards of an hour, sitting on an

ordinary chair, and had found no inconvenience. He remembered the photograph in Zeiss's catalogue, and agreed that the figure viewing the Microscope looked very uncomfortable. As to the precisely best method of focusing from a distance, he thought Mr. Nelson was wrong in supposing there was only one really good method. He had used a Hooke's joint for focusing in Zeiss's photographic room at Jena on several occasions, the illumination being an arc lamp, and projecting the images on a distant screen, and he found it quite convenient. He had tried a number of pulley arrangements, most of which had seemed to him fairly efficient. Excellent work could be done with very various means. No one had exhibited better work than Mr. Thomas Comber, who used a Zeiss Microscope, and who sat down while adjusting the instrument, as would be seen in the woodcuts that would be published in the August Journal. It should be remembered that Mr. Pringle had had the advantage of knowing Mr. Nelson's apparatus and methods, so that any variations he had devised were considered by him as improvements. He was sorry Mr. Pringle was not present to meet Mr. Nelson's criticism.

The Chairman said Mr. Nelson had criticized the new apparatus in his characteristic manner. He thought the subject had taken up as much time as could well be allowed, considering the other matters on the Agenda. He would, therefore, not ask any one to continue the discussion, but would at once call upon the meeting for a vote of thanks to Mr. Andrew Pringle for sending the apparatus for exhibition, and to Mr. Mayall for the description he had given of it.

Mr. E. M. Nelson exhibited upon the screen two photographs of bordered pits of pine wood, taken from sections prepared and mounted by Mr. Suffolk. He thought these pictures showed clearly that the pits were of the nature of clack-valves, and probably served the purpose of checking the downward pressure of fluid in the vascular system, which, in the case of a tree 150 feet high, would amount to about 75 lb. to the square inch. He also showed some new photographs of diatoms × 1350.

Mr. Mayall said a paper had been received from Mr. Charles E. West, of Brooklyn, on "Early Binocular Instruments." After giving a summary of the contents, he pointed out that the paper was rather remarkable for the omission from it of any allusions to binocular instruments of earlier date than Rheita's 'Oculus Enoch et Æliæ, sive Radius Siderio Mysticus,' published in 1645. The modern text-books of the history of physics, &c.—such as Grant's 'History of Physical Astronomy,' or Poggendorff's 'Geschichte der Physik,' or Harting's 'Das Mikroskop'—all referred to the official documents discovered at La Haye in the early part of the century by Van Swinden, whence it was proved that upon Lippershey's pressing for a money recognition from the States General in 1608, for his newly-constructed telescope, the payment was deferred until he could perfect the instrument by making it available as a binocular, which he did before the end of the same year. Then, as to the invention of binocular Microscopes, their American friend was content to quote from Zahn's 'Oculus Artificialis Teledioptricus, sive Telescopium,' published in 1685, apparently oblivious that Zahn was not an original authority on the matter, but that he had roughly summarized from Chérubin

d'Orléans' 'La Vision Parfaite,' published in 1677, where the inventor of the instrument figured and described it in full detail. He (Mr. Mayall) had dealt with the subject somewhat fully in his Cantor Lectures in 1885, and had given a photozincograph from the original figure, and he exhibited the original work to the meeting. He thought, therefore, it would be unnecessary to give any extended publication to Mr. West's notes, especially in view of the fact that twelve pages of the MS. were devoted to translations of passages relating to the binocular telescope, whilst little more than a page was devoted to those on the binocular Microscope.

The Chairman thought that without the reproduction of the figures, both from Chérubin d'Orléans' work and from the first and second editions of Zahn's work, the subject could not be thoroughly explained. In Harting's 'Das Mikroskop' several figures were given from Zahn's work, in some of which two tubes were shown converging in an upright form.

Mr. G. F. Dowdeswell's paper, entitled "A Contribution to the Study of Yeast—No. I. Baker's Yeast," was read by Prof. Bell. Culture-tubes containing specimens illustrative of the subject were handed round for inspection.

The thanks of the Society were given to Mr. Dowdeswell for his communication.

Mr. C. D. Sherborn read some portions of a paper which had been prepared by himself, conjointly with Mr. H. W. Burrows and the Rev. G. Bailey, on "The Foraminifera of the Red Chalk of Norfolk, Lincolnshire, and Yorkshire." The paper contained a long list of the genera and species described, and was illustrated by numerous drawings.

The Chairman, in moving a vote of thanks to the authors of the paper, said that the Council's sense of the value of the communication might be judged from the fact that they had decided to allow four plates to be prepared in illustration, which was considerably beyond the limit of expense to which they felt justified in going under ordinary circumstances.

The thanks of the Society were voted to Messrs. Sherborn, Bailey, and Burrows for their paper.

The Chairman said he thought that was the largest meeting they had yet had in the month of June. It concluded their meetings for the present session, and they would therefore adjourn until Wednesday, October 15th.

The following Instruments, Objects, &c., were exhibited:—

Mr. G. F. Dowdeswell:—Culture-tubes of Micro-organisms from Baker's Yeast.

Mr. E. M. Nelson:—Slides of the Bordered Pits of *Pinus*, and Diatom-structure.

Mr. A. Pringle:—Improved Photomicrographic Apparatus.

Mr. C. Rousselet:—Larval Ascidians, tadpole stage.

Mr. W. B. Strugnall:—Specimens of *Patella pellucida*.

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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

F. JEFFREY BELL, M.A.,

One of the Secretaries of the Society
and Professor of Comparative Anatomy and Zoology in King's College;

WITH THE ASSISTANCE OF THE PUBLICATION COMMITTEE AND

A. W. BENNETT, M.A., B.Sc., F.L.S., *Lecturer on Botany at St. Thomas's Hospital,*
JOHN MAYALL, JUN., F.Z.S.,
R. G. HEBB, M.A., M.D. (*Cantab.*),

AND

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

FELLOWS OF THE SOCIETY.

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JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

OCTOBER 1890.

TRANSACTIONS OF THE SOCIETY.

VIII.—*The Foraminifera of the Red Chalk of Yorkshire, Norfolk, and Lincolnshire.*

By H. W. Burrows, C. Davies Sherborn, and the Rev. Geo. Bailey.

(*Read* 18*th June*, 1890.)

Plates VIII. to XI.

In 1888 we communicated to this Journal (p. 383) a provisional list of Foraminifera from the Red Chalk, promising a memoir on the subject later. It is now our privilege to redeem this promise and further to

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LIST OF FORMS RECORDED AND EXPLANATION OF PLATES.

Plate VIII.

Fig.
1.—*Spiroloculina papyracea* sp. n. × 50.
2. „ *tenuis* (Czjz.) × 50.
3, 4.—*Miliolina* sp. × 50.
5, 6.—*Cornuspira cretacea* Reuss × 50.
7.—*Ammodiscus gordialis* (J. & P.) × 50.
8. „ *incertus* (d'Orb.) × 50.
9. „ *tenuis* Brady × 50.
10.—*Textularia attenuata* Reuss × 75.
11. „ *pygmæa* Reuss × 50.
12. „ *agglutinans* d'Orb. × 50.
13. „ *gramen* d'Orb. × 50.
14. „ *trochus* d'Orb. × 50.
15*a*, *b*. „ *turris* d'Orb. × 50.
16. „ *complanata* Reuss × 50.
17*a*, *b*.—*Textularia* sp. (cf. fig. 10) × 50.
18*a*, *b*.—*Verneuilina propinqua* Brady × 50.
19, 20. „ *triquetra* (v. M.) × 50.
21.—*Spiroplecta biformis* (P. & J.) × 50.
22.—*Gaudryina pupoides* d'Orb. × 50.
23.—*Bulimina affinis* d'Orb. × 75.
24. „ *Presli* Reuss × 50.
25.—*Bolivina textularioides* Reuss × 50.
26. „ *Beyrichi* Reuss v. *alata* Seg. × 50.
„ sp. (not figured).
27, 28, 29*a*, *b*.—*Pleurostomella subnodosa* Reuss × 50.
30. „ *alternans* Schwager × 75.

Plate IX.

Fig.
1, 2, 4.—*Lagena globosa* (Mont.) × 50.
3. „ *lævis* (Mont.) × 50.
6, 7, 9, 10, 11. „ *apiculata* Reuss × 50.
8, 12, 13. „ „ v. *emaciata* Reuss × 50.
5. „ *cincta* Seguenza × 50.
14, 15.—*Nodosaria* (*Glandulina*) *lævigata* d'Orb. × 50.
16. „ „ *obtusissima* Reuss × 50.
17. „ „ *cylindrica* Reuss × 50.
18. „ „ *candela* Egger × 50.
19.—*Nodosaria simplex* Silvestri × 75.
20. „ *longiscata* d'Orb. × 50.

illustrate our remarks by a series of plates generously granted to us by the Royal Microscopical Society.

The material contributing to this paper has been derived from six sources.

(1) A small collection made by C. D. Sherborn from material carefully selected from the softer band of the Red Chalk at Hunstanton by Mrs. R. E. May. These specimens are of minute size.

(2) A large collection made by H. W. Burrows, from material obtained from the upper portion of the Red Chalk at Speeton, kindly

---

PLATE IX.—*continued.*

Fig.
21.—*Nodosaria calamorpha* Reuss × 50.
22. „ sp. × 50.
23. „ *limbata* d'Orb. × 50.
24. „ *obscura* Reuss × 40.
25*a*, *b*. „ *prismatica* Reuss × 50.
26. „ (*Dentalina*) *soluta* Reuss × 100.
27. „ „ *communis* d'Orb. × 50.
28.—*Nodosaria* (*Dentalina*) *brevis* d'Orb. × 50.
29. „ „ *filiformis* d'Orb. × 50.
30. „ „ *marginulinoides* Reuss × 50.
31. „ „ *mucronata* Neugeboren × 50.
32. „ „ *abnormis* Reuss × 75.
33.—*Marginulina inæqualis* Reuss × 50.

PLATE X.

Fig.
1.—*Marginulina glabra* d'Orb. × 50.
2. „ *variabilis* Neugeboren × 50.
3*a*, *b*.—*Lingulina carinata* d'Orb. × 50.
4.—*Frondicularia biformis* Marsson × 50.
5. „ *gaultina* Reuss × 25.
6*a*, *b*. „ *Archiaciana* d'Orb. × 50.
7*a*, *b*.—*Rhabdogonium tricarinatum* (d'Orb.) × 50.
8*a*, *b* „ *minutum* Reuss × 75.
9.—*Vaginulina eurynota* Reuss × 25.
10, 11, 12, 13.—*Vaginulina recta* Reuss × 50.
14, 15. „ *arguta* Reuss × 50.
16. „ *legumen* (Linn.) × 75.
„ sp. (not figured).
17*a*, *b* (and XI. 7) *Cristellaria rotulata* (Lam.) × 50.
18*a*, *b*. „ *cultrata* (Montf.) × 50.
19*a*, *b*, 21. „ *gibba* d'Orb. × 50.
20. „ *italica* (Defr.) × 50.
22 (and XI. 8) „ *variabilis* Reuss × 50.

PLATE XI.

Fig.
1.—*Cristellaria lata* Reuss × 50.
2. „ *multiseptata* (F. & M.) × 50.
3, 4. „ *crepidula* (F. & M.) × 50.
5*a*, *b*. „ *Marckii* Reuss × 50.
6. „ *cymboides* d'Orb. × 50.
9, 10.—*Polymorphina lactea* (W. & J.) × 50.
11. „ *communis* d'Orb. × 50.
12, 13. „ *amygdaloides* Reuss *vel P. gibba* d'Orb. × 50.
14, *h* „ *horrida* Reuss × 75.
15. „ sp. × 50.
Uvigerina sp. (not figured). × 50.
16.—*Ramulina aculeata* (d'Orb.) × 50.
17.—*Globigerina bulloides* (d'Orb.) × 50.
18*a*, *b*, *c*. „ *cretacea* (d'Orb.) × 50.
19. „ *Linnæana* (d'Orb.) × 75.
Orbulina universa d'Orb. (not figured).
20, 21.—*Sphæroidina bulloides* d'Orb. × 75.
22.—*Truncatulina variabilis* d'Orb. × 50.
23*a*, *b*.—*Planorbulina ammonoides* (Reuss) × 50.
Pulvinulina Menardii (d'Orb.) (not figured).
24*a*, *b*.—*Discorbina* vel *Truncatulina* × 50.
25*a*, *b*.—*Anomalina grosserugosa* (Gümb.) × 50.
26*a*, *b*.—*Polystomella macella* (F. & M.) × 50.

(Some of these specimens have been deposited in the Natural History Museum.)

supplied by Mr. J. T. Day, F.G.S., who also suggested the method of disintegrating the hard material which is described in the footnote.*

Many of the specimens obtained are gigantic in comparison with those from the same and other localities.

(3) A still larger collection of balsam-mounted slides of material from Speeton, disintegrated and prepared by the Rev. G. Bailey. The greater part of this material was obtained from a deep-red band about two miles east of Speeton Gap, and near the boundary line of Buckton and Bempton parishes. It was collected at extreme low water during spring tides, at which time the bed is most conveniently exposed.

(4) A large collection of sliced Red Gaults and Red Chalks from various localities in Norfolk, Yorkshire, and Lincolnshire, kindly placed at our disposal by Mr. W. Hill, jun., F.G.S.

(5) Three slides of balsam-mounted dust from the Red Chalk of Flamborough Head† lent to us by Dr. H. B. Brady, F.R.S.

(6) A slide of dust, also balsam-mounted, by the favour of Dr. Clifton Sorby, F.R.S.

We have also availed ourselves of the published records of the Rev. T. Wiltshire, Messrs. Parker, Jones, Blake, and Whitaker, details of which will be found in our previous note.

Spiroloculina d'Orbigny, 1826.

Spiroloculina papyracea sp. n., plate VIII. fig. 1.—The lower half of a thin and much compressed form from the red chalk of Flamborough Head. The nearest figures to this which have come under our notice are *Spiroloculina* sp. (Hantken, Mitth. Jahrb. k. ung. Geol. Anst., iv. 1875, plate xiii. fig. 1) and *S. Freyeri* (Reuss, Denkschr. k. Ak. Wiss. Wien, xxiii. 1864, plate i. fig. 9), of which the former shows rounded chambers, and the latter is referable to *S. planulata* d'Orb. We have therefore ventured to record it under a new specific name. Dr. Brady's Coll.

S. tenuis (Czjz.) plate VIII. fig. 2. *Quinqueloculina tenuis* Czjzek, Haidinger's Nat. Abh., ii. 1848, p. 149, plate xiii. fig. 31–34; *S. tenuis*, Brady, Rep. Challenger, ix. 1884, p. 152, plate x. fig. 9. One specimen (Canada balsam, Bailey Coll.) is referable to this form: the outer chamber has been crushed and displaced.

* Owing to its great hardness, the separation of the Foraminifera from the Red Chalk is always difficult. The following method, however, greatly simplifies the process:—Break up the chalk into small pea-sized fragments, and boil in strong solution of sulphate of soda till reduced to powder; wash till all muddiness is removed.

† Speeton or Buckton. This applies also to the "Flamborough Head" of Emmett, these being the nearest places to Flamborough Head at which the red chalk crops out. (See Parker and Jones, 'Geologist,' 1860, p. 419.)

Miliolina Williamson, 1858.

Miliolina sp., plate VIII. figs. 3, 4.—Two characteristic examples of a triloculine form occurring at rare intervals in Mr. Bailey's preparations. We are not at all sure that these do not represent younger stages of *Spiroloculina tenuis* (*supra*), but as only one specimen, by reason of the number of its chambers, can be truly referred to that genus, we hesitate either to place these with it, or to impose upon them a new specific name.

Cornuspira Schultze, 1854.

Cornuspira cretacea Reuss, plate VIII. figs. 5, 6. Reuss, SB. k. Ak. Wiss. Wien, xl. 1860, p. 177, plate i. figs. 1*a*,*b*.—Occurs frequently at Speeton. The individuals vary in shape from circular to oval, as shown in the figures, but all possess the true characters of the "species." Several have either grown irregularly or have been injured since being deposited, for they show a depressed line from margin to margin, and appear at first sight to belong to *Spiroloculina*.

Ammodiscus Reuss, 1861.

Ammodiscus gordialis (Jones & Parker), plate VIII. fig. 7. *Trochammina gordialis* Jones & Parker, Quart. Journ. Geol. Soc., xvi. 1860, p. 304. *A. gordialis*, Brady, Rep. Challenger, ix. 1884, p. 333, plate xxxviii. figs. 7–9.—Two specimens of this interesting foraminifer occur in Mr. Burrows' washings. In one example the tube is thickened by subsequent deposition into an apparently solid boss in the centre.

A. incertus (d'Orbigny), plate VIII. fig. 8. *Operculina incerta*, d'Orb. in De la Sagra's Hist. Ile Cuba, 1839, Foram., p. 49, plate vi. figs. 16, 17; *A. incertus*, Brady, Rep. Challenger, ix. 1884, p. 330, plate xxxviii. figs. 1–3.—Several specimens of this variable form occur in Mr. Bailey's preparations.

A. tenuis Brady, plate VIII. fig. 9. Brady, Rep. Challenger, ix. 1884, p. 332, plate xxxviii. figs. 4–6. — This foraminifer, of which only one example was found, agrees so closely with Brady's figure that we do not hesitate to record it as such; at the same time we endorse Dr. Brady's remark, "that it is probably nothing more than a local variety of *A. incertus*." Bailey Coll.

Textularia Defrance, 1824.

Textularia attenuata Reuss, plate VIII. fig. 10. Reuss, SB. k. Ak. Wiss. Wien, xlviii. (i.) 1863, p. 59, plate vii. fig. 87.—Reuss figures and describes this species from the Septarienthon, and states that it is very variable in shape. Our specimen agrees with his figure, except that it has fewer chambers. One specimen, Bailey Coll.

T. pygmæa Reuss, plate VIII. fig. 11. Reuss, SB. k. Ak. Wiss. Wien, xlvi. (i.) 1862, p. 80, plate ix. fig. 11.—Described by Reuss from

the *Minimus*-Thon of the North German gault. The specimen figured comes from Hunstanton (Sherborn Coll.), and is the only one met with. Jones and Parker record this species as "common" in the Emmett collection, from Flamborough Head.

T. agglutinans d'Orb., plate VIII. fig. 12. D'Orbigny in De la Sagra's Hist. Ile Cuba, 1839, p. 144, plate i. figs. 17, 18, 32–34.—Occurs rarely in our collections; the specimen figured is from Mr. Burrows' washings.

T. gramen d'Orb., plate VIII. figs. 13*a*, *b*. D'Orbigny, Foram. Foss. Vienne, 1846, p 248, plate xv. figs. 4–6.—One specimen, Burrows Coll.

T. trochus d'Orb., plate VIII. fig. 14. D'Orbigny, Mém. Soc. Géol. France, iv. 1840, p. 45, plate iv. figs. 25, 26.—Common in Mr. Bailey's preparations. The chambering in all the specimens is obscure, and can only be made out by careful study.

T. turris d'Orb., plate VIII. figs. 15*a*, *b*. D'Orbigny, Mém. Soc. Géol. France, iv. 1840, p. 46, plate iv. figs. 27, 28.—This form seems rare in the red chalk; Hunstanton (Sherborn Coll.); Speeton (Bailey Coll.).

T. complanata (Reuss), plate VIII. fig. 16. *Proroporus complanatus*, Reuss, SB. k. Ak. Wiss. Wien, xl. 1860, p. 231, plate xii. figs. 5 *a*, *b*.—This interesting textularian occurs abundantly in Mr. Burrows', but more sparingly in Mr. Bailey's preparations. The specimens vary from Reuss' type, in that they are shorter and broader and have fewer chambers.

Textularia sp., plate VIII. figs. 17*a*, *b*.—One specimen only of a textularian with a bladder-like final chamber, the orifice being produced into a snout; Burrows Coll. Dr. Brady informs us that this anomalous condition is occasionally met with, and therefore the character is not specific. It is probably a well-developed specimen of Reuss's *T. attenuata* (*supra*).

Verneuilina d'Orbigny, 1840.

Verneuilina propinqua Brady, plate VIII. figs. 18*a*, *b*. Brady, Rep. Challenger, ix. 1884, p. 387, plate xlvi. figs. 9, 10.—Specimens of *Verneuilina* in Mr. Burrows' collection show so strong a resemblance to Dr. Brady's species that we do not hesitate to refer them to that form. In the figure the mouth is perhaps a little accentuated, the tenacious adherence of the matrix making it difficult to ensure the absolute freedom of the specimens.

V. triquetra (Münster), plate VIII. figs. 19, 20. *Textularia triquetra* v. Münster in Roemer, Neues Jahrb., 1838, p. 384, plate iii. fig. 19: *V. triquetra*, Brady, Rep. Challenger, ix. 1884, p. 383, plate xlvii. figs. 18–20.—Extremely common in Mr. Bailey's preparations, but often obscure and difficult to determine. We have, however, no doubt as to its identity. In many cases, possibly from its extra-

transparency, this form has the appearance of a textularian, and occasionally (see fig. 20) resembles closely Reuss's *Polymorphina subrhombica* (SB. k. Ak. Wiss. Wien, xliv. 1861, p. 339, plate vii. fig. 3), from the Senonian of New Jersey, in general shape and appearance. It is likely, too, that Marsson's *Bolivina tenuis* (Mitth. Nat. Ver. Neu-Vorpommern u. Rügen, x. 1878, p. 126, plate iii. fig. 23*b*) is this form, as also *B. tenuis* Marss. as figured by Tutkovskiĭ (Zap. Kievsk. Obsch. Estest., vii. 1887, p. 350, plate viii. fig. Г), for both these figures were drawn from balsam-mounted specimens, in which medium false appearances are very apt to occur.

Spiroplecta Ehrenberg, 1844.

Spiroplecta biformis (Parker & Jones), plate VIII. fig. 21. *Textularia agglutinans* v. *biformis*, Parker & Jones, Phil. Trans., 1865, p. 370, plate xv. figs. 23, 24; *S. biformis*, Brady, Rep. Challenger, ix. 1884, p. 377, plate xlv. figs. 25–27.—A few examples have been met with in Mr. Bailey's preparations. Parker and Jones record it from the Gault and Chalk in their paper quoted above; the species occurs also in a section of Red Chalk from Speeton, and in another of Gault from Roydon, both in Mr. W. Hill's collection.

Gaudryina d'Orbigny, 1840.

Gaudryina pupoides d'Orb., plate VIII. fig. 22. D'Orbigny, Mém. Soc. Géol. France, iv. 1840, p. 44, plate iv. figs. 22–24; Brady, Rep. Challenger, ix. 1884, p. 378, plate xlvi. fig. 2.—One large individual, Burrows Coll.

Bulimina d'Orbigny, 1826.

Bulimina affinis d'Orb., plate VIII. fig. 23. D'Orbigny in De la Sagra's Hist. Ile Cuba, 1839, p. 105, plate ii. figs. 25, 26; Brady, Rep. Challenger, ix. 1884, p. 400, plate l. figs. 14 *a*, *b*.—Common in Mr. Bailey's preparations. From its minute size, it has probably escaped observation when searching dry material from the same and other localities.

B. Presli Reuss, plate VIII. fig. 24. Reuss, Verst. böhm. Kreide, part i. 1845, p. 38, plate xiii. fig. 72, and Haidinger's Nat. Abh., iv. (i.) 1851, p. 39, plate iii. fig. 10.—One of the most common forms in the red chalk as in other cretaceous deposits, occurring often of a considerable size.

Bolivina d'Orbigny, 1839.

Bolivina textularioides Reuss, plate VIII. fig. 25. Reuss, SB. k. Ak. Wiss. Wien, xlvi. (i.), 1862 (1863), p. 81, plate x. figs. 1 *a*, *b*.—Abundant but small in Mr. Bailey's slides. Described by Reuss from the middle Hils-Thon of north-west Germany.

B. Beyrichi Reuss, plate VIII. fig. 26. Reuss, Zeitschr. deutsch.

geol. Ges., iii. 1851, p. 83, plate vi. fig. 51.—Fragments of Seguenza's variety *alata* * are frequently met with in Mr. Bailey's preparations.

Bolivina sp. A third species of this genus is common in Mr. Bailey's slides. Apparently near to *B. punctata* d'Orb., but the difficulty of determining balsam-mounted specimens prevents us from doing more than recording its presence.

Pleurostomella Reuss, 1859.

Pleurostomella subnodosa Reuss, plate VIII. figs. 27, 28, 29 *a*, *b*. *Dentalina subnodosa* Reuss, Verst. böhm. Kreide, part i. 1845, p. 28, plate xiii. fig. 22. *P. subnodosa* Reuss, SB. k. Ak. Wiss. Wien, xl. 1860, p. 204, plate viii. figs. 2 *a*, *b*.—Nine examples, the characteristic variation of which is well shown in the specimens selected for illustration. The rapidly increasing form (fig. 29) is the more common, that shown in fig. 27 approaches *P. alternans*. Burrows Coll.

P. alternans Schwager, plate VIII. fig. 30. Schwager, Novara Reise, 1866, p. 238, plate vi. fig. 80.—A small specimen, the last chamber of which is possibly imperfect. Bailey Coll.

Lagena Walker & Boys, 1784.

Lagena globosa (Mont.), plate IX. figs. 1, 2, 4. *Vermiculum globosum* Montagu, Test. Brit., 1803, p. 523; *L. globosa* Brady, Rep. Challenger, ix. 1884, p. 452, plate lvi. figs. 1–3.—Rare in our washings. Some of the specimens show the entosolenian neck. Bailey preparations.

L. lævis (Mont.), plate IX. fig. 3. *Vermiculum læve* Montagu, Test. Brit., 1803, p. 524: *L. lævis* Brady, Rep. Challenger, ix. 1884, p. 455, plate lvi. figs. 7–14, 30.—One specimen; the closing of the aperture is probably due to matrix. Burrows Coll.

L. apiculata Reuss, plate IX. figs. 6, 7, 9, 10, 11. *Oolina apiculata* Reuss, Haidinger's Nat. Abh., iv. (i.) 1851, p. 22, plate i. fig. 1; *L. apiculata* Reuss, SB. k. Ak. Wiss. Wien, xlvi. 1862, p. 319, plate i. figs. 4–8, 10, 11; Brady, Rep. Challenger, ix. 1884, p. 452, plate lvi. figs. 4, 15–18.—Most abundant and very variable in shape, a condition characteristic also of its living representatives.

L. apiculata var. *emaciata* Reuss, plate IX. figs. 8, 12, 13. *L. emaciata* Reuss, SB. k. Ak. Wiss. Wien, xlvi. 1862, p. 319, plate i. fig. 9.—Numerous specimens occur in Mr. Burrows' collection. It can scarcely be separated from the foregoing, and Reuss says of it, "der wesentliche Unterschied liegt in dem völligen Mangel des Centralstachels an der Basis des Gehäuses."

L. cincta Seguenza, plate IX. fig. 5. *Fissurina cincta* Seguenza, Foram. Monotal. Messina, 1862, p. 62, plate ii. fig. 31.—One specimen

* *Vulvulina alata* Seg., Atti Acc. Gioenia, [2] xviii. 1862, p. 115, pl. ii. f. 5; *B. Beyrichi* v. *alata* Seg., Brady, Rep. Challenger, ix. 1884, p. 422, pl. liii. figs. 2–4.

only (Bailey Coll.) of this curious compressed Lagena, previously described by Seguenza, with a fissurine aperture, from the Miocene of Messina.

Nodosaria Lamarck, 1816.

(Glandulina d'Orbigny, 1826.)

Nodosaria (*Glandulina*) *lævigata* d'Orb., plate IX. figs. 14, 15. D'Orbigny, Ann. Sci. Nat., vii. 1826, p. 252, No. 1, plate x. figs. 1–3; Brady, Rep. Challenger, ix. 1884, p. 490, plate lxi. figs. 17–22.—Rare at Speeton, the specimen figured is in the Burrows Coll.

N. (*G.*) *obtusissima* Reuss, plate IX. fig. 16. Reuss, SB. k. Ak. Wiss. Wien, xlviii. 1863, p. 66, plate viii. fig. 92; Sherborn & Chapman, Journ. R. Micr. Soc., 1886, p. 746, plate xiv. fig. 21.—One specimen, Burrows Coll.

N. (*G.*) *cylindracea* Reuss, plate IX. fig. 17. Reuss, SB. k. Ak. Wiss. Wien, xl. 1860, p. 190, plate iv. fig. 1: also figured as *N. glandulinoides* = *Geinitziana*, by Neugeboren, Verh. Mitth. Siebenbürg. Ver. Nat., iii. 1852, p. 37, plate i. fig. 2, and ibid., xi. 1860, p. 55, etc.; and as *N. parvula* by Dunikowski, from the Lemberg Chalk, Kosmos (Lwow), iv. 1879, p. 107, plate, fig. 6.—One specimen, Burrows Coll.

N. (*G.*) *candela* Egger, plate IX. fig. 18. Egger, Neues Jahrb., 1857, p. 304, plate xv. fig. 28.—Described by Egger from the Miocene of Ortenburg, Lower Bavaria. In his figure the second chamber is slightly smaller than the first, otherwise our specimen corresponds with it exactly. Burrows Coll.

(Nodosaria.)

N. simplex Silvestri, plate IX. fig. 19. Silvestri, Atti Acc. Gioenia, vii. 1872, p. 95, plate xi. figs. 268–272; Brady, Rep. Challenger, ix. 1884, p. 496, plate lxii. figs. 4–6.—Of rare occurrence in our washings. This = *N. oligostegia* Reuss, referred to in our earlier list (this Journal, 1888, p. 384).

N. longiscata d'Orb., plate IX. fig. 20. D'Orbigny, Foram. Foss. Vienne, 1846, p. 32, plate i. figs. 10–12; Brady, Quart. Journ. Geol. Soc., xliv. 1888, p. 6.—One fragment, Burrows' collection. Dr. Brady has cleared up the doubt as to the exact shape of d'Orbigny's original specimens in the paper referred to above.

N. calamorpha Reuss, plate IX. fig. 21. Reuss, Denkschr. k. Ak. Wiss. Wien, xxv. 1865, p. 129, plate i. fig. 18. See also *Glandulina crassa* Dunikowski, Kosmos (Lwow), iv. 1879, p. 122, plate, p. 14, from the chalk of Lemberg.—This and similar forms figured on plate IX. are all closely allied to *N. radicula* Linn., which has been met with by us, only in a varietal form at Hunstanton (Sherborn), but as trivial names have been given to them, we repeat them here for convenience of classification and reference.

Nodosaria sp., plate IX. fig. 22.—Apparently a very coarsely grown variety of *N. calamorpha*. A similar form was figured by Soldani as "*Orth. perfecte globularia*," Saggio Oritt., 1780, p. 108, plate vi. fig. G, *g*.

N. limbata d'Orb., plate IX. fig. 23. D'Orbigny, Mém. Soc. Géol. France, iv. 1840, p. 12, plate i. fig. 1. Hunstanton, Sherborn Coll. Gümbel's *N. granito-calcarea*, Abh. k. bay. Ak. Wiss. (cl. ii.) x. (2) p. 613, plate i. fig. 19, apparently belongs to this form.

N. obscura Reuss, plate IX. fig. 24. Reuss, Verst. böhm. Kreide, part i. 1845, p. 26, plate xiii. fig. 8.—This figure is a much restored drawing of a damaged specimen in Mr. Burrows' collection. The sutures are not shown as they are quite indistinguishable in the original. Since the figure was drawn two or three more perfect specimens have been found by Mr. Bailey at the same locality (Speeton).

N. prismatica Reuss, plate IX. fig. 25 *a*, *b*. Reuss, SB. k. Ak. Wiss. Wien, xl. 1860, p. 180, plate ii. fig. 2.—Two upper chambers of a specimen so exactly corresponding to Reuss's type that we have ventured to restore the missing portion by a dotted outline traced from Reuss's figure. Burrows Coll.

Dentalina d'Orbigny, 1826.

N. (*Dentalina*) *soluta* Reuss, plate IX. fig. 26. Reuss, Zeitschr. deutsch. geol. Ges., iii. 1851, p. 60, plate iii. fig. 4.—A small but perfect individual, from Mr. Bailey's preparations.

N. (*D.*) *communis* d'Orb., plate IX. fig. 27. D'Orbigny, Ann. Sci. Nat., vii. 1826, p. 254, No. 35; Brady, Rep. Challenger, ix. 1884, p. 504, plate lxii. figs. 19–22.—Common. Recorded by Jones and Parker from Flamborough Head (Emmett Coll.).

N. (*D.*) *brevis* d'Orb., plate IX. fig. 28. D'Orbigny, Foram. Foss. Vienne, 1846, p. 48, plate ii. figs. 9, 10.—One specimen, Burrows Coll.

N. (*D.*) *filiformis* d'Orb., plate IX. fig. 29. D'Orbigny, Ann. Sci. Nat., vii. 1826, p. 253, No. 14; Brady, Rep. Challenger, ix. 1884, p. 500, plate lxiii. fig. 4.—Three chambers of a specimen occurring in one of Mr. Bailey's slides is here figured.

N. (*D.*) *marginuloides* Reuss., plate IX. fig. 30. Reuss, Haidinger's Nat. Abh., iv. (i.) 1850, p. 25, plate ii. (i.) fig. 12.—Closely allied to *D. brevis*; figured by Reuss from the chalk of Lemberg. One specimen, Bailey Coll.

N. (*D.*) *mucronata* Neugeboren, plate IX. fig. 31. Neugeboren, Denkschr. k. Ak. Wiss. Wien, xii. (2) 1856, p. 83, plate iii. figs. 8–11; Brady, Rep. Challenger, ix. 1884, p. 505, plate lxii. figs. 27–29.—A few specimens of this variety occur in Mr. Bailey's preparations.

N. (*D.*) *abnormis* Reuss, plate IX. fig. 32. Reuss, SB. k. Ak. Wiss. Wien, xlviii. 1863, p. 46, plate ii. fig. 24.—Bailey Coll.

MARGINULINA d'Orbigny, 1826.

Marginulina glabra d'Orb., plate X. fig. 1. D'Orbigny, Ann. Sci. Nat., vii. 1826, p. 259, No. 6; Brady, Rep. Challenger, ix. 1884, p. 527, plate lxv. figs. 5, 6.—One specimen, Bailey Coll.

M. inequalis Reuss, plate IX. fig. 33. Reuss, SB. k. Ak. Wiss. Wien, xl. 1860, p. 207, plate vii. fig. 3.—Reuss figures this from the chalk of Westphalia. One example, Burrows Coll.

M. variabilis Neugeb., plate X. fig. 2. Neugeboren, Verh. Mitth. Siebenbürg. Ver. Nat., ii. 1851, p. 133, plate v. figs. 10–14 (including *M. Ackneriana*, *M. erecta*, and *M. intermedia* Neugeboren, ibid., xi. 1860, p. 55, etc.).—Abundant in the rich tertiary deposits of Felsö-Lapugy, Hungary. Occurring rarely in Mr. Bailey's preparations.

LINGULINA d'Orbigny, 1826.

Lingulina carinata d'Orb., plate X. figs. 3 *a*, *b*. D'Orbigny, Ann. Sci. Nat., vii. 1826, p. 257, No. 1; Brady, Rep. Challenger, ix. 1884, p. 517, pl. lxv. figs. 16, 17.—One specimen from Hunstanton (Sherborn), now in the Geological Collection, Science Schools, South Kensington. Reuss figured this foraminifer from the chalk of Bohemia under the name of *L. bohemica* (Verst. böhm. Kreide, part 2, 1846, p. 108, plate viii. (xliii.) fig. 10) and also as *L. nodosaria* from the Speeton clay of Spectsbrink (SB. k. Ak. Wiss. Wien, xlvi. 1862, p. 59, plate v. fig. 12). We have also seen it in a slice of red gault from Hersingham lent to us by Mr. W. Hill, F.G.S.

FRONDICULARIA Defrance, 1824.

Frondicularia biformis Marsson, plate X. fig. 4. Marsson, Mitth. Nat. Ver. Neu-Vorpommern u. Rügen, x. 1878, p. 137, plate ii. fig. 17.—One specimen, Burrows Coll.

F. gaultina Reuss, plate X. fig. 5. Reuss, SB. k. Ak. Wiss. Wien, xl. 1860, p. 190, plate v. fig. 5.—One example, Burrows Coll.

F. Archiaciana d'Orb., plate X. figs. 6 *a*, *b*. D'Orbigny, Mém. Soc. Géol. France, iv. 1840, p. 20, plate i. figs. 31–36.—We regard this as referable to d'Orbigny's form. Reuss figured it from the chalk of Bohemia under the name of *F. bicuspidata* (Verst. böhm. Kreide, part 1, 1845, p. 32, plate xiii. fig. 46), a varietal form, with which our specimens closely agree. Dunikowski's *F. polonica* (Kosmos [Lwow], iv. 1879, p. 124, plate, fig. 16), from the chalk of Lemberg, belongs also to d'Orbigny's species.

RHABDOGONIUM Reuss, 1860.

Rhabdogonium tricarinatum (d'Orbigny), plate X. figs. 7 *a*, *b*. *Vaginulina tricarinata* d'Orbigny, Ann. Sci. Nat., vii. 1826, p. 258, No. 4, and Modèles, No. 4; *R. tricarinatum* Brady, Rep. Challenger, ix. 1884, p. 525, plate lxvii. figs. 1–3.—A fine and perfect specimen,

Burrows Coll. This species appears only to have been recorded previously from Tertiary and Recent deposits.

Rhabdogonium, plate X. figs. 8 *a*, *b*.—A small example in Mr. Burrows' collection. The specimen is free from matrix, but the chambering is very obscure. We believe it to be referable to Reuss's *R. minutum*, SB. k. Ak. Wiss Wien, lv. (1) 1867, p. 84, plate v. figs. 4, 5; Brady, Rep. Challenger, ix. 1884, p. 526, plate lxvii. figs. 4–6, but cannot definitely say.

Vaginulina d'Orbigny, 1826.

Vaginulina eurynota Reuss, plate X. fig. 9. Reuss, SB. k. Ak. Wiss. Wien, xlvi. (1) 1863, p. 90, plate xii. figs. 9 *a*, *b*.—Rare at Speeton.

V. recta Reuss (*non* Karrer, 1864), plate X. figs. 10–13. Reuss, SB. k. Ak. Wiss. Wien, xlvi. (1) 1863, p. 48, plate iii. figs. 14, 15. Frequent, Burrows Coll. A variety of this form is given at fig. 11, and differs from it in the ornamentation produced by the mouths of each succeeding chamber.

V. arguta Reuss, plate X. figs. 14, 15. Reuss, SB. k. Ak. Wiss. Wien, xl. 1860, p. 202, plate viii. fig. 4. Rare, at Speeton.

V. legumen (Linn.), plate X. fig. 16. *Nautilus legumen* Linnæus, Syst. Nat. ed. 12, 1767, p. 1164; Brady, Rep. Challenger, ix. 1884, p. 530, plate lxvi. fig. 14.*—Several specimens, Bailey Coll.

Vaginulina (immature).—Numerous similar examples of elongate nodosarian forms occur in Mr. Bailey's preparations.

Cristellaria Lamarck, 1816.

Cristellaria rotulata (Lam.), plate X. figs. 17 *a*, *b*, and plate XI. fig. 7. *Lenticulites rotulata*, Lamarck, Ann. du Mus., v. 1804, p. 188, and viii. 1806, plate lxii. fig. 11; *C. rotulata* Brady, Rep. Challenger, ix. 1884, p. 547, plate lxix. fig. 13.—Common, but the figured specimen in Mr. Burrows' collection is gigantic as compared with the others. Jones and Parker record it from Flamborough Head (Emmett Coll.), and Wiltshire figures it from Hunstanton.

C. cultrata (Montf.), plate X. figs. 18 *a*, *b*. *Rotulus cultratus* Montfort, Conch. Syst., i. 1808, p. 215, genre 54; *C. cultratus* Brady, Rep. Challenger, ix. 1884, p. 550, pl. lxx. figs. 4–8.—One fine specimen only, Burrows Coll. Doubtless many of the small specimens in Mr. Bailey's preparations belong to this species, but they are too immature for determination.

C. gibba d'Orb., plate X. figs. 19 *a*, *b*, 21. D'Orbigny, Ann. Sci. Nat., vii. 1826, p. 292; and in De la Sagra's Hist. Ile Cuba, 1839, p. 40, plate vii. figs. 21, 22.—One example, Bailey Coll.

* See also Fornasini, Boll. Soc. Geol. Ital., v. 1886, p. 25, pl. i., where the life-history of the typical form is traced and figured.

C. italica (Defrance), plate X. fig. 20. *Saracenaria italica* Defrance, Dict. Sci. Nat., xxxii. 1824, p. 177, Atlas Conch., plate xiii. fig. 6; *C. italica* Brady, Rep. Challenger, ix. 1884, p. 544, plate lxviii. fig. 17, etc.—Rare in Mr. Bailey's slides.

C. lata Reuss, plate XI. fig. 1. *Rotulina lata* Reuss, SB. k. Ak. Wiss. Wien, xlviii. 1868, p. 52, plate v. fig. 57.—Recorded by Reuss from the Septarienthon of Offenbach. One specimen (Bailey Coll.) is damaged, but preserves enough character to admit of identification.

C. variabilis Reuss, plate X. fig. 22, and plate XI. fig. 8. Reuss, Denkschr. k. Ak. Wiss. Wien, i. 1850, p. 369, plate xlvi. figs. 15, 16; Brady, Rep. Challenger, ix. 1884, p. 541, plate lxviii. figs. 11–16. Reuss's figures give the student little idea of the variability of this species. Brady, more fortunate in working over the 'Challenger' material, was able to trace and figure the life-history, finding individuals of all ages. It is interesting to find in the red chalk an example (fig. 22) of the youngest form figured by Brady. Bailey Coll.

C. multiseptata Reuss, plate XI. fig. 2. Reuss, Haidinger's Nat. Abh., iv. 1850, p. 33, plate ii. fig. 9.—This robust variety of *C. crepidula* was found by Reuss in the chalk of Lemberg. Our drawing is taken from a specimen from Flamborough Head, from a balsam-mounted slide lent to us by Dr. Brady. It is drawn as viewed by transmitted light. *C. multiseptata* differs but little from *C. gibba* d'Orb., and was figured several times by Reuss under different specific names. Of these we may mention *C. recurrens* (Denkschr. k. Ak. Wiss. Wien, xxv. 1865, p. 140, plate ii. fig. 36) and *C. galeata* (ibid., p. 141, plate iii. fig. 8) from the German Septarienthon. Marsson's *C. foliacea* (Mitth. Nat. Ver. Neu-Vorpommern u. Rügen, x. 1878, p. 143, plate ii. fig. 18) also belongs to this form.

C. crepidula (F. & M.), plate XI. figs. 3, 4. *Nautilus crepidula* Fichtel & Moll, Test. micros., 1798, p. 107, plate xix. figs. *g–i*; Brady Rep. Challenger, ix. 1884, p. 542, plate lxviii. fig. 1.—Abundant. The two figured are drawn as viewed by transmitted light.

C. Marckii Reuss, plate XI. figs. 5*a*, *b*. Reuss, SB. k. Ak. Wiss. Wien, xl. 1860, p. 212, plate ix. fig. 4.—Found by Reuss, but rarely, in the Senonian clays of the Hilgenberges. One specimen, Burrows Coll.

C. cymboides d'Orb., plate XI. fig. 6. D'Orbigny, Foram. Foss. Vienne, 1846, p. 85, plate iii. figs. 30, 31; v. Hantken, Mitth. Jahrb. k. ung. Geol. Anst., iv. 1875, p. 49, plate v. fig. 3.—Although regarded as synonymous with *C. crepidula* this foraminifer has amongst fossil forms some representatives far removed from the neat and elegant type of that species shown by us in fig. 3. One of these representatives, coarsely grown, and with but four chambers, we have figured. It agrees almost precisely with the specimen given by v. Hantken from the *Clavulina Szaboi* Tertiary beds of Hungary.

Polymorphina d'Orbigny, 1826.

Polymorphina lactea (Walker & Jacob), plate XI. figs. 9, 10. *Serpula lactea*, Walker & Jacob in Kanmacher's edition of Adams, Essays Micros., 1798, p. 634; *P. lactea*, Brady, Rep. Challenger, ix. 1884, p. 559, plate lxxi. fig. 11.—Common in the red chalk. The two figured specimens of *P. lactea* v. *elongata* Brady, Rep. Challenger, ix. 1884, p. 559, plate lxxi. fig. 14, are in Mr. Burrows' collection.

P. communis d'Orb., plate XI. fig. 11. D'Orbigny, Ann. Sci. Nat., vii. 1826, p. 266, No. 15, plate xii. figs. 1–4.—Not rare. Mr. Bailey's preparations.

P. amygdaloides Reuss, and *P. gibba* d'Orb., plate XI. figs. 12, 13. — Abundant specimens of small *Polymorphinæ* occur in Mr. Bailey's preparations, and can, we believe, be referred to these two forms. As shown in the figures given by Brady, Parker, and Jones (Trans. Linn. Soc., xxvii. plate xxxix., woodcuts p. 215) these forms differ principally in degree of compression; it is therefore difficult to separate them when mounted in Canada balsam.

P. horrida Reuss, plate XI. fig. 14. *Globulina horrida* Reuss, Verst. böhm. Kreide, part 2, 1846, p. 110, plate xliii. fig. 14. *P. horrida* J. Wright, Proc. Belfast Nat. Field Club, App. iii. 1875, p. 85 (87), plate iii. figs. 14, 15.—This characteristic cretaceous foraminifer occurs sparingly in our washings.

Polymorphina sp., plate XI. fig. 15.—One large, irregularly grown form in Mr. Burrows' collection.

Uvigerina d'Orbigny, 1826.

A fine and perfect specimen of *Uvigerina* was found by Mr. Bailey in Speeton washings, but was unfortunately lost before a drawing had been taken.

Ramulina Rupert Jones, 1875.

Ramulina aculeata (d'Orb.), plate XI. fig. 16. *Dentalina aculeata* d'Orbigny, Mém. Soc. Géol. France, iv. 1840, p. 13, plate i. figs. 2, 3; *R. aculeata*, Wright, Proc. Belfast Nat. Field Club, App. ix. 1886, p. 331, plate xxvii. fig. 11.—Several large isolated chambers of this foraminifer occur in Mr. Burrows' collection. Fragments have also been met with in Mr. Bailey's preparations.

Globigerina d'Orbigny, 1826.

Globigerina bulloides d'Orb., plate XI. fig. 17. D'Orbigny, Ann. Sci. Nat., vii. 1826, p. 277, No. 1.—Frequent in our washings. Jones & Parker record it from Flamborough Head (Emmett Coll.).

G. cretacea d'Orb., plate XI. figs. 18 *a*, *b*, *c*. D'Orbigny, Mém. Soc. Géol. France, iv. 1840, p. 34, plate iii. figs. 12–14.—Very common.

G. Linnæana (d'Orb.), plate XI. fig. 19. *Rosalina Linneiana*

d'Orbigny in De la Sagra's Hist. Ile Cuba, 1839, Foram., p. 101, plate v. figs. 10–12. *G. Linnæana* Brady, Rep. Challenger, ix. 1884, p. 598, plate cxiv. figs. 21*a*, *b*, *c*.—Also common as the last.

ORBULINA d'Orbigny, 1839.

Orbulina universa d'Orb. D'Orbigny, Hist. Nat. Canaries, 1839, Foram., p. 123, plate i. fig. 1.—We have not met with this foraminifer in our washings. It occurs, however, in Mr. Hill's section of red chalk from Bed 1 at Speeton, and also at Great Girendale. It is a rare red chalk form, and is liable to be confounded with the larger of the curious spherical bodies (*incertæ sedis*) which crowd this deposit, the white chalk of Yorkshire, and some of the Norfolk gaults.*

SPHÆROIDINA d'Orbigny, 1826.

Sphæroidina bulloides d'Orb., plate XI. figs. 20, 21. D'Orbigny, Ann. Sci. Nat., vii. 1826, p. 267, No. 1. Brady, Rep. Challenger, ix. 1884, p. 620, plate lxxxiv. figs. 1–7.—Occurs twice in Mr. Bailey's slides.

TRUNCATULINA d'Orbigny, 1826.

Truncatulina variabilis d'Orb., plate XI. fig. 22. D'Orbigny, Ann. Sci. Nat., vii. 1826, p. 279, No. 8. Brady, Rep. Challenger, ix. 1884, p. 661, plate xciii. fig. 6.—Four chambers of a foraminifer in Mr. Burrows' collection, which we refer with some doubt to this variable Truncatuline.

PLANORBULINA d'Orbigny, 1826.

Planorbulina ammonoides (Reuss), plate XI. figs. 23*a*, *b*. *Rosalina ammonoides* Reuss, Verst. böhm. Kreide, pt. i. 1845, p. 36, plate viii. fig. 53, plate xiii. fig. 66; T. R. Jones, 'Geologist,' vi. 1863, p. 294, plate xv. figs. 7, 8.—Very common in all chalk deposits. Recorded by Jones & Parker from Flamborough Head (Emmett Coll.). The fine specimen figured is from Mr. Burrows' collection.

PULVINULINA Parker & Jones, 1862.

Pulvinulina Menardii (d'Orb.). *Rotalia Menardii* d'Orbigny, Ann. Sci. Nat., vii. 1826, p. 273, No. 26. Brady, Rep. Challenger, ix. 1884, p. 690, plate ciii. figs. 1, 2.—A typical and well-marked specimen of this form was found by Burrows in his Speeton washings, but unfortunately was subsequently lost.

(DISCORBINA Parker & Jones, 1862; vel TRUNCATULINA.)

Discorbina vel *Truncatulina*, plate XI. figs. 24*a*, *b*.—A small rotaline showing affinities to both of these genera. As, however, the

* See this Journal, 1888, p. 383: "I do not think they can be placed with Radiolaria, and they are not to be included with Sponges."—G. J. Hinde, *in litt.* August 25, 1890.

test is much altered by infiltration it would be unwise to attempt to fix its position.

ANOMALINA d'Orbigny, 1826.

Anomalina grosse-rugosa Gümb., plate XI. figs. 25*a*, *b*. *Truncatulina grosserugosa* Gümbel, Abh. k. bay. Ak. Wiss. (cl. ii.) x. (2) 1868, p. 660, plate ii. fig. 104. *A. grosserugosa* Brady, Rep. Challenger, ix. 1884, p. 673, plate xciv. figs. 4, 5. From a fine specimen in the Burrows Collection. We have also noted its occurrence at Hunstanton (Sherborn).

POLYSTOMELLA Lamarck, 1822.

Polystomella macella (F. & M.), plate XI. figs. 26*a*, *b*. *Nautilus macellus* Fichtel & Moll, Test. microsc., 1798, p. 66, plate x. figs. *e–g*, *h–k*. *P. macella* Brady, Rep. Challenger, ix. 1884, p. 737, plate cx. fig. 8.—One small, but perfect individual, Burrows Coll.

In our preliminary list (Journal, 1888, p. 383) we quoted *Lagena aspera* and *L. marginata*, *Nodosaria oligostegia*, *Nonionina* sp., and *Polystomella subnodosa* as occurring in the red chalk. The first of these has turned out to be a piece of matrix, the second was due to false appearance, possibly from an abnormally thick cell-wall; *Nodosaria oligostegia* is absorbed by *N. simplex* Silvestri; *Nonionina* does not occur, nor does *Polystomella subnodosa*.

The whole of the Foraminifera described above, with the exception of *Spiroloculina papyracea*, *Textularia pygmæa*, and *Lingulina carinata*, occur in the red chalk of Speeton. The following lists of occurrences in the red chalk at other localities will be useful to the worker:—

HUNSTANTON, NORFOLK.—*Text. pygmæa*, *T. trochus*, *T. turris*, *Bulim. Presli*, *Lagena brevis*, *L. apiculata*, *Nodos. radiata* var. (*N. limbata*), *Dent. communis*, *Lingul. carinata*, *Crist. rotulata* *C. italica*, *C. crepidula*, *Polymorphina*, *Globig. cretacea*, *G. bulloides*, *G. Linnæana*, *Anom. grosserugosa*, *Planorb. ammonoides*.

CANDLESBY, LINCOLNSHIRE.—Hunstanton limestone, varying from yellowish-pink to true red chalk:—*O. universa*, *G. cretacea*, *G. bulloides*, *L. apiculata*, *Dentalina*, *Verneuilina*, *Miliolina*, *N. radicula* var., *C. rotulata*, *C. crepidula*, *Polymorphina*, *Textularia*, *Glandulina*.

SOUTH CAVE, YORKSHIRE.—Pink limestone:—*O. universa*, *G. cretacea*, *L. apiculata*, *C. crepidula*, *C. variabilis*, *Verneuilina*, *Glandulina*, *Miliolina*. Red chalk (streaky, white and red):—*O. universa*, *G. cretacea*, *G. bulloides*, *Dentalina*, and *Planorbulina*.

FLAMBOROUGH HEAD, YORKSHIRE.—*Spiroloc. papyracea*, *Text. pygmæa*, *Dent. communis*, *C. cultrata*, *C. rotulata*, *C. multiseptata*, *G. bulloides*, *G. Linnæana*, *P. ammonoides*, *Bolivina*, *Polymorphina*, *Lagena*.

Great Girendale, Yorkshire.—*C. crepidula, Polymorphina, G. cretacea, G. bulloides, G. Linnæana. O. universa, Miliolina.*

Whanam Grange, Yorkshire.—*Textularia, Lag. lævis, Pleurostomella* (?), *C. rotulata, C. crepidula, Polymorphina, G. bulloides, G. cretacea.*

The report * appended on Mr. Hill's microscopical sections of red chalks and red gaults shows in an interesting way the connection between the red chalk, red gault clays, and gaults, On the whole, we cannot at present say that the Foraminifera help us in deciding the age of the red chalk, for our knowledge of the fauna of other English cretaceous deposits is very limited. This lack of knowledge will, however, soon be supplied for the gault, at least, as we understand that our friend, Mr. Fred. Chapman, has decided to publish shortly the result of many years' labour on these deposits.

Report on a Collection of Microscopical Sections of Red Chalk and Gault belonging to Mr. W. Hill, F.G.S.

While writing his paper on the Upper Cretaceous Series in Suffolk and Norfolk, in conjunction with Mr. Jukes Brown, Mr. W. Hill prepared a large series of microscopical sections of red chalk, red clays, and gaults. The results of his investigations will be found in the Quart. Journ. Geol. Soc., xliii. 1887, pp. 544 *et seq.*, while below are given some few observations on a selected series of the slides, which he has kindly placed at our disposal. The distribution of the "spheres" is of especial interest.

(1) Hunstanton limestone (yellowish-pink). Top of Rutters Pit, Candlesby, Lincolnshire. A thin section showing little matrix and containing *Orbulina universa, Globigerina cretacea, G. bulloides, Lagena apiculata,* Dentalinæ, Verneuilinæ and Miliolinæ, Ostracoda, spheres and sponge-spicules.

(2) Hunstanton limestone (pink). Middle of Rutters Pit. Little matrix and containing *O. universa, G. cretacea, L. apiculata, Nodosaria radicula, Cristellaria crepidula, C. rotulata,* Dentalinæ, Polymorphinæ, Textulariæ, Miliolinæ, Ostracoda, spheres, and spicules.

(3) Hunstanton limestone (red chalk). Base of Rutters Pit. A thick section, almost entirely composed of Foraminifera and spheres. Contains *G. cretacea, Glandulina,* Textulariæ, Miliolinæ, and others obscured on account of the thickness of the section, Ostracoda, spheres, and spicules.

(4) Streaky red chalk (red and white). From a railway cutting, east of South Cave Station; the organisms occurring in lines and more abundantly in the red than in the lighter coloured streaks.

* C. D. Sherborn is alone responsible for this Report.

Containing *O. universa, G. cretacea, G. bulloides,* Dentalinæ and Planorbulinæ, Ostracoda, spheres, and sponge-spicules in position.

(5) Hunstanton limestone (pink) from South Cave cutting. Almost entirely composed of organisms. Containing *O. universa, G. cretacea, L. apiculata, C. crepidula, C. variabilis,* Verneuilinæ, Glandulinæ, Miliolinæ, Ostracoda, spheres, and sponge-spicules.

(6) Gault from floor of pit at Muzzle, near West Dereham. Full of organisms. *G. cretacea,* Nodosariæ, and others mostly unrecognizable; entire absence of spheres.

(7) Gault, West Dereham, from the base of the gault. Full of organic fragments, but almost entirely devoid of recognizable Foraminifera.

(8) Gault from a well-boring at Stoke Ferry (54–55 feet). Containing *O. universa, G. cretacea, G. bulloides, C. rotulata,* Textularia, and Ostracodal valves.

(9) Red chalk, Whanam Grange, Yorkshire (2 slides), streaky, with abundant Foraminifera, chiefly fragmentary. *G. cretacea, G. bulloides, C. crepidula, C. rotulata, Lagena lævis,* and another, *Pleurostomella* (?), Textulariæ, Polymorphinæ, Glauconitic and brown grains, spheres, sponge-spicules, black specks, with some dendritic markings.

(10) Red chalk, Great Girendale, Yorkshire. Streaky, and although almost entirely composed of spheres and Foraminifera, the latter are not generally recognizable. *O. universa, G. cretacea, G. bulloides, G. Linneana, C. crepidula,* Polymorphina, Miliolinæ, Glauconitic and brown grains, Ostracoda, and spheres.

(11) Red chalk, Speeton, bed 1 (upper part). A thick section showing abundant unrecognizable Foraminifera. *O. universa, G. cretacea, G. bulloides, Cristellaria, Spiroloculina,* and spheres.

(12) Red chalk, Speeton, basal band of bed 1. A thick section almost entirely made up of spheres to the exclusion of other organisms. Containing *G. cretacea, Dentalina, Spiroplecta biformis,* Miliolinæ, spheres, and Ostracoda.

(13) Red chalk, Hunstanton, upper third. Containing *G. cretacea, G. bulloides, N. radicula, C. rotulata, C. crepidula,* Planorbulinæ, Textulariæ, spheres, Ostracoda, and abundant sponge-spicules, some of which are in position.

(14) Red chalk, Hunstanton. Containing *G. cretacea, G. bulloides, L. lævis, N. radicula, C. rotulata,* Planorbulinæ, Polymorphinæ, and other forms of doubtful affinity, spheres, and Ostracoda; few spicules.

(15) Red chalk, Hunstanton (middle). *G. cretacea, G. bulloides, L. apiculata, T. trochus, C. rotulata, C. crepidula, Planorbulina,* spheres, and Ostracoda; few spicules.

(16) Red gault from boring at Hersingham. *G. cretacea, G. bulloides, C. rotulata, Lingulina carinata.* Ostracoda and spicules

are absent, Foraminifera rare, and the spheres characteristic of the red chalk entirely absent.

(17) Gault, Hersingham boring; the brown bed above the red gault. The same as the last, but without *L. carinata.*

(18) Gault, the brook, Grimstone. Densely packed with spheres and Foraminifera; few spicules. *G. cretacea, L. apiculata, Textularia* (very large compared with the other forms), *Miliolina.*

(19) Pink gault, the brook, Grimstone. Similar to the last.

(20) Red gault, Roydon Cutting (Norfolk). Densely packed with spheres and Foraminifera, the latter very small. *G. cretacea, Cristellaria.*

(21) Gault, Roydon cutting. Foraminifera abundant in some layers but absent in others. Spheres entirely wanting. *G. cretacea, Polymorphina* (long var.), *Planorbulina, Textularia, Spiroplecta biformis* (one with ten chambers above the spiral, another with six).

(22) Gault, Roydon cutting (15 feet). A thick section. Foraminifera almost absent. *G. cretacea* only noticed.

(22) Hard nodules from just above the red gault, Roydon cutting. Crowded with spheres. Foraminifera rare (*G. cretacea*).

(23) Gault, lower hard bed, Grimstone Cutting. Containing *G. cretacea*, large *Textularia, Nodosaria, C. rotulata*, spheres and spicules.

(24) "Red chalk, Speeton, No. 3." A thin section, kindly lent to us by Mr. H. Clifton Sorby, F.R.S., showing plenty of matrix. Foraminifera abundant, amongst which can be recognized *G. cretacea, G. Linnæana, Dentalina, Nodosaria, C. crepidula*, Planorbulinæ, Textulariæ, and spheres.

IX.—*Note on a New Type of Foraminifera of the Family Chilostomellidæ.*

By Henry B. Brady, LL.D., F.R.S.

(*Read 15th October*, 1890.)

One of the most curious and interesting features of the Foraminifera, often an element of difficulty to the student, is the tendency of the modifications of the types composing the larger groups to run in parallel isomorphous series. Thus, if the entire Class be divided roughly, as it has sometimes been, into three Orders, comprising respectively the forms characterized by porcellanous, arenaceous, and hyaline tests, species with tests presenting the same general conformation and similar arrangement of chambers may in some cases be found in each of the three series. We have examples of three isomorphous forms—that is to say, of porcellanous, arenaceous, and hyaline genera possessing similar morphological characters—in *Cornuspira*, *Ammodiscus*, and *Spirillina*; in *Alveolina*, *Loftusia*, and *Fusulina*; in *Nubecularia* (*N. tibia* and *N. divaricata*), *Reophax*, and *Nodosaria*; and in *Hauerina* / *Peneroplis*, *Trochammina* / *Haplophragmium*, and *Cristellaria* / *Nonionina*; and a considerable number of instances might be added of two such isomorphous genera. The same tendency exhibits itself even in the smaller groups, most remarkably, perhaps, in the *Rotaliidæ*, of which the species of three or four genera may be arranged in parallel columns, in more or less closely isomorphous series. The phenomenon, in fact, is so common as almost to suggest a general law.

It is somewhat remarkable, however, that hitherto we have been unacquainted with any forms of the hyaline and arenaceous classes corresponding at all closely in general structure to the commonest of all the porcellanous types, those namely of the Sub-family *Miliolininæ*. The characters of the Sub-family are summarized as follows in the scheme of classification appended to the report on the 'Challenger' Foraminifera,*—"Chambers, two in each convolution, coiled on an elongated axis, either symmetrically in a single plane, or inequilaterally. Aperture alternately at either end of the shell"—the entire family, of course, being characterized by the imperforate and (normally) porcellanous and calcareous investment. Turning to the perforate or hyaline series, the only approach to corresponding structure is to be found in the *Chilostomellidæ*. In the genus *Chilostomella* the segments may be said to be two in each convolution, inasmuch as each does not completely inclose that preceding it; they follow each other alternately from the two ends of the test, and the aperture is at

* 'Report on the Foraminifera of the Challenger Expedition,' 1884, p. 61.

the end of the final segment, though not at the extremity of the entire shell.

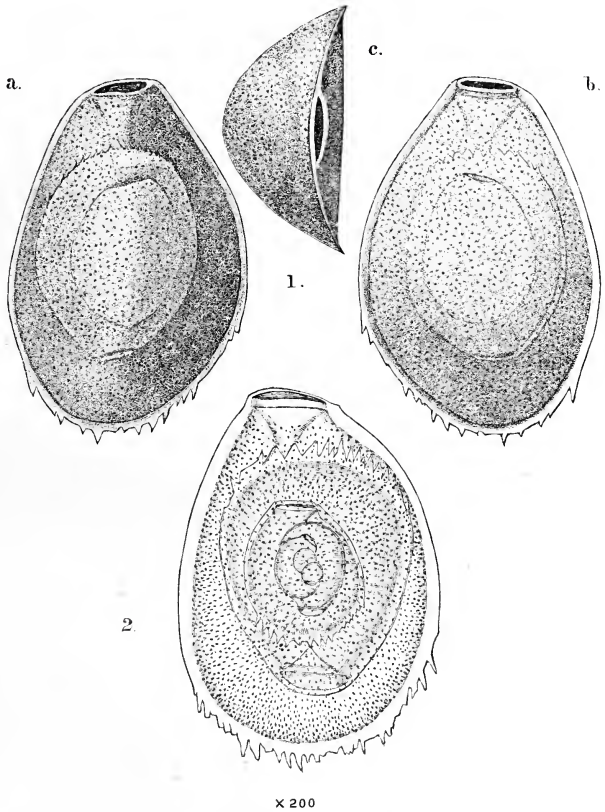
Two years or more ago * my friend Mr. W. H. Harris, then of Cardiff, brought me a mounting with two or three specimens of a Foraminifer, the characters of which did not appear to coincide with those of any hitherto described species. The shells, however, were very minute and their structure obscure, and it appeared better to wait for further material before attempting to work out the points of difficulty they presented. From time to time I have received further specimens from the same correspondent, and I now propose to give as full a description of them as circumstances permit.

Some of the shells referred to are of smaller size than the rest, and whilst possessing the same general features, exhibit certain minute structural differences. Whether the larger and smaller specimens represent different conditions of the same organism or two independent species, the material at my command is insufficient to determine satisfactorily. The present description applies primarily to the larger form, which in any case may be regarded as the type of the genus. The accompanying woodcuts, from very careful drawings by Mr. Hollick, give an accurate idea of the general features of two of the larger shells. The largest example I have seen is scarcely 1/100 in. (0·25 mm.) in length, and somewhat resembles a compressed *Biloculina*, though of less symmetrical configuration. The outline is approximately oval, more or less inequilateral, broader towards the aboral end, tapering a little towards the oral extremity; one face of the shell is convex, the other nearly flat, and the peripheral edge sharp and subcarinate. The margin of the broad aboral end is serrate, the teeth being irregular as to size and disposition. The smaller specimens, above referred to, have even margins, without carina or serration. The aperture is simple, and consists of a long narrow opening, surrounded by a thickened lip, occupying the superior extremity of the test. The shell-wall is exceedingly thin and transparent, and distinctly porous, the perforations being minute and evenly distributed. Owing to the small size and extreme fragility of the shell, it is almost impossible to study its internal structure by means of sections; nor is this needful, inasmuch as the condition of the interior is readily made out from specimens mounted in Canada balsam, and viewed by transmitted light. From a shell so mounted (fig. 2) it may be seen that the adult organism consists of about seven segments; that the primordial chamber is round, and that it is followed by another of similar size and shape; that these are partially embraced by a long, arched, Milioline chamber with terminal aperture, and that this again is succeeded by one of like contour on the opposite side, with the aperture at the opposite end. The three remaining chambers each completely envelopes those

* In June 1888.

previously formed, or at any rate appears to do so when viewed in this way. They are not, however, equilaterally disposed, but lie in the hollow of the convex side of the inclosing chamber, to which they are adherent, closely resembling *Chilostomella* in this respect. Whether the wall in this region is double, or the final segment leaves a portion

FIG. 60.



Seabrookia pellucida.

Fig. 1, *a*, *b*. Lateral aspects. *c*. Oral aspect.
Fig. 2. Specimen mounted in Canada balsam and viewed as a transparent object.
(All magnified 200 diameters.)

of the wall of the penultimate exposed (as in *Biloculina*), I have not been able to make out satisfactorily. The outline of the penultimate segment, and sometimes that of the ante-penultimate, can be easily traced on the exterior, but this may be entirely due to the tenuity and transparency of the walls; at the same time it is possible that

this portion may be the wall of the inner chamber partially exposed. The size of the smaller specimens to which reference has been made is rather more than 1/200 in. (0·127 mm.) in length, that of the larger somewhat less than 1/100 in. (0·25 mm.), the breadth being about two-thirds the length. The largest, and on the whole the best, examples hitherto found, were obtained by Mr. Harris from sand dredged in the Java Sea, by Captain Seabrook, the master of a merchantman, unfortunately lost in the Samoa hurricane two years ago. Smaller examples occurred in a dredging made off Cebu, Philippine Islands, and more recently the same form has been met with in 'Challenger' material from Station 33—off Bermudas, 435 fathoms. As stated at the commencement, I am indebted to Mr. W. H. Harris for the specimens which form the subject of the present Note, and it seemed fitting that the organism should bear his name, but he prefers that it should be associated with that of Captain Seabrook, and I have acted accordingly. Further research with a larger supply of material will probably add to our knowledge of the type, meanwhile the following provisional descriptions will serve for its identification.

SEABROOKIA, nov. gen.

Essential characters:—Test free, hyaline, perforate; composed of a number of chambers, each inclosing, partially or entirely, that preceding it; aperture terminal, alternately at the two ends of the test.

Seabrookia pellucida, n. sp.

Test oval, depressed, the two sides unequally convex, sometimes almost plano-convex; aboral end broad and rounded, oral end somewhat drawn out; peripheral edge acute or subcarinate, in large specimens serrate. Composed of a number of segments, the later chambers of the adult shell each inclosing, partially or entirely, those preceding it, a portion of the penultimate segment visible externally on the gibbous face of the test. Walls thin and transparent, smooth, or nearly so, externally, minutely perforated. Aperture simple, terminal, taking the form of a linear or elongate-oval slit with thickened lip. Length 1/100 in. (0·25 mm.) or less.

The facts which have been brought forward are sufficient to show that we have in *Seabrookia* a tolerably close isomorph of *Biloculina*, the one belonging to the vitreous series of Foraminifera, the other to the porcellanous. Further, that amongst already known types its nearest ally is *Chilostomella*, and that its natural position is in the *Chilostomellidæ*, probably between *Chilostomella* and *Ellipsoidina*.

Postscript.—Since the foregoing Note has been in the printer's hands and the woodcuts prepared, I have learnt, quite accidentally, that the smaller form above referred to is the organism of which a MS. name without description (*Millettia earlandi*) appeared in my friend Mr. Joseph Wright's list of Foraminifera dredged in 1000 fathoms off the south-west coast of Ireland, on the 'Flying Fox' expedition; published in the 'Annals and Magazine of Natural History' for December 1889: and that a detailed description both of this and the larger form has been prepared by him for the Report of the dredging expedition on the same or adjacent ground in the steam-tug 'Flying Falcon,' 1888, which has been already presented to the Royal Irish Academy, though not yet published. Mr. Wright, nevertheless, has very kindly expressed his wish that this notice should not be withdrawn, and as it is admitted that Mr. Harris was the first to find the organism and recognize in it an undescribed type, it is fair that his position with regard to it should be respected. I only regret that my prolonged absence from England through ill-health should have been the cause of any question of priority in the matter.—H. B. B.

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.†

Inconsistencies of Utilitarianism as the Exclusive Theory of Organic Evolution.‡—The Rev. J. T. Gulick thinks he finds various inconsistencies in the exclusive use of utilitarianism as explanatory of the theory of evolution, and expresses his conviction that his theory of divergence through segregation can consistently explain them.

Embryology of Vertebrates.§—M. F. Houssay has made a series of studies of the development of the Axolotl. He finds that as the ovum of Batrachians has a shell it incloses dense nutrient materials; the egg is very large, and as a result, its segmentation is unequal. The poles are not previously determined. There is no epiboly; in other words, the epiblast does not arise from four initial superior cells, but from all the peripheral cells. The pigment and size of the granules cannot be considered as characteristic of the elements. There is no "hypoblast of invagination"; that is to say, the dorsal wall of the intestine does not come from without, but is organized on the spot; the multiplication of the cells of this wall and their precocious differentiation are the result of the diminution of pressure caused by the increase in the dorsal epiblast which is preparing to give rise to the nervous system. As the

* 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.

‡ Amer. Journ. Sci., xl. (1890) pp. 1–14. Ann. and Mag. Nat. Hist., vi. (1890) pp. 125–39.

§ Arch. de Zool. Expér et Gén., viii. (1890) pp. 143–244 (5 pls.).

same cause does not exist on the ventral or lateral surfaces there cannot be the same result; hence the difference between the dorsal and ventral walls of the intestine. The multiplication of the elements of the dorsal wall of the intestine causes the formation of a layer which grows in and leaves below it a space—the intestine—while it becomes, dorsally, attached to the two other layers. The curvature of the dorsal wall of the intestine causes the curvature of the blastopore which becomes at first semilunar and then circular. The blastopore persists and forms the permanent anus.

The author next deals with the origin and development of the peripheral nervous system. He confirms the results of Beard as to the epiblastic derivation of the dorsal roots of the cranial nerves. He describes the primitive stage of the cranial ganglia as an unsegmented epiblastic band which, later on, extends into the trunk to form the lateral nerve and line. While this cord is being differentiated posteriorly it becomes segmented anteriorly to give rise to the different ganglia, and this segmentation follows that of other parts of the head. The central nervous system, which is at first unsegmented, is directly metameric in the brain and spinal cord; this metamerism, which is easily recognizable in young examples, is called "neurotomy." The dorsal spinal and the cranial roots of the nerves arise behind the neurotome of their segment, and their relations with it are secondary. The ciliary and the auditory nerves have each a postbranchial branch, which passes behind the branchial cleft of their segments. The facial nerve not only has a suprabranchial branch which is double at its extremity, but the ganglion itself is double and has two postbranchial branches, one of which passes behind the hyo-mandibular cleft and the other behind the hyoidean. The author believes that he has removed any difficulty with regard to the identity of the segments of the trunk and of the head, and he believes that he has established the complete homodynamy, at least in its fundamental parts, of the peripheral nervous system of all the metameres of the body.

In his third essay M. Houssay treats of the metamerism of the head, and discusses the principles on which the determination of the metameres must be based. The segments appear at different points and at different times and obey no simple law. There is an absolute agreement in the way in which the central nervous system (neurotomy), the peripheral nervous system (neuromery), the branchial intestine (branchiomery), and the mesoderm (mesodermery) become divided. At the same time it is to be noted that parts which typically ought to exist, retrograde or are even not produced at all, and thence arise errors in the theories as to the segments of the head.

In addition to the cephalic segments which are generally admitted—the nasal, the mandibular, the hyoidean, and the branchial, the author brings forward evidence in favour of the oculo-hypophysial, of which he finds the branchial cleft, the postbranchial nerve, and the mesodermal segment; of the buccal; of the hyo-mandibular, of which he fixes the branchial cleft, the ganglion, and the post-branchial branch; and of the auditory.

Further arguments are required to justify us in regarding the oculomotor, the trochlear, and the abducens nerves as ventral roots.

Placenta of Dugong.*—Prof. Sir W. Turner has been able to show that the placenta of *Halicore Dugong* is not, as Harting supposed, diffused, but is truly zonary; at the same time it is certain that it is in whole or in great part non-deciduate, so that we now know of two types of zonary placenta, the deciduate, found in Carnivora, Pinnipedia, *Elephas*, and *Hyrax*, and non-deciduate in the Dugong, and probably also in the Manatee.

Development and Life-histories of Teleostean Food- and other Fishes.†—Prof. W. C. M'Intosh and Mr. E. E. Prince have published the results of several years' labours at St. Andrews Laboratory. They endeavoured to examine as thoroughly as possible the ovarian growth, oviposition, hatching, and development of such of the important white fishes as could be obtained, and to fill up the gaps in our knowledge of the period between the escape of the embryo from the egg and the young, though advanced, forms known to naturalists and fishermen. The ova of about forty British fishes have been examined; some of them were pelagic or floating as of the Turbot, Plaice, Flounder, Sole, Whiting, and Sprat, and others non-pelagic or demersal as of the Herring, Smelt, Salmon, Stickleback, and Sea-Bream.

The mature ovum is first treated of, and there are remarks on the reproductive organs and period of spawning; extrusion and deposition, segmentation, the blastoderm, the periblast, the embryonic shield, the general development of the trunk, the fins, the embryonic, larval, and post-larval stages, general remarks, and a history of *Anarrhichas lupus* form the subjects of successive chapters. The reader must be referred to the memoir itself for the numerous details which it contains.

β. Histology.‡

Nuclear Modifications which affect the Nucleolus.§ — M. E. Bataillon describes some early stages in the histolysis of Amphibians, which may be well studied in the cutaneous elements of the tail, though they are to be seen in other tissues also. Elongated elements may be found, of which the upper extremity is swollen like a club and contains the nucleus; starting from it is a thread which becomes intensely stained by nuclear reagents, passes into the handle of the club, and extends more or less towards the base. The following stages of the phenomenon may be observed:—The nucleolus becomes pushed to the periphery of the nucleus, and appears to protrude a process about double its own diameter; above the nucleus is a kind of rod which half surrounds it, and still arises from an internal nucleolus; the most varied free forms surround the nucleus and end in a swelling. The author thinks that the normal chromatic filament may be developed at the expense of the plasma of the nucleolus by absorbing grains of chromatin, while the nucleolar filament may be formed by a condensation of the hyalo-plasmic framework, of which the nucleolus is in some

* Trans. Roy. Soc. Edinb., xxxv. (1890) pp. 641–62 (3 pls.).
† T. c., pp. 665–946 (28 pls.).
‡ This section is limited to papers relating to Cells and Fibres.
§ Comptes Rendus, cx. (1890) pp. 1217–9.

way the centre. In either case the nucleolus is seen to be an element of the highest importance in the biology of the cell.

Division of Pigment-cells and Capillary Wall-cells.*—Prof. W. Flemming gives an account of some observations which, like the budding of Protista and the division of leucocytes, show that a cell-body may be divided by forces which need not in any way correspond with those which are active in the division of the nucleus.

B. INVERTEBRATA.

Functions of Central Nervous System of Invertebrates.†—Prof. J. Steiner has a short account of his experiments on the central nervous system of various Invertebrates. He comes to the conclusion that, while the Arthropoda have a true brain like that of Vertebrates and represented by the dorsal œsophageal ganglion, no others of the Invertebrates have a brain. In the Mollusca and Annelida this dorsal ganglion is, according to our present knowledge, only a sensory centre; in the unsegmented worms (of which *Distoma hepaticum* is taken as the type) the dorsal ganglion forms the whole of the central nervous system; on the one hand, it is the primary centre of the locomotor organs, but at the same time it is also a sensory centre. Further investigations must show whether other distinct types of nervous systems are exhibited by the Echinodermata and Cœlenterata.

Animal Parasites of Sheep.‡—Dr. Cooper Curtice has published a report on the parasites of the sheep, which ought to be of particular interest and value. Twenty-six species of animal parasites are recorded, six of which are Cestodes, three Trematodes, and ten Nematodes, the rest being Arthropods of various groups; nine of all these are the most destructive. A new species is described in the form of the nematode *Œsophagostoma columbianum*, which seems to be the cause of a hitherto undescribed disease which is characterized by tumours in the upper part of the large intestine; one great misfortune of this disease is the disturbance to the business of the sausage-makers, who are compelled to import the greater part of the covering material which is used in their business. The origin of this pest, which does not seem to have been brought over to America from the Old World, is still obscure, and the complete life-history of the species has still to be made out.

German Names for Porifera, Cœlenterata, Echinoderms, and Worms.§—As English-speaking naturalists are very often at a loss to know what is meant by the German name of an animal or a group—e. g. by Kieferwürmer and Röhrenkieferwürmer, or by Würzelschopfschwämme, we may call attention to a useful list lately published by Dr. E. v. Marenzeller.

* Arch. f. Mikr. Anat., xxxv. (1890) pp. 275–86 (1 pl.).

† SB. K. Preuss. Akad. Wiss., 1890, pp. 39–49.

‡ 'The Animal Parasites of Sheep.' U.S. Department of Agriculture, Washington, 1890, 8vo, 222 pp. and 36 pls.

§ Abh. Zool.-Bot. Gesell., xl. (1890) pp. 177–84.

Mollusca.

Revision of British Mollusca.*—Canon Norman continues his revision, and now deals with the Gastropoda; dealing first with the Pteropoda he enumerates six species. The Opisthobranchiata and the Nudibranchiata are next enumerated, one hundred and fifty-three species being recognized.

Sensory Organs of Lateral Line and Nervous System of Mollusca.†—Dr. B. Rawitz calls attention to certain points in Herr Thiele's memoir,‡ in which he thinks he has been misrepresented; and promises to show that some of that author's results are not in correspondence with the facts of the case.

α. Cephalopoda.

Genesis of the Arietidæ.§—Mr. A. S. Hyatt's prolonged researches on the Arietidæ, now published in a large monograph, include an account of the genealogy of the three great stocks—*Psiloceras*, *Plicatus*, and *Levis*, and their subordinate series; of the genesis of characteristics—progressive, retrogressive, and differential; of the geological and faunal relations; and of the genera and species. The author's theoretical conclusions are tersely summed up in a preface, and expounded in an introductory chapter, but a complete summary would involve an explanation of terms exceeding the limits of our space.

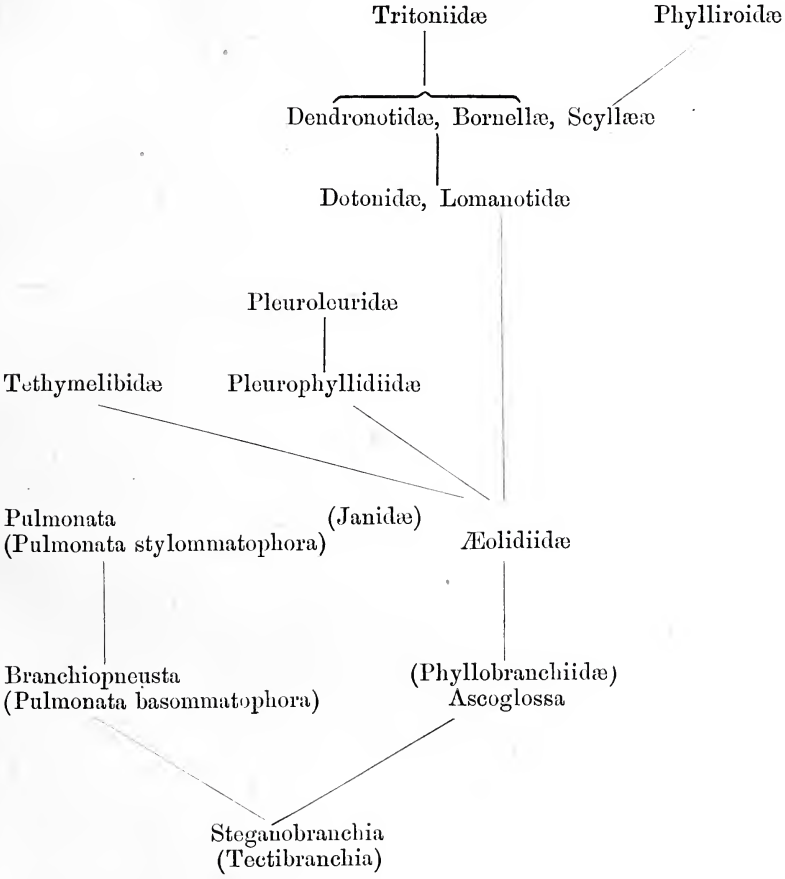
"Specialization has in all cases appeared to us to be due, *not to natural selection, but to physical selection*, or the production of suitable modifications by the action of forces which changed in a similar way large numbers of the same species, perhaps nearly all the individuals in the same locality or same habitat, within a comparatively limited period of time." "We do not intend to dispute entirely the action of natural selection and the influence of the struggle for existence, but simply to deny the applicability of the law to the more important modifications and series of modifications which have occurred in the history of animals, taking the fossil Cephalopods as a type." "Changes in the surroundings acted upon the plastic organism, inducing it to make efforts to accommodate itself to new conditions." "In so far as causes and habits are similar, they probably produce representation or morphological equivalence between different series or forms of the same type in the same habitat, and in so far as they are different, they probably produce the differentials which distinguish series and groups from each other."

γ. Gastropoda.

Cladohepatic Nudibranchs.‖—Prof. R. Bergh emphasizes the contrast between the Steganobranchiata (Tectibranchiata) and the Nudibranchs, but finds connecting links in the order Ascoglossa. The latter are allied especially to the cladohepatic Nudibranchs, the holohepatic

* Ann. and Mag. Nat. Hist., vi. (1890) pp. 60–91.
† Zool. Anzeig., xiii. (1890) pp. 361–4. ‡ See this Journal, *ante*, p. 160.
§ Smithsonian Contributions, xxvi. (1890) 238 pp., 14 pls. and 35 figs.
‖ Zool. Jahrb., v. (1890) pp. 1–75.

forms being more remote. The scheme of relationship which Bergh supports is as follows:—



The memoir gives diagnoses of the various families of cladohepatic Nudibranchs noted in the above scheme from the Æolidiidæ which are nearest to the Ascoglossa, to the Tritoniidæ, which approach most closely to the holohepatic forms.

The Titiscaniæ.*—Dr. R. Bergh establishes the new genus *Titiscania*, and makes it the type of a family of Rhipidoglossal Prosobranchiates. The animals are shell-less and slug-like; in internal structure, e.g. gills and lingual armature, they belong distinctly to the group Neritaceæ; while the structure of the radula and the absence of the median plates suggest a position in the subdivision Neritopsidæ. Bergh gives a detailed account of *Titiscania limacina* sp. n. from one

* Morphol. Jahrb., xvi. (1890) pp. 1–26 (3 pls.).

of the Philippines and Mauritius, and adds for purposes of comparison a description of *Nerita peloronta* and *Neritella pulligera*.

Pallial Organs of Prosobranchiata.*—M. F. Bernard has a lengthy memoir on the pallial organs of the Prosobranchiata. After some introductory chapters he discusses in detail the organ of Spengel; first in *Cassidaria*, where differentiation has reached a maximum; the progressive differentiation in the Diotocardia is traced through the Neritidæ, Fissurellidæ, Trochidæ, and Haliotidæ; similarly the Monotocardia are described—the Valvatidæ, the Littorinidæ, the Vermetidæ, and others, the Naticidæ, the Siphonostomata proboscidifera, the Rachiglossata, the Cypræidæ, and the Toxoglossata, being taken in order; next *Helicina* and *Cyclophora*, Prosobranchs without the organ of Spengel, and then the Patellidæ are discussed. The organ of Lacaze Duthiers in the Pulmonata, Paludina, and the Opisthobranchs are the subjects of the next three chapters. The author, in his third part, deals with the structure of the branchial lamellæ, making a special study of the muscular elements and the interepithelial nervous plexus. Finally, with the mucous gland a study is made of secreting elements. Morphological and histological comparisons of the neuroepithelial cells in Gastropods and Acephala, the morphology of the venous system, the connective tissue and blood-spaces form the subject of more general chapters.

We have only space to deal with the more general conclusions at which M. Bernard arrives. Nothwithstanding the numerous variations presented by the pallial organs in the different types examined, it is possible to show that not only are the homologous organs composed of the same elements, however different their morphological differentiation, but also that, in a general way, these elements always belong to the same types, whatever organs are considered.

Thus, there are three types of epithelial cells—the secretory, the indifferent (which is generally ciliated in Prosobranchs), and the sensory. The connective elements are of four kinds—multipolar, plasmatic, endothelial, and greatly elongated cell-fibres. The nervous elements do not differ from the two forms described for other organs—these are multipolar ganglion cells with prolongations, some of which are much more important than others, and nerve-fibres with proper nuclei. This result is of special interest, as it applies to the nervous plexuses found in the epithelium, and hitherto incompletely known. The muscular elements are very frequently branched; they form long narrow bands or short trabeculæ with numerous prolongations, which connect two adjoining connective plates.

All these elements are, as a rule, found in all parts of the mantle, and in all the pallial organs, whatever be their degree of differentiation. The cause of the differentiation of an organ or its functional specialization is the accumulation of certain elements of each of these categories.

For example, the three varieties of epithelial cells exist normally in the mantle, but in the region between the rectum and the gill the glandular cells are much more abundant than elsewhere, and the region becomes specially secretory. A simple modification of the epithelium brings about this transformation. The accumulation of glandular elements is correlated with the formation of folds which increase the

* Ann. Sci. Nat., ix. (1890) pp. 89-304 (10 pls.).

secreting surface, and the gland becomes localized, while it is more sharply marked off in higher types. The gill, as has long been known, is only a continuation of the folds formed by the internal layer of the mantle; in the interior of these folds there is a system of muscular fibres which may adduct or abduct the two folds, and so diminish or increase the blood-spaces. When differentiation is highest the different regions of a lamella are, in consequence of the localization of the different epithelial elements, either secretory (on the afferent edge), sensory (on the efferent edge), or merely respiratory. The organ of Spengel is clearly sensory in function; it owes its form to the accumulation of neuro-epithelial cells on a nerve which either arises from (Diotocardia) or ends in (Neritidæ, *Valvata*) the branchial ganglion, and persists after the ganglion disappears.

These elements are not different from those which are found in other pallial organs, and that of Spengel has only a general sensibility; when the differentiation is greatest the large number of nervous and neuro-epithelial cells which are present, the appearance of pigment-cells, and the localization of the groups of elements, show that sensibility has increased, but do not demonstrate whether the sensibility is tactile or olfactory.

Compared with the results obtained as to the tissues of the Pulmonata, Opisthobranchiata, and Acephala, we may note certain points of remarkable agreement; at the same time dermal gland-cells are wanting from the mantle of Prosobranchs, although present in the foot.

With regard to the classification of the group, M. Bernard urges that the distinction between bipectinate and monopectinate gills is of capital importance, because it clearly agrees with the principal characteristics drawn from other organs, and particularly those recently investigated by M. Bouvier and M. R. Perrier. In other words, the groups Aspidobranchiata and Pectinibranchiata agree with the Diotocardia and the Monotocardia; *Valvata* has a bipectinate gill, while most of its characters approximate it to the Tænioglossata. In the Patellidæ, the gill of *Tectura*, like its nervous system, inclines us to place it with the Diotocardia, but the heart and kidney would make us separate it from them.

Among the Diotocardia, the classification, proposed by Spengel and adopted by Bouvier, into Zygobranchiata and Azygobranchiata does not appear to be satisfactory. The most natural classification seems to agree with that of R. Perrier, and in it we have the following divisions:—

A. Scutibranchiata = Diotocardia = Aspidobranchiata = Rhipidoglossata.
   (1) Fissurellidæ (Homonephridiata).
   (2) Trochidæ, Turbonidæ, Haliotidæ, &c. (Heteronephridiata).
   (3) Neritidæ (Mononephridiata = Orthoneuroidea).

B. Cyclobranchiata = Heterocardia = Doxoglossa.
   Patellidæ, Tecturidæ, Lepetidæ.

In the Monotocardia the false gill varies considerably, and its different degrees of complication have been utilized by M. Bouvier in his classification; they agree with the characters drawn from the anterior part of the digestive tube and the nervous system. The author consequently proposes no change in the classification proposed by his predecessor.

Gland of Auricle in Paludina, and Nephridial Gland in Murex.*—M. L. Cuénot describes the wall of the auricle of *Paludina vivipara* as being considerably thickened. It is covered externally by a cubical epithelium, below which is a thick muscular and connective zone, which is crowded with nuclei; on its inner side this zone is in direct contact with the blood. On teasing the wall, after treatment with osmic acid, picro-carmine and glycerin, the nuclei of the stroma may be seen in the course of being transformed into amœbocytes. A considerable number of them are surrounded by the refractive granules characteristic of mature amœbocytes, and are ready to pass into the cavity of the auricle; it is quite obvious that we have to do here with a lymphatic gland. Fixation with Flemming's liquid shows the same facts even more distinctly. The author has already described another lymphatic gland in *P. vivipara*, which is situated in the gills. The products of these two glands are identical, and the two organs are simultaneously functional.

The nephridial gland of *Murex brandaris*, teased as before, is found to have its glandular tissue formed of a plexus of fibres, crowded with nuclei and cells. The former do not develope into amœbocytes, but take, on their death, the place of certain cells. These cells, of which there is a large number, are very large (10 μ to 25 μ), ovoid or spherical in form, and are bounded by a very distinct fine membrane. They inclose a central nucleus; the cellular cavity is filled with large refractive granules, which are yellowish-green during life and proteid in composition. When alive they actively absorb fuchsin, and become red; they are coloured grey by osmic acid. These cells are not a characteristic element of the nephridial gland, for they are found wherever there is connective tissue, but they are specially abundant in that organ. The histological structure of the nephridial gland of *Murex brandaris* leads us to suppose that it is not a lymphatic organ, but merely an organ of reserve.

Mechanism of Respiration in Ampullariidæ.†—MM. P. Fischer and E. L. Bouvier have had the opportunity of studying the mechanism of respiration in *Ampullaria insularum* and *Lanistes Bolteniana*. The former of these was the subject of the observations of Guilding, Cazenavetti, and Bavay, and, when in water, exhibits a mode of pulmonary respiration curiously similar to that of Cetacea. When immersed in water the mollusc breathes by its gills. As the siphon divides the left pallial cleft into two slightly unequal halves fine granules of carmine may be seen to penetrate into the chamber by the right half of the cleft; they are rapidly directed from before backwards, and from right to left, and the water does not seem to take more than six to eight seconds to make the entire course of the branchial chamber. When the animal is on land the lung plays an essential and exclusive part in respiration; the pulmonary orifice opens and closes alternately, but not with great regularity, and these movements correspond to elevations and depressions of the floor of the lung. These irregular movements of inspiration and expiration are powerfully aided by the general movements of the body.

While *Ampullaria* is dextral, *Lanistes* is sinistral, and the mechanism of respiration is altogether different. *Lanistes* respires air and water by the

* Comptes Rendus, cx. (1890) pp. 1275–7. † T. c., cxi. (1890) pp. 200–3.

siphon, and does not move its head in the way which is so characteristic of the aerial respiration of *Ampullaria*. The animal comes to the surface, extends its siphon into the air, and so renews the air in the lung. *Lanistes* seems to be much less aerial in its respiration than *Ampullaria*, for it comes much less rarely to the surface. The elongation of the siphon in *Ampullaria* and the physiological differentiation between the siphon and pallial cleft is to be explained as due to its better adaptation to aerial life. The mode of aquatic respiration in *Lanistes* is very similar to that of *Ampullaria*.

Olfactory Sense of Snails.*—M. R. Dubois has made a number of experiments on the sense of smell in *Helix pomatia*. He concludes that (1) the larger tentacles are more sensitive than any other points of the integument; (2) the sensibility of the smaller tentacles to various olfactory stimuli, although very general, is much less marked than that of the larger; (3) the olfactory sensitiveness of the rest of the integument is only evident for very few stimuli (such as vapour of benzine), and even for these stimuli it is much less marked than that of the tentacles; (4) in the large tentacles sensibility is not confined to the extremities, though it is more marked there than elsewhere. The author's experiments lead him to think that, for the special senses, primary excitation is mechanical, as it is with the tactile organs strictly so called.

New Neomeniæ from the Mediterranean.†—M. G. Pruvot has found at Banyuls eight species of *Neomeniæ*, all of which, with the exception of *Proneomenia aglaopheniæ* and *P. desiderata*, are new. Three of the species belong to the genus, lately established by Hubrecht, *Dondersia;* these are called *D. banyulensis*, *D. flavens*, and *D. ichthyodes;* the last would deserve separate generic rank did a sufficient number of specimens afford material for a comparative study. *Paramenia* is a new genus which exhibits a remarkable mixture of the characters of *Neomenia* and *Proneomenia;* three species—*P. impexa*, *P. sierra*, and *P. palifera* – are placed in it; the last of these was, unfortunately, represented by a single individual, for the form and distribution of its spicules, the absence of penial spicules, and the reduction of the radula afford characters which indicate the generic distinctness of the species. Further details are promised.

Circulatory Apparatus and Gonads of Neomeniæ.‡—M. G. Pruvot states that the so-called heart of the Neomeniæ is very variable in its constitution, even within the limits of a single species. In some cases it appears to be a simple fold of the dorsal wall of the pericardium, while in others it is entirely detached in its median part. It never has any muscular elements, but is formed of a mass of connective cells which are sometimes arranged compactly and sometimes leave between them spaces, in which blood-cells accumulate. It is not connected with a dorsal vessel—which does not exist—but with a dorsal sinus. The heart also varies considerably in form; in *Dondersia flavens* and *D. banyulensis* it is cylindrical; in *Proneomenia aglaopheniæ* and *P. desiderata* it is flattened and slightly bilobed, while in *P. sierra* it has the form of a

* Comptes Rendus, cxi (1890) pp. 66-8.
† Arch. Zool. Expér. et Gén., viii. (1890) pp. xxi.-iv.
‡ Comptes Rendus, cxi. (1890) pp. 59-62.

plate flattened dorsoventrally and divided by a constriction into an upper and a lower mass.

The gonads are two long tubes with proper and continuous walls; in their lower part they gradually acquire a common envelope which is at first connective and then muscular, and which also incloses the dorsal sinus. They, like the pericardium, have no relation with the general cavity, and like it, do not contain a single blood-cell. The pericardium is lined by a pavement epithelium, which is continuous and forms on the sides two longitudinal folds, where the cells become higher, cubical and ciliated.

The author concludes that the so-called heart is not a propelling organ, as it is often devoid of a cavity, and never has contractile elements; morphologically it is a mere dorsal raphe, a continuation of the septum of the gonad which becomes incomplete and incloses a portion of the general cavity; physiologically, it aids in forming, on each side, with the lateral ciliated folds of the pericardium, a groove such as that which is seen at the end of the gonad of hermaphrodite Gastropods, and it is destined, like it, to separate the male and female elements which have hitherto been mingled with one another. The spermatozoa are conveyed into a special portion of the nephridial tubes, or into two long seminal vesicles, while the ova pass from the groove and accumulate in the so-called pericardium; this last is nothing more than an accessory pouch of the genital apparatus.

The so-called nephridial tubes are simple genital ducts which have neither renal function, since their epithelium is not glandular, nor the value of segmental organs, since they do not communicate with the general body-cavity; in fact, the genital apparatus, as a whole, recalls most nearly that of hermaphrodite Gastropods, with the difference that, in the Neomeniæ, all the parts are paired and symmetrical.

δ. Lamellibranchiata.

Identity of Composition of Nervous System of Lamellibranchiata and other Molluscs.*—M. P. Pelseneer points out that in most Mollusca each pedal ganglion receives two connectives—the more ventral or more anterior, which comes from the cerebral ganglion, and the more dorsal or posterior, which arises from the pleural ganglion. This arrangement is general in Gastropods, and has been found also in Cephalopods and in *Dentalium*. The absence, in Lamellibranchs, of the pleuro-pedal connective and of a distinct pleural ganglion have been regarded as definitely characteristic of the class; however, in *Nucula* and *Solenomya*, more primitive genera which M. Pelseneer has united under the group-name Protobranchiata, the pleural centres and the pleuro-pedal connectives are to be found. In *Nucula* the cerebral ganglia occupy the usual position, above the œsophagus; they each give off fibres which pass to the adductor muscle and to the palps, as well as the connective which unites the cerebral centre to the corresponding pedal ganglion. More posteriorly, at the point where, as a rule, the visceral commissure commences, there is a ganglion which is as large as the cerebral; this gives off the visceral commissure posteriorly and the anterior pallial

* Comptes Rendus, cxi. (1890) pp. 245-6.

nerve externally, while, ventrally, there is a strong nerve-cord which is directed towards the pedal ganglion, which, about half-way on its course, becomes united with the cerebro-pedal connective.

In *Solenomya* there is a similar arrangement, with the sole difference that the nerve-fibres which go from the ganglion at the origin of the visceral commissure as far as the pedal centre join those of the cerebro-pedal connective on their exit from the ganglion; in this way the common trunk which they form arises from the junction of the cerebral ganglion with that which is connected with it posteriorly.

If we compare the arrangement observed in *Nucula* and *Solenomya* with that which obtains in Gastropods and *Dentalium*, we see that the ganglion from which arise the anterior pallial nerve, the visceral commissure, and the fibres which pass to the pedal centre, is the pleural ganglion, while the fibres which join this last centre to the pedal ganglion of *Nucula* and *Solenomya* form the pleuro-pedal connective which was believed to be wanting in the Lamellibranchiata. In such as are more specialized than these two Protobranchs the pleural and cerebral ganglia are fused into a single ganglionic mass (which is always called the cerebral), as may be seen when sections of the mass are made, and the two connectives—the cerebro-pedal and pleuro-pedal—are united for their whole length.

Progression and Rotation of Bivalve Molluscs and of Detached Ciliated Portions.*—Mr. D. M'Alpine has continued † his observations and experiments on this subject, and now gives an account of what he has observed in the freshwater mussel (*Unio*), in which the general results are much the same as with *Mytilus*, and in the Oyster.

When the movements of these three forms are compared in their natural condition, it will be found that *Unio* has the greatest activity, and *Ostrea*, as far as known, the least; but if the progressive and rotatory movements due to cilia are in question, then *Mytilus* undoubtedly takes the lead. Each of these three forms has a distinct and specially active part, suggestive of underlying differences; in *Mytilus* it is the gill, in *Unio* the ventral margin of the foot, and in *Ostrea* the labial palp. The cilia are supposed to continue their work without any rest, but it may be imagined, in a structure like the gill, with its innumerable cilia, that they rest in relays without interfering much, if at all, with the general effect.

In the course of his investigations the author noticed an important distinction between the action of the cilia and the movement of the cilia-bearing mass. The movement of the mass might cease and yet the cilia themselves, when examined under the Microscope, would be in active motion. The cilia in themselves are, therefore, not the cause of movement; there has to be co-operation or co-ordination of some sort before the ciliary motion can give rise to movement of the part bearing the cilia. Ciliary motion which causes currents in streams must, therefore, be distinguished from ciliary motive power.

Organ of Bojanus in Anodonta cygnea.‡—Dr. W. M. Rankin gives a very full account of his observations on the organ of Bojanus in the

* Proc. Roy. Soc. Edinb., xvi. (1888-9) pp. 725-43 (2 pls.).
† See this Journal, 1889, p. 739.
‡ Jenaische Zeitschr. f. Naturwiss., xxiv. (1890) pp. 227-67 (2 pls.).

Mussel. He divides his account of its macroscopic anatomy under the heads of (1) renal duct and ureter, (2) renal sac, (3) tip of organ, (4) its loops, and then deals with its blood and nerve supply. Its microscopical characters are first treated of in relation to the structure of the walls, the epithelial cells, and the sensory epithelium being next dealt with. The walls of the organ are found to be composed of a homogeneous ground-substance with which are associated various kinds of connective-tissue-cells. These form a delicate wall for the true kidney and a firmer partition between it and the pericardium. Smooth muscle-cells are scattered between the connective cells. The apices or tips are formed of firm bandlike connective and muscular cells which are arranged circularly and longitudinally. Around the ureters the fibres are chiefly arranged in a circular manner.

The epithelial investment consists of three kinds of cells; the excretory with scattered flagelliform cilia, which are found in the whole of the organ except the tips and ureters; in these last there are cylindrical cells with closely set cilia; at the renal end of the tips there are cells with extraordinarily long cilia.

The author concludes with some observations on the morphology and physiology of the organ of Bojanus. In the Acephala the organ is in close relation with the posterior adductor and the gills; in those species (e. g. in *Pecten* and *Cardium*) in which the longitudinal axis is short, the organ is saccular and lies in the space between the pericardium and the posterior adductor; but when the body is long, as in *Anodonta* or *Mytilus*, the organ extends almost the whole length of the gills; these facts lead us to suppose that the primitive position of the organ was between the pericardium and adductor. The history of its development shows that the first portion of the organ was the ciliated funnel or tip of the kidney; the second, the true kidney formed of sac and loops; the various coils seen in *Cyclas* are in *Anodonta* replaced by coils which are simpler but rich in folds. The points made out by Ziegler are intelligible if we suppose that the ureter has an ectodermal origin.

There can be little doubt of the renal function of the organ of Bojanus, but it is of interest to inquire whether it has any other functions —does it assist the circulation of the pericardial fluid or does it introduce water into the pericardium, and so into the whole vascular system? The former is possible, but the arrangement of valves is such as to prevent the entrance of water from without.

Repair of Test of Anodon.*—M. Moynier de Villepoix has made some experiments on the repair of the test of *Anodonta ponderosa*; he has removed from the edges or sides of the shell pieces sufficiently large to allow observation of the modifications which supervene. The subjects of the experiments were put in (1) a basin which communicated with the stream from which they were taken, or (2) water from the stream which was renewed every two days, or (3) water entirely deprived of carbonate of lime. In all cases the animal reformed the parts which had been removed.

In those in which the edge of the shell was removed the epidermis

* Comptes Rendus, cxi. (1890) pp. 203-6.

which forms numerous folds at the edge of the shell was destroyed before the ablation of the calcareous part. In all cases this epidermis was renewed; in animals preserved in their normal medium it had all its original characters; it was covered on its outer side by crystals formed of a calcareous but not carbonated substance; the crystals appear to be a product of the secretion of the elongated epithelial cells near which they are found, and appear to play the part of reserve-materials. In the animals kept in non-calciferous water there were young crystals, but they are less regular and not so numerous; the presence of these few crystals is easily explained; the shell of the animal after four months' stay in the water had become completely transparent and so soft that, though still calcareous, it could be folded under the fingers like an elastic membrane.

In all the specimens examined there had been a secretion of a substance destined to close the wound made on the shell. This layer was formed of several organized membranes, placed on one another, arising at some millimetres from the edge of the wound and all around it. At its surface and between the membranes which form it, the calcareous matter takes on very various forms. Rhombohedra, radiated crystals, or crystalline plates were all seen; but in the animals which were preserved in the chalkless water there were no crystals of any kind.

The pallial epithelium was led by the necessity of an active secretion to undergo profound modification. The cells are greatly elongated and provided with a large oval nucleus in which are one or two highly refractive nucleoli; the protoplasm of the outer part of the cell is very granular and becomes stained green with methylene; it is, in fact, identical in form and reactions with the glandular epithelia of the fold of the mantle-lobe and of the dorsal region.

The author concludes that these observations show that the shell of these animals is a secretion-product of the mantle, that the earliest stage of the test is always a purely organic formation, and that the lime which strengthens the shell is obtained from the surrounding medium.

Molluscoida.

γ. Brachiopoda.

Stratigraphical Distribution of Deep-Sea Brachiopods.*—MM. P. Fischer and D. P. Oehlert report that the expeditions of the 'Travailleur' and 'Talisman' dredged sixteen species of deep-sea Brachiopods. Thirteen of these have been found in the marine pliocene deposits of Sicily and Calabria; since the period of these deposits these species have become extinct in the Mediterranean while almost identical forms to them have been perpetuated in the Atlantic; three other species appear to be in course of extinction, as isolated valves were alone dredged from the Mediterranean, while the forms are still abundant in the Atlantic.

The authors ask why there should be this tendency to the disappearance of abyssal forms from the Mediterranean, and correlate it with the gradual heating of that sea, which is, as compared to the Atlantic, closed. These considerations seemed to confirm the hypothesis that the

* Comptes Rendus, cxi. (1890) pp. 247–9.

distribution of marine animals is chiefly regulated by temperature. We may suppose that abyssal forms will become extinct in the Mediterranean and that their place will be taken by forms occupying more shallow waters and better adapted to higher temperatures.

Arthropoda.

Signification of Vitelline Cells in Tracheata.*—Mr. W. Schimkewitsch points out that in Amphibia and several Tracheata the cavity of the mesenteron is surrounded by elements of two kinds—the cells of one side are deprived of vitellus, while those of the other are true vitelline cells. These latter are differentiated in very early stages, sometimes during the segmentation of the egg; they may take part in the formation of the epithelium of the mesenteron. It is very probable that in those Tracheata in which the rudiment of the internal lamella, formed by invagination, is destined entirely for the formation of the mesoderm, that the epithelial layer of the mesenteron is developed exclusively at the expense of the vitelline cells. These cells in Amphibians and Tracheates are elements which long preserve their embryonic character, but from the morphological point of view they belong to the endoderm. It remains to be seen whether they are comparable to the vitelline nuclei of other Vertebrates.

α. Insecta.

The Retinal Image of the Insect Eye.†—Prof. Exner believes that he has been able to settle the controversy as to whether creatures provided with facetted eyes see by one erect image or by many inverted ones, in favour of the first hypothesis. In the case of the glow-worm (*Lampyris splendidula*), he has succeeded in demonstrating this erect image, and has shown that the dioptric apparatus of the eye is of such a kind that the distance of the image from the refracting media increases with the distance of the object from the eye. The two focal points lie on the same side of the refracting media, and by transmission of the rays in the opposite direction, a virtual inverted image is produced, which has the same position with regard to the refracting media as the erect image. The eye has no optic axis in the ordinary sense of the word, and the retinal image lies on a spherical surface parallel to the outer curvature of the eye.

It was in 1826 that J. Müller proposed his theory of the erect retinal image in the insect eye. According to this theory each element or facet consists of a transparent tube, coated with black pigment. These tubes are arranged in radial position on a hemisphere. Thus for each tube only rays incident in the direction of the radius can reach the retina at the extremity, while rays at any other incidence are absorbed by the pigment. An erect image is accordingly formed on the hemispherical convex retina at the base of the tubes. This theory was supposed to have been refuted by the observation made by Grüel and Gottsche, that, under certain conditions, an inverted image corresponding to each facet of the eye of a fly could be seen under the Microscope.

* Zool. Anzeig., xiii. (1890) pp. 399-402.

† SB. K.K. Akad. Wiss. Wien, xcviii. (1889) pp. 13-65, 143-51 (3 pls. and 7 woodcuts).

Fr. Boll, however, nineteen years after them, finding that the rods of the retina of the Triton gave inverted images, called in question the functional importance of these images, and once more directed attention to Müller's theory. Grenacher followed in the same direction, and lastly, Exner proved by *Hydrophilus piceus* that the image of Gottsche cannot be produced in the living animal, for it could not possibly lie in the position accorded to it by theory.

The author's recent observations were made exclusively on the eye of the male *Lampyris splendidula*. In this there is a fusion of the crystalline cones with the cornea, so that it is possible to wash away the pigment and the soft parts of the eye, and to examine the whole dioptric apparatus in the normal relation of the crystalline cones to the corneal facets. The eye was mounted in glycerin of refractive index 1·346 (that of the blood of *Hydrophilus piceus*), in such a way that the convex cornea was in contact with air, the crystalline cones with a fluid of approximately the same refractive index as the glow-worm's blood. Under the Microscope, with low powers, an erect image is seen of an object placed between the Microscope mirror and the eye. The sharpness of the images given by a fresh eye was extraordinary. A less perfect image of an arrow was given by an eye which had been kept in spirit 4–5 months. It measured 0·24 mm., while the length of the arrow was 32 cm., and its distance from the preparation 52 cm. The distance between the ends of the crystalline cones and the retina was determined by adjustment of the Microscope to be 0·23 mm.

When the position of the eye on the stage was inverted, so that the concave side was turned towards the object, an image was observed which was approximately in the same position as the normal retinal image, and had the same magnitude, but was inverted. Numerous observations and experiments were made in order to determine the path of the rays in the eye necessary for an erect image.

Directing the Microscope on the centre of the line joining two flames and adjusting on the plane of the retinal image, two light-points were seen. By approaching the focal plane towards the cornea it was determined that two rays come from each crystalline cone, one from the right object-point being deflected to the right image-point, while the other from the left object-point is in the same crystalline cone deviated to the left image-point. Thus it was found that a ray entering the crystalline cone at an angle makes an angle with it on emergence, and is on the same side of the axis, and in the same plane.

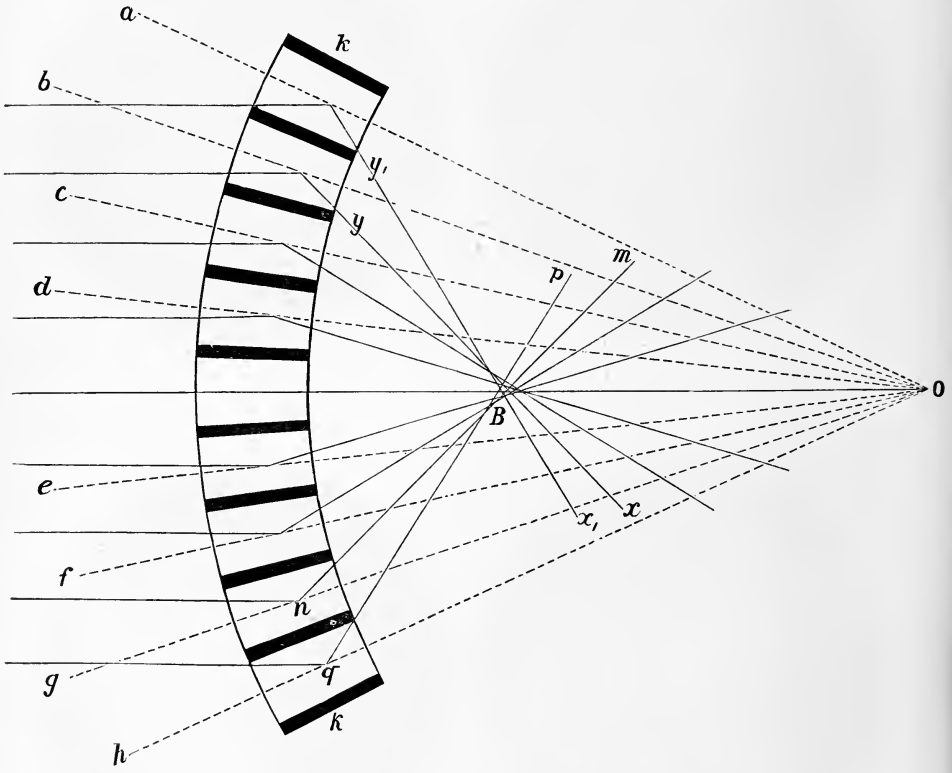
Fig. 61 shows the path of the rays for a single light-point at such a distance that the rays are approximately parallel. *k k* represent the facets, O *a* to O *h* their axes; the parallel rays are deflected in the crystalline cones so as to form the image at B. O is the centre of curvature of the eye. Similarly an image would be formed of another object-point lying for example in the direction O *b*, and it is clear that the total image would be erect.

Fig. 62 represents the image obtained when the Microscope is adjusted on a plane in front of the cornea. This gradually passes into that of fig. 63, when the focal plane is moved back until in the neighbourhood of the vertices of the crystalline cones. On moving the focal plane still further back, the bright circles of fig. 63 become

narrower, and finally the image shown in fig. 64 is obtained. Fig. 65 shows the appearance when the focal plane is behind the retinal image.

The author's experiments lead to the conclusion that the dioptric apparatus of the *Lampyris*-eye is very similar in its effects to a system of two lenses on the same axis which are separated by a distance equal to the sum of their focal lengths. In the *Lampyris*-eye the two convex

Fig. 61.



lenses are replaced by two cylindrical lenses, the Linsencylinder of Exner, which form the crystalline cone. The path of two pencils in a crystalline cone, according to this principle, is shown in fig. 66. The inverted image $a_2 b_2$ of the distant object $a b$, which gave rise to so much confusion in the physiology of the compound eye, is formed not at the vertex or behind the cone, but in front, where there can be no nerve-fibres. The rays m and n proceeding from a form an image at a_1; similarly the rays p and q from b form an image at b_1. The image $a_1 b_1$

is formed between the focus on the hinder part of the crystalline cone and its vertex, so that the rays m, n from a_1, on leaving the cone, are slightly divergent. Thus $a_1\, b_1$ gives rise to the virtual image $a_2\, b_2$. The figure shows how the angle of emergence of a pencil to the axis is on the same

FIG. 62.

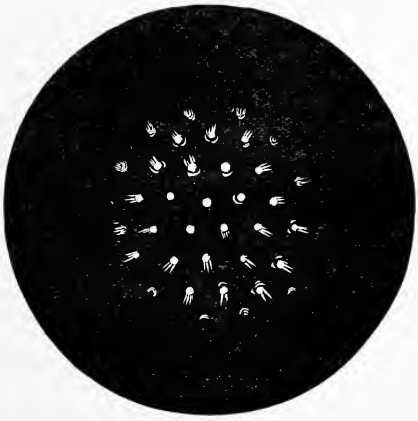


FIG. 63.

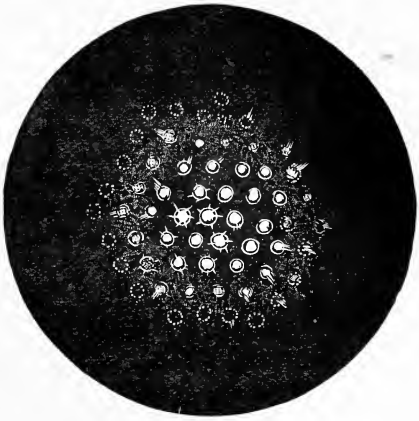
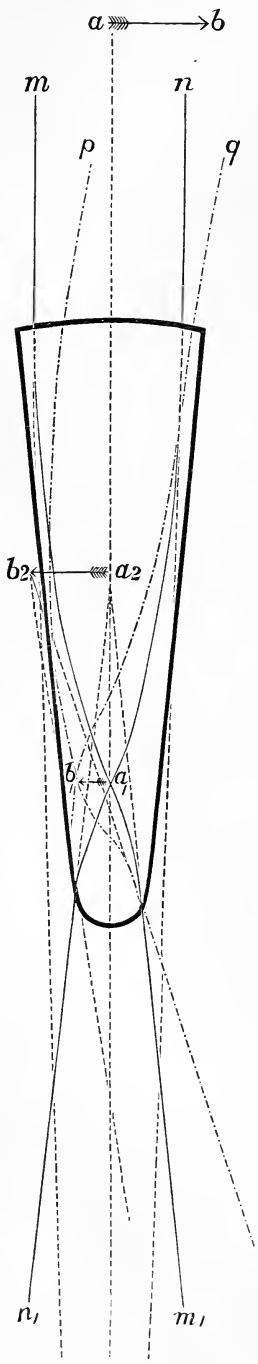


FIG. 64.

FIG. 65.

side as the incident pencil, and that it is so much greater, as the incident angle is greater. The author has constructed a model of an insect eye on the above principles. It consists of ten pairs of convex lenses, each of focal length of 2 in. The two members of each pair are separated by

FIG. 66.



4 in., and the ten sets are arranged on an arc of 75 cm. radius. The formation of the inverted image which is seen when the concave side of the *Lampyris*-eye is turned towards the object is explained by fig. 67. The crystalline cone acts like an astronomical telescope adjusted for infinite distance. The deviation which a ray undergoes is shown in fig. 68.

$$a\,b = a\,h_1 \tan \alpha = a\,h_2 \tan \beta.$$

Denoting the focal lengths $a\,h_1$, $a\,h_2$ by ϕ_1, ϕ_2

$$\frac{\tan \alpha}{\tan \beta} = \frac{\phi_2}{\phi_1} = \text{const.};$$

or, $\phi_1 \sin \alpha = \phi_2 \sin \beta$ since α, β are small.

The rays incident on the eye will be deflected in each crystalline cone according to the above law, and by means of it the calculation of the image, optical constants, &c., follows in a way strictly analogous to that of an ordinary lens.

Let $b\,c$ (fig. 69) be the curvature of the eye, $a\,p$ a radius from the centre of curvature a, $p\,c$ a ray from the point p, which is deflected to d.

Then by the above law,

$$\frac{\phi_2}{\phi_1} = \frac{\sin p\,c\,d}{\sin q\,c\,a} = \frac{\sin p\,c\,a}{\sin q\,c\,a} = \frac{\dfrac{\sin p\,c\,a}{\sin c\,a\,p}}{\dfrac{\sin q\,c\,a}{\sin c\,a\,p}} = \frac{\dfrac{a\,p}{c\,p}}{\dfrac{a\,q}{c\,q}},$$

$$\therefore \quad \frac{\phi_2}{\phi_1} \cdot \frac{c\,p}{c\,q} = \frac{a\,p}{a\,q}.$$

For rays near b

$$\frac{c\,p}{c\,q} = \frac{b\,p}{b\,q} = \frac{f_1}{-f_2}.$$

$$\therefore \quad \frac{\phi_2}{\phi_1} \cdot \frac{f_1}{-f_2} = \frac{a\,p}{a\,q} = \frac{f_1 + r}{r + f_2}$$

which leads to the equations

$$\frac{\phi_1}{f_1} + \frac{\phi_2}{f_2} = \frac{\phi_1 + \phi_2}{r}$$

$$\frac{\phi_1}{g_2} + \frac{\phi_2}{g_1} = \frac{\phi_1 + \phi_2}{-r}$$

where g_1, g_2 denote $a\,p$, $a\,q$.

FIG. 67.

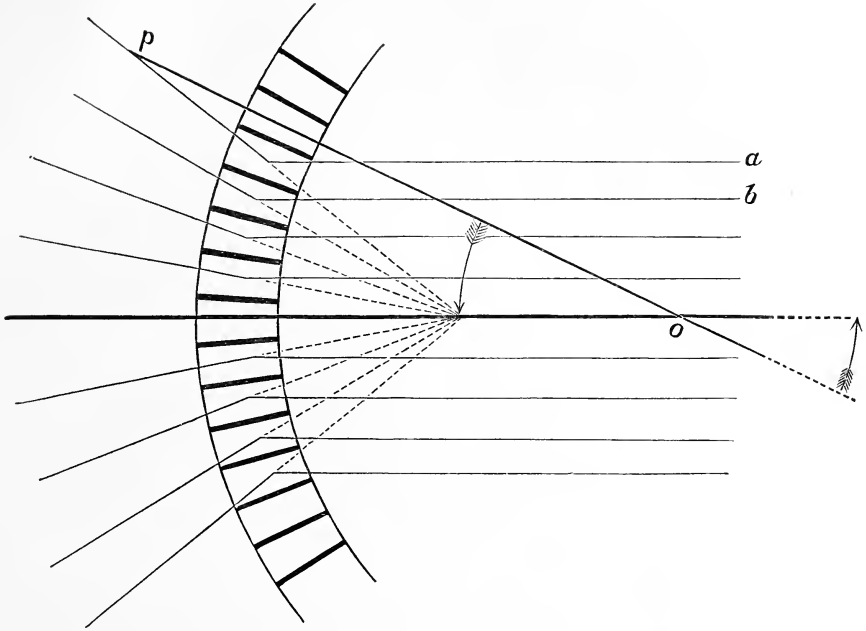


FIG. 68.

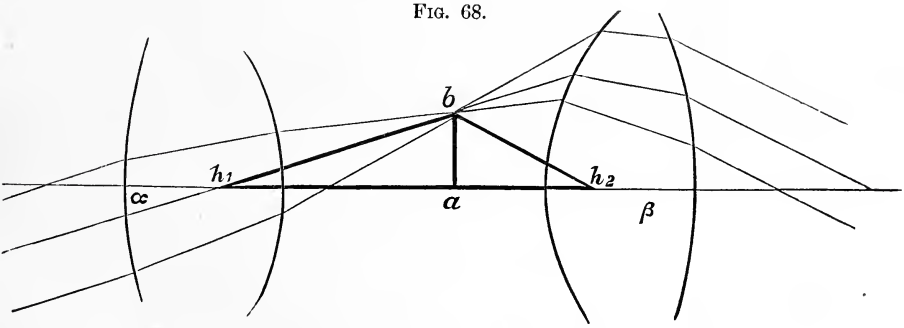
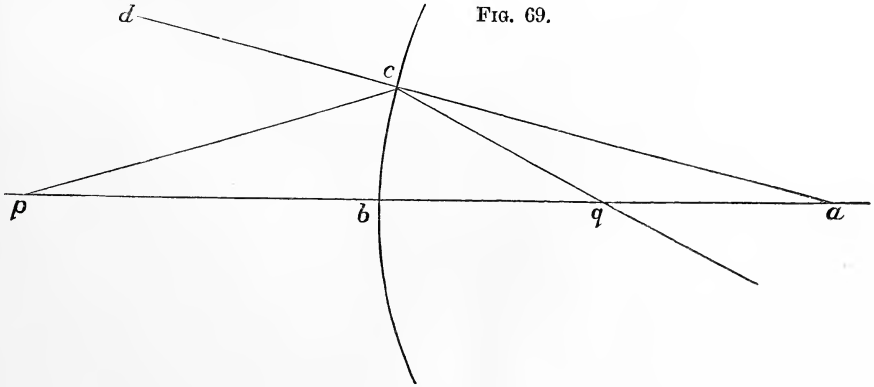


FIG. 69.



Then for $f_1 = \infty$ and $g_1 = \infty$

$$F_2 = \frac{-r\phi_2}{\phi_1 + \phi_2} \quad \text{and} \quad G_2 = \frac{r\phi_1}{\phi_1 + \phi_2},$$

and for $f_2 = \infty$ and $g_2 = \infty$

$$F_1 = \frac{-r\phi_1}{\phi_1 + \phi_2} = -G_2$$

$$G_1 = \frac{r\phi_2}{\phi_1 + \phi_2} = -F_2.$$

Finally, eliminating r by means of

$$r = G_1 + G_2 = -(F_1 + F_2),$$

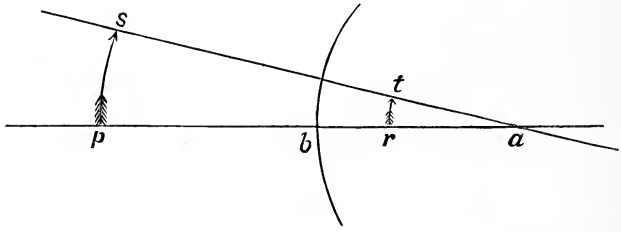
we have

$$\frac{F_1}{f_1} + \frac{F_2}{f_2} = 1$$

$$\frac{G_1}{g_1} + \frac{G_2}{g_2} = 1.$$

As regards the size of the image, we have from fig. 70,

FIG. 70.



$$\frac{\beta_1}{\beta_2} = \frac{p\,s}{r\,t} = \frac{a\,p}{a\,r} = \frac{g_1}{g_2},$$

and from the above equations

$$\frac{\beta_1}{\beta_2} = \frac{g_1 - G_1}{G_2} = \frac{G_1}{g_2 - G_2}$$

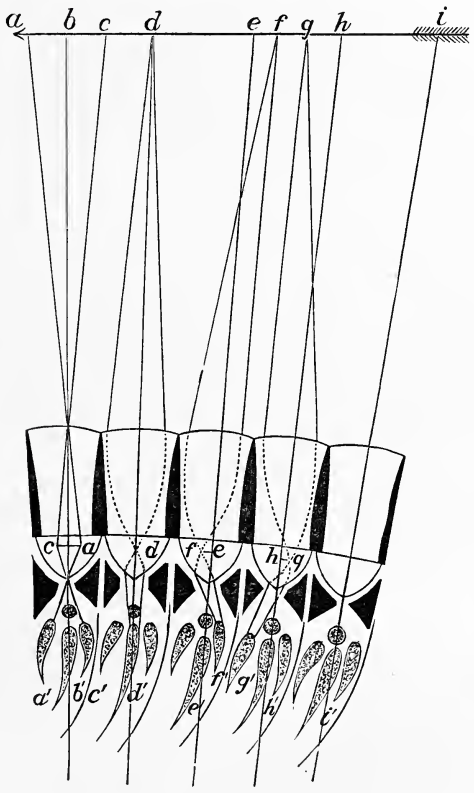
$$\frac{\beta_1}{\beta_2} = \frac{F_1 - f_1}{F_1} = \frac{F_2}{F_2 - f_2}.$$

The formation of the image in the *Lampyris*-eye may be looked at in

a somewhat different way. Each facet acting as an astronomical telescope may be considered as imprinting an image on the retina. Thus for each point of the object there will be a "summation image," consisting of about thirty superposed images.

On seeking to apply the principle of the image formation in the *Lampyris*-eye to insect eyes in general, a difficulty arises owing to the fact that in many the space between the crystalline cones and the retina is for the most part filled with black pigment instead of with transparent material as in the *Lampyris*-eye. Now it is known that the pigment of the Frog's retina is by illumination driven forward between the rods so

FIG. 71.



as to separate the individual retinal elements, but that in the dark it passes back to the choroid, leaving the retina free. The author therefore supposes that in the insect eye a similar phenomenon takes place, and that the pigment regulates the brightness of the retinal image in a way analogous to that of the iris. This theory was put to the test in the case of *Hydrophilus piceus*, *Dyticus marginalis*, and *Colymbetes fuscus*.

Two specimens were taken, one killed in bright sunshine, the other in the dark. The author gives figures showing (1) a section of the eye of *Hydrophilus piceus* taken in the dark, in which the crystalline cones may be seen to be thickly coated with pigment, but to have ends free, and the space between them and the retina clear; (2) a section of the illuminated eye has the spaces between the cones poor in pigment.

Other figures represent a crystalline cone of *Dyticus marginalis*. By the effect of the pigment the summation image, instead of consisting of thirty or more images, is made up of only a few. It may be even so far reduced that each point of the object is depicted only by one facet.

Fig. 71 shows a number of facets of a *Ctenophora flaveolata*, in which the retinula, consisting of seven cells, is separated from the dioptric part of the facet by pigment in such a way that light can only reach the retinula through a narrow opening. Supposing the dioptric apparatus of each facet to act, as in the *Lampyris*-eye, as an astronomical telescope, there results an erect image as seen from the figure.

As regards the accommodation of the *Lampyris*-eye, the forward displacement of the image corresponding to the approach of the object was in one case measured. It amounted to 0·092 mm., when the object was moved from a distance of 810 mm. to that of 1·2 mm.

Secretion of Silk in Bombyx mori.*—M. R. Dubois discusses the mode of coagulation of the silk-secretion. He comes to the conclusion that it is not comparable to that caused in white of egg either by alcohol or heat, but to the coagulation of blood or muscular fluid. A sort of serum or sericigenous plasma may be easily obtained by macerating silk-glands, for two or three days in a cool place, with distilled water, water containing 4 per cent. of salt, or, still better, with a 15 per cent. solution of carbonate of potash. This serum will give a coagulum without the addition of any reagent, and, when still moist, has the ductility and elasticity of freshly-formed silk, but it soon loses its property of being drawn out into threads. As with the coagulation of blood, the formation of silk-clot is favoured by oxygen.

Parthenogenesis of the Ova of Bombyx.†—Sig. E. Verson found that the development of unfertilized eggs of the silkmoth stopped, without power of further progress, after twenty-eight days, and that at a stage which corresponded approximately to the state of fertilized eggs three days after deposition. He also criticizes the methods and results of previous investigators of this case of parthenogenesis.

Anatomy of Sesia tipuliformis and Trochilium apiforme.‡—Prof. E. K. Brandt points out that the anatomy of the Clear-wings is particularly interesting, as these moths exhibit obvious mimicry. It is probable that the Clear-wings are ancient forms which have lately acquired a special adaptation to (or mimicry of) other flower-frequenting Insects. The proboscis of *Sesia tipuliformis* is moderately developed, but very weakly constructed; the nervous system is arrested in develop-

* Comptes Rendus, cxi. (1890) pp. 206–7.

† Bull. Soc. Entomol. Ital., xxi. (1890) pp. 118–23.

‡ Horæ Soc. Entomol. Ross., xxxii. (1889) pp. 41–9. See Ann. and Mag. Nat. Hist., vi. (1890) pp. 285–90.

ment; the digestive apparatus "represents about half the usual development in typical Lepidoptera." The ovary of *S. scoleciformis* is remarkable for containing seven, in place of four, egg-tubes. In *Trochilium apiforme* the skeleton and the nervous system exhibit the same peculiarities as in *Sesia*, and the same is largely true of many of the other organs.

Sculpturings on Elytra of Coleoptera.*—Herr A. von Bonsdorff finds that the variations in the different sculpturings on the elytra of Coleoptera are almost endless; sometimes a type is constantly predominant in a group (Elateridæ), while at others there may be within narrow limits (*Carabus*) so great variation that scarcely two species can be found to exhibit the same structure. Three chief types may be recognized:—

A. Primary costæ present, areas undivided. The costæ may be elevated greatly (*Carabus nitens*) or only slightly (*Silpha obscura*) above the surface of the wing. In the areæ the network may be seen as such (*Chrysochroa vittata*), or be wrinkled (*Hammatoceros hæros*), or compressed to more or less deep dots (*Necrophorus germanicus*).

B. The areas are divided into two. The primary are better developed than the secondary costæ (*Anthia* 10-*guttata*), or resemble them, when they are only separated by rows of dots or depressed lines (*Amara*, *Gyrinus*, *Passalus*).

C. The areas are divided into four parts. In this type the primary are often not better developed than the secondary costæ.

In each type there are forms in which the elytra tend to become almost smooth; *Silpha obscura* may be compared with *S lævigata*. The regular costæ also tend sometimes to break up.

Germinal Vesicle of Flies.†—Dr. P. Mayer is of opinion that the structures described by Mr. B. T. Lowne as germinal vesicles ‡ are the chitinogenous vesicles which are so often found in the glands of Insects; a reference to Leydig's work in 1859 would have prevented the perpetration of this mistake.

British Phytophagous Hymenoptera.§—Mr. P. Cameron has published the third volume of his valuable work on these insects, in which he deals with the Cephidæ, Siricidæ, Oryssidæ, and the parasitic Cynipidæ. With another volume he hopes to be able to complete his undertaking.

Viviparous Caddis-fly.‖—Prof. J. Wood-Mason has observed the exit from the extremity of the abdomen of a Caddis-fly of innumerable tiny living creatures. These were Trichopterous larvæ, which possessed all the characters—slender and tapering body, laterally expanded and dorsally humped first abdominal segment, and disproportionately long and slender third pair of legs—of typical Leptoceridæ; no tracheal gills could be detected. The abdomen of the mother retains after preservation in spirit the distended condition it had before parturition, and has the

* Zool. Anzeig., xiii. (1890) pp. 342-6. † T. c., pp. 367-8.
‡ See this Journal, *ante*, p. 170.
§ 8vo, London, 1890 (Printed for the Ray Society), 274 pp., 17 pls.
‖ Ann. and Mag. Nat. Hist., vi. (1890) pp. 139-41.

form of a thin and transparent membranous sac; the four penultimate abdominal segments appear to be extended and stretched to the limit of the extensibility of all their interarticular membranes, and the posterior half of the abdomen appears, therefore, to be the region which gives lodgment to the main mass of the brood-pouch. The arrangement is much more like that of the white-ant queen than of the viviparous Coleoptera. The species belongs to the genus *Notanatolica*, and may be called *vivipara*. The nature of the brood-pouch, the habits of the larvæ —whether aquatic or terrestrial—the male, and the form of the larva-case, are important points as to which information is desirable.

Ovarian Envelope of Phyllium.*—M. L. F. Henneguy has examined the structure of the envelope of the ova of this orthopterous insect. The egg of *P. crurifolium*, from the Seychelles, measures 5·5 by 4 mm., and a vertical section, under a low power, is seen to consist of three zones; the outermost is formed by large, irregular alveoli; the median by thick, parallel fibres, which are set perpendicularly to the internal surface; the innermost zone is compact in structure and striated. The outermost layer is very thick in the wings of the capsule which it forms entirely, and much thinner in the interalar spaces. It and the median zone represent the exochorion of authors, while the innermost corresponds to the endochorion. It is but rarely that the alveoli have the pentagonal or hexagonal form described by Murray and Joly; their walls, the thickness of which is not constant, are formed of a homogeneous substance of a chitinous nature; the alveoli are filled with air, and contain no traces of protoplasm. The median zone, which does not seem to have been seen by Murray or Joly, is characterized by short fibres, equal in thickness, and set parallel with one another. The innermost zone has the most complex structure, for four or five different layers can be made out in it. The most external layer is very delicate, and homogeneous, and is set against the layer on the surface of which are implanted the fibres of the median zone. Next there is a layer which is finely and regularly striated, and the striæ are perpendicular to the preceding layer; this may, indeed, be divided into two layers, for the outer part remains colourless while the inner becomes rosy on treatment with safranin. These are followed by an irregularly striated layer, and this by one which is homogeneous. The second and third layers have a very remarkable crystalline structure; when examined with polarized light they exhibit double refraction. They are very fragile, and break easily under the razor; the lamellæ thus formed have a calcareous appearance, but are insoluble in acids; on treatment with potash the only apparent alteration is the loss of the double refraction. It would be very interesting to study, from the histological point of view, the structure of the egg-capsule of different Phasmidæ, and the mode of formation in the genital passages; it is difficult to conceive how so complex a tissue can be secreted by the walls of the oviduct and the ovigerous sheaths.

The author repeatedly compares the egg to vegetable seeds, and he points out the interest of the fact that while the adult insect exhibits a mimicry of parts of plants the egg should do so likewise.

* Bull. Soc. Philom. Paris, ii. (1890) pp. 18–25.

δ. Arachnida.

Embryology of Euscorpius italicus.*—Mr. M. Laurie has investigated the development of the Scorpion, on which no detailed work has been done for twenty years. It is exceptional among Arthropods in that the whole development takes place within the ovarian tubes, and the history does not agree with any other Arachnid type as yet described. The development of the eye has been accurately worked out by Parker, but the author has been able to add details as to the earlier stages and as to the connection of the eyes with the cerebral invagination. The author's observations confirm the conclusions of Lankester and Bourne, but afford no support to the views of Patten.

The mode of formation of the ventral nervous system is exceptional among Invertebrates, and resembles rather that of the Chordata, for the nerve-chord, instead of peeling off from the superficial layer of epiblast, sinks down bodily, and is covered by a layer of epiblast which grows over it from each side. From the history of its development there can be little doubt that the coxal gland is a nephridium, and it seems probable that the genital tubes are, in part at least, nephridial. The gill-books are undoubtedly comparable to the abdominal appendages of *Limulus*, but their mode of origin is still open to some doubt. The author thinks it quite conceivable that there have been changes in the conditions of development, due to terrestrial life and the consequent pressure on the embryo.

The mesoblast consists at first of a pair of segmented bands with a separate cœlomic space in each somite and also one in the cephalic segment. The cœlomic spaces soon unite, and the mesoblast bands join across the ventral surface. Later on, they extend round—the cœlomic space extending with them—and unite in the middle line on the dorsal surface, where a thickened band gives rise to the heart. A portion of the cœlom in the seventh segment becomes separated off to form the genital tubes. The outer layer of the mesoblast forms chiefly the muscles of the body, while the inner layer becomes folded so as to surround the liver and intestine, and the cœlomic space becomes partly filled up by trabecular tissue.

American Spiders.†—Dr. Henry M'Cook has nowhere shown the thoroughness and enthusiasm of his study of animals more happily than in this valuable work. The first volume of the book is all that is at present published; and, considering the scheme of the whole work, we should have preferred to see the last or third volume first; that volume will treat systematically of the spider fauna, especially the Orb-weavers of the United States. The European reader is unable to follow as intelligibly and with as much interest as he otherwise would, for want of certainty about the specific character and geographical distribution of several of the forms, concerning which most interesting details are furnished.

That which distinguishes Dr. M'Cook's work is the completeness

* Quart. Journ. Micr. Sci., xxxi. (1890) pp. 105-41 (6 pls.).

† 'American Spiders and their Spinning Work. A Natural History of the Orb-weaving Spiders of the United States, with special regard to their industry and habits.' By Henry C. M'Cook. i., Philadelphia, 1889, sm. 4to, 369 pp., 354 figs. in text.

with which he has studied American spiders in their native haunts and normal habits. The anatomy and physiology of spiders is but lightly dealt with, and in no sense as the result of original investigation; but their habitats, their geographical distribution in the States, the characters of their snares, dens, nurseries, and hiding-places, and, above all, the manner in which the often exquisitely delicate but dynamically perfect snares are woven, are all presented with a clearness and originality which give this work on 'American Spiders' a distinctive place in the literature of this fauna.

The illustrations throughout the book are original, and to the outdoor student of spider-life are redolent of the heath, the hedge-row, and the river-side. They are what has been constantly looked for, but most sparingly provided, even by our best European authorities. A knowledge of the individual characters, and the anatomical distinctions of a form, justifying its position in a classification, have, as a rule, sufficed. Writing in regard to another group of spiders Mr. Moggridge says, "The *dwellings* of only eight out of thirty-six species of Trap-door stated by Prof. Ausserer to belong to the Mediterranean region, are known in books, those of the remaining twenty-eight being . . . yet to be discovered." * What Mr. Moggridge sought to do for this striking group Dr. M'Cook has done concerning the Orb-weavers of the United States, and has pointed out a mode of study which any intelligent naturalist may follow, and with patience be certain of securing most profitable results, not only in the accomplishment of his own object, but as an aid to other experts, for we believe it will be clearly shown that no classification of a spider fauna can be thorough which does not include a complete knowledge of the weaving habits of the genera and species.

Dr. M'Cook rejects the arrangement of the order Araneæ adopted by Blackwall, dividing the order into (1) Sedentary Spiders and (2) Wandering Spiders. In the former he includes (1) Orb-weavers; (2) Line-weavers; (3) Tube-weavers; and (4) Tunnel-weavers. In the latter are placed (1) Citigrades; (2) Laterigrades; and (3) Saltigrades.

But it is in the details of construction, as we have already hinted, that his original work is seen. The exact manner in which the bridges and scaffolding of silk are stretched across wide interspaces, and the viscid spirals laid in, is what was needed to inspire other minds to a like study. The "fenders" he so clearly indicates as forming part of "Argiope's snare," the adoption of means by the spider, which from an engineering point of view, obtain the greatest strength with the slightest means, all tend to present this group to the naturalist of the fields in a new light.

Dr. M'Cook must have enjoyed exceptionally fortunate opportunities to obtain such beautiful examples. Some of the snares which he figures of *Uloborus* are of extreme delicacy and beauty; the snare of the "Triangle Spider" and its mode of "operating" its snare are of much interest. So are his observations on the spinning work of *Hyptiotes* and the "Ray Spider." But he may be, as he has already been by those who have followed the reports of his work in America, congratulated on

* 'Trap-door Spiders,' p. 75.

his discovery, while studying the agricultural ants of Texas, of the remarkable domed snares of what he has designated *Epeira basilica*.

The second volume of this work is to deal with the courtship and mating of spiders, the early life and distribution of species, their senses and the relation of these to their habits, their enemies, and fossil spiders.

Habits of Mygale.*—Herr C. Grevé gives an account of the behaviour of a *Mygale*, which (along with four others, several millipedes, and a snake) was found at Moscow in the cavity of a log shipped from Honduras. After a voyage of some six months, the liberated spider showed a naturally large appetite, and devoured thirty cockroaches in ten days. Its hunger diminished, however, and for a while some enticement was requisite to arouse fresh appetite. Across the floor of the cage fine threads were spun on which the cockroaches were entangled. The spider's activity was emphatically nocturnal, for during the day it usually remained lurking in a hole. Herr Grevé observed it killing its prey, and noted that it sometimes left the corpses for future use. On the floor of the room it would run about like a mouse, and a morning douche-bath seemed to be enjoyed. Its power of vision was keen for objects above its eyes, but not for things on its own level. From his observations, Herr Grevé concludes that the spider lurks in holes for prey entangled in the almost invisible snares spun round about. An unlucky fall injured his pet, and brought his interesting studies to an end.

Water-Mite Parasitic on a Snail.†—Herr F. Koenike has a preliminary notice of *Atax Ampullariæ* sp. n., a water-mite found living parasitically in the gills of a South American species of *Ampullaria*. Up till now species of this mite have been found parasitic only on Bivalve Molluscs.

ε. Crustacea.

Variations of Decapod Crustacea.‡—Mr. W. F. R. Weldon has investigated the average length of three or four organs which admit of accurate measurement, and the frequency with which the average length and every deviation from it occurred in one or two local races of *Crangon vulgaris*. The organs selected were four; the total length of the carapace; the distance from the posterior margin of the carapace to the front of the median spine; the length of the sixth abdominal tergum; and the length of the telson. Four hundred individuals were obtained from Plymouth Sound, three hundred from Southport, and three hundred from Sheerness. It was found that not only does the average size of the carapace differ in different local varieties, but the range of deviation from that average differs also. Nevertheless the frequency with which the observed deviations from the average occur is in all the three observed cases expressed by a curve of error; this was precisely the result predicted by Mr. Galton.

Results similar to the above have been obtained from measurements

* Zool. Jahrb., v. (1890) pp. 179–83.
† Zool. Anzeig., xiii. (1890) pp. 364–5.
‡ Proc. Roy. Soc., xlvii. (1890) pp. 445–53.

of a larger series of organs and parts of organs in *Pandalus annulicornis* (two races) and *Palæmon serratus* (one race), but not more than one hundred individuals of each race have as yet been examined, and the curves of distribution of the magnitudes of the various organs are therefore more irregular than those given for the shrimp.

Circulatory System of Carapace of Decapod Crustacea.*—M. E. L. Bouvier states that the afferent system of the membrane which lines the carapace in the branchial region arises from a large postcephalic lacuna which surrounds the liver and carapace; the efferent system consists of a well-defined trunk which follows the membrane close to the free border of the carapace; it increases in size from before backwards and opens directly into the pericardium at its posterior angle (*Astacus*) or at the sides. There is, in fact, a cutaneous respiratory apparatus analogous to that of *Mysis*, and it is the exaggeration of this arrangement which allows certain Crustacea, such as *Birgus latro*, to live for a very long time out of water.

In other words, the Schizopods and the abranchiate larvæ of Decapod Crustacea, have a purely cutaneous mode of respiration; in the adult Decapod this respiratory apparatus persists, and in some of its characters is constant; but to it there has been superadded a secondary respiratory apparatus, the branchial, and this is the only one which is, as a rule, described in our text-books.

Histology and Development of Eye of Lobster.†—Mr G. H. Parker gives an account of the minute structure and development of the eye of the Lobster. The ommateum, which lies between the corneal cuticula and the basement membrane, is composed of cells of the corneal hypodermis, cone-cells, distal retinulæ, proximal retinulæ and accessory pigment-cells, each of which the author describes in order. The view that the corneal cuticula is separated from the cone-cells by an intervening layer of cells is one which has been held only by recent investigators; though Claus suspected the presence of a corneal hypodermis he searched for it in vain. Each hypodermal square appears to consist of two flattened cells, triangular in outline and very intimately applied to one another on their longest sides. The author supports the view of Schultze and Grenacher that the cone-cells and rhabdoms are separate structures, and it is probable that in the crayfish, as in the lobster, the fibrous ends of the cone-cells terminate in the basement membrane. The distal retinulæ have not as yet been identified in the eyes of many Decapods, though Carrière has seen them in *Astacus*. In the region of the retina which lies between the proximal ends of the cones and the distal border of the deeper band of pigment, the groups of cone-cells and the pairs of distal retinulæ are separated by a considerable intervening space; the space is filled by a fluid which contains a very small amount of albuminoid substance; on coagulation it forms vesicular bodies of varying size, which usually become loosely attached to the cone-cells and the fibres of the distal retinulæ; they readily take up colouring matter, and it was probably these bodies which Newton described as the nuclei on the investing membrane.

* Comptes Rendus, cx. (1890) pp. 1211-3.
† Bull. Mus. Comp. Zool., xx. (1890) pp. 1-60 (2 pls.).

The proximal retinulæ are pigment-cells which closely invest the rhabdome. Accessory pigment-cells occupy the open space at the base of the ommatidia, and their function seems to be that of filling what would otherwise be an unoccupied space, as though they gave solidity to the tissue in the base of the retina; similar cells have been seen by Carrière in *Astacus*, and by Patten in *Penæus*. As the fibres of the optic nerve pass into the proximal retinulæ, it is most likely that the rhabdome and not the cone is the perceptive body; this conclusion is further supported by the ultimate distribution of the optic fibrillæ. The author shows that the cone-cells form a transparent axis which leads directly to the rhabdome, and through which light could readily have reached that structure, and it is, no doubt, in it that the light is transformed into that kind of energy which is transmitted by nerve-fibres.

In treating of the development of the eye of the Lobster, the author points out that four different types of structure have been indicated as possible by the work of various investigators. He is himself led to reject that of Patten as unsupported by embryology, while Reichenbach and Kingsley are said to have misinterpreted structures. On the whole, the balance of evidence seems at present to be in favour of the view that the retina originates as a thickened layer of hypodermis, and is not modified by any form of involution. When there is an involution it is connected only with the formation of the optic ganglion; and in the production of this ganglion, the involution can be replaced by a proliferation of cells. In Crustaceans the nerve-fibres are always attached to the proximal ends of the retinulæ, and we may, therefore, suppose that the retina has never been inverted, but retains its original position; any explanation which involves the inversion of the retina is, in all probability, wrong.

It is difficult to draw any general conclusion as to the number of retinulæ in the ommatidia of the higher Crustacea, but Herrick's statement that there are seven in *Alpheus* coincides fairly with the results obtained from the lobster. The author concludes with some discussion as to the types of ommatidia, in which he attempts to bring the ommatidia of all Crustaceans into relation by suggesting a process of cell-division, but the question of what constitutes the simplest form of ommatidium is one which still requires study.

Blastoderm of Isopoda.*—M. L. Roule describes the formation of the blastoderm in *Porcellio scaber* as a twofold process:—(1) The peripheral differentiation of the deutoplasm, under the influence of the nucleated "islet," into a formative layer; and (2) the successive nuclear divisions which establish the blastoderm. The deutoplasm is in no sense nucleated; all the nuclei of the blastoderm are derived from the segmentation-nucleus; the nuclei of the "vitelline cells" of other investigators are, like those of the embryonic body, derived from the nuclei of the blastoderm accounted for above.

The Oxycephalids.†—Under this title Mr. C. Bovallius has published a memoir on these Amphipoda. He discusses the principles

* Comptes Rendus, cx. (1890) pp. 1373–4.

† Nova Acta Reg. Soc. Sc. Upsal., iii. (1890) 141 pp., 7 pls., and 87 figs. in text.

of classification of the Amphipoda Hyperiidea; gives morphological notes on the group he has especially studied, and concludes with a monographic account of the genera and species of the Oxycephalidæ, in which there are ten genera, and the Xiphocephalidæ, in which there is only one.

Bosmina.*—Dr. O. E. Imhof makes an appeal for specimens of species of this genus of the Cladocera, of which he proposes to write a monograph. Twenty-nine species and four varieties have already been described, and it is important to have exact information as to their geographical distribution.

Organization of Cyprides.†—Prof. C. Claus has taken up the study of *Cypris*, as no sensible addition to our knowledge of the Cyprides has been made since 1854, when Zenker published his monograph. The ventral nervous cord is elongated, and contains five pairs of ganglia. The anterior portion of the brain gives off nerves to the tripartite frontal eye, and has a particularly strong coating of ganglionic cells. The frontal eye has three closely connected pigment-cups, each of which is occupied by some sixteen to twenty cells, into which the nerve fibres enter, beneath a nearly spherical lens.

The endoskeleton is represented by a broad, indistinctly bipartite, chitinous plate, to which pairs of muscles for all the limbs of the trunk, as well as the second pair of antennæ are attached. The alimentary apparatus commences with a rather narrow atrium. Zenker's "rake-like masticating organs" are situated at the bottom of this atrium, and belong, as a sort of hypopharynx, to the labium. The gizzard is not, as Zenker supposed, free, for its larger hinder portion is united with the intestine; the smaller anterior portion is capable of a forward and backward displacement which calls to mind the motor mechanism of the gizzard of the Decapoda; but it affects only the dorsal wall, the strong convexity of which projects into the lumen, beset with rows of pointed teeth, and acts like a rasp against the concave ventral wall, which is also densely armed with points. The mid-intestine is divided by a deep constriction into two sections, the anterior of which surrounds the throat-like opening of the gizzard, and gives off two hepatopancreatic tubes into the interspace of the fold of the shell. It contains a very deep glandular epithelium, and must, as the stomach, have the function of digesting albuminous foods.

Both the antennary gland and the gland of the second pair of maxillæ are well developed in *Cypris*, but the former is placed in the shell-cavity, and must, therefore, be called the shell-gland. The gland-duct consists only of a series of perforated cells, the nuclei of which are of enormous size, and emit above and below digitiform branches, each of which represents only a single perforated cell.

The complicated penis represents a metamorphosed pair of limbs, while the external genitals of the female are probably the basal joints of a pair of limbs. The oviduct is much coiled, and the duct of the receptaculum is spirally twisted like a watch-spring.

* Zool. Anzeig., xiii. (1890) pp. 359-61.

† Anzeig. K.K. Akad. Wiss. Wien, 1890, pp. 1-6; see Ann. and Mag. Nat. Hist., vi. (1890) pp. 108-12.

Ostracoda from South Sea Islands.*—Prof. G. S. Brady has a report on the Ostracoda collected by Dr. H. B. Brady in the South Sea Islands. Very little is as yet known as to these Crustaceans from the region where this collection was made. Various Cypridinidæ were found to be abundant between tide-marks, whereas in the northern hemisphere no members of the family have, except on one occasion, been taken except by the dredge or in the tow-net over deep water. More than eighty species are reported on, a large number of which are new; *Pleoschisma* and *Streptoleberis* are new genera of Cypridinidæ.

Vermes.

a. Annelida.

Occurrence of Pelagic Annelids and Chætognaths in St. Andrews Bay throughout the Year.†—Prof. W. C. M'Intosh continues his account of the fauna of St. Andrews Bay. The only adult pelagic forms are *Autolytus* and the sexual forms of the Nereides. The rest are larval, postlarval, and young stages of Annelids; they often occur in large numbers, and probably exercise an important function in connection with the food of postlarval and young fishes. As in some other groups larvæ of the same species are found during several months. *Tomopteris*, formerly considered somewhat rare, is a form which frequents the inshore waters from January to December. Chætognaths exist in enormous numbers, and in some inshore areas the bag of the large midwater-net is distended with a semi-solid mass of them.

The author deals with the months of the year in order. In July there is a decided increase in the number of pelagic larval Annelids; the most abundant were the postlarval forms of *Spio*, *Polydora*, and *Nerine*, but in August the larval Annelids attain their maximum. In November and December there is a marked paucity of Annelidan life, but the *Sagittæ* were remarkably numerous and large.

Polychæta Sedentaria of Firth of Forth.‡—Messrs. J. T. Cunningham and G. A. Ramage have published the notes and drawings made by them when studying the sedentary polychætous worms at the Granton Marine Laboratory.

Arenicola cristata and its Allies.§—Mr. J. E. Ives thinks that *Arenicola cristata* is found in the Mediterranean as well as in the West Indies and North American seas, and that the sixteen species described may be reduced to three—*A. marina*, *A. ecaudata*, and *A. cristata*.

Hekaterobranchus Shrubsolii.‖—Miss F. Buchanan gives an account of this new genus of the Spionidæ, which is found in soft mud at Sheppey. It receives its name from the fact that two kinds of branchial organs are present, and that there is a single pair of each kind. A single pair of dorsal branchiæ, very large, is found on the first segment; the cephalic tentacles are not grooved, but ciliated all over. The prostomium is well developed and bears four eyes; the first segment is

* Trans. Roy. Soc. Edinb., xxxv. (1890) pp. 289–525 (4 pls.).
† Ann. and Mag. Nat. Hist., vi. (1890) pp. 174–82.
‡ Trans. Roy. Soc. Edinb., xxxii. (1888) pp. 635–84 (12 pls.).
§ Proc. Acad. Philadelphia, 1890, pp. 73–5.
‖ Quart. Journ. Micr. Sci., xxxi. (1890) pp. 175–200 (2 pls.).

prolonged forwards on the ventral surface to form a collar. The pharynx is eversible and richly ciliated; there is a single pair of thoracic nephridia which open to the exterior in the second segment, reach back into the sixth, and then bend forward again. The giant fibres are minute, and there is in each nerve-cord one near the upper and inner surface. The dorsal "cirri" form a sort of collar in the second segment.

Classification of Earthworms.*—Dr. W. B. Benham has published an interesting "attempt to classify earthworms." He begins by offering some suggestions as to the nomenclature of certain organs. He proposes to use the term "couple" in place of "pair" when speaking of the arrangement of the setæ which is found in *Lumbricus*, and in place of "dorsal" and "ventral" to use "outer" and "inner." He regards the peristomium as the first somite. In referring to the position of an aperture between two somites he uses the form x/xi. When the "clitellum" is equally developed all round the body it may be called the "cingulum." The terms "vesiculæ seminales" and "seminal reservoirs" are conveniently replaced by "sperm-sacs," the "receptacum ovorum" by "ovisac," and "vas deferens" by "sperm-duct." The term "capsulogenous gland" is misleading, and may be replaced by Vejdovsky's term "albumen-gland." Such anterior nephridia as are used, not for excretory purposes, but for softening or otherwise acting on the food, may be called "pepto-nephridia," and they are either intra-buccal or extra-buccal.

In the alimentary canal the following regions may be distinguished: buccal region, pharynx, œsophagus, gizzard, tubular intestine, and saccular intestine; there are often two or more gizzards, and in some cases there is none. The typhlosole is absent in a few cases only. The calciferous glands are very frequently absent, and when present are very variable in number and position.

The class Oligochæta may be divided into two sub-classes, according as asexual reproduction is or is not effected.

Sub-class I. Naidomorpha.

Order 1. Naidina, with the families Aphanoneura, Naididæ, Chætogastridæ, and the genus Ctenodrilus.

Sub-class II. Lumbricomorpha.

Order 1. Microdrili (Lumbricomorpha minora), with the "families" (Vejdovsky) Discodrilidæ, Enchytræidæ, Tubificidæ, Phreoryctidæ, and Lumbriculidæ.

Order 2. Megadrili (L. majora).

These may be divided into two branches, the first of which is called Plectonephrica, in consequence of the excretory system being in the form of numerous delicate tubules in each somite, which unite to form a network with more or less numerous external apertures; a large "nephridium" with cœlomic funnel may be present in addition to these tubules; in this are the families Typhœidæ, Acanthodrilidæ, and Perichætidæ.

In the second branch, that of the Meganephrica, the excretory network is absent, and replaced by a pair (rarely two pairs) of large

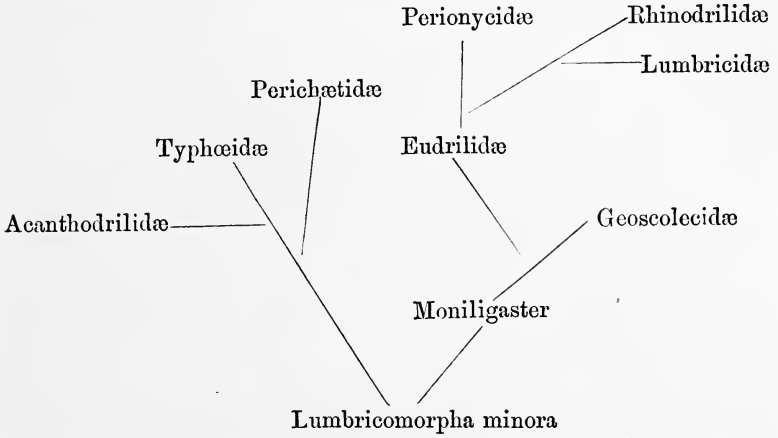
* Quart. Journ. Micr. Sci., xxxi. (1890) pp. 201-315 (36 figs.).

nephridia in each somite. Here are the families Moniligastridæ, Eudrilidæ, Perionycidæ, Geoscolecidæ, Rhinodrilidæ, and Lumbricidæ.

The author next gives an account of the families and genera *in extenso*, and next a tabular summary of generic characters, with an index to the identification of genera.

An attempt is next made to discuss the phylogeny of the group of earthworms—the excretory system, the setæ, clitellum, prostate, and sperm-ducts may be taken as the more important characters.

The results arrived at are indicated by this phylum:—



Atrium or Prostate.*—Dr. W. B. Benham raises some objections to Mr. Beddard's suggestion that the "prostates" of many earthworms are homologous with the "atria" of the Tubificidæ and other freshwater Oligochæta. By the term prostate we ordinarily understand a glandular structure which secretes a fluid, which is utilized in some way or another —how is not thoroughly known in Oligochæta—in the process of copulation. It is admitted that the organs in question have some such function, and it seems better to retain the word prostate than to replace it by the ill-defined term atrium. Mr. Beddard, indeed, would seem to regard the epiblastic prostate of *Tubifex* as the homologue of the mesoblastic covering of the atrium of *Moniligaster*.

Anatomy of Moniligaster.†—Mr. F. E. Beddard gives an account of the structure of *Moniligaster*, which, in his opinion, is not an earthworm except in habit. It differs from all earthworms in the following points:—The vas deferens is single on each side; it only occupies a single segment, or at most two; there is only a single pair of testes; the sperm-sacs are a single pair with a simple cavity, that is, one not divided up by trabeculæ; the atrium opens on to segment x/xi, and its structure is that of the atrium of *Rhynchelmis;* the oviduct opens into segment xi; the clitellum occupies segments x–xiii; the egg-sacs are very large, and occupy about three segments. In these points *Moniligaster* approaches

* Zool. Anzeig., xiii. (1890) pp. 368–72.
† Proc. Roy. Soc. Edinb., xvii. (1890) pp. 5–7.

various limicoline genera. In the species described the more novel points are the small size of the prostomium, which does not extend on to the peristomial segment; the setæ are like those of earthworms; there are dorsal pores; the mesenteries between the several segments from v–ix are very much thickened; the hearts are in segments vi–xiv, and are of large size; the nephridia commence in segment v, and each has a saccular diverticulum. These and other points seem sufficient to render it necessary to regard *Moniligaster* as the type of a distinct family, equal to the Terricolæ, Lumbriculidæ, &c.

Diachæta Windlei.*—Mr. F. E. Beddard gives an account of the structure of this earthworm, which he compares with *D. Thomasii* and *Urochæta*. The setæ are remarkable for being highly specialized, for while some are simple *f*-shaped, others are ornamented as in Urochæta, and others are large and hooked. There are no epiderm glands between the setæ. The anterior pair of nephridia form a "mucous gland," which is not branched, and opens on segment iv. The orifices of the nephridia are guarded by a sphincter. There are no posterior glands connected with the nephridia, and no calciferous glands; as to the latter character, however, it is to be noted that part of the intestine (segment xii–xiv) has a similar structure.

Phreoryctes.†—Mr. F. E. Beddard has a memoir on the anatomy, histology, and affinities of this form. Among the more important or novel points we may note the absence of genital or penial setæ, and the position of the clitellum from the tenth to the thirteenth segments; the epidermis of this region is formed by a single layer of glandular cells which differ from the cells of the general body surface by their glandular character and greater length; the nephridia commence in the sexually mature worm in the sixteenth segment; both series of genital ducts have the distal region lined with a chitinous membrane, which, perhaps, indicates their origin from an ectodermic invagination; the developing spermatozoa are contained in sperm-sacs which occupy segments nine to fourteen; the ova, which, when mature, are of very large size, undergo their development in egg-sacs.

These and other characters justify the formation of a distinct family for this genus; as to its systematic position it is observed that in the character of its generative organs it stands midway between earthworms and the majority of the forms that have been grouped together as Limicolæ; so, too, in other points it has retained some of the characteristics of earthworms, while in other respects it has acquired the simpler structure of the aquatic Oligochæta. It can neither be placed with the "Limicolæ" nor the "Terricolæ," and it makes such a division of the Oligochæta impossible.

Russian Earthworms.‡—Mr. N. Kulagin makes some additions to his previous observations on the anatomy of Russian earthworms. Club-shaped glands are alone found in the hypodermis of *Lumbricus terrestris*; the apparent difference in the glands to which Uhde has drawn attention is due to whether the glands do or do not contain secretions. The cell-

* Quart. Journ. Micr. Sci., xxxi. (1890) pp. 159-74 (1 pl.).
† Trans. Roy. Soc. Edinb., xxxv. (1890) pp. 629-40 (1 pl.).
‡ Zool. Anzeig., xiii. (1890) pp. 404-6.

aggregates observed by Uhde in the setigerous regions of segments 9–11, 26 and 29 are connected with nerves which arise from the abdominal ganglia. In *Allolobophora fœtida* the glands of the clitellum are sometimes not confined to the hypodermal layer, but traverse the circular and longitudinal layers of muscles. The innermost, third, layer of the membrane of the nervous system is connective and not cuticular. The subœsophageal ganglion of *Lumbricus terrestris* gives off eight pairs of nerves, and not seven, as stated by Friedländer. The contents of the nerve-canals consist of fibres which are imbedded in a plasmatic mass. The author's account of the histology of the stomach does not agree with that of Claparède; he finds the gastric cavity lined by epithelial cells, above which there is a layer of cells, which in form resemble those of the cœlom; they are succeeded by the circular and longitudinal layers of muscles. On the abdominal surface the circular muscles run parallel to the abdominal wall of the stomach, while at the sides they are directed obliquely to the axis of the body; the fibrils of the circular muscles are longitudinally striated, and in isolated filaments nuclei may sometimes be found. The longitudinal muscles are in the form of special bands which vary in form in cross section.

In the region of the typhlosole and the cylindrical cells which line the enteric cavity cells are sometimes found which, in form, closely resemble those of the cœlom; similar cells are also found in the muscular layers of the enteron; all intermediate stages are found between these and the chloragogen cells. The various statements which have been made as to the number of heart-like vascular loops in various species of earthworms are probably due to the age of the worm and the time of year when the investigation was made; in winter these loops are narrower in diameter than they are in summer. Every heart has not the form of a string of pearls, but of a curved tube narrowed at either end, where it opens into the dorsal and abdominal vessels.

Development of Germinal Layers of Tubicolous Gephyrea.*—M. L. Roule has studied at Cette the development of the germinal layers of *Phoronis Sabatieri*. The fertilized egg undergoes very regular segmentation; the young morula, composed of thirty-two blastomeres, has no central cavity, and the divisions of the cells are effected in all directions. Most, however, are radial in direction and a blastocœl appears which gradually increases in size. The young spherical blastula takes on an oval and then a discoidal form. When it becomes a disc flattened on each surface it becomes depressed in the centre. The blastopore of this gastrula soon becomes excentric in position, and the body becomes divided into a preoral and a postoral portion.

In the narrow blastocœl there may soon be seen a few thick cells which arise from the meso-endoblast and form a primary mesenchym. Later on, the archenteron becomes pierced by a second orifice which forms the anus of the *Actinotrocha*, while the blastopore becomes the mouth. The ectoblastic cells at the tip of the preoral region elongate considerably and so produce a small cephalic plate. The initial mesoblast-cells segment and give rise to some mesenchymatous cells which form the mesoblastic stripes.

* Comptes Rendus, cx. (1890) pp. 1147-9.

On the whole, the development of the germinal layers in *Phoronis* recalls that which one is in the habit of finding in the *Trochophora*-type; the presence of more than two primitive mesoblast-cells is a sign of inferiority, and suggests that their presence in the Trochozoa is a simplification of a primitive plurality such as is found in the larvæ of some Platyhelminths.

β. Nemathelminthes.

Histology of Ascaris.*—M. L. Jammes states that he has searched in vain, in *Ascaris megalocephala*, *A. lumbricoides* and *A. suilla* for the epithelial layer formed of very small cells which Leuckart thinks lies against the muscle-cells. The so-called granular layer has been found to be continuous, and identical in structure, with the œsophageal nerve-ring; both are formed of fibrils mingled with cells. Sections taken along the body show, in this granular layer, small beds of cells which are often arranged in several rows, but never form a continuous epithelium. These cells are rarely cubical, sometimes rounded, often flattened parallel to the wall of the body, and have a varying number of prolongations. No intercellular substance was ever found.

The great resemblance in structure between the granular layer and the nervous system allows us to suppose that the former represents the ectoderm; this would differ much from the ectoderm of other Metazoa, in being formed of neuro-epithelial elements. If this be so the nervous system described by various authors would be merely a condensation of this layer in different parts of the body. The author is testing this hypothesis by embryological researches.

γ. Platyhelminthes.

Anatomy and Histology of Nemertines.†—Dr. O. Burger has given considerable attention to the structure and systematic relations of the Nemertinea. They all have a ciliated cylindrical epithelium which either contains the whole of the glandular mass of the skin, in which cases it rests upon an almost structureless layer of connective tissue, or some of the gland-cells sink into the layer of connective-tissue, where a cutis is formed, which is often rich in muscles. The appearance of this cutis leads to some considerable changes—the appearance of an external layer of longitudinal muscles, of subepithelial muscular layers, and the formation of a muscular tissue at the cephalic extremity. The Enopla are characterized by a cephalic gland. In all groups there is found the radial musculature, the bands of which divide into chambers the muscular layers of the dermo-muscular tube. By the presence of a ciliated epithelium and numerous gland-cells, the integument of the Nemertines exhibits a distinct resemblance to that of the Turbellaria. The Annelids as a rule have no cutis, but such a layer has been described by Andreæ in *Sipunculus nudus*. In both Annelids and Nemertines the naked gland-cells of the skin become greatly swollen at the time of sexual maturity, and the dermo-muscular tube of Annelids resembles that of many Nemertines in that it consists of a circular and a longitudinal

* Comptes Rendus, cxi. (1890) pp. 65–6.
† Zeitschr. f. Wiss. Zool., li. (1890) pp. 1–277 (10 pls.).

muscular layer. In all Nemertines a parenchyme is greatly developed and the organs are imbedded in a gelatinous tissue; in many this tissue is, in the region of the mid-gut, divided into dissepiments. In some there is a cleft which Salensky has compared to a cœlom. Though the Turbellaria have no spaces between the body-tissue and gut, there are muscular septa which are specially noticeable in the elongated *Gunda segmentata*; on the other hand the marked metamerism of the dissepiments of the Nemertinea lead us to the Annelids, and especially to the Hirudinea.

In the digestive apparatus of the Nemertinea there are two regions distinguished both histologically and morphologically; the intestine is on the type of that of Annelids, while that of Turbellarians is aproctous. The characteristic cavity of the proboscis—or rhynchocœlom—is not to be compared with any structure in the Turbellaria. As to the Annelids the author suggests that, while in them the organs lie in a cœlom, only a limited cœlom is developed in the Nemertinea in which the proboscis and part of the dorsal vessel lie—this is the rhynchocœlom, and the free bodies which are to be found in it may be compared with the bodies of the perivisceral fluid. The body of the more highly organized Nemertinea contains two cavities which one may regard as a cœlom, but it is not to be supposed that these cavities are of equal value. The cleft between parenchyme and intestine appears, from its cellular investment which is very similar to that of the genital sacs, to be in all probability a schizocœl. The rhynchocœlom, on the other hand, represents the remains of the primitive cleavage-cavity. Whether or not either of these spaces is the homologue of the cœlom of Annelids, embryological investigations will have to determine.

The Nemertinea have, but the Turbellaria have not, a blood-vascular system. The similarity of the excretory systems of the two groups is undoubted, especially if the ends of the excretory vessels in Nemertines are, as in *Tetrastemma aquarum dulcium*, provided with ciliated lobules. At the same time, a comparison with the same system in Annelids is not excluded, for we have only to call to mind *Lanice conchilega* where four nephridia on either side are connected by a longitudinal canal.

The nervous system of Nemertines passes, as is well known, through a number of stages. On the whole, it exhibits a very large number of points of resemblance to that of Annelids, while its points of agreement with that of the Turbellaria are much more general; on the other hand, the Nemertine eye may be briefly characterized as a Turbellarian eye.

The extraordinarily complicated generative apparatus of the Turbellaria finds no parallel in Nemertines, and we must come to the conclusion that while the latter are derived from forms like the Turbellaria they branched off along the Annelid stock and again diverged to take up an independent line of their own.

The author describes a number of new species belonging to *Cerebratulus*, *Eupolia*, and other genera, and a new genus of the Enopla; this last, which he calls *Prosadenoporus*, is distinguished from all four-eyed aquatic genera by its large cephalic gland, the confluence of mouth and proboscis-orifice, and the complete hermaphroditism of its species.

δ. Incertæ Sedis.

Philodina macrostyla and Rotifer citrinus.*—Mr. G. Western has some notes on these two Rotifers, found in a bog pool on Wimbledon Common. *R. citrinus* does not seem to have been found, at any rate, in England since Ehrenberg's time, and certainly differs from any described in the monograph of Dr. Hudson and Mr. Gosse; the latter author was probably wrong in regarding *R. citrinus* as synonymous with *R. tardus*.

Echinodermata.

Echinodermata.†—Prof. H. Ludwig concludes his account of the Cuvierian organs of Holothurians, and next deals with the generative organs. External sexual differences are very rare, but the males of *Thyone aurantiaca*, *Cucumaria lævigata*, and *C. elongata* have a genital papilla, while the females of *Cucumaria crocea* and some other species have a kind of brood-pouch.

The blood-vascular system is next described; the vessels are distinguished by two anatomical peculiarities—a tendency to form plexuses, and the absence of an internal epithelium; in some, but not in all cases, calcareous corpuscles are to be found in their connective tissue. Radial blood-vessels may be said to be certainly present in the Aspido- and Dendrochirota, but it is not certain that they are present in the Synaptidæ. The ciliated organs of the Synaptidæ are next described; they are found in numbers, connected with the mesenteries, and occasionally also on the body-wall. The cœlom forms the subject of the fourteenth chapter; its secondary spaces are arranged under the heads of pharyngeal and subpharyngeal sinus, genital sinus, pseudhæmal and epineural canals; the connection of the cœlom with other cavities of the body or with the outer world, the lining of the cœlom and its fluid contents, form the remaining subjects dealt with in this part of Professor Ludwig's work.

Anatomical Nomenclature of Echinoderms.‡—Dr. P. Herbert Carpenter makes a plea for greater uniformity of nomenclature in the parts of Echinoderms. He suggests that the term water-tube should be used only to denote the madreporic or stone-canal; he falls foul of various writers who have confused the dorso-central of the Echinoid with the centro-dorsal of the Crinoid. As the nomenclature of the plates forming the dicyclic base in many Crinoids is still wanting in uniformity and precision, he proposed an amended nomenclature; the changes will be best seen by the following table:—

Nomenclature of J. Muller ..	Basals	Parabasals	First Radials	Second Radials	Third Radials
Nomenclature of Carpenter and de Loriol ..	Underbasals	Basals	,,	,,	,,
Nomenclature now proposed	Infrabasals	Basals	Radials	First Costals	Second Costals

* Journ. Quek. Micr. Club, iv. (1890) pp. 87–91 (1 pl.).
† Bronn's Klassen u. Ordnungen, II. 3, Echinodermata, pp. 177–240 (pls. ix.–xii.).
‡ Ann. and Mag. Nat. Hist., vi. (1890) pp. 1–23.

Function of Madreporic Plate and Stone-canal of Echinodermata.* —Prof. H. Ludwig altogether denies the accuracy of Prof. M. Hartog's observation that the direction of the current is from within outwards in the pore canaliculi of the madreporic plate and in the interior of the stone-canal. Prof. Ludwig took the opportunity of a visit to Naples to investigate the point in *Holothuria tubulosa*, *Stichopus regalis*, *Sphærechinus granularis*, *Asterina gibbosa* and *A. Pancerii*, *Antedon rosacea*, and some Auriculariæ. In all cases he found the direction of the stream to be from without inwards, and he gives details of his observations in support of his generalization.

M. L. Cuénot† answers Prof. Hartog's note of reclamation,‡ and gives reasons for not noticing his work, and then proceeds to raise certain objections to Prof. Hartog's view as to the nephridial function of the madreporic system.

Function of Gemmiform Pedicellariæ of Echinoids.§ — M. H. Prouho contributes a very interesting observation to the very vexed question of the functions of pedicellariæ. If a specimen of *Strongylocentrotus lividus* or *Sphærechinus granularis* be placed in a vessel in which there are one or more specimens of *Asterias glacialis* which have been compelled to fast for some time, the Echinoid will be immediately attacked by the starfishes. As soon as it feels the touch of their ambulacral tubes it rapidly withdraws its spines from the part threatened; the spines bend out from the centre of attack to so great an angle that they become almost tangential to the test. In thus removing its spines the urchin unmasks its gemmiform pedicellariæ, which are then stretched towards the arms of the starfish with the jaws widely open. The starfish continues its attack, but as soon as one of the pedicellariæ touch an ambulacral tube it immediately bites it; we may suppose that the pain produced is considerable, for the arm of the starfish is actively withdrawn; but it always carries with it the offending pedicellaria fixed in the wound.

In some cases the first bites are sufficient to drive off the starfish, but in others it prolongs its attack, and then it is very interesting to see the urchin unmask its pedicellariæ on the points attacked, and, so to speak, follow the movements of its enemy by showing its teeth. In a first fight the victory is always with the urchin, and the starfish retires covered with wounds. But, as each pedicellaria serves only once for the defence of the urchin, it is gradually deprived of its organs for this purpose. If an urchin is put with several starfishes and abandoned to its fate it succumbs at last.

The moment an Echinoid is warned by its peripheral nervous system of the danger which threatens it, it moves its spines in a way which has nothing in common with the ordinary movements of these organs, and which has no other object than to unmask its gemmiform pedicellariæ. It is of interest to observe that this movement is exactly the opposite of that which is produced when the surface of the test is wounded by, for example, the point of a needle; in that case the spines and pedicellariæ are inclined towards the wounded point.

* Zool. Anzeig., xiii. (1890) pp. 377-9.
† T. c., pp. 315–8.
‡ See this Journal, *ante*, p. 337.
§ Comptes Rendus, cxi. (1890) pp. 62–4.

Rhynchopygus woodi.*—Mr. J. W. Gregory brings forward evidence to show that the problematic form called by E. Forbes *Echinarachnius woodi* belongs to the genus *Rhynchopygus;* this settles the question raised by Prof. Alex. Agassiz that it was probable that we had here to do with a fossil Pourtalesiid.

Sense of Smell in Starfishes.†—M. Prouho has made a number of experiments with *Asterias glacialis.* Some of these have shown him that when a starfish is excited by a desire for food, the sensations which it obeys are perceived by the extremity of the arms; but others show that it is the sense of smell and not of sight that guides it to its food. The "palps" or tentacles near the eye-like spot, which are useless for locomotion, were removed from a starfish, which, for a month or more afterwards, never showed the least excitement in the presence of either living or dead food; the retention of the ocular spot makes no difference. It is clear, then, that the sense of smell is not diffused in Starfishes, but is localized in the ambulacral tubes which are unsuitable for locomotion and are situated behind the eye-spot. If the ambulacral nerves are cut through at about 2 cm. from the extremity in such a way as to isolate in each a small distal portion, provided only with a small number of ambulacral tubes, these last become distended in the presence of food, but the excitement ceases at the level of the section.

Cœlenterata.

Actiniæ of South-west Coast of Ireland.‡—Prof. A. C. Haddon has a short notice of some species of Actiniæ from the deep water off the south-west coast of Ireland. *Actinan[u]ge* sp., *A. richardi, Chitonactis* sp., *C. coronata, Sagartia* sp., *S. miniata, Adamsia palliata, Bolocera tuediæ,* and *Actinerus* sp. are recorded.

Morphology of Skeleton of Stony Corals.§—Dr. A. Ortmann discusses the morphology of the skeleton of Stony Corals in relation to the formation of colonies. He points out that the simplest form of a Stony Coral arises in the following manner:—A coral-person, at first without a skeleton, but with enteric cavity, pharynx, and mesenterial folds, becomes fixed. The parts in contact with the substratum give out a cuticular calcareous excretion, by which the foot-plate (basal plate of v. Koch) is formed. From the base of the coral radially arranged folds are formed between the mesenterial folds, and their ectodermal elements (chalicoblasts) secrete the calcareous septa. The skeleton consists, therefore, of the basal plate lying on the substratum and the septa (radial plates of v. Koch) which rise up from it. No recent coral exhibits this primitive form of skeleton, but it is often found in the young buds of coral colonies; the primitive form is always complicated by certain characters. The further developments of the skeleton not connected with the formation of colonies may be grouped thus:—(*a*) The septa become connected by epitheca; (*b*) or by a wall; (*c*) or fuse laterally to a varying extent. The further developments of the skeleton which are

* Geol. Mag., vii. (1890) pp. 300–3 (1 fig.).
† Comptes Rendus, cx. (1890) pp. 1343–6.
‡ Proc. Roy. Irish Acad., i. (1890) pp. 370–4.
§ Zeitschr. f. Wiss. Zool., l. (1890) pp. 278–316 (1 pl.).

connected with colonial formation may be prolate or acrogenous growths, or both.

The colonial formation of stony corals is brought about by a number of processes of budding, each of which causes a certain characteristic growth; the different forms may be grouped under certain heads. The simple young form may produce new persons in two ways—either by internal or by external budding. In the former process the calycinal cavities of the body and of the maternal calyx are directly connected, while they are not so in the latter; the two modes of budding pass into one another.

The following arrangement of the various processes is proposed:—

A. Internal Budding. The budding is effected within the wall of the simple young polyp, and the calycinal cavities of the buds are directly connected with those of the maternal calyx.

1. Partial Budding. The wall of the young is almost cylindrical. The buds are formed by a constriction of a part of the maternal calyx. (Partial + Septal Budding of v. Koch.)
2. Cœnenchym-Budding. The wall of the young is broadened out. The septa form a cœnenchym in which new calycinal centres, which are not constricted, are formed. (Partly v. Koch's Cœnenchym-Budding.)

B. External Budding. The budding is effected outside the wall of the simple young polyp, and the calycinal cavities of the buds are not directly connected with those of the maternal calyx.

3. Wall-Budding. The buds are placed directly on the wall of the maternal calyx.
4. Costal-Budding. The buds are set on the costæ, which are developed outside the wall. (Typical Cœnenchym-Budding of v. Koch.)
5. Stolon-Budding. The buds lie at some distance from the maternal calyx, and are at first connected with the latter by stolons. (Stolon-Budding of v. Koch.)

If the soft parts and not the skeleton are considered, the same classification is arrived at.

Well-marked partial budding is only possible when there is acrogenous growth, by which dichotomously branched trunks are formed (*Mussa*). Cœnenchym-budding is connected with prolate growth, and gives rise to flat lamellæ (*Phyllastræa*). Wall-budding, in its typical form, gives rise to upright trunks, the branches of which are formed by a calyx (*Cyathohelia*). Costal budding gives flattened astræoid colonies, and is always associated with acrogenous growth. Stolon-budding causes basal enlargements, from which the several calyces rise up.

In most cases, however, the several processes of budding are not developed typically. It very often happens that such as require prolate growth are also connected with acrogenous growth so that curved broad colonies are formed, the surface of which may be branched. The several processes of budding are extremely characteristic of forms and even whole groups, for it is very seldom that, as in *Leptastræa*, different modes of budding obtain in one species.

The author regards Prof. Duncan's recent classification as quite

artificial, and attempts another, the chief points of which are here indicated:—

ZOANTHARIA MADREPORARIA.

I. Order: Athecalia.

No circular fold arises from the base of the coral to give rise to a true wall.

1. Suborder: Inexpleta.

Septa either placed simply on the basal plate or only connected by epitheca. Interseptal chambers empty, no synapticulæ. No acrogenous growth. *Cylicia.*

2. Suborder: Synapticulata.

Septa connected by synapticulæ which may unite to form wall-like structures, &c.

a. Simple forms, no prolate growth. *Stephanophyllia.*

b. Internal budding; prolate or prolate and acrogenous growth.

Thamnastræidæ, Lophoseridæ, Poritidæ, Fungiidæ.

c. Simple form with acrogenous growth and secondary wall-thickening, or colonies formed by wall-budding. Secondary thickening of porous wall constant.

Eupsammiidæ (with *Balanophyllia* and *Heteropsammia*), *Madreporidæ.*

3. Suborder: Pseudothecalia.

Septa connected by lateral fusion to form a false wall.

a. Simple form. *Caryophyllia, Desmophyllum.*

b. Colonies formed by division. *Mussidæ* (fam. nov.).

c. Colonies formed by external budding.

Cladocora and *Cyathohelia: Heliastræidæ* (fam. nov.).

II. Order: Euthecalia.

A circular fold rises up from the base of the coral and secretes a true wall.

a. Simple forms; acrogenous growth not considerable. *Deltocyathus, Paracyathus.*

b. Colonies formed by internal (cœnenchym) budding; marked prolate growth. *Echinoporidæ.*

c. Colonies formed by division; marked acrogenous growth.

Eusmiliidæ (fam. nov.) and *Euphylliidæ* (fam. nov.)

d. Colonies formed by wall-budding; growth chiefly acrogenous.

Amphihelia, Acrohelia, Galaxea.

Porifera.

Freshwater Sponges of Canada and Newfoundland.*—Mr. A. H. Mackay gives a brief outline account of the Spongillidæ of Canada. Ten species belonging to three genera have as yet been recorded.

* Trans. Roy. Soc. Canada, Section iv. (1889) pp. 85–95 (1 pl.).

Protozoa.

Ophrydium versatile and its Zoochlorellæ.*—M. P. A. Dangeard has studied the structure of this Infusorian and of its coloured guests. The cyst recalls that of the *Vorticellæ;* the ectocyst disappears under the influence of concentrated potash, sulphuric, chromic, or nitric acids; the endocyst resists the prolonged action of these reagents. The macronucleus, which in ordinary individuals has the form of a greatly elongated cord, becomes spherical in the cysts; similar observations were made by Stein in *Epistylis branchiophila* and by Entz in *Actinobolus radians.* The author has no doubt that the Zoochlorellæ are true individuals; they are Algæ, belonging to the Protococcaceæ, which live in the interior of their host; they are most nearly similar in organization, development, and size to *Palmella hyalina.* We know but little as to the part which they play. If they are symbiotic the Infusorian profits little by their presence. M. Dangeard suggests that they secrete a gelatinous matter which is utilized by the Infusorian in producing the gelatinous masses which *Ophrydium* is known to form.

Observations on Acinetina.†—The same author gives us the results of his studies of *Podophrya fixa, Metacineta mystacina,* and *Trichophrya angulata* sp. n. In the last he has observed a mode of nutrition which is very similar to that of Rhizopoda. Although several authors have described a considerable enlargement of the tentacles for the ingestion of food, none have yet demonstrated the direct entrance of food without the intermediation of the tentacles; that it should happen in this species is, no doubt, due to the great plasticity of its body, the contours of which are easily modified, and to the absence of a solid membrane.

Notes on Flagellata.‡—In another communication M. P. A. Dangeard speaks of the homology of flagella with pseudopodia, which is not freely admitted by some authors. From some observations which he has made on a *Cercomonas,* he concludes that the flagella are only condensed protoplasm, and that they may be formed directly by the transformation of pseudopodia, while, inversely, a flagellum may become a pseudopodium. He thinks that the affinities of the true Flagellata are with the Amœbæ.

Loxodes.§—Prof. E. G. Balbiani gives a detailed account of this Ciliate, the affinities of which have been so much disputed. As the author's historical account shows, many distinguished observers have busied themselves with this form. *Loxodes rostrum* exhibits considerable variability in size, and the figures given by Wrzesniowski apply best to larger examples. There are also differences in coloration, the smallest being perfectly colourless. Conjugation has not yet been observed, and the author brings his detailed account to an end without offering any general conclusions as to the results of his investigation.

Cryptomonadinæ and Euglenæ.‖—M. P. A. Dangeard continues ¶ his studies on these questionable Protozoa, which he somewhat positively

* Le Botaniste (2) i. (1890) pp. 1-14 (1 pl. and 2 figs.).
† T. c., pp. 14-29 (12 figs.).
‡ T. c., pp. 27-33 (2 figs.).
§ Ann. de Micrographie, ii. (1890) pp. 401-31 (1 pl.).
‖ Le Botaniste, i. (1889) pp. 1-38 (1 pl.).
¶ See this Journal, 1888, pp. 754-5.

regards as Algæ, mainly on account of their exclusively holophytic nutrition. He describes species of *Cryptomonas*, *Euglena*, *Phacus*, and *Trachelomonas*, and sums up the general characters of the two families Cryptomonadinæ and Euglenæ. Distinguishing three phases of life—nutritive, reproductive, and conservative, he maintains that those who support the Protozoic character of the above forms have restricted their attention too much to the active stages. Yet in reproduction as well as in nutrition, Dangeard believes that *Cryptomonas*, *Euglena*, &c., are emphatically nearer to Algæ than to Infusorians. Moreover, he concludes that all animals which contain "chlorophyll" owe this (except in two species of *Vorticella*) to the presence of symbiotic Algæ, and thus finds in the chlorophyll of the dubious forms under discussion another argument in favour of their Protophyte character.

Monadina and Chytridiaceæ Parasitic on Algæ.*—M. C. de Bruyne presents the results of his study of the Protozoic parasites on Algæ from the Gulf of Naples. To guard against the error of confounding the parasites with the reproductive cells of the Algæ, he studied the life-histories, and observed the process of parasitism and the impoverishment of the seaweed. His list of Monadina includes *Pseudospora benedeni*, *Ps. edax*, *Gymnococcus cladophoræ*, *G. gomphonemarum*, *G. licmophoræ*, *Aphelidium lacerans*, *Leptophrys villosa*, *Vampyrella incolor*, all new species, and *Ectobiella plateaui* g. et sp. n.; while of Chytridiaceæ he describes *Olpidium bryopsidis*, also a new species.

In his general notes he emphasizes the following facts:—All the forms which he observed carefully were nucleated; *Ectobiella* absorbs materials which have been digested on its surface; though the different species have their favourite hosts, it is possible to transplant them to others. He contends that cilia are modified pseudopodia, connected with the latter by intermediate forms, and capable of being retracted and remade.

Coccidia of Stickleback and Sardine.†—M. P. Thélohan describes two new species of Coccidium—*C. gasterostei* and *C. sardinæ*. The former lives in the cells of the liver, where it undergoes the whole of its development. An encysted form segments and gives rise to four small nucleated spheres or sporoblasts; the nucleus of each divides and the binucleated sporoblasts elongate, become surrounded by an envelope, and take on the typical appearance of a spore containing two nucleated falciform bodies. *C. sardinæ* was found in the testes of sardines, and is a good deal larger (50 μ) than *C. gasterostei;* the adult only was examined; it is remarkable for the small amount of space in the cyst which is occupied by the granular mass and the spores.

* Arch. de Biol., x. (1890) pp. 43–104 (3 pls.).
† Comptes Rendus, cx. (1890) pp. 1214–6.

BOTANY.

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

a. Anatomy.

(1) Cell-structure and Protoplasm.

Morphology and Physiology of the Cell.*—Dr. A. Zimmermann has investigated the structure of the chromatophores and differentiations of the cytoplasm in the vegetable cell, with the aid of the methods of fixing and staining employed by Altmann † in the case of animal cells. The following are his most important results.

In various Commelynaceæ the leucoplasts were found to inclose small spherical bodies, apparently consisting of albuminoids, for which he proposes the term *leucosomes*. They were observed in the epidermal cells up to those of the youngest leaf, and were found to differ from those of the future assimilating tissue. Similar leucoplasts containing leucosomes were also found in the mechanical cells, and in certain elements of the vascular bundles. They are distinguished by the fact that at no period of their existence do they contain starch, the formation of this substance usually beginning in the immediately adjacent tissue. Those of the epiderm appear to be quite unable to form starch out of sugar transported to them.

No destruction of the chromatophores takes place in those parts which exhibit etiolation from the want of iron; but the chromatophores are usually considerably smaller and of lighter colour than the chloroplasts of normally green leaves. They could only be detected with certainty by the use of very good objectives and of the best methods of staining. They also appear to be incapable of forming starch.

Altmann's stainable "granules" were found in the assimilating tissue, bodies consisting apparently of proteids, and very widely distributed. In *Tradescantia albiflora* it appears probable that they are connected with the nitrogenous nutrition. Except in young leaves of *Polypodium ireoides*, they had always a more or less spherical form.

By the aid of the method of staining described in detail, the occurrence of protein-crystalloids was detected in the vegetative organs of many ferns. In *Polypodium ireoides* the crystalloids in the epiderm lie not in the cytoplasm, but in the cell-sap. In some ferns the author was able to follow the development of the crystalloids of the nucleus, and found that they result from the coalescence of smaller granules or of vacuoles filled with albuminoids. Similar crystalloids were detected also in some flowering plants, e. g. *Hippuris vulgaris* and various Campanulaceæ and Scrophulariaceæ. They were found chiefly in the epiderm, and, except in *Platycodon grandiflorum*, always within the nucleus. In some cases they are subsequently absorbed, and their constituents probably used up again in metastasis.

* Beitr. z. Morphol. u. .Physiol. d. Pflanzenzelle, Heft 1, 79 pp. and 2 pls., Tübingen, 1890. Cf. this Journal, 1888, p. 442.

† Cf. this Journal, 1888, p. 146.

Processes of Growth in the Vegetable Cell.*—Herr J. Behrens has investigated the phenomena connected with the formation of so-called cellulose-folds, chiefly in certain species of *Spirogyra*, and in the assimilating cells of *Pinus*. In *Spirogyra Weberi* the splitting up of the nucleus into two is readily followed. The earlier processes resemble those of direct division; but fixed preparations show that the entire process of nuclear division is the ordinary one of karyokinesis. The space between the combined threads of the daughter-nuclei is a vacuole. In this, as in other examples which are described (epidermal cells of *Tradescantia*, &c.), no entrance of cytoplasm into the nucleus could be detected. The vacuole between the nuclei in *Spirogyra* is not formed by the enlargement of one previously in existence, but is altogether freshly formed; ultimately it entirely disappears.

The peculiar formations on the septa of *Spirogyra Weberi* have been hitherto regarded as folds; but the author confirms the statement of Strasburger that they are thickening-bands; they grow by apposition at their margin, like the septa themselves. The similar folds in the cell-walls of the assimilating tissue in the leaves of *Pinus sylvestris* can also, according to the observations of the author, be explained on the theory of apposition, though it is not impossible that intussusception may also contribute to their growth. The processes appear to be similar in the folds of the cell-wall in the mesophyll of *Calamagrostis epigejos*, and in those of the shields of the antherid of *Chara fœtida*.

Commenting on this paper, Herr G. Haberlandt † points out that his views on the position of the nucleus in mature cells,‡ which Behrens has criticized unfavourably, refer simply to the fact that the nucleus does take up a definite position in such cells, and do not touch the question whether this is brought about by an active motion in the nucleus itself, or whether it is carried passively by currents in the protoplasm.

Reactions of Cytoplasm.§—From experiments on the leaves of a specimen of *Echeveria*, Herr T. Bokorny finds that a 1 per cent. solution of caffein causes aggregation of the cytoplasm and formation of proteosomes without killing the protoplasm. From the fact that there is frequently a very great abundance of both protoplasm and tannin in the same cell, he infers a close connection between these two substances.

Quantitative Estimate of Cellulose.‖—By the use of Hoppe-Seyler's method, Herr G. Lange has determined the proportion of cellulose in various woods and in turf to vary from 44 per cent. in the latter to 55 per cent. in oak-wood.

Alkalinity of Protoplasm.¶—Herr A. Meyer contests the statement of Schwarz** that the protoplasm in the living cell has generally an alkaline reaction. He affirms that this reaction is frequently the result of the treatment to which the protoplasm has been subjected in making the experiments; and, moreover, that the so-called alkaline reaction of

* Bot. Ztg., xlviii. (1890) pp. 81-8, 97-101, 113-7, 129-34, 145-50.
† T. c., pp. 221-2. ‡ Cf. this Journal, 1887, p. 980.
§ Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 101-12 (1 pl.).
‖ Zeitschr. f. Physiol. Chemie, xiv. pp. 283-9. See Bot. Centralbl., xlii. (1890) p. 307.
¶ Bot. Ztg., xlviii. (1890) pp. 231-7. ** Cf. this Journal, 1887, p. 979.

a substance, i. e. an action on certain pigments similar to that produced by alkalies, is by no means a certain proof that the substance in question contains an alkali, or even possesses basic properties.

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

New Green Vegetable Colouring Matter.*—Mr. C. M. Smith describes a green colouring matter obtained from the green bitter pulp of the fruit of *Trichosanthes palmata*. The spectrum of its alcoholic solution differs from that of chlorophyll in its first absorption-band having its centre almost midway between the two chief chlorophyll-bands, while the bands III., IV., and V. are probably coincident with bands of true chlorophyll. Its behaviour with ammonium sulphide entirely differs from that of chlorophyll. This colouring matter appears to be a substance in which the "blue chlorophyll" of Sorby or the "green chlorophyll" of Stokes is replaced by some other substance easily decomposed by reducing agents and acids.

Chromatophores of Bleached Leaves.†—Dr. A. Zimmermann finds well-defined chromatophores to be generally present in albinized parts of plants; they agree with the normal green chloroplasts in form, but are much smaller and of a much lighter colour. Frequently also they are of a vesicular character, from containing one or more vacuoles. But all these modified chromatophores, even the vesicular ones, still retain the power of forming starch, though to a diminished extent.

Proteinaceous bodies in Oncidium.‡—Herr K. Mikosch finds in the cells belonging to the epiderm of both sides of the leaf of *Oncidium microchilum*, from Guatemala, peculiar proteinaceous bodies formed out of the granular protoplasm of the cells, and bearing a strong resemblance to those previously found by Molisch § in *Epiphyllum*. They are annular, fusiform, or loop-shaped, partially or entirely soluble in alcohol, and are coloured bright red by Millon's reagent, pink by a solution of sugar and sulphuric acid. Their occurrence is exceedingly irregular, and nothing could be determined as to their function; they appear to be formed independently of external conditions, sometimes disappearing, and being apparently again re formed. No similar structures were found in other species of *Oncidium* examined.

Tannin and its Functions.‖—Dr. K. Bauer describes in detail the mode of occurrence of tannin in the following plants, chiefly in the leaves, stem, root, and rhizome:—*Iris pseudacorus*, *I. sibirica*, *Marica Northiana*, *Ficus elastica*, *F. australis*, *Cyperus Papyrus*, *Saururus cernuus*. It may occur either in the ordinary cells of the tissue or in specially formed cells, idioblasts. In the former case it is often accompanied by starch or chlorophyll; in the latter case it is always the sole content of the cell.

As to the function of the tannin, it is clear that in many cases,

* Proc. Roy. Soc. Edinburgh, March 17, 1890. See Nature, xli. (1890) p. 573.
† Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 95-7.
‡ T. c., pp. 33-8 (1 pl.). § Cf. this Journal, 1886, p. 89.
‖ Oesterr. Bot. Zeitschr., xl. (1890) pp. 53-7, 118-23, 160-3, 188-91. Cf. this Journal, *ante*, p. 53.

especially when stored up in the testa of the seeds, it serves to protect the part against the attacks of animals, and also as an antiseptic agent. The immense quantities in which it is stored up in the rhizome of *Iris pseudacorus* and *sibirica*, and especially in the spots where adventitious roots are about to be formed, appears to indicate that it is, at least in these cases, something more than a mere product of excretion, and is used up again in the process of metastasis.

Anthocyanin.*—Prof. D. Levi-Morenos has investigated the anthocyanin which is the colouring matter of the dark dots on the leaves of certain species of *Sedum*, e. g. *S. album*, especially in the epidermal cells in the neighbourhood of the stomates. The function of this colouring matter appears to be protective, in preventing the too powerful action of the rays of light.

Localization of the Principles of Hydrocyanic Acid.†—M. L. Guignard refers to the production by certain plants of hydrocyanic acid, due to the action of emulsin or synaptase on amygdalin in the presence of water. He now describes the localization of the principles of hydrocyanic acid in the almond and cherry-laurel. Emulsin is found in the almond in the pericycle, and in the vascular bundles of the cotyledons; while in the cherry-laurel, the pericycle being sclerotized, it is found in the endodermal sheath. The presence of emulsin may be determined by Millon's reagent, or by sulphate of copper; with the former a red coloration is obtained, and with the latter a violet.

Distribution of Chemical Substances in Plants.‡—Herr E. Schär gives an exhaustive summary of what is known with regard to the distribution of the various chemical substances in the vegetable kingdom. These he treats under the head of—I. Generally distributed substances, such as the inorganic constituents, carbohydrates, acids, and pigments. II. Specific vegetable substances; the latter being again classified under the following seven heads:—(1) Alkaloids; (2) fatty acids; (3) acids of the aromatic series; (4) phenols, chinones, and ketones (benzol, naphthalen, and anthracen series); (5) essential oils; (6) specific pigments; (7) glucosides (such as digitalin and santalin) and bitter substances. He points out the remarkable fact of the complete absence or great rarity of alkaloids in very large sections of the vegetable kingdom, such as the Vascular Cryptogams, the Gymnosperms, the Monocotyledons, and the orders Compositæ and Labiatæ.

(3) Structure of Tissues.

Transformation of Epiderm.§—Herr E. Heinricher describes a peculiar development of the inner layer of the epiderm of the capsule in *Adlumia cirrhosa* (Fumariaceæ). It becomes converted, as the fruit ripens, into a layer of mechanical fibre-cells, with narrow or transversely oval dots; they broaden out at their apex, and their walls are uniformly

* Nuov. Giorn. Bot. Ital., xxii. (1890) pp. 79–80.

† Journ. de Bot. (Morot), iv. (1890) pp. 3–12, 21–7 (4 figs.), and Comptes Rendus, cx. (1890) pp. 477–80.

‡ Vierteljahrschr. Naturf. Gesell. Zürich, 1888 (1890) pp. 323–78.

§ SB. Akad. Wiss. Wien, xcix. (1890) 15 pp. and 1 pl. See Bot. Centralbl., xlii. (1890) p. 345.

strongly thickened and lignified; there is no cuticle. The layer of cells thus peculiarly transformed appears to serve the purpose of a reservoir of water for the purpose of assisting in the germination of the seeds which commences within the capsule.

Resin-producing Receptacles.*—Herr A. Tschirch states that purely lysigenous secretion-receptacles are probably rare; in a large number which are ordinarily so termed the cavity is first formed schizogenously, its subsequent development being in a lysigenous manner. The resin or oil is never found in the cavity itself, but in the adjacent epithelial cells, and the formation of these substances must be a purely chemical process, since living protoplasm is never found in them, whether they be of schizogenous or of lysigenous origin. In *Styrax Benzoin* there are no resin-receptacles, the fragrant substance not being a product of the plant in a healthy condition; it flows out copiously from wounds in the stem, and must be regarded as a pathological result of injury.

Gluten-layer in the Endosperm of Grasses.†—Herr G. Haberlandt states that the gluten-layer (Kleberschicht) in the endosperm of rye and other grasses is not, as has been hitherto stated, primarily a tissue for storing up food-materials; nor does it serve merely to conduct the diastase from the scutellum to the growing embryo; the enzyme is actually formed in it. As soon as germination commences, both the pericarp and this layer detach themselves from the rest of the endosperm. A similar phenomenon occurs in buckwheat, and probably also in many other seeds.

Comparative Structure of the Stem of Trees.‡—M. L. Flot divides this paper into two parts; in the first the external morphology is treated of, and in the second the internal morphology of a number of types is carefully described and compared.

In a plant a year old the lower part of the stem differs in structure from either the root or the stem proper, and the author calls this the tigellary region. The distribution of cork affords one of the most interesting morphological differences in the structure of stems. It may appear in five places:—(*a*) In the epiderm (apple). (*b*) In the majority of trees it forms a subepidermal layer of from 1–2 (mountain ash) to 20 layers (*Paulownia*). (*c*) In certain trees (*Robinia*) the separating meristem arises in a deeper stratum, and several sub-epidermal layers are in this way atrophied. (*d*) It can appear in a region deeper than the cortex and near the endoderm (Rosaceæ). (5) In *Clematis*, the vine, &c., it forms in the pericycle.

A *résumé* of the characters of the cortex is then given. The cortex of the cauline region of a plant a year old is similar in structure to that of an old branch; an external zone with thick walls may be distinguished, and an internal zone with thin walls. In the tigellary region all the parenchyme has thin walls.

The general conclusions arrived at are as follows:—(1) In a plant a year old there are two distinct regions: the cauline and the tigellary.

* SB. Gesell. Naturf. Freunde Berlin, 1889, pp. 173–5. Cf. this Journal, 1888, p. 604. † Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 40–8 (2 figs.).

‡ Rev. Gen. de Bot. (Bonnier), ii. (1890) pp. 17–32, 66–77, 122–36 (4 pls. and 32 figs.).

(2) In certain trees the tigellary region only developes during the first year. (3) The tigellary region is a special structure, and is characterized by (*a*) the early appearance of hypodermal, cortical, or pericyclic cork; (*b*) a large development of the external parenchymatous zone; (*c*) absence of differentiation in the external zone of cortex; (*d*) a great reduction or absence of sclerenchyme; (*e*) a large development of wood; (*f*) absence of the parenchymatous circum-medullary zone; (*g*) feeble lignification of the ligneous elements; (*h*) a reduction in the diameter of the pith. (4) From a physiological point of view the terminal shoot of an old tree presents no differences from the caulinary region of a tree a year old; the tigellum is always distinguished by the accumulation of reserve-material.

Stem of Cycadeæ.*—Graf zu Solms-Laubach finds, in the stem of *Stangeria*, a cone of vascular bundles, which is prolonged upwards into a simple cylindrical tube, and the axis of which deviates only slightly from the horizontal. A similar structure probably occurs also in the stems of other Cycadeæ.

Decortication of the Stems of Calycanthaceæ, Melastomaceæ, and Myrtaceæ.†—M. O. Lignier states that the structure of the cork in Melastomaceæ presents various aspects. When it forms in the epiderm it is composed of uniform cells with thin walls. The pericambial cork of the Memecyleæ is formed of uniform sclerotized cells, whereas the cork of the first group of Melastomaceæ (comprising the Microlicieæ, Osbeckieæ, and Rhexieæ) is stratified when it is pericambial. The author confirms many of the observations of M. Douliot,‡ and also points out that the successive layers of cork in the Myrtaceæ present a very regular stratification.

Function of the Sieve-portion of Vascular Bundles.§—Herr J. Blass argues against the prevalent view that the main purpose of the sieve-structures in the phloëm of vascular bundles is for the transport of albuminoids. His main arguments are derived from the fact that sieve-structures do not occur in the part where they would be most required for this purpose, viz. in the immediate vicinity of the growing point, being never found in the uppermost internode; from their very small number in proportion to the number of vessels; and from the circumstance that the sieve-pores are frequently almost entirely closed, or the passage through them of the albuminoids greatly hindered by large accumulations of callus. From an examination of woody and herbaceous plants, Herr Blass found that the development of the sieve-structure bears, as a general rule, a direct proportion to the development of xylem, being, e. g., almost entirely suppressed in aquatic plants; and he believes that its chief function is to supply a store of food-material for the formative cambium, and for the xylem of the vascular bundles, bearing the same relation to these portions of the bundle that the starch-sheath does to the phloëm portion.

* Bot. Ztg., xliii. (1890) pp. 177–87, 193–9, 209–15, 225–30 (1 pl.).
† Bull. Soc. Bot. France, xxxvii. (1890) pp. 12–7.
‡ Cf. this Journal, 1889, p. 406.
§ Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 56–60.

Special Elements in Glycine sinensis.*—Dr. B. Pasquale finds in the young branches of this leguminous plant, here and there in the tissue of the pith, soft bast and cortex, special elements of two forms—tubular and isodiametric, the former of which have a temporary, the latter a permanent function. The transitory elements are formed of living, the permanent of dead cells. The isodiametric elements result from the development of single cells, the tubular from the fusion of several. Both kinds appear to serve as reservoirs for substances varying widely in composition, among which are always found proteids, and frequently tannin and sugar. Their chief function appears to be a protecting one.

Constituents of Lignin.†—Herr G. Lange has obtained the same results from pine as from beech and oak-wood, decomposition of the lignin taking place, under the action of alkalies, into cellulose and two different lignic acids. He thinks it probable, however, that in the wood the cellulose is in composition with one lignic acid only.

(4) Structure of Organs.

Monocentric and Polycentric Flowers.‡—Prof. F. Delpino classifies the flowers of Angiosperms under two great series:—*euanthic*, or those which are strictly monothalamic, and *pseudanthic*, which have either polythalamic flowers, or in which the inflorescence perfectly simulates the structure of a simple flower. All Monocotyledons are euanthic, as also are nearly all Corollifloræ and Achlamydeæ, many Monochlamydeæ, and other orders belonging to primitive types, such as the Ranunculaceæ, Papaveraceæ, Aristolochiaceæ, and many others. On the other hand, the Malvaceæ and allied orders, such as the Sterculiaceæ, Tiliaceæ, Geraniaceæ, and Linaceæ, are pseudanthic, as also are many Euphorbiaceæ. To the same series belong also the Rosaceæ and all allied orders, such as the Myrtaceæ, Saxifragaceæ, Rutaceæ, Guttiferæ, Cistaceæ, &c.

Change of Flowers to Tubers.§—Mr. C. A. Barber describes a plant of *Nymphæa Lotus*, which shows great abnormality in the formation of its flowers. While the first formed flower-buds were developing into the normal flowers, a further and very large development of buds took place; and these buds, which were of slow growth, were found to be curiously deformed. The sepals, which appeared as usual, were not followed in due course by petals and stamens, but were found to enfold a number of green leaves, with occasional buds in their axils, separated from one another, and almost concealed from view by a dense mass of long white hairs. This formation of foliage, instead of floral leaves, accompanied as it was by a swelling of the end of the axis of the flower, may be briefly described by saying that tubers were developed in place of flowers. The author then carefully describes the structure of the deformity which he characterizes as a case of chloranthy.

* Malpighia, iii. (1890) pp. 451–67 (1 pl.).

† Zeitschr. f. Physiol. Chem., xiv. pp. 212–27. See Bot. Centralbl., xlii. (1890) p. 308. Cf. this Journal, *ante*, p. 353.

‡ Malpighia, iv. (1890) pp. 479–92 (3 figs.).

§ Ann. of Bot., iv. (1890) pp. 105–15 (1 pl.).

Stamens of Solanaceæ.*—Prof. B. D. Halsted describes a peculiarity in the stamens of Solanaceæ which is quite independent of their variable mode of dehiscence in the different genera. The central portion of the anther is very fleshy, and is termed by the author the "columella"; the pollen-bearing portion being in the form of a very broad horse-shoe, while all between is cellular tissue. The wall inclosing this pollen-layer often separates early from the columella. In *Solanum carolinense* there are two pollen-cavities in each anther lobe. In *S. rostratum* one of the five stamens is three or four times the size of the other four, but the pollen-cavities themselves are no larger.

Development of Ovary and Placenta.†—Herr B. Schäfer has traced out the history of development of the ovary and placenta, especially in *Ailanthus glandulosa*, and in the orders Malvaceæ, Scrophulariaceæ, Solanaceæ, Caryophyllaceæ, Compositæ, Campanulaceæ, and Œnothereæ. A point on which he lays considerable stress is the area of the receptacle consumed in the formation of a carpel. The superior ovary of Angiosperms is the product of the development of the carpels (leaves), the axis, especially in the inferior ovary, serving only as a support to the carpels. The various forms of placenta can always be traced back to a massive development of the margin of the carpels; where the ovules are scattered over the surface of the carpels there is no true placenta. The placentation in inferior corresponds in all respects with that in superior ovaries.

Bracts of the Involucre of Compositæ.‡—M. L. Daniel draws the following conclusions on the structure of these organs:—(1) The structure of the bracts nearly always differs from that of the foliage-leaves. (2) The orientation of the foliage-leaves being but slightly variable the types of structure are few; they are either homogeneous (both surfaces alike), or normally heterogeneous (with palisade-tissue on the upper surface); occasionally one finds the inverted heterogeneous type (with palisade-tissue on the lower surface). (3) The orientation of the sheath is constant. (4) The orientation of the bracts is exceedingly variable. (5) The absence of chlorophyll or the presence of lacunæ on the two surfaces should not prevent the structure being considered homogeneous. (6) A colourless parenchyme with one surface close and the other provided with lacunæ, and a parenchyme of the same form, but with chlorophyll more abundant on one of the surfaces, belong to the heterogeneous type. (7) The heterogeneous parenchyme is not necessarily of a palisade form on the surface most exposed to light.

Stone of Drupes.§—M. A. G. Garcin distinguishes two types of structure in the stone of stone-fruit,—those which are homogeneous, and those which are composed of different kinds of tissue. They may also be classified into the indehiscent, and those which are partially or entirely dehiscent. The former includes true drupes—*Prunus*, *Zizyphus*,

* Bot. Gazette, xv. (1890) pp. 103–6 (1 pl.).
† Flora, lxxiii. (1890) pp. 62–104 (4 pls.).
‡ Ann. Sci. Nat., xi. (1890) pp. 17–119 (6 pls.).
§ 'Contrib. à l'étude des péricarpes charnus. Du noyau des drupes,' Lyon, 1890. See Bot. Centralbl., xlii. (1890) p. 343.

Rhamnus, and those which are provided with a wing, and resemble a samara—*Loxopterygium*, *Botryceras*. The dehiscent drupes may either split through both mesocarp and putamen—*Juglans*, *Caria*, *Aquilaria*, or through the mesocarp only, and then either septicidally, *Clusia*, *Quapoya*, &c., or septifragally—*Balsamea*, *Boswellia*.

When the tissue of the stone is of uniform structure, it may consist either of true sclerenchymatous cells, as in *Vaccinium*, or of tubular cells, as in *Tropæolum pentaphyllum*. The non-homogeneous stone consists of from one to four distinct layers; in the black and red currant there is only a single layer; in *Cratægus* there are three; in the middle one, each cell contains a crystal of calcium oxalate; in the almond there are four layers. The author concludes, from the history of their development, that the mass of sclerenchymatous cells in the pear have been erroneously regarded as a rudimentary or reduced stone.

Cupule of the Beech and Chestnut.*—From an examination both of the normal structure and of abnormal examples, Dr. L. Celakovsky concludes that the cupule of the Fagaceæ or true Cupuliferæ (*Fagus* and *Castanea*) is not strictly homologous to that of the oak. It is, in fact, a compound cupule or cup-shaped sympode, composed of three orders of axes, each of the three orders (in the chestnut) representing a successive generation. The spines are metamorphosed leaves reduced to a few lateral veins. The male inflorescence of the beech must be regarded as a catkin composed of cymes.

Stomates in the Fruit of Iris.†—Mr. J. B. Farmer points out that in the wall of the ovary of *Iris pseudacorus* stomates continued to be formed during the ripening of the fruit; and that cell-division sometimes takes place in their guard-cells. The two guard-cells of the same stomate do not always behave alike; in some cases one, in others both, guard-cells contain two nuclei, but the cell-wall between them has failed to appear; and all stages of transition may be observed until each guard-cell is divided transversely into two cells, each of which contains a nucleus.

Integument of the Seed of Papilionaceæ.‡—Sigg. O. Mattirolo and L. Buscalioni have made a careful investigation of this structure, and especially of the region adjacent to the umbo of the seed, which they divide into three portions—the micropyle, the "chilarium" or hilary lamina, and the two tubercles (tubercoli gemini), the latter filled with a large quantity of tannin.

Absorbing-organs of the Seeds of Scitamineæ.§—Dr. A. Tschirch believes that a more or less well-developed absorbing-organ occurs in the seeds of all the families of Monocotyledons which possess an endosperm or perisperm. In the Zingiberaceæ, e. g. *Elettaria speciosa*, it has an elongated conical form, and remains in the seed after germination. The young seedling is united with the absorbing-organ,

* Jahrb. f. Wiss. Bot. (Pringsheim), xxi. (1890) pp. 128–62 (1 pl.). Cf. this Journal, 1887, p. 613.

† Ann. of Bot., iv. (1890) pp. 174–6 (8 figs.).

‡ Atti R. Accad. Sci. Torino, xxiv. (1889). See Bot. Centralbl., xlii. (1890) p. 21. Cf. this Journal, *ante*, p. 355.

§ SB. K. Preuss. Akad. Wiss. Berlin, vii. (1890) pp. 131–40.

which is surrounded by the endosperm, by a long filiform appendage of the base of the sheath-like cotyledons. In the Cannaceæ it has a similar form; the seed has no endosperm, and the absorbing organ is surrounded by the perisperm. In the Marantaceæ it is long and filiform, and hooked at the apex. In the Musaceæ, e. g. *Musa Ensete*, it is broad and disk-like, resembling the scutellum of grasses. It remains in the seed, increasing greatly in size after germination.

As to the morphological value of the absorbing organ, Herr Tschirch believes that the cotyledon takes a greater or less share in its formation, but that it does not in itself represent the cotyledon. It is remarkable that in seeds which contain no endosperm, a structure occurs with none of the functions of an absorbing organ, but which resembles it greatly from a morphological point of view.

Anatomy of Cotyledons.*—According to Herr P. Kumm, leaf-like cotyledons exhibit a general agreement in structure with foliage-leaves, but are usually somewhat thicker; the mechanical system is less strongly developed, and, except in *Impatiens*, collenchymatous bundles replace the true bast-fibres. The simplest structure occurs in the cotyledons of exalbuminous seeds which remain permanently beneath the soil, as those of *Phaseolus* and *Vicia*. The palisade-parenchyme and epiderm are but feebly developed in the cotyledons of exalbuminous seeds. Stomates are found on all cotyledons which emerge above the surface, either on one side only or more commonly on both sides. Trichomic structures occur but rarely.

Influence of Alpine situations on Leaves.†—According to observations carried on by Herr K. Leist, the chief differences observed in the leaves of Alpine plants, as contrasted with those of lower altitudes, are in their diminished thickness and increased extent of surface. The former depends chiefly on a decreased development of the palisade-tissue. This may result either from the reduction of the number of layers of palisade-cells, or from a decrease in their vertical diameter and corresponding increase in their width, the number of layers remaining the same. The number and size of the intercellular spaces is increased; the spongy parenchyme often becomes somewhat less close. The cuticle is considerably thickened. The causes of these peculiarities appear to be the lower temperature, and the excessive moisture of the ground at the time when the leaves are unfolding.

Knees of Taxodium distichum.‡—Mr. R. H. Lamborn describes the structure of the so-called "knees" in *Taxodium distichum*, the deciduous cypress of the United States, roots which project horizontally from the stem at a considerable distance from the ground, put out branches which descend vertically into the soil, and are frequently provided with knobs or protuberances on the upper side. He concludes that their function is not connected, as has been generally supposed, with the aeration of the tree, but that their purpose is to support it in the situations where it is

* 'Zur Anat. einiger Keimblätter,' 8vo, Breslau, 1889, 38 pp. See Bot. Centralbl., xlii. (1890) p. 163.

† Mittheil. Naturf. Gesell. Bern, 1889. See Bot. Centralbl., xlii. (1890) p. 118.

‡ Amer. Natural., xxiv. (1890) pp. 333–40 (1 pl. and 1 fig.).

generally found, in a very sandy soil which is constantly flooded by water. Their form, and the fact that the knees as well as the lower part of the stem are usually hollow, gives the necessary elasticity to resist the strain of high winds on the enormous weight of the crown of foliage. When the tree grows in dry upland situations it does not produce these knees.

Spines and Emergences of Euryale.*—Prof. G. Arcangeli describes the hairs and spiny protuberances found on the leaves, leaf-stalk, flower-stalk, and calyx of *Euryale ferox*. The latter are of four distinct kinds, two of which may be classed as emergences, springing from the epiderm or hypoderm, the other two as arrested branches or spines. The stellate bodies which are found on the leaves and floral organs contain large deposits of calcium oxalate in their cell-walls, and answer the double purpose of fulfilling a mechanical function and of eliminating excess of calcium oxalate. The author proposes to bestow on them the term *cladosclereids*.

Intumescences.†—By this term Herr P. Sorauer designates those small knot-like excrescences on leaves, usually of a yellow colour, which are the result of an elongation of the cells without any considerable increase in their number. They are a pathological phenomenon, the result of the presence in the tissue of an unusually large quantity of water at the same time that transpiration is strongly checked.

Tuber of Corydalis.‡—According to Herr L. Jost, the tuber of *Corydalis solida* differs essentially in structure from that of *C. cava*, which is an abbreviated rhizome. It consists, at the time of flowering, of three distinct portions: the uppermost portion has the typical structure of a stem, is provided with scale-leaves, and is penetrated by leaf-traces; the lowermost has the structure of a root, and is provided with lateral roots; while the central and largest portion presents, from a morphological and anatomical point of view, an intermediate structure, and is always formed from the cambium of the parent tuber. This description does not apply to the tuber in its earliest condition, which is simply a swelling of the hypocotyl, and is renewed annually. A similar structure is found in all the species belonging to Irmisch's section of the genus "Pes gallinaceus," which includes, besides *C. solida*, *C. fabacea*, *pumila*, *bracteata*, *longifolia*, *angustifolia*, *nudicaulis*, *caucasica*, *laxa*, *densiflora*, and *kolpakowskiana*. As in other species of *Corydalis*, the embryo has only a single well-developed cotyledon.

Production of Fruit without Fertilization.§—Dr. Fritz Müller records several instances of the production of fruit in plants in which access of pollen to the pistil was impossible, viz. in *Cycas revoluta*, and in a species of *Hedyosmum*. In the latter case the seeds were apparently well developed, but dissection showed most of them to be empty.

* Nuov. Giorn. Bot. Ital., xxii. (1890) pp. 266–71.
† Bot. Ztg., xlviii. (1890) pp. 241–52.
‡ T. c., pp. 257–65, 273–82, 289–94 (1 pl.).
§ Biol. Centralbl., x. (1890) pp. 65–6.

β. Physiology.

Frank's Text-book of Physiology.*—Herr A. B. Frank's new Text-book of Vegetable Physiology is divided into three sections: (1) The physical characters and phenomena of the plant; (2) Metastasis; (3) Reproduction; by far the larger portion being devoted to the second, which treats of the Nutrition of Plants through the roots, i. e. the absorption of water and nutrient substances, transpiration, assimilation, &c. The work is illustrated by some excellent new figures.

(1) Reproduction and Germination.

Ornithophilous Flowers.†—Mr. G. F. Scott-Elliot describes the structure of the flowers in *Musa*, *Ravenala madagascariensis*, and *Strelitzia reginæ*, and the part played by birds in their fertilization. In the banana the usual fertilizers, at least in Natal, are sun-birds, although insects appear to assist. The *Ravenala* is proterandrous, and is often visited by sun-birds. The same is the case with *Strelitzia;* the honey-bee and the diptera, which also visit it, appear to take no part in the pollination.

In South Africa the Cinnyridæ or sun-birds are exceedingly good fertilizers, especially *Nectarinia chalybea* and *bicollaris*, and *Promerops caper*. Like bees they, as a rule, visit only one species of flower at a time. Mr. Scott-Elliot believes that the identity of colour (an unusual shade of red) in the majority of ornithophilous flowers, and on the breast of species of *Cinnyris*, is an important element in this pollination. He describes the mode in which a large number of flowers, natives of the Cape of Good Hope, are visited by birds, viz.:—*Melianthus major* and *comosus;* among Leguminosæ, *Schotia speciosa*, *Erythrina caffra*, and *Sutherlandia frutescens; Erica Plunkenetii* and *purpurea; Tecoma capensis*, *Lycium tubulosum*, *Lobostemon montanum;* among Labiatæ, *Leonotis ovata*, *Salvia aurea*, *Sarcocolla squamosa;* among Proteaceæ, *Protea incompta*, *mellifera*, *lepidocarpon*, and *grandiflora*, *Leucospermum conocarpum*, and *Antholyza æthiopica*.

Insects as Fertilizers.‡—Herr E. Loew gives a number of statistical details with regard to the visits of insects to flowers, and the part taken by them in pollination, chiefly in relation to the flora of the Alps and of northern regions; the results are in general in harmony with those of H. Müller. In reference to the phenomenon of pollination, he proposes to classify the flowers into those with honey near the surface, at a moderate depth, and at a great depth; and the visiting insects into allotropous, hemitropous, and eutropous.

Flowers and Insects.§—Mr. C. Robertson continues his observations on the mode of pollination of American flowers, and of the insects by

* 'Lehrbuch d. Pflanzenphysiologie, mit besonderer Berücksichtigung d. Culturpflanzen,' Berlin, 1889, 242 pp. and 52 figs. See Bot. Centralbl., xlii. (1890) p. 210.

† Ann. of Bot., iv. (1890) pp. 259-80 (2 pls.).

‡ Abhandl. Bot. Ver. Prov. Brandenburg, 1889, pp. 1-63. See Biol. Centralbl., x. (1890) p. 12. Cf. this Journal, 1885, p. 999.

§ Bot. Gazette, xiv. (1889) pp. 297-304; xv. (1890) pp. 79-84. Cf. this Journal, 1889, p. 781.

which the pollination is effected. The present instalments refer to species belonging to the natural orders Nymphæaceæ, Cruciferæ, Geraniaceæ, Balsamineæ, Celastraceæ, and Papilionaceæ.

Dichogamy.*—Dr. A. Kerner v. Marilaun describes the various degrees of perfect and imperfect proterandry, and of perfect and imperfect proterogyny in plants, and the part which imperfect dichogamy (proterandry or proterogyny) plays in the production of hybrids in nature.

Conversion of a bisexual into a diœcious Plant.†—M. A. Giard describes the finding of several plants of *Pulicaria dysenterica*, in which all the ligulate were replaced by tubular flowers. By destroying all normal plants in the vicinity, he succeeded in perpetuating this anomalous form from generation to generation for ten years; thus transforming, by artificial selection, a gyno-monœcious into a diœcious Composite.

Strengthening of the Sexuality of a Hybrid.‡—M. L. Trabut describes an *Ophrys* intermediate between *O. tenthredinifera* and *O. scolopax* which showed a transformation in some of the flowers of two petals into two stamens, or, in other words, a strengthening of the sexuality—which is the reverse of what is generally found in most hybrids.

Fertilization of Arum and Dracunculus.§—According to Prof. G. Arcangeli, the fertilization of the flower of *Dracunculus vulgaris* (*Arum Dracunculus*) is effected mainly by necrophilous Coleoptera, attracted by the powerful odour which exhales from the open spathe, and chiefly by *Saprinus nitidulus*, the species next in efficiency being *S. subnitidus*, *Dermestes undulatus*, and *D. Frischii*.

Prof. F. Delpino,‖ on the other hand, adduces arguments in favour of the view that these Coleoptera-play but a subordinate part in the pollination, the chief agents being carnivorous flies, principally *Calliphora vomitoria* and *Sarcophaga carnaria*.

Prof. Arcangeli ¶ replies to the observations of Delpino, classing *Dracunculus* among necrocoleopterophilous plants, along with *Rafflesia*, *Amorphophallus*, *Hydnora abyssinica*, and others.

The flowers of *Arum pictum* are, according to Sig. U. Martelli,** strongly proterogynous, and exhale, when open, a most powerful odour of human excrement, which attracts insects belonging to various orders to perform the function of pollination.

Fertilization of Brassica oleracea.††—Dr. R. Cobelli enumerates as many as fifty species of Apidæ, which he has observed visiting the flowers of different varieties of the cabbage, and which may possibly take part in the pollination of the stigma.

* Oesterr. Bot. Zeitschr., xl. (1890) p. 1–7.
† Bull. Scient. France et Belgique, 1889, pp. 53–75 (1 pl.). See Biol. Centralbl., x. (1890) p. 19.
‡ Comptes Rendus, cx. (1890) p. 480.
§ Nuov. Giorn. Bot. Ital., xxii. (1890) pp. 52–7. Cf. this Journal, 1883, p. 382.
‖ Malpighia, iii. (1890) pp. 385–95.
¶ T. c., pp. 492–507.
** Nuov. Giorn. Bot. Ital., xxii. (1890) pp. 129–32.
†† Verhandl. K. K. Zool. Bot. Gesell. Wien, xl. (1890) Abhandl., pp. 161–4.

Germination of Jerusalem Artichoke.*—Mr. J. R. Green states that during the germination of the Jerusalem artichoke the tubers develope a ferment which is capable of transforming inulin into sugar. It can be extracted from the tubers by glycerol, and can be artificially formed in them by heating for twenty-four hours at 35° C. The sugar formed does not crystallize, and reduces less readily than dextrose or levulose.

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

Transport of Reserve-materials from the Endosperm to the Embryo.†—Herr W. Hirsch describes the contrivances for the transmission of the reserve food-material from the endosperm (or perisperm) of albuminous seeds to the embryo on germination. These may be arranged under four heads:—(1) In large seeds where the embryo is small and more or less nearly central, the reserve-cells of the endosperm are more or less elongated, and radiate towards the embryo. (2) In very small seeds in which the endosperm consists of only a very few layers of cells, no such elongation occurs, but the walls of the cells are often very strongly pitted. (3) The cell-walls of the endosperm-tissue are very thin, and its cells are brought into contact with all parts of the embryo by the spirally-coiled form of the latter. (4) The elongation and radial arrangement of the endosperm-cells is accompanied by the presence of a well-developed absorbing organ.

In all albuminous seeds which have not a special absorbing-organ, its functions are performed by the layers of the endosperm which are in immediate contact with the embryo possessing the property of swelling up strongly, their contents being then transferred to the epiderm of the embryo.

Relation between Temperature and Growth.‡—Herr E. Askenasy describes in great detail the results of a series of experiments to determine the relationship between growth and temperature in the case of roots of young plants of maize. The optimum temperature was found to be between 26° and 29° C., the slowest growth at this temperature being 1·7, and the most rapid 3·8 mm. in an hour. He asserts that in all circumstances the growth of the protoplasm is the primary phenomenon, the growth of the cell-wall being entirely dependent on it. The turgidity remains the same at different temperatures, and therefore cannot be the cause of the variation of the rate of growth with the temperature. The author does not think that recent observations prove the impossibility of the growth of the cell-wall by intussusception.

Growth of the Leaf-stalk in Water-plants.§—Prof. G. Arcangeli has attempted to investigate the laws by which the stalks of floating leaves adapt themselves as to length to the depth of the water in which they grow, the growth ceasing when the lamina reaches the surface. In the case of *Euryale ferox* he believes that this is mainly due to the traction on the tissues of the leaf-stalk resulting from the lamina of the leaf

* Ann. Agron., xv. p. 569. See Journ. Chem. Soc., 1890, Abstr., p. 656.
† Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 1–8. ‡ T. c., pp. 61–94.
§ Nuov. Giorn. Bot. Ital., xxii. (1890) pp. 121–9, 300–3 (1 fig.).

being of a less specific gravity than water, owing to the abundance and size of its intercellular spaces, this traction ceasing when the leaf has reached the surface. A similar explanation, with some modifications, can be offered in those cases where the direction of the leaf-stalk is oblique rather than vertical to that of the lamina. In no case, he believes, is this arrest of growth due to chemical causes, i. e. to the difference in proportion of the oxygen in the air contained in solution in the water and in the atmosphere.

Theory of Growth in Height.*—Prof. Weber proposes a mechanical theory for the energy of a plant in relation to its growth in height. Representing this energy as K, the weight of the plant as P, and the height as H; then K = P H in meterkilograms; and when K remains uniform, P and H are always reciprocals of one another. The author believes that the force which determines the mechanical equivalence of the annual sum of the work in the movements of the sap must be sought for not in "root-pressure," but in the merismatic tissue or its protoplasm.

Apparatus for illustrating the Growth of Plants.†—Dr. J. Kündig describes and figures an apparatus which he has constructed for the purpose of demonstrating the phenomena of growth in length of plants. It consists of a number of metal tubes, arranged one within another in telescope-fashion, the uppermost of which represents a growing point and the rest internodes of different lengths. The whole is inclosed within a box with an opening at the top, through which the system of metal tubes emerges by the turning of a key, their successive appearance and separation representing the development of the internodes.

Transpiration and Assimilation.‡—M. G. Curtel describes a very simple apparatus by means of which the variations in transpiration can be studied. A U-shaped tube is taken, and two corks of caoutchouc; into one of the corks a capillary tube is inserted, and through the other a plant (of rye) is let into one of the arms of the tube. The apparatus is filled with water, the corks fixed and waxed, and the variations of the column of liquid in the capillary tube indicate the progress of the transpiration.

Assimilation of Carbon by Green Plants.§—Mr. E. H. Acton has conducted a series of experiments in entirely removing the starch from the leaves and tissues of growing plants, by placing them either in the dark or under a bell-jar with substances which entirely remove all carbon dioxide from the air, and then supplying them with various organic compounds as food-materials. The general results arrived at are that green plants cannot normally obtain carbon for assimilation from any substances except carbohydrates or bodies closely related to them, not from aldehydes or their derivates, and not even from all carbohydrates. A compound may be a source of carbon when supplied to the leaves, but not when supplied to the roots, and *vice versâ*. Ordinary

* SB. Bot. Verein München, Dec. 9, 1889. See Bot. Centralbl., xli. (1890) pp. 10 and 42.

† Bot. Centralbl, xli. (1890) pp. 203–5 (1 fig.).

‡ Rev. Gen. de Bot. (Bonnier), ii. (1890) pp. 7–16 (1 fig.).

§ Proc. Roy. Soc., xlvii. (1890) pp. 150–75 (3 figs.).

non-parasitic green plants have, however, to a large extent, lost the power of using such substances as a source of carbon. The author considers that his experiments do not settle the question whether the immediate result of the mutual decomposition of carbon dioxide and water by plants is formic aldehyde.

Cause of the Movement of Water in Transpiring Plants.*—Dr. J. Boehm adduces additional arguments in favour of his view that the absorption of water in transpiring plants is not due primarily to endosmotic action in the root, or to differences in the pressure of the air. The absorption of water through the roots, and the ascent of sap are, on the other hand, in his view, a capillary function of the vessels, which may be regarded as a continuation of the capillary spaces in the soil. The ascent of sap takes place only in the outermost alburnum, and is exceedingly rapid when transpiration is excessive. The sap-conducting vessels of Conifers are the tracheïd bundles, the elements of which are in open connection with one another.

Transpiration.†—Herren E. & J. Verschaffelt state that, other conditions of light, temperature, &c., being the same, transpiration is greater in an air containing no carbonic acid than it is in the ordinary atmosphere.

(3) Irritability.

Chemotactic Irritability.‡—Herr B. Stange has made a series of observations on the sensitiveness to the presence of various chemical substances of the zoospores of Saprolegniaceæ and the myxamœbæ of Myxomycetes. The results confirm de Bary's general statement that parasitism and saprophytism are influenced by the chemical composition of the host or medium.

The experiments on Saprolegniaceæ were made on a species belonging to the *Saprolegnia ferax* group, grown, with due precautions, on the dead bodies of flies. They determined the fact that, while certain other substances exercise a smaller or greater attractive or repulsive influence on the zoospores, it is the phosphates in the decaying body of the insect or in the nutrient fluid, and not the compounds of nitrogen or carbon, which excite most strongly the sensitive movements of the zoospores; and there is, for this purpose, an optimum concentration for phosphoric acid itself and for each of its salts. No other free acid produced the same effect. Whether the effect is attractive or repulsive depends on the concentration of the solution. Neither free oxygen nor variations of temperature had any considerable influence on the irritability.

The Myxomycetes observed were chiefly *Chondrioderma difforme* and *Æthalium septicum*. The results differed materially from those obtained with *Saprolegnia*. Phosphoric acid and its salts, citric acid, tannic acid, glycerin, cane-sugar, and other substances exercised no attractive force on the myxamœbæ of *Chondrioderma;* on the other hand, malic and

* Verhandl. K. K. Zool-Bot. Gesell. Wien, xl. (1890), Abhandl., pp. 149–60 (3 pls.). Cf. this Journal, 1886, p. 824.

† Bot. Jaarboek (Gent), ii. (1890) pp. 306–24 (2 pls.). See Bot. Centralbl., xlii. (1890) p. 373.

‡ Bot. Ztg., xlviii. (1890) pp. 107–11, 124–7, 138–42, 155–9, 161–6.

lactic acid and their salts acted powerfully, butyric acid and asparagin with less energy; the action is again attractive or repulsive, according to the concentration. With *Æthalium septicum* positive results were also obtained with valerianic and propionic acids. The plasmodes of this species are apparently influenced by the same irritants as the myxamœbæ.

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

Chemical Changes during Germination.*—Mr. H. T. Brown and Dr. G. H. Morris describe the phenomena of metabolism which take place during the germination of the grain of some grasses, especially barley. They state that a disintegration and dissolution of the cell-walls of the endosperm always precede any attack upon the cell-contents, and that this depends on the production during germination of a special cellulose-dissolving or "cyto-hydrolytic" enzyme, which, like diastase, is soluble. Owing to the non-diffusible nature of the "amylo-hydrolytic" enzyme, or diastase, the previous breaking down of the cell-wall is a necessary prelude to the dissolution of the contained starch-grains. The appearance of both these hydrolysts is due to a specialized secretory function of the layer of columnar epithele which covers the outer surface of the scutellum.

The authors support the view that the relation of the embryo to the endosperm is that of parasite to host, and they found it possible to cultivate the excised embryo after separation from the endosperm, on suitable media. Of all the host-substances thus tried, cane-sugar has by far the greatest nutritive power. Other carbohydrates, as invert-sugar, dextrose, levulose, maltose, raffinose, galactose, and glycerol, have more or less nutrient value, while milk-sugar and mannitol do not in any way contribute to the growth of tissue in the young plant. The authors believe that the transformed starch of the endosperm is absorbed by the embryo in the form of maltose, and that the seat of the production of the cane-sugar which germinated grain contains is the tissues of the embryo itself.

Prof. J. R. Green† has made a series of experiments on the same subject in the case of the castor-oil plant (*Ricinus communis*). He finds in the resting seeds a ferment or zymogen, which is readily developed into an active condition by warmth and weak acids, the results of its activity being the splitting up of the oil with formation of glycerin and (chiefly) ricinoleic acid. The proteids of the seed, which consist of globuline and albumose, are split up by another ferment with formation of peptone and asparagin. During the progress of germination there is also liberated in the endosperm a rennet-ferment of considerable vigour. The author states that the only products which enter the embryo during germination are a crystalline acid, sugar, possibly some peptone, and asparagin.

Transformation of the Alkaloids during Germination.‡—From observations made chiefly with strychnine, brucine, daturine, and

* Journ. Chem. Soc., 1890, pp. 458-528 (2 pls.).
† Proc. Roy. Soc., xlvii. (1890) pp. 146-7.
‡ Comptes Rendus, cx. (1890) pp. 88-90.

caffeine, Herr E. Heckel concludes that the alkaloids in the seeds are true reserve food-materials, since they are entirely transformed into assimilable substances during the process of germination. The experiments on caffeine were made chiefly with *Sterculia acuminata*, those on the three other alkaloids with *Strychnos nux-vomica* and *Datura Stramonium*. In all cases the alkaloids contained in the cotyledons or in the embryo had completely disappeared as soon as the seedlings had attained a considerable size, the products of the transformation of caffeine being glycophyll and potassium nitrate. A similar result was obtained with the eserine contained in the seeds of *Physostigma venenosum*.

Fixation of Free Nitrogen.*—Sir J. B. Lawes and Prof. J. H. Gilbert have repeated Hellriegel and Wilfarth's experiments† on the source from which leguminous plants obtain their nitrogen, and their conclusions are, in the main, in harmony with those of these observers. While with Cruciferous, Chenopodiaceous, Graminaceous, and all other cultivated crops except those belonging to the Leguminosæ, all their nitrogen would appear to be derived from the nitrates in the soil, this is apparently not the case with Leguminous plants, those on which the observations were made being chiefly peas, lupins, clover, vetches, and lucerne. The authors consider that there is no evidence whatever that these plants have any power to fix the free nitrogen of the atmosphere; but that the tubercles on the roots are the organs through which a large proportion of the nitrogen is absorbed, the bacteria which infest these tubercles utilizing and fixing the free nitrogen from the soil, and thus forming nitrogenous compounds which are taken up by the host. The most striking results were obtained with the yellow lupin.

Formation of Nitrates.‡—Herr Serno finds nitric acid present in almost all plants, the largest quantities occurring in the Malvaceæ, Cruciferæ, Papaveraceæ, Convolvulaceæ, Labiatæ, Compositæ, and Urticaceæ. In other plants it occurs only in the roots, and especially in the newly formed absorbing roots. In older roots it is often absent, and always in those which carry on a symbiotic existence with fungi. The author found nitric acid present in the greatest abundance in aquatic plants, usually, but not always, in those that grow in sandy situations, always wanting in marsh-plants. In many perennial plants the nitrates are stored up in winter as a reserve-material; in others they are formed only in the spring. In annual plants they occur abundantly in all parts. The function of the nitric acid is believed by the author to be connected with the formation of amides, especially of asparagin.

M. Berthelot§ refers to the observations of Heckel as to the simultaneous disappearance of caffeine and formation of potassium nitrate in the seeds of kola, as confirming his view that the formation of nitrates in plants is a similar process, from a physiological point of view, to the formation of nitrates in the soil, and is equally due to the action of microbes.

* Proc. Roy. Soc., xlvii. (1890) pp. 85–118. Cf. this Journal, 1888, p. 261.

† Cf. this Journal, 1889, p. 781.

‡ Landwirthsch. Jahrb., xviii. (1889) pp. 877–905. See Bot. Centralbl., xlii. (1890) p. 156.

§ Comptes Rendus, cx. (1890) p. 103.

Respiration of Roots.*—Mr. J. Bancroft figures the aerial roots of a number of shore-plants, and describes their function in assisting in the respiration of the plant.

γ. General.

New Insectivorous Plant.†—Dr. D. D. Gonzalez describes the structure of the gigantic flowers of *Aristolochia grandiflora* of Central America. The swollen base of the corolla-tube forms a hollow chamber, within which are found countless numbers of the dead bodies of insects, in various stages of decomposition. He believes that these are actually digested, and the products absorbed into the tissues of the plant, though he is not yet able to describe the pepsin-producing glands by means of which the digestion is effected.

Atavism of Plants.‡—MM. le Baron d'Ettinghausen and Prof. Krasan call attention to the heteromorphism in the form of the leaves of the oak and the beech when injured by excessive cold, or by the attacks of caterpillars or other insects. Under these conditions the injured branches frequently put out shoots which bear leaves very different in form and size from the normal leaves of the species, or of other existing species of the same genus, and more or less resembling those of extinct species; and the authors regard this as an illustration of atavism or reversion to an ancestral type.

Adaptation of Grasses to Dry Climates.§—Herr E. Hackel describes the peculiarities by means of which, in addition to the anatomical characters of the leaves, grasses are enabled to flourish in a very dry climate. These are mainly two, viz.:—(1) The formation of bulbs or tubers on the lower part of the stem, frequently on as many as three or four of the lowest internodes; (2) The formation of "tunics," i. e. of a number of dry sheaths surrounding the lowest internodes which are thrown off in succession. A list of grasses is given which display each of these characters, and the special arrangements are described in detail.

Value of Chlorine to the Plant.‖—Herr C. Aschoff gives the percentage of chlorine in different parts of the seed and seedling of *Phaseolus multiflorus*, *P. vulgaris*, and *Zea Mays*, and deduces, as the result of a series of experiments, that chlorine is an essential constituent of the food-material of these plants.

"Pock-disease" of Tobacco.¶—Herren D. Iwanowsky and W. Poloftzoff have determined that the disease known by this name, which is very destructive to tobacco-plantations, appearing as brown spots or streaks on the leaves, is not due to the attacks of a parasitic fungus, but either to excessive moisture in the soil or to sudden evaporation after wet weather. It occurs also on allied plants, such as *Datura Stramonium* and *Hyoscyamus niger*, and is probably widely distributed through the vegetable kingdom.

* Rep. Australasian Assoc. for the Advancement of Science, 1889, pp. 327–3. (10 pls.). See Bot. Centralbl., xlii. (1890) p. 341. Cf. this Journal, 1887, p. 111.

† Journ. de Micrographie, xiv. (1890) pp. 109–13.

‡ Arch. Sci. Phys. et Nat., xxiii. (1890) pp. 76–81.

§ Verhandl. K.K. Zool. Bot. Gesell. Wien, xl. (1890) Abhandl., pp. 125–38.

‖ Landwirthsch. Jahrb., xix. (1890) pp. 113–41 (3 pls.). See Bot. Centralbl., xlii. (1890) p. 212.

¶ Mém. Acad. Imp. Sci. St. Pétersbourg, xxxvii. (1890) 24 pp. and 3 pls.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Male Prothallium of Azolla.*—Herr V. W. J. Bielajew describes the germination of the microspore of *Azolla* (*filiculoides*). The processes show a very close resemblance to those in *Salvinia*, and furnish an additional argument for dividing the Hydropterideæ (Rhizocarpeæ) into the two families of Salviniaceæ and Marsileaceæ.

From the exospore there first protrudes a tubular outgrowth, which pierces the spongy tissue of the massula, and which is curved as in *Salvinia*. At the base of this tubular prothallium a small lens-shaped cell is separated, which is followed by a large tubular cell; at the opposite upper end of the prothallium lies a rather large sterile cell, and between the two is a mass of fertile cells (producing antherozoids) arranged in two layers, each layer consisting of four cells. The cells of the upper layer are covered, on the ventral side of the prothallium, by a flat lid-cell; and a small sterile cell also lies on the dorsal side of the prothallium next the lower layer. The chief difference between the structure of the male prothallium in *Salvinia* and in *Azolla* lies in the fact that in the former genus the two antherids are separated from one another by a large sterile cell; while in the latter the fertile cells are united into a single group.

Fructification of Marsilea.†—From an examination of the normal fruits of *Marsilea macra*, and of abnormal developments of that species and of *M. hirsuta*, Herr M. Büsgen draws the conclusion that the fructifications are homologically branches of leaves; but that each fruit does not correspond to a pinna, but is equivalent to an entire sterile leaf. As in the isosporous Filicineæ, the sporanges are developed from superficial cells of the rudiment of the fructification.

Germination of the Megaspore of Isoetes.‡—Observations on the earliest stages of germination of the megaspore of *Isoetes echinospora* by Dr. D. H. Campbell differ in some important points from the results previously recorded by Hofmeister and Farmer.§ The spores were fixed with absolute alcohol or chromic acid, imbedded in paraffin, and coloured with gentian-violet, after sections had been made with the microtome. The large, sharply differentiated nucleus lies at first in the lower posterior portion of the spore; but, after the first stages of division, the new nuclei are found near its apex; here they continue to divide until they amount to from 30 to 50; they are found exclusively in the parietal protoplasm, much more numerous in the apical region, and are entirely absent from its central and lower portion. The nuclei are sometimes connected by fine threads; the cell-plates are formed between them, and soon become transformed into firm membranes; the formation of septa commences at the apex, and advances towards the base of the

* SB. Warschauer Naturf.-Gesell., Oct. 27, 1889. See Biol. Centralbl., x. (1890) p. 287.

† Flora, lxxiii. (1890) pp. 169–82 (1 pl.).

‡ Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 97–100 (1 pl.).

§ Cf. this Journal, 1889, p. 551.

spore; and the apex soon becomes occupied by a cellular tissue. The process corresponds closely to that of the formation of endosperm in seeds; and the author holds that *Isoetes* presents, among Pteridophyta, the nearest relationship to Flowering Plants.

Affinities of the Filicineæ.*—Prof. D. H. Campbell dissents from Bower's theory† that the Hymenophyllaceæ represent the most primitive form of the Filicineæ, and are probably derived from some form intermediate in character between existing bryophytes and the higher green algæ. From a comparison of the oophytic and sporophytic generations in the various orders, he has come to the conclusion that the Ophioglossaceæ must be placed at the base of the Filicineæ; from them sprang two main branches, one through the Marattiaceæ, possibly terminating in the Cycadeæ, the other through the Filices, giving rise to two branches ending in the two heterosporous groups, the Marsiliaceæ and the Salviniaceæ. According to this view the Hymenophyllaceæ must be regarded as a degenerate group from the leptosporangiate Filices, the simple prothallium and sporophyte being the result of their semi-aquatic habit.

Oophyte of the Gleicheniaceæ.‡—Herr N. W. P. Rauwenhoff has succeeded in germinating the spores of several species of *Gleichenia*, and in following the development of the archegones and antherids on the prothallium, which differs in no essential point from that in other ferns. The growth of the prothallium is exceedingly slow. It is at first filiform, and the antherids appear near its apex; subsequently it becomes club-shaped, and they then make their appearance over almost its whole surface, even on the upper side. Finally it becomes heart-shaped, and the archegones are then formed chiefly near the apex on the under side. Occasionally two oospheres are impregnated on the same prothallium. The epidermal cells of the root spring from the lateral segments and not from the apical segments of the apical cell. There is a strong tendency towards dicœcism in the prothallium, large numbers of archegones being borne on prothallia which produce only a single antherid or none at all. The prothallium sometimes grows to a great size, remaining quite barren, and not unfrequently exhibiting prolification. The spores have three coats.

Sclerotized Elements in the Tissues of Ferns.§—Dr. G. Walter has investigated the structure, chemical nature, and development of the brown-walled sclerotized elements in the tissue of thirty-eight species of fern, with special reference to the "supporting bundle" of Russow.

While in the aerial stem of the tree-ferns the predominant form of the sclerenchyme is prosenchymatous, in the creeping rhizome of ferns with a dorsiventral structure it has chiefly a parenchymatous character. The "supporting bundles" which frequently occur in the creeping rhizome when the leaves are in two rows consists of isolated, usually parenchymatous strings of sclerenchyme in the fundamental tissue.

* Bot. Gazette, xv. (1890) pp. 1–7. † Cf. this Journal, *ante*, p. 66.
‡ Arch. Néerl. Sci. Exact. et Nat., xxiv. (1890) pp. 157–231 (7 pls.).
§ Luerssen u. Haenlein's Biblioth. Bot., Heft 18 (1890) 21 pp. and 3 pls.

They were found in sixteen out of the thirty-eight species examined, presenting the appearance of black shining exceedingly narrow threads varying greatly in size, between 0·4 and 18 mm. in length and between 0·06 and 0·35 mm. in thickness. In almost all cases the cells from which the fundamental tissue and the supporting bundle originate were found to be uniform in size and form; in only two species (*Pteris aquilina* and *Oleandra hirtella*) was there a differentiation of the elements of the primary meristem. With the appearance of the brown substance the merismatic power of the cells ceases. The cells become at a late period periodically filled with starch, like the surrounding parenchymatous cells.

The sclerotized brown membrane, which occurs only in the Filicineæ, is extraordinarily resistant to acids and other chemical agents. Treatment with eau-de-Javelle showed that the colour and hardness are not due to lignification, but to the deposition of a foreign brown substance in the membrane. The chemical nature of this substance appears to be identical with that known as phlobaphene belonging to the group of humin-substances, which has been obtained in many instances from bark. The main physiological purpose of these layers appears to be to replace the cork which is never found in ferns.

Stem of Ferns.*—M. Leclerc du Sablon contrasts the structure of the stem of flowering plants with that of ferns, and then takes special instances of the latter, and describes them in detail. In ferns, in place of the single central cylinder surrounded by cortex, we have several fibrovascular bundles, each with a special endoderm in the middle of an irregular cortex. The collateral bundles of Phanerogams are then contrasted with the bicollateral or concentric fibrovascular bundles of ferns; and, in the various forms of the latter, the following will be found to be common to all. In a developed stem, if nothing has been destroyed:—(1) there will be towards the base a conical region, the oldest part, and (2) a cylindrical region which elongates indefinitely. The passage of the root into the stem is always the same. The first root incloses two xylem-bundles and two phloëm-bundles; in passing into the stem, the two xylem-bundles unite by their base, and the two phloëm-bundles form a complete ring round the xylem. Certain species have pith in the centre of the central cylinder, in the middle of the xylem, and this is composed of parenchyme (*Polypodium aureum*, *Osmunda regalis*). In other cases (*Pteris aquilina*, *Nephrodium molle*), the tissue in the interior of the xylem is formed of phloëm-elements together with parenchyme.

Transformation of Roots into Shoots in Ferns.†—From experiments made chiefly on *Asplenium esculentum*, *Platycerium alcicorne*, *P. stemmaria*, *P. Hilli*, and *P. Willinkii*, Herr S. Rostowzew has determined that the root can be transformed directly into a shoot, the apical cell of the root becoming the apical cell of the shoot, and being no longer segmented in the direction of the root-cap, but only on the three other sides. The vascular bundle passes directly into the shoot, and undergoes

* Ann. Sci. Nat., xi. (1890) pp. 1–15 (2 pls.).
† Flora, lxxiii. (1890) pp. 155–68 (1 pl.).

similar changes to those in the hypocotyl of the embryo of higher plants; the bundle-sheath gradually disappears in the young shoot; the endoderm passes without change; the pericycle is divided into several layers; the xylem of the diarch bundle is separated from the pericycle by narrow phloëm-cells; a large portion of the xylem in the centre of the bundle remains unlignified; and the bundle gradually assumes the concentric structure with phloëm on each side of the xylem; later, from this circular bundle proceeds one of a horseshoe form, dividing finally into two, which present the character of normal stem-bundles. Both primary and secondary roots can be transformed into shoots; and the shoot may then either be placed at the end of a root or may spring from it laterally; in the latter case its position shows that it is actually a lateral root, and not an adventitious shoot. In *Asplenium* the root-cap is soon burst and thrown off from the apex of the metamorphosed root; in *Platycerium* it remains attached for a longer period to the apex of the shoot.

Muscineæ.

Anatomy of the Capsule of Mosses.*—Herr E. Bünger has made a detailed examination of the structure of the sporange in a great number of mosses, especially as regards the stomates and the assimilating tissue.

The stomates are almost always limited to the lower portion or neck of the sporange. While usually bicellular, as in most flowering plants, unicellular stomates occur in *Funaria*, *Physcomitrium*, *Buxbaumia aphylla*, *Physcomitrella*, &c., and three- or four-celled, probably functionless, stomates, in the Hypnaceæ and Polytrichaceæ. In *Mnium* they are depressed below the epiderm from the small size of the guard-cells; while in some species, as in *Buxbaumia aphylla* and species of *Orthotrichum*, they project above the epiderm and form an external breathing-pore. The pore or orifice is generally characterized by its very small size, and especially its short length. The fissure or the division-wall between the two guard-cells is almost invariably parallel to the longer axis of the sporange. The mechanical arrangement for opening and closing the stomate is described in detail in a number of species.

The assimilating tissue is least strongly developed in those mosses in which the stomates are either altogether wanting, or are functionless, as in the Sphagnaceæ, where the whole of the sporange is composed of aquiferous tissue without any air-spaces, and the Andreæaceæ, which are also destitute of stomates. A variety of intermediate stages are described in detail, leading up to the fullest development of the assimilating tissue, in the Polytrichaceæ. The Cleistocarpæ—*Archidium*, *Ephemerum*, *Physcomitrella*, *Phascum*, *Sphærangium*—stand even below *Sphagnum* in the complete suppression of the assimilating and aquiferous tissue; and the stomates are also often entirely wanting.

* Bot. Centralbl., xlii. (1890) pp. 194–9, 225–30, 257–62, 289–96, 321–6, 353–6 (1 pl.).

Characeæ.

Rabenhorst's Cryptogamic Flora of Germany (Characeæ). — An admirable monograph of the Characeæ of Germany, Austria, and Switzerland, by Dr. W. Migula, has been commenced as a section of this work, four parts being now published. It commences with a very full account of the morphology and history of development of the family, which the author regards as a primary division, distinct from Algæ on the one and Muscineæ on the other hand. He suggests that their origin may possibly be in the Chlorophyceæ near to *Coleochæte*, the Characeæ or Charophyta and the Bryophyta being two distinct branches. The family is, as usual, divided into the two sub-families Nitelleæ and Chareæ, the former comprising two genera, *Nitella* and *Tolypella*, and the latter four, *Tolypellopsis*, *Lamprothamnus*, *Lychnothamnus*, and *Chara*. The third part is occupied by the species and sub-species of *Nitella*, thirteen species being described, and a large number of sub-species, some of which are also figured. The fourth part is devoted chiefly to the six species of *Tolypella*, which are treated with equal detail, and with the most thorough knowledge of the subject; it contains also the diagnosis of the sub-family Chareæ and of the new genus *Tolypellopsis* (v. Leonh.) Mig., in which there is no cortication of the stem or leaves and no stipular structures, but in their place a stronger development of three small cells of the node; the leaves have only one or two nodes, and the leaflets are often entirely suppressed. The antherids are sessile and solitary on the ventral side of the leaf; the oogones occupy the same position, solitary or in pairs, with a very short pedicel-cell; the neck-portion of their cortical cells is elongated into a beak; the crown small, composed of narrow cells, not erect, and narrowing at their apex. The illustrations throughout are copious and exceedingly clear.

Algæ.

Formation of Vacuoles in Algæ.*—From observations made on the mode of formation of the vacuoles in the reproductive cells of a large number of Algæ belonging to different families, Herr F. A. F. C. Went confirms his previous conclusion that they are formed only as the result of the division of vacuoles already in existence. The different modes may be arranged under various heads.

To the first group belong the tetrasporanges and carpospores of the Florideæ, the tetrasporanges of *Dictyota*, and the oogones of the Fucaceæ. When young these cells contain a parietal layer of protoplasm, with chromatophores, often arranged round the nucleus, which is hung up in the centre of the large vacuole by threads or plates of protoplasm. The vacuoles decrease in size and increase in number by the multiplication of these threads or plates, the chromatophores increasing in number at the same time by division. On germination the vacuoles and chromatophores distribute themselves through the newly formed cells, so that each cell of the young alga contains only one or a few of them.

The second group includes those cases where a remnant of the protoplasm and of the vacuole remains over as a central vesicle, as in

* Jahrb. f. Wiss. Bot. (Pringsheim), xxi. (1890) pp. 299-366 (4 pls.). Cf. this Journal, 1889, p. 674.

the formation of the zoospores of *Chætomorpha aerea*, *Acetabularia mediterranea*, *Codium tomentosum*, and *Halimeda Tuna*, or in which the entire protoplast is divided into numerous smaller ones, as in the formation of the swarm-cells of *Sporochnus pedunculatus*, *Arthocladia villosa*, and *Derbesia Lamourouxii*. The young sporange contains a central vacuole and a parietal layer with imbedded chromatophores, and one or more nuclei. As the nuclei and chromatophores multiply, strings or plates of protoplasm are formed traversing the vacuole and breaking it up. The chromatophores, each with its own nucleus, vacuoles, and cytoplasm, collect into small groups; between these groups colourless lines make their appearance, and each protoplast thus formed developes into a zoospore. The antherozoids of the Fucaceæ are formed in the same way.

A third group consists of plurilocular sporanges, of which *Ectocarpus confervoides* may be taken as a type. A cell containing a parietal layer of protoplasm, with chromatophores, nucleus and vacuole, divides into a mass of cells, each of which again contains, as the result of division, all the organs of the protoplasm. The contents of each cell becomes a zoospore. Similar phenomena characterize the formation of the pollinoids of the Florideæ, and the antherozoids of the Characeæ and of the higher Cryptogams.

In the gemmæ of such algæ as *Sphacelaria tribuloides* each cell contains a nucleus and a layer of protoplasm with chromatophores and vacuoles, which bodies have been formed by division out of the mother-cells of the gemma.

Lemaneaceæ.*—Prof. G. F. Atkinson publishes a monograph of the United States' species of Lemaneaceæ, which he unites into the single genus *Lemanea*, of which he describes seven species, five belonging to the subgenus *Lemanea* proper (two of them new), and two to the subgenus *Sacheria*, with several varieties.

The oophyte has three distinct successional forms:—(1) A permanent cellular or confervoid prostrate form, the former consisting of an irregular mass of polyhedral cells spread over the surfaces of rocks; (2) a *Chantransia*-form, usually developed as erect lateral shoots from the prostrate form, rarely direct from the spore; it consists of branched filaments composed of a single series of elongated cells, the endochrome in some species coloured violet; but does not produce gonids; these two forms constitute the protoneme of the plant; (3) the sexual shoot, originating as a special lateral shoot from the *Chantransia*-form. This is a hollow or tubular shoot, containing a system of delicate filaments, the apparatus for fructification. The wall is more or less cartilaginous, and is composed of three layers—the medullary, consisting of a single layer of comparatively large cells, an intermediate layer of somewhat smaller polyhedral cells, and a cortical layer of small prismatic cells, rich in colouring matter. It derives its nourishment from the *Chantransia*-form, but soon becomes independent by the development of rhizoids at its base. The apparatus for fructification consists of a central axis, ray-cells, and generative filaments, with the tie-cells which unite them to the medullary layer. The development of each of the

* Ann. of Bot., iv. (1890) pp. 177–229 (3 pls.).

three forms is described in detail, with its variations in the two subgenera.

The antherids arise from specialized cells which terminate the generative filaments. Each antheridiophore produces either one or two antherids. They are oblong thin-walled sacs, and each contains a single oblong hyaline non-motile pollinoid ("spermatozoid"). The procarp also arises as a special branch from the generative filament. It consists of from 3–10 oval cells; the terminal or carpogenous cell is surmounted by the trichogyne, which penetrates through the intermediate layer and the cortex to the outside of the sexual shoot. Fertilization takes place by contact of the pollinoid with the apex of the trichogyne; its protoplasm is probably absorbed by the trichogyne, and conveyed to the carpogenous cell. After fertilization the carpogenous cell developes, by budding, a whorl of cells, the ooblastema-filaments, which soon begin to branch, and produce chains of carpospores. Both apogamy and apospory were observed in several species.

The subgenus *Sacheria* differs from *Lemanea* proper mainly in the antherids being in well-defined patches, rarely confluent; the procarps consist of only from 3 to 4 cells, always developed in and near the antherid-zone; the generative filaments are closely applied to the wall of the tube throughout their entire length; the basids or basal sterile cells of the ooblastema-filaments being elongate and cylindrical; and the prostrate form of the protoneme being mainly cellular.

Bladders of Fucaceæ.*—According to Prof. N. Wille, the structure of the bladders of the Fucaceæ belongs to two different types:—(1) In *Fucus vesiculosus* and *Ozothallia nodosa* the tissue in which they are formed is composed of much-branched filaments; (2) In *Halidrys siliquosus* and *Cystoseira ericoides* the filaments of which it consists are parallel, and but slightly branched. The proportion of oxygen in bladders which still remained immersed in the water amounts to as much as 35–37 per cent.; they never contain any carbon dioxide.

Macrocystis and Thalassiophyllum.†—Herr O. Rosenthal describes in detail the vegetative structure of these two genera of Laminariaceæ, which he regards as constituting a special group, contrasted with a second group formed of *Laminaria*, *Alaria*, *Costaria*, and *Agarum*. The distinguishing feature lies in the segmentation of the frond, this again depending on a difference in the position of the growing point—in the first group lateral on the margin of the lamina, in the second group opposite the middle of the base of the leaf, at the point of junction between stem and lamina. In *Macrocystis* the leaves are in consequence inserted laterally, and are perennial, while in *Laminaria* they are terminal, and are usually thrown off annually; their duration is not known in the other genera of the group. In *Macrocystis* and *Thalassiophyllum* the growing point divides into two unequal halves, which is not the case with *Laminaria*. In *Macrocystis* and *Laminaria* the lamina splits up into narrow strips; while the formation of holes in that of *Agarum* corresponds somewhat to a similar process in *Thalassiophyllum*.

* Biolog. Fören. Stockholm Förhandl., i. pp. 63–5. See Bot. Centralbl., xlii. (1890) p. 110.

† Flora, lxxiii. (1890) pp. 105–47 (2 pls.).

Vaucheria-galls.*—Mr. A. W. Bennett gives a *résumé* of the literature of the so-called *Vaucheria*-galls, caused by the attack on various species of *Vaucheria* of the rotifer *Notommata Werneckii*. The galls are, in all probability, at least very often, a fertile branch prevented from forming oogones and antherids by the attacks of the parasite.

Mr. W. Narramore† contends that the occasional septation of the filaments of *Vaucheria* is not, as usually stated, always the result of injury. He also describes the occurrence of peculiar disc-shaped protoplasmic bodies within the filaments, whether septated or unseptated; and the formation of the so-called "galls" on *V. dichotoma*.

Cephaleuros, Phycopeltis, and Hansgirgia.‡—Dr. G. B. de Toni and Prof. F. Saccardo give diagnoses of these three genera of epiphytic algæ, and of their known species, viz.:—*C. virescens* Kze., *P. epiphyton* Mill., *P. arundinacea* De Ton., and *H. flabelligera* De Ton. *Cephaleuros* Kze. they regard as perfectly autonomous, and not a form of *Strigula*, although it may possibly constitute the gonids of some species of this genus of lichens; while the gonids of other species of the genus belong to *Phycopeltis* or *Protococcus*. Cunningham's genus *Mycoidea* must be sunk in *Cephaleuros*.

M. E. de Wildeman§ agrees with the opinion of Hariot and De Toni that *Mycoidea* Cunn. is a synonyme of *Cephaleuros*, and that the name *Mycoidea parasitica* Cunn. must be suppressed in favour of *Cephaleuros virescens* Kze.

Reproduction of Codium.‖—Contrary to the observations of previous observers, Herr F. A. F. C. Went finds microzoosporanges and megazoosporanges of *Codium tomentosum* on the same plant, the former being later in their appearance than the latter. He was unable to detect any process of conjugation, either in the microzoospores among one another, or between these and the megazoospores.

Fungi.

Paraphyses of Fungi.¶—M. Boudier discusses the various opinions which have been brought forward as to the utility of these organs, and then points out that the paraphyses in fungi ought to be regarded as imperfect or sterile basids, and as protective organs or receptacles for reserve material.

Saccharine Substances contained in Fungi.**—M. R. Ferry gives a *résumé* of the process he adopts in order to analyse chemically the saccharine substances in fungi. This consists in first drying the material and then reducing it to small fragments, when it is boiled with alcohol (90 per cent.) for a few minutes. It is then filtered into porcelain capsules and allowed to evaporate, and the residue from the evaporation

* Ann. of Bot., iv. (1890) pp. 172–4, 300–1 (1 fig.).
† Journ. Liverpool Micr. Soc., i. (1890) pp. 61–76 (2 pls.).
‡ La Nuova Notarisia, i. (1890) pp. 1–20 (3 pls.). Cf. this Journal, *ante*, p. 70.
§ Notarisia, v. (1890) pp. 953–5.
‖ Vergad. Ned. Bot. Vereen., xlviii. (1889) (1 pl.). See Bot. Centralbl., xlii. (1890) p. 111.
¶ Bull. Soc. Mycol. de France, 1890, p. x. See Rev. Mycol., xii. (1890) p. 145.
** Rev. Mycol., xii. (1890) pp. 136–40.

treated with distilled water. After some days crystals will usually appear. The conclusions drawn from numerous analyses are as follows: —(1) That mannite is nearly always present in the larger fungi, crystallizing in long fine needles. It was met with in 90 per cent. of the species examined. (2) Trehalose is less frequently present, and may be known by its hard massive crystals. It was met with in 25 per cent. of the species. (3) In some species of the genus *Amanita* chloride of potassium was met with in sufficient quantity to form crystals. (4) Glucose was met with in certain species, e. g. *Amanita valida*, *A. spissa*, *A. mappa*, *Tricholoma sulfureum*, *Russula virescens*, &c.

M. Bourquelot * confines his observations to the genus *Lactarius*, and states that other saccharine bodies besides trehalose and mannite exist in these fungi. In *L. volemus* there is a sugar analogous to mannite which crystallizes easily.

Development of Phytophthora infestans.†—By cultivating diseased potatoes in complete darkness, Herr J. Smorawski believes that he has obtained the hitherto unknown oogones of *Phytophthora infestans*, and possibly also the antherids, though he conjectures that reproduction may sometimes take place parthenogenetically.

Parasitic Fungi.‡—Dr. C. von Tubeuf describes the results of the attacks on seedling birches of *Phytophthora omnivora*, which, both on this and on other seedlings, frequently incites the formation of a third cotyledon. He also speaks of the ravages committed on *Alnus incana* by *Exoascus borealis*; on *Pinus excelsa* by *Trichosphæria parasitica*, which also attacks *Picea excelsa* and *Tsuga canadensis*; and on *Pinus Strobus* by *Lophodermium brachysporum*.

Physomyces.§—The name *Physomyces heterosporus* is proposed by Prof. C. O. Harz for an undescribed fungus, which he finds abundantly infesting manufactories of soap and candles. It forms a continuous dark brown pellicle on a warm solution of raw glycerin, with bright carmine spots; and produces stylospores varying in size from 7–8 to 9–11 μ, and sporanges 40–50 μ in size, containing spherical or shortly oval sporangiospores measuring 4–5 μ. The cell-wall is colourless; but the carmine pigment, which the author proposes to call *physomycin*, occurs in both the hyphæ and the stylospores. Although resembling Lankester's bacterio-purpurin in colour, it differs altogether from that substance in its properties, being insoluble in water, soluble with difficulty in ether, very readily in alcohol; caustic soda and potassa, hydrochloric and sulphuric acids, change it to an orange-yellow. It is cultivated readily on a decoction of apples, pears, plums, or quinces, or on horse-dung.

Dr. Harz proposes the establishment of a new order Leptomycetes, of the same rank as the Oomycetes and Zygomycetes, with the following characters: — Fungi hyphomycetiformes, saprophytici v. parasitici,

* Bull. Soc. Mycol. de France, 1890, p. vii. See Rev. Mycol., xii. (1890) p. 145.

† Landwirthsch. Jahrb., xix. (1890) pp. 1–12 (1 pl.). See Bot. Centralbl., xlii. (1890) p. 285.

‡ SB. Bot. Ver. München, Feb. 10, 1890. See Bot. Centralbl., xli. (1890) p. 374.

§ SB. Bot. Ver. München, Feb. 10, 1890 (14 figs.). See Bot. Centralbl., xli. (1890) pp. 378 and 405 (1 pl.).

hyphis decumbentibus, lanuginosis tomentosis v. sericeis, ramosissimis, septatis; sporocarpiis (oogoniis) pedicellatis, apicibus ramulorum innatis, corticatis. It is made up of the three genera *Physomyces*, *Helicosporangium*, and *Papulospora*, the first being thus characterized:—Sporocarpio polysporo, sporis liberis, hyphis numerosis rugoso-corticato.

Development of Pycnids.*—Sig. P. Baccarini classifies the pycnids of Fungi under two types—those with definite and those with indefinite development. The first type includes those forms in which the conceptacle is completely corticated, and is distinctly separated from the vegetative mycele. This includes the greater part of the Sphærioideæ; and the principal differences observed with regard to the development of this form of pycnid relate to the greater or less vigour of the nutritive pseudo-parenchyme, to the rapidity of its resorption, and to the mode of formation of the cavity, whether lysigenous or schizogenous. The second type comprises those forms in which the basidiogenous hyphæ maintain more or less connection during their activity with the vegetative mycele; the cortical investment is then incomplete, and is constantly interrupted at the base of the peridium, and the formation of a nutritive pseudo-parenchyme is greatly reduced, or almost entirely suppressed. To this type belong various forms of Nectrioideæ, Leptostromaceæ, and Melanconieæ.

Non-crystallizable Lichen-pigments.†—In 120 species of lichen examined, Herr E. Bachmann finds as many as sixteen different uncrystallizable pigments, viz. five green, one blue, four red, and six brown, of all of which the microchemical reactions are given. These all occur imbedded in the cell-membrane, a few others as drops in the interior or as excretions. They are not distributed uniformly through the thallus, but are limited to certain portions, almost always the cortex, very rarely penetrating to the medullary layer; the hyphæ of the gonidial layer are never coloured. In the hymenium the asci are never coloured, the paraphyses rarely. The colour of lichens is not unfrequently concealed by a coating of calcium oxalate. Within the membrane of the hyphæ, the pigment is always so distributed that the middle lamellæ contain a larger quantity of it than the inner ones.

The author has been unable to determine whether these pigments are formed from the activity of the protoplasm, or whether they arise in the cell-wall itself by metastasis. Their purpose appears to be to protect the organisms which contain them from unfavourable atmospheric conditions; the pigment itself and the calcium oxalate often associated with it also affording a protection against consumption by snails and caterpillars.

Spicaria verticillata.‡—M. C. Roumeguère states that in the neighbourhood of Toulouse the Chinese primroses, Clivias, and Begonias in the glass-houses are attacked by a mucedineous fungus, which appears to be *Spicaria verticillata* (Cord.) Harz. The hyphæ are simple at their base, but above are divided into 3–5 branches; the conids are oval and white, and measure 4·5 μ.

* Nuov. Giorn. Bot. Ital., xxii. (1890) pp. 150–14.
† Jahrb. f. Wiss. Bot. (Pringsheim), xxi. (1890) pp. 1–61 (1 pl. and 1 fig.).
‡ Rev. Mycol., xii. (1890) pp. 70–1.

Sphæropsideæ parasitic on Dianthus.*—M. C. A. J. A. Oudemans reduces all the species of Sphæropsideæ which are known as parasites on leaves of the European species of *Dianthus* to two—*Ascochyta Dianthi* Lib., and *Septoria Dianthi* Desm., regarding *Depazea Dianthi* Rab., *Phyllosticta Dianthi* West, and *Dimemasporium Dianthi* Oud. as synonyms of the former, and *Ascochyta Dianthi* Lasche and *Depazea Dianthi* Desm. as synonyms of the latter species.

Herpotrichia nigra.†—Dr. R. Raimann describes the injury inflicted on *Pinus Mughus* by this parasitic fungus belonging to the Trichosphæriaceæ. The favourable condition for its luxuriant development is excessive moisture, as, for example, when the branches are laden with snow. *Pinus excelsa*, though growing in the immediate neighbourhood, enjoys immunity from its attacks.

New Entyloma.‡—Under the name *Entyloma Ellisii*, Prof. B. D. Halsted describes a new species of this genus of parasitic fungi on the common spinach. It is the first species of *Entyloma* known to be parasitic on any plant belonging to the Chenopodiaceæ, and the first on any cultivated plant in America.

Hydnocystis.§—Herr P. Magnus assigns reasons for placing this genus of Fungi among the Pezizeæ, instead of among the Tuberaceæ, to which it has hitherto been considered to belong. He regards the Tuberaceæ as strictly cleistocarpous Ascomycetes, allied to the Perisporiaceæ, and especially to *Eurotium* and *Penicillium*.

New Parasitic Fungi.‖—M. C. A. J. A. Oudemans describes the following new Micromycetes:—Among Pyrenomycetes,—*Ophiobolus Jacobææ* on stems of *Senecio Jacobæa*; among Discomycetes,—*Phialea appendiculata*, on rotten stems of *Mentha aquatica*; among Sphæropsideæ,—*Sclerotiopsis Cheiri* on rotten stems of *Cheiranthus Cheiri*, *Ascochyta Solani* on dry stems of *Solanum tuberosum*, *Piggotia Gneti* on leaves of *Gnetum Gnemon*; among Hyphomycetes,—*Botrytis longibrachiata* on leaves of *Curcuma rubricaulis*, *Clonostachys Gneti* on leaves of *Gnetum Gnemon*, *Cercospora Violæ sylvaticæ* on leaves of *V. sylvatica*, *Stilbum sanguineum* on rotten leaves of *Gnetum Gnemon*, *Fusarium Caricis* on leaves of a species of *Carex*.

Dr. C. Massalongo ¶ gives descriptions of the following new species of parasitic fungi observed in the neighbourhood of Verona:—*Cylindrosporum Pimpinellæ* on *Pimpinella nigra*, *Phyllosticta astragalicola* on *Astragalus glycyphylloides*, *Ramularia Ballotæ* on *Ballota nigra*, *R. lamiicola* on *Lamium album*, *Stagonospora Iridis* on *Iris germanica*.

Dr. F. Cavara** describes a new *Macrosporium* (*M. sarcinæforme*) which he found on red clover in the neighbourhood of Pavia. The parasite makes itself known by the presence of brown spots on the leaves.

* Med. K. Akad. Wetensch. Amsterdam, 1890, pp. 97–107 (1 pl.).
† Verhandl. K.K. Zool.-Bot. Gesell. Wien, xl. (1890) SB. pp. 10–1.
‡ Bull. Torrey Bot. Club, xvii. (1890) pp. 95–7.
§ Hedwigia, xxix. (1890) pp. 64–6.
‖ Med. K. Akad. Wetensch. Amsterdam, 1890, pp. 312–27 (2 pls.).
¶ Bot. Centralbl., xlii. (1890) pp. 385–7.
** 'La difesa dei parassiti,' 1890. See Rev. Mycol., xii. (1890) p. 148.

Prof. B. D. Halsted * describes a new species of *Zygodesmus*, a genus of fungi which is usually saprophytic, truly parasitic on a species of *Viola*.

British Hymenolichen.—Mr. C. H. Wright remarked at the April meeting of the Society :—"In Berkeley's Mycological Herbarium, now at Kew, there exists a plant collected at Coed Coch, North Wales, in 1866, which had been placed by Berkeley with *Stereum hirsutum* Fr., a fungus to which it bears a considerable amount of external resemblance, which is intensified by the latter being frequently infested by small algæ, e. g. *Chlorococcus*, &c. Upon microscopical examination this plant proves to be *Dictyonema sericeum* Mont. (*Dichonema sericeum* Fr.), a hymenolichen of frequent occurrence in the tropics of both hemispheres.

In 'English Botany,' Supplement, t. 2954, is figured a plant under the name of *Rhizonema interruptum* Thw., which, as Bornet † has suggested, is identical with *Dictyonema sericeum* Mont. This figure is repeated in Cooke's 'British Freshwater Algæ,' p. 266, t. 106, f. 2, where *Calothrix interrupta* Carm. is added as a synonym, with a note to the effect that 'we have seen no specimen of this.' Carmichael's specimen agrees perfectly with the 'English Botany' figure, as does also a specimen from Machynlleth (the original 'English Botany' locality) in Berkeley's herbarium. A similar specimen has been collected at Killarney. Both Carmichael and Hassall omit the colourless hyphæ in their figures, and class the plant as an alga.

The British localities for this species are :—Machynlleth (Ralfs)! ; Coed Coch (Berkeley)! ; Bristol ; Wareham ; Appin (Carmichael)! ; Killarney!"

Chromogenic Pseudo-Yeasts.‡—Under the name "formes-levures" M. E. Laurent designates certain fungi which resemble true yeasts, but which are devoid of the fermentative faculty. In common with certain bacteria, these pseudo-yeasts possess the power of producing colouring matter. The oldest designation was *Saccharomyces glutinis*, a name which embraced many different kinds. They are extensively distributed in air and water, grow on boiled potato when exposed to air, and are much more frequent than *Micrococcus prodigiosus*, with which they may be easily confounded.

After recalling the fact that certain kinds of these organisms are found to produce a red, black, and violet pigment, the author narrates the life-history of a pseudo-yeast which developes a yellow colour. In most of its characteristics it was found to resemble *Dematium pullulans*, from which it only differs in its colour, its inability to liquefy gelatin, and in the fact that the older cells do not become embrowned. The author therefore considers this yellow pseudo-yeast to be a new variety of *Cladosporium herbarum*, a fungus remarkable for its polymorphism, and from which *Dematium pullulans* is descended.

Influence of Concentration of Nutritive Medium on Growth of Fungi.§—Herr P. Eschenhagen finds, from his experiments with various nutritive

* Bull. Torrey Bot. Club, xvii. (1890) pp. 151–2.
† Ann. Sci. Nat., ser. 5, xvii. p. 82.
‡ CR. Soc. Roy. Bot. Belgique, 1890, pp. 76–9.
§ Ber. Verhandl. R. Sächs. Gesell. Wiss., 1890, pp. 343–6.

media, that the growth of fungi therein diminishes according to the increasing concentration and finally ceases altogether. The fungi employed were *Aspergillus niger*, *Penicillium glaucum*, and *Botrytis cinerea*, all of which gave analogous results. These were grown on solutions of varying concentration of glucose, glycerin, nitrates of potash and soda, chlorine, &c. In the glucose experiments 0·6 per cent. of inorganic salts was added, and in the saline media 0·5 per cent. glycose was used as well.

Thrush-fungus.*—The thrush-fungus, says M. E. Laurent, has been classed as an *Oidium* and as a *Saccharomyces;* but it is neither a true *Oidium* nor is it an alcoholic ferment. The author cultivated specimens of thrush-fungus, obtained from hospitals in Paris and at Brussels. These cultivations presented sparsely septate filaments, 3–6 μ in diameter, commingled with pseudo-saccharomyces which were from 4·5–6 μ long, and 2·5–4 μ broad. In slightly acid saccharated liquids (sugared beer-wort), only the oval pseudo-yeasts were developed. They possessed no fermentative powers, and after the lapse of a month in a liquid containing 5 per cent. of sugar, only 0·6 per cent. of alcohol per volume was found. Hence they resemble the pseudo-yeasts of *Cladosporium herbarum* (*Dematium pullulans*). Another characteristic assimilates the thrush-fungus to the pseudo-yeasts. When cultivated on gelatinized beer-wort, it always developes quite dense spheroidal colonies, in connection with filaments from the ends of which they are propagated. In liquid media such colonies soon become free, and hence the connection between these and the filaments is not so apparent. Under no circumstances was the development of endospores observed. The author suggests that this fungus should be named *Dematium albicans*.

Himalayan Uredineæ.†— A second instalment of Dr. A. Barclay's monograph of the Uredineæ of the neighbourhood of Simla is devoted to the genus *Puccinia*. The following new species are described:—*P. Rosæ* on *Rosa macrophylla*, *P. Saxifragæ ciliatæ* on *Saxifraga ligulata* var. *ciliata*, *P. Roscoeæ* on *Roscoea alpina*, *P. Arundinellæ* on *Arundinella setosa* and *A. Wallichii*, *P. Anthistiriæ* on *Anthistiria anathera*, *P. Chrysopogi* on *Chrysopogon gryllus*, *P. Caricis filicinæ* on *Carex filicina*.

Dr. Barclay further describes ‡ the following three new species from the Simla region:—

(1) *Gymnosporangium Cunninghamianum*. The teleutospore-form occurs on *Cupressus torulosa*, the æcidium-form on the wild pear, *Pyrus Pashia*. The genetic connection between the two was determined by cultivation.

(2) *Puccinia Collettiana*, parasitic on *Rubia cordifolia;* spermogones, uredospores, and teleutospores; but no æcidiospores were detected. The author believes the spermogones not to be sexual organs, but the so-called spermatia to be a form of conid.

(3) *Chrysomyxa himalense*, parasitic on *Rhododendron arboreum*. The

* Bull. Soc. Belge de Microscopie, xvi. (1889–90) pp. 14–8 (2 figs.).

† Journ. Asiatic Soc. Bengal, lviii. (1889) pp. 232–51 (3 pls.). Cf. this Journal, 1889, p. 790.

‡ Scient. Mem. by Med. Officers Army of India. part v. (1890) 8 pp. and 3 pls., 5 pp. and 1 pl., 7 pp. and 2 pls.

author found presumptive evidence, but no experimental proof, of the genetic connection between this teleutospore-form and the æcidium on *Pinus excelsa*.

Trametes radiciperda.*—Dr. R. Hartig records the observation of the formation of conids in this hymenomycetous fungus. It takes place, however, only very rarely and with great difficulty, in artificial nutrient solutions.

Ceriomyces.†—M. J. de Seynes has investigated the structure of the fungus-forms included under the genus *Ceriomyces*, which are in fact the pycnids or endocarpous conidiiferous receptacles of species of *Polyporus*. Of the 1600 species of *Polyporus*, only about 10 are known in their *Ceriomyces* form; these all belong to the sections Mesopus, Pleurotus, Merisma, and Apus, none of them to the section Resupinati.

Development of Hypogæi.‡—Dr. R. Hesse recurs to the description of the motile rod-like bodies which he finds throughout the Hymenogastreæ, Tuberaceæ, and Elaphomycetes, and which he now terms "swarmers." In the presence of water these combine with one another and form compound swarmers, which, after coming to rest, unite into chains; from these is formed the mycele in all species of Hypogæi. The development of the ascospores of the Hypogæi is described in the case of *Balsamia fragiformis*. If the elliptical ascospores of this fungus are placed in a drop of water beneath the cover-glass, they are seen to be in a state of spontaneous motion, joining in pairs by their narrow rounded ends, separating, and again uniting in the same way with others. The spores have no cilia; but this proceeding gives the impression as if some substance passed out of one of the spores into the other. The whole of the mycele and receptacle of the Hypogæi is stated by the author to originate from structures which have a power of spontaneous motion.

The ascospores of this species present remarkable variations in size and form, and this is explained by the phenomena which accompany their conjugation. When two spores lie side by side, a gradual transfer of the contents of one of them into the other takes place; but this process may extend over several days. The product of conjugation is at first somewhat dumb-bell shaped, but finally oval or spherical.

Similar phenomena were observed in the ascospores of *Hydnocystis*, and in those of all other Tuberaceæ and Elaphomycetes examined.

Mycetozoa.

Development of Mycetozoa.§—Mr. A. Lister describes the mode of cultivation and life-history of several species of Mycetozoa, especially of *Chondrioderma difforme*, which was cultivated in several different ways, the most successful being by sowing the spores together with seeds of cress on moist blotting-paper. The spores of several species germinate

* SB. Bot. Verein München, March 10, 1890. See Bot Centralbl., xlii. (1890) pp. 109 and 136.

† Bull. Soc. Bot. France, xxxvi. (1890) pp. 109-12

‡ Bot. Centralbl., xli. (1890) pp. 196-8 (1 fig.); and xlii. (1890) pp. 1-4 (5 figs.). Cf. this Journal, *ante*, p. 77.

§ Ann. of Bot., iv. (1890) pp. 281-98 (1 pl.).

with great rapidity, even after having been kept more than a year in the cabinet. Ingestion of the food-material by the swarm-cells of *Perichæna corticalis* was observed similar to that already described in the case of *Stemonitis fusca*. The calcareous matter is discharged from the plasmode of *Chondrioderma difforme* immediately after it has taken the sporange-form.

Mr. Lister supports the view of De Bary that the Mycetozoa should be placed in the animal rather than in the vegetable kingdom. He considers it probable that many forms hitherto considered as distinct species will ultimately be traced to a common parentage; remarkable variation occurs in the progeny of a common parent, when the natural conditions are slightly altered by cultivation, in the structure of the calcareous wall of the sporange, in the degree of development of the capillitium (or even in its presence or absence), in the colour and size of the spores, and in the colour of the membranous wall of the sporange, of the threads of the capillitium, and of the plasmode. The colour of the plasmode is described in between 40 and 50 species.

Ingestion of Food-material by the Swarm-cells of Mycetozoa.*—Mr. A. Lister gives an account of observations on the ingestion of food-material by the swarm-cells of *Chondrioderma difforme*, *Physarum Tussilaginis*, *Stemonitis fusca*, and other Mycetozoa, the food-material being chiefly fragments of *Stereum hirsutum*, and the bacilli which accompany its decomposition. The bacilli become attached to delicate pseudopodes put out by the swarm-cells; the pseudopodes gradually contract and draw in the bacilli, which then become inclosed in vacuoles, where they are entirely absorbed, scarcely a trace of residuum remaining behind. Carmine was also greedily incorporated by the swarm-cells of *Stemonitis*, but not by those of *Amaurochæte;* the observation being thus opposed to that of De Bary, who states that the food is taken in during the swarm-cell condition only in a fluid state. The ingestion is frequently accompanied by a violent jerking movement of the swarm-cell. If inorganic matter was taken in, it was expelled after a longer or shorter period. The food-material appears to be taken in only at the posterior end of the swarm-cell, and the refuse matter discharged from the same region.

Protophyta.

a. Schizophyceæ.

Defensive Structure of Diatoms.†—Dr. D. Levi-Morenos asserts that the nutritive value of diatoms to fishes and other marine animals which feed upon them is not so much their protoplasmic contents as the mucilaginous envelope which covers them, many species passing uninjured and without being killed through the digestive tube. Their rapid passage is assisted by the fusiform and sinuous shape of many species of *Cymbella*, *Synedra*, *Nitzschia*, *Navicula*, *Pinnularia*, *Pleurosigma*, &c.

* Journ. Linn. Soc. (Bot.), xxv. (1890) pp. 435–41 (6 figs.). Cf. this Journal, 1888, p. 783.

† Boll. Soc. Ital. Microsc., i. (1890) pp. 103–18; and Notarisia, v. (1890) pp. 956–63.

Many of the larger species are also protected against being swallowed by the frustules being connected together into a pseudo-thallus, or by a large number being invested in a common gelatinous envelope. Since these characters are not constant in nearly allied species, it would appear as if they had been acquired at a comparatively late period for the purpose of protection.

Diatoms from New Zealand.*—Count Abbé F. Castracane describes a diatomaceous deposit from "Jackson's Paddock," Oamaru, New Zealand, in which he finds further evidence of the fact which he has already published—the formation of internal sporules. He also records the observation that in one of the species in this deposit the punctation of one of the frustules, in other words, the number of the granules, is determined from the first moment of existence of the diatom.

Diatoms in abundance.†—"The Golden Star Cleaning Powder," prepared at Keene, New Hampshire, and peddled about for the polishing of silver and plated ware, tin, glass, and other articles, is composed entirely of diatomaceous earth. The deposit is an exceedingly rich one, and the material seems to have been put through some process by which it has been partly cleaned, so that the diatoms are ready to be picked out, soaked in chloroform, and mounted. Many valves are broken, but there is abundance in a perfect state, some of them being well worth examining and preserving. Electro-silicon, a similar powder, sold for the same purpose, is also a diatomaceous earth, but of an entirely different character. The frustules included are usually small, disciform, and apparently all of one genus and species. Any one in need of diatoms is recommended to purchase a box of the "Golden Star Powder," when he will have more than he could look at if he should live to the age of Methuselah, and devote his whole time to their examination. The following recommendation from the N.H. State Assayer is worth noting: "The article you send is absolutely pure silica, of the kind known as polishing powder, formed by the decomposition of minute organisms supposed to be plants. Its great use is for polishing, but it is used for many other purposes."

'Le Diatomiste.'‡—We have received the first number of a new quarterly journal devoted to the interests of Diatomology, edited by M. J. Tempère, with the assistance of MM. Brun, Bergon, Cleve, Dutertre, Grove, and Peragallo. The present number contains descriptions of a number of new species with illustrative figures, an abstract of Mr. Rattray's synopsis of *Aulacodiscus* and *Auliscus*, published in this Journal, an index to the recently published numbers of Schmidt's 'Atlas de Diatomées,' together with a Bibliography and Correspondence.

Gelatinous sheath of the Oscillariaceæ.§—Under the name *Lyngbya Borziana* Prof. L. Macchiati describes a new species of this genus of Oscillariaceæ, distinguished by the fact that the hormogones sometimes consist of a single cell only. He takes the opportunity of expressing

* Atti Accad. Pontif. Nuov. Lincei, xliii. (1890) 12 pp.
† The Microscope, x. (1890) pp. 151–2.
‡ No. 1, June 1890, 4to, Paris (12 pp. and 2 pls.).
§ Nuov. Giorn. Bot. Ital., xxii. (1890) pp. 40–6. Cf. this Journal, 1888, p. 1012.

his agreement with Gomont,* rather than with Borzì, in sinking the genus *Lyngbya* in *Oscillaria*. The presence of a gelatinous sheath in species of the latter genus is so frequent that it cannot be relied on in distinguishing *Lyngbya* from *Oscillaria*. Kützing's genus *Phormidium* must also be reunited to *Oscillaria*.

The special colouring-matter of the Cyanophyceæ, phycocyanin, is soluble in water, but insoluble in alcohol or ether; it differs also from chlorophyll in not being acted upon by solar light; other microchemical reactions of this substance are given. The author does not agree with Borzì † that the straight hormogones are always destitute of a gelatinous sheath, those of *Lyngbya Borziana* frequently display one evidently. Microchemical reactions show that the gelatinous sheath of the Oscillariaceæ does not consist of cellulose or of protoplasm, but that it seems to have some relationship to the cutin of higher plants. The formation of spores appears to take place only at certain times of the year.

β. Schizomycetes.

Bacillus of Cholera in Soil.‡—Prof. V. de Giaxa draws the following conclusions from his experiments with the cholera bacillus on soil. When the cholera bacillus enters a soil rich in common bacteria, even though it find conditions favourable to its existence and reproduction, it rapidly succumbs in the struggle which takes place between itself and the other bacteria. The latter increase in number, and this increase is rendered possible as far as the deeper layers of the soil are concerned by the addition of nutrient material which agrees with them, and also modifies the condition of the ground.

Should the cholera bacillus enter in relatively large numbers a soil which is inhabited by few ordinary bacteria, not only its preservation, but also its reproduction become possible, until an increase of the common bacteria takes place from the penetration of the soil by nutritive matters which enter along with the pathogenic bacteria.

Germicidal action of Blood-serum and other Body Fluids.§—The doctrine of phagocytosis, invented by Metschnikoff, and claiming that bacteria are destroyed by certain cells (phagocytes), has been recently opposed by the conjecture that it is the fluid constituents of the blood which really furnish the destructive agent. Dr. T. M. Prudden has made experiments with two pathogenic bacteria, *B. typhosus* and *Staphylococcus pyogenes aureus*, on blood-serum and other body fluids. The experiments were conducted in the usual manner and with the usual precautions, and as the result thereof it was found "that fresh blood-serum possesses, though in different degrees in different animals, and in varying potency with the different bacterial species, a most marked germicidal power; that a similar germicidal power resides in fresh human non-inflammatory transudations. That this power is not directly associated with the formed elements of the blood or transudates,

* Cf. this Journal, 1889, p. 784. † Cf. this Journal, 1887, p. 448.
‡ Annales de Micrographie, ii. (1890) pp. 222–51.
§ Medical Record, Jan. 25, 1890.

but is in some way dependent upon their albuminoid constitutents. It would furthermore appear that this singular and apparently most significant capacity of the body fluids is ultimately associated with that complex condition which we call life."

In conclusion, we may state that the author's paper is a most excellent summary of the present condition of this question, as well as a record of his own personal experience.

Bacteria of Milk.*—Professor H. W. Conn, in discussing the bacteria of milk, remarks that their function varies with the species, some of them having the property of imparting an agreeable flavour to the butter made from it, while others communicate a disagreeable odour and taste.

From milk and cream the author has isolated 40 different species, which, from their effects, are divisible into three classes:—(1) Some produce no visible effect, the milk remaining apparently unchanged. Some of these, however, render it slightly acid, others slightly alkaline, and nearly all produce certain decomposition odours. (2) Another series has the power of breaking up the milk-sugar, producing sufficient acid to curdle the milk. To this belongs *B. acidi lactici*. (3) A third class curdles milk, but the reaction is either alkaline, or the reaction is not affected. Such bacteria have the additional function of dissolving the curd which they produce, converting it slowly into peptones, whereby the milk becomes liquid again.

The author then proceeds to discuss the connection between butter and bacteria, the connection being established through cream, in which the growth is longer continued and more prolific. Now the action of bacteria on cream results in what is known as "ripening," by which butter "comes" more easily; secondly, it keeps longer; thirdly, the flavour is improved.

The ripening is effected by the action of bacteria which disintegrate the albumen, partly by production of an acid, and partly by a peptonization. The flavour is due to the impregnation of the butter with aromatic principles, the product of decomposition; the difference in taste and odour being due to the action of different bacterial ferments. Hence butter made from sweet cream is flat, insipid, and tasteless, because the bacteria have not had time or opportunity to produce the volatile decomposition products.

The author finally discusses the relation of milk-souring to electricity. From a series of experiments made on milk, he finds that electricity has not this effect on milk, and offers in explanation that "thunderstorms are usually preceded by climatic conditions of temperature and moisture very favourable to bacteria growth."

Spirobacillus gigas.†—M. A. Certes has found in the freshwater reservoirs at Aden a Spirillum which is remarkable in form and size.

In length it varies from 15–35 μ, and the width of the spirals is from 7–8 μ. In breadth the Spirillum does not exceed 1 μ. When alive or fixed by osmic acid, it resembles a spiral spring made of glass,

* 'Associated Dairying. Connecticut Board of Agriculture Report,' 1890, 43 pp.

† Bull. Soc. Zool. France, xiv. (1889) pp. 322-5 (8 figs.).

in which the spirals are very close together. The size of the individual varies with the number of spiral turns.

In some, spores which seemed black, or with bluish reflex, were observed. The sporiferous individuals were observed to possess a different method of locomotion to those which contained no spores. The former progress by a movement of rotation round their own axis; while the latter move backwards or forwards by means of vertical or horizontal undulations.

Under a 1/16 immersion no trace of internal organization is discoverable. Weak solutions of dahlia and methyl-blue fail to stain the Spirillum, but the spores become coloured violet or pale blue. The microbe is easily fixed by the vapour of osmic acid and by iodine solution. When mounted in Allen's or Farrant's media the microbe is quite life-like, and if dried it may be stained, like other micro-organisms, by anilin dyes, and then mounted in balsam.

This *Spirobacillus* appears at the expiration of three or four days in cultivations made with sterilized water and kept at a temperature of 20°–25°. For five days they multiply by fission, after which they disappear altogether. The author failed to revivify the spores left behind. But these cultivations were found to contain long straight mobile bacilli, especially characterized by the presence of two or four spores placed symmetrically at the extremities.

Flagella of the Cholera Microbe.*—It is not difficult, says Mr. G. F. Dowdeswell, provided that appropriate but quite ordinary means be adopted, to demonstrate the flagella of minute microbes, for example, the comma forms. The first to do this was Mr. E. M. Nelson, who showed them, in 1886, at a meeting of the Royal Microscopical Society. The optical apparatus required are a normal retina, a good objective with moderate angle of aperture, and a good light. For staining purposes gentian-violet answers as well as any other colour, but it is necessary to be particular as to the method of mounting. The specimens must be mounted in solution of acetate of potash, and not in balsam.

By this method no difficulty will be experienced in demonstrating flagella of microbes as small as *Bacterium termo*.

Resistance of the Cholera Vibrio to drying heat.†—The results of experiments with regard to the resistance offered by the cholera spirilla to desiccation and heat present two opposite conclusions, and it was to reconcile these antagonistic views, that Dr. S. Kitasato essayed further experiments to ascertain if the contradictory views might be explained by differences in the degree of resistance of cultivations, according as they are more or less old, or have been produced on different nutritive media.

With this intent the author steeped silk threads in cultivations, or spread a drop of them upon a slide. The threads and slides were dried, some over sulphuric acid, others in sterilized glass boxes; others were kept in moist heat as control experiments.

From hour to hour, threads and glasses were removed and sown in bouillon and gelatin. In order to ascertain the resistance of the different

* Annales de Micrographie, ii. (1890) pp. 377-9.

† Zeitschr. f. Hygiene, v. p. 136. Cf. Annales de Micrographie, ii. (1890) pp. 385-7.

cultures to heat, a droplet was mixed with liquid gelatin and kept at the desired temperature in a water-bath. The gelatin was afterwards made into Esmarch's plates.

From his experiments the author concludes:—(1) that there is no difference between young and old cultures, in respect to their resistance to heat and drying. (2) The length of time required to kill by desiccation depends on the way in which the material has been prepared, the silk threads being more resistant than the glass slides. (3) The nature of the cultivation exercises considerable influence, and threads dried over acid are more resistant than those dried in the air. (4) Different cultivations did not contribute any appreciable difference for temperatures between 50° and 60°. (5) The contradictions between authors relative to this resistance are easily explicable by the differences in the way in which desiccation has been effected; the more complete and rapid it has been, the more quickly the bacteria die.

Microbes of Hæmoglobinuria of Ox.*—This disease, says M. V. Babes, is an acute febrile disorder, endemic in certain marshy districts of Roumania, and is characterized by hæmoglobinuric urine and the presence of a microbe within the red corpuscles.

These microbes vary somewhat in appearance. In the living unstained condition they are seen as round pale spots about 1 μ in diameter, lying within the red corpuscles. When stained with a weak solution of violet B, they look like coloured globules 0·5–1·5 μ in diameter, often with a division line across their centre, sometimes like the figure 8. In this living condition their outline is ill defined. When dried and stained they are smaller, while their contour becomes strictly defined and stains well.

Cultivations on artificial media produced colonies which showed under the Microscope cocci and diplococci, surrounded by a less colourable zone, this reproducing an appearance similar to that found in the blood. But the vitality and the pathogenic properties of the microbes developed artificially were soon lost.

From the author's remarks it is to be inferred, though it is not quite clear, that inoculation experiments were made, and that the symptoms of the disease and the suspected organism were reproduced.

Putrefaction Ptomaine obtained from cultivations of Bacterium Allii.†—The microbe, discovered by Mr. A. B. Griffiths, is from 5 to 7 μ long and 2·5 μ broad. It was found on rotten onions, upon which, as well as on gelatin, it produces a green pigment. This pigment, when dissolved in alcohol, gives an absorption band extending from the extreme violet to the blue, and also bands in the green and yellow. The end of the band in yellow is exactly in the same position as D in the solar spectrum.

Allowed to grow for several days on peptonized agar, *Bacterium Allii* produces a ptomaine, which was extracted by the methods of Gautier and Brieger. It is a white solid body soluble in hot water, alcohol, ether, and chloroform. It crystallizes in microscopic needles belonging to the prismatic system. These crystals are extremely deliquescent and have the odour of Mayflower, especially when heated.

* Comptes Rendus, cx. (1890) pp. 800-2. † T. c., pp. 416–8.

Analysis of its composition showed that its formula is $C_{10}H_{17}N$.

With regard to the origin of this alkaloid it cannot be doubted that it is a product of the chemical decomposition of the albuminoid molecules of the peptonized agar, produced during the life of *Bacterium Allii*.

Chromogenic Function of Bacillus pyocyaneus.*—Although, says M. C. Gessard, the earlier bacteriologists assumed that the hues produced by chromogenic bacteria were invariably and constantly associated with their vital activity, it now seems more probable that the presence of pigment represents a symptomatic reaction of the microbe which produced it, since the colouring matters obviously vary with the slightest differences in the cultivation medium and its environment. Hence it would be more in accord with our present knowledge to state the law thus:—The same microbe may present different biological and morphological characteristics, and identical morphological and biological characters may be found in different microbes.

This law is derivable from the colour appearances of the bacillus of blue pus, which is distinguished by producing a blue crystallizable pigment, pyocyanine. This blue pigment is easily recognizable on and isolable from dressings of wounds, but when *B. pyocyaneus* is cultivated in beef or veal broth, the pigment produced is not a pure blue, but a greenish blue, and is further marked by a certain degree of fluorescence. Both of these characteristics can be separately cultivated, the pigment in commercial peptone dissolved in 50 parts of water and the fluorescence in egg-albumen. A further characteristic of this fluorescence is that it is destroyed by addition of acid and increased by alkalies.

Hence the chromogenic function of *B. pyocyaneus* varies with the medium, and from these varieties the author deduces the law above stated.

Pathogenic Microbes in filtered water of the Rhone.†—MM. Lortet and Despeignes have found that, although the Rhone water when filtered contains only 7000 germs per litre, yet there passed through a Chamberland filter a considerable deposit consisting of organic and inorganic material remains.

In order to ascertain if this deposit from potable water reported to be of excellent quality, and in appearance perfectly filtered, contained pathogenic microbes in any considerable quantity, the authors inoculated guinea-pigs. Most of the animals died with suppurative visceral lesions, the organs most severely and most often affected being the liver and lungs.

These results indicate that this apparently good water is fraught with danger to the public health, and when the pressure on the filtering beds rises, as it must do whenever the river swells, this danger increases, since the deposit on the gravel is then detached, and thus becomes mixed up with the water distributed throughout a town.

Loss of virulence in cultivations of Bacillus anthracis.‡—From observations made on cultivations of *Bacillus anthracis*, M. S. Arloing concludes that in one cultivation the bacilli do not possess the same virulence nor the same vegetative potentiality. Senescence first shows itself in the

* Comptes Rendus, cx. (1890) pp. 418-20. † T. c., pp. 353-5.
‡ T. c., pp. 939-41.

feeblest bacilli, so that when a cultivation has been left to itself, the number of virulent and fertile organisms decreases.

At a given period a weak inoculation may not reveal any trace of virulence. Nevertheless, from the cultivation, quite a generation of virulent bacteria may be reared. But in order to bring this evidence to light, cultivation methods or strong inoculations must be employed.

Negative Indol-reaction as a test for the Typhoid Bacillus.*—The resemblance, from their morphological and cultivation aspects, of numerous bacilli to the bacillus of typhoid, suggests the importance of having some specific test which may be easily applied in making a differential diagnosis between the bacillus of typhoid and other bacteria.

Recent observations have shown that potato cultivations do not afford a certain criterion; but after experimenting with sixteen kinds of bacteria, Dr. S. Kitasato found that these, when cultivated in bouillon, produced indol, while the typhoid bacillus did not.

The indol was tested for by Salkowski's method, that is, by treating the cultivations with a solution of nitrite of potash, and then adding a few drops of strong sulphuric acid. With this test the typhoid bacillus remained colourless, while the other sixteen bacilli assumed the characteristic red hue.

Careful chemical analysis also constantly showed the absence of indol from the typhoid cultivations.

As all these pseudo-typhoid bacilli developed on potato quite differently from the real typhoid bacillus, the author concludes that the negative indol reaction is in itself no better test that the growth on potato is.

Canestrinis' Bacteriology.†—The 'Bacteriology' of G. and R. Canestrini is quite up to date on all branches of the subject. The general part of the work deals with the morphology and biology of micro-organisms, and also their mode of infection, while at the same time prophylaxis and hygienic precautions are not neglected. The various apparatus, cultivation, and staining methods as applied to the examination of water, air, and earth are clearly and precisely described. The special part deals with a number of micro-organisms pathogenic to man or the lower animals, and is very thorough.

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* Zeitschr. f. Hygiene, vii., No. 3. See Bot. Centralbl., xli. (1890) pp. 364–5.

† 'Batteriologia,' R. e G. Canestrini, 8vo, Milano (Hoepli), 1890, 29 pls. Cf. Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 131–2.

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„ „ **Études sur l'immunité. III. Le charbon des rats blancs.** (Studies on immunity. III. Anthrax of white rats.) *Annales de l'Institut Pasteur*, IV. (1890) pp. 193–212.

OBERDORFFER, H. J.—**Ueber die Einwirkung des Ozons auf Bakterien.** (On the action of ozone on Bacteria.) Thesis, Bonn, 1889.

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MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

ALTMANN, R.—**Ueber die Verbesserungsfähigkeit der Mikroskope.** (On the possibilities of improvements in the Microscope.) Part II.
Arch. f. Anat. u. Physiol., Anat. Abtheil., 1889, H. 5, 6, p. 326.

ANDERSON, R. J.—**A panoramic arrangement for the Microscope.**
Internat. Monatsschr. f. Anat. u. Physiol., VI. (1889) H 8, p. 289.

BERNARD, P.—**Note sur un Microscope composé du 18e siècle.** (Note on a compound Microscope of the 18th century.)
Journ. des Sci. Med. de Lille, XI. (1889) p. 1.

HEITZMANN, C.—**Die Zukunft der Mikroskopie.** (The future of Microscopy.)
Wiener Med. Bl., XII. (1889) Nos. 37, 39.

OLIVIER, L.—**Histoire des Microscopes.** (History of Microscopes.)
La Nature, XVII. (1889) pp. 267, 314.

POLI, A.—**Le Microscope et sa théorie.** (The Microscope and its theory.)
Rev. de Bot., VII. p. 20.

(2) Eye-pieces and Objectives.

The Achromatic Object-glass. — J. Godfrey writes:† — "I am glad to find our correspondent 'Prismatique' coming to the front again, and as an amateur optician I write to ask his opinion upon a curious point. The glass I have always worked upon has been Chance's hard crown and dense flint, and after all sorts of experiments with different combinations of curves, I have found that a very good combination is to make the crown lens equiconvex, and the curves of the flint in the proportion of ten to one double concave. Of course I am well aware that these curves are foundation curves only, and that delicate and final corrections are indispensable; the workman, so I find, can only select curves to work up to, and alter, according to his experience and manual skill. Now I find—and this is the result, not of theory, but of experience—that with these proportions of the curves the flint lens corrects the achromatism of the crown slightly more at the marginal zone than it does at the centre. For example, if the flat lens so far over-corrects the crown as to eliminate the irrationality of the crown lens with respect to the red of the spectrum for the outside zone, there then remains, as I have found by practice, a minute residuum of the secondary spectrum in favour of the crown lens in the centre of the object-glass, a faint trace of red, which of course is not obtrusive, but it is there. Now I want to eliminate this want of balance between the outside and centre of the object-glass. At present I am very busy working upon two very fine and massive discs of Chance's hard crown and dense flint, and the object-glass will be 7 in. clear aperture; of course this is not the first glass I have made. My present 5 in. will show a curiously mottled and indented terminator upon Venus, and she is a terrible planet to define. Now I want 'Prismatique's' opinion upon this point. I propose to make my crown-lens equiconvex, 27·5 in. radius, and the focal length of the flint to be 49·6 in. This will give the proportions of the focal

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

† Engl. Mech., li. (1890) p. 118.

lengths 1:1·8, which I have found a good proportion. But now instead of putting the radii of the flint as 1 : 10, or nearly so, I propose to take a plano-concave and make the radius 24·8. Then I should work the back of the flint, not to an absolute curve, but to an exceedingly long concave curve, nearly a plane. This would necessitate the flint lens being fitted a short distance from the crown, about two-tenths or so by experiment, and I think that this would give a better correction for achromatism. I am quite aware that this would give a slight excess of spherical aberration to the concave; but, if necessary, I propose to correct it after fixing the distance between the lenses that will best suit the achromatism. Now, I am rather fortified in my belief that this modification will answer, in that my proposed construction will closely approximate to the construction of the object-glass of the Lick telescope, in which the convex is an equiconvex, and the flint is a double concave with a long concave curve at the back, and the two lenses are separated and are not in contact. It appears to me that the achromatism would be improved by separating the lenses."

The Jena Lenses.* — The following is part of a letter from "F.R.M.S.": †—As statements have been made in former numbers of this paper impugning the good faith of MM. Zeiss, as to the new objective of 1·6 N.A., I wrote them requesting an authoritative statement on the subject. They have very kindly sent me a copy of a letter which their Prof. Abbe has written to Mr. Mayall in consequence of my communication to them. Their letter is dated 10th September, and in it Prof. Abbe says :—"Please to take notice of a formal assertion from *my* part that the objective has *not* undergone any alteration whatever, while in Jena; *that every lens and every piece of the mounting was in exactly the same state at the second departure to London in which it was at the first departure.*"

The italics are the Professor's, not mine.

Prof. Abbe further states :—"Though I have not myself looked up the lens all the time over, I am in a position to give this assertion quite *positively* on these grounds.

"(1) Nobody in the workshop had any sensible interest in making an alteration and *concealing it to me.* For *nobody* except myself was responsible for whatever defect of the objective. The computations had been made under my personal direction, and I had approved of the optician's work after execution. If a defect of any kind had happened to come out afterwards, the fault would have been *mine only.*

"(2) Nobody *could* try to change or improve the system without consulting me, because no other person was *au fait* with regard to that particular construction."

Prof. Abbe further states:—"The objective had not been tried *photographically* by us, neither Van Heurck's sample, nor the other one. I was therefore *quite prepared to admit* that a 'chemical' focus could exist, owing to an insufficient approximation in uniting the violet ray with the other rays (in our computation) under the condition always that in Van Heurck's sample *the same defect must exist,* as both objec-

* Engl. Mech., Oct. 1890, p. 124.

† Published, however, without the authorization of Prof. Abbe.—Ed. J.R.M.S.

tives had shown the *same* degree of achromatism of the *visual* light. Though it appeared rather strange that Dr. Van Heurck should *not* have observed the fault, I supposed that he could perhaps have overlooked it, or had not found it hurtful, owing to his particular mode of illumination or photographic operation.

"In *this* spirit I advised Dr. Czapski to measure the residual difference of the chemical focus, and to compute a correcting lens, to be added to the system, in order to compensate for the expected difference.

"Having left the matter to Dr. Czapski, as I am not versed in photomicrography, I was *much astonished* to hear from him—a *short* time after arrival of the lens—that he could not find a difference of focus. In face of the positive assertion about the result of *your* trial, I felt doubtful about the accuracy of Dr. Czapski's observation, and I requested him decidedly *to repeat the trial* with all possible precautions, though *he* considered this as useless."

Fluor-spar at Oltscheren.*—Dr. E. v. Fellenberg gives a very full account of the occurrence at Oltscheren of fluor-spar, which is the subject of so much interest to microscopists at the present time. Fluorite is a mineral very widely distributed in the Alps. A locality long noted for the abundance of the pale-green variety is "Rann," or more correctly "Runn," a wood near Giesbach opposite to Brienz. The first mention of this locality is to be found in G. S. Gruner's 'Versuch eines Verzeichnisses der Mineralien des Schweizerlandes,' Bern, 1775, and a further description is given in Höpfner's 'Magazin für die Naturkunde Helvetiens,' vol. iv., 1789, in an account of a journey made by General-Commissioner Manuel in the Bernese Alps. Green fluor was also obtained in the Jura limestone from the Vordendürrschreuncalp am Säntis and yellowish-brown and wine-coloured crystals from the Upper Jurassic limestone at Salève bei Genf. But by far the most remarkable and interesting occurrence of fluor is that at Oltscheren or Oltschialp, more exactly at Oltschikopf, south of the village of Brienzwyler in the Bernese Oberland. Here in 1830, according to a label on a specimen in the Bern Museum, Hans Fischer and Mitkaften discovered in a cleft of the mountain opposite Brienzwyler about 200 cwt. of fluor, of which 2 cwt. consisted of crystals. These men appear to have made considerable journeys with their treasure piled up in a cart in huge blocks, some of which, according to Prof. B. Studer, who purchased several specimens from them at the time, were a foot in diameter, and water-clear like blocks of ice. The precise locality of this remarkable find had been forgotten, when in 1886 Prof. Abbe began to make inquiries about the occurrence of water-clear fluor-spar. Many years before the author had sent to Herr Wappler, a mineral dealer in Freiberg, in exchange for Saxon minerals, some water-clear crystals of fluor from "das untere Haslithal im Kanton Bern." Prof. Abbe having seen these specimens was induced to visit the author, by whom he was referred to Herr Hamberger, the director of the pyrotechnic laboratory in Oberried, near Brienz, as well as to the hunter Caspar Blatter, as being the most likely persons from whom information could

* 'Ueber den Flusspath von Oltscherenalp,' Mittheil. Naturf. Ges. in Bern, 1889, pp. 202-19.

be obtained of the occurrence of fluor-spar of similar quality at Oltscheren. The crystal seekers, M. Ott and C. Streich, of Guttanen, as well as the hunter Caspar Blatter, were at once commissioned by Prof. Abbe to make investigations in the neighbourhood, but it was not until the spring of 1887 that they succeeded in rediscovering the old locality of 1830. A new locality was also discovered, from which beautiful green crystals, varying in size from 1 cm. in diameter to one over 20 cm. in length, were obtained. The surface of most of these specimens was rough, many being covered with irregular holes, while others looked like ice which had begun to melt in the sun. These specimens were offered for sale by Ott and Streich without the knowledge of Prof. Abbe, and were purchased by the authorities of the Bern Museum. Of the material sent to Prof. Abbe at Jena very little was found to be fit for optical use. The authorities of Brienzwyler now took action and prohibited further search for useful minerals in the district under their jurisdiction. An agreement was then drawn up by them with a company of capitalists, at whose head stood the firm of Zeiss, in Jena, and Prof. Abbe, by which the exclusive right of search for fluor-spar in that district was granted to the latter. The stipulation was, however, made that all material unfit for optical purposes should become the property of the authorities. The company began work in the summer of 1888 under the directorship of Herr Kable of Jena, who was stationed in a hut on the Alp Bühlen. According to a letter of Prof. Abbe to the author the old find of 1830 came from two cavities on the south part of the mountain. The lower one was easily accessible, but the other, high above, could only be reached by a 72 ft. ladder from another projecting rock mass. Both were found to have been exhausted, and further search for fluor in the neighbourhood only met with indifferent success as regards quality. In conclusion the author describes the visit he himself paid to the locality under the guidance of Caspar Blatter and Herr Kable. Starting from Meyringen with Blatter he passed by Prasti, Schüttelboden, Laui-Vorsass, and Platten to Bühlen, where Herr Kable was installed. With the latter he then proceeded through the valley of Oltscheren to the upper Alp Oberfeld, whence could be seen the south slope of the Oltschikopf, with the two cavities, from which came the extraordinary find of 1830, plainly visible.

JOHNSTON, C.—**The American Objective as compared with the German.** *Maryland Med. Journ.*, XXI. (1889) p. 130.

(3) Illuminating and other Apparatus.

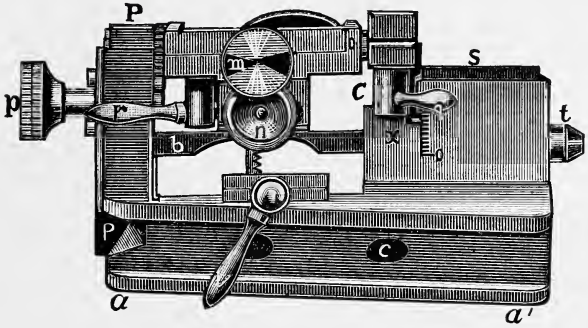
Object-carrier with Vertical Displacement for the Jung Microtome.*—Prof. L. Koch points out that the object-carrier hitherto used only allows a comparatively slight elevation (3 to 4 mm.) of the object adjusted. This is due to a great part of the slide-way being occupied by the micrometer screw and the object-carrier. In fact, for the object itself, the displacement is only about a millimetre, since often more than a millimetre of paraffin has first to be removed, and, if the course

* Bot. Centralbl., xl. (1889) pp. 283–5.

of the knife is very restricted, the full extent of the slide-way cannot be utilized. In most cases this small displacement is not sufficient, so that it is necessary to dismount the object during the work and readjust it. This entails loss of sections, irrespective of the inconvenience of such a process.

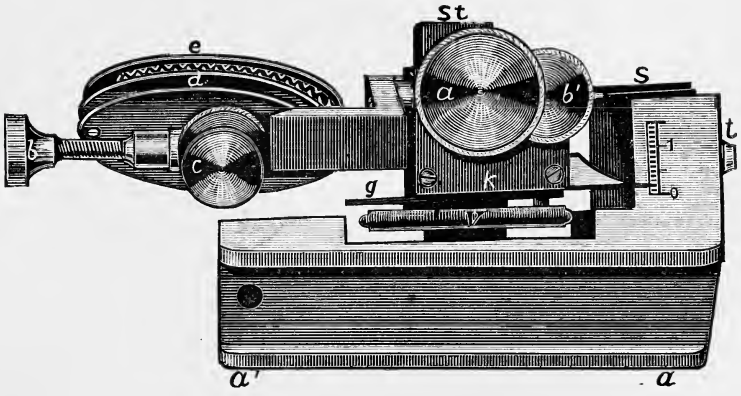
To get rid of this difficulty, Herr R. Jung of Heidelberg has, under the author's direction, constructed an object-carrier with vertical displacement. In one of these, represented in fig. 72, the frame O,

FIG. 72.



carrying the object-clamp, is movable in the vertical direction. This runs in a prismatic groove with so much friction that no fixing-arrangement is necessary to keep it in any given position. The

FIG. 73.



movement is effected by rack and pinion. The frame rests upon a steel base *b*, provided with a ratchet in which works a toothed wheel, set in motion by the lever *r*. One turn of the lever effects a rise of the frame, and consequently of the slide-way, of 1·2 cm.

To begin work, the lowest position is given to the frame carrying the object-clamp, the paraffin block is mounted somewhat high, and the

surface to be cut is raised, by means of the lever, up to the knife-edge. The removal of the paraffin is effected in the same way by means of the vertical displacement, but the cutting of the object itself is done exclusively by the use of the micrometer-screw. When the latter is turned to the end it is screwed back so as to bring the object-carrier into its original position, and the object is then again brought up to the knife-edge by means of the lever.

The object-carrier is especially serviceable in all cases in which the object is to be sectionized only at intervals determined by the development of lateral organs. The micrometer-screw is then used for the parts to be sectionized, and the vertical displacement for the rest. There is an index at x for measuring the intervals between two of the lateral organs to be cut. The object-carrier represented in fig. 73 is of simpler construction, but is quite satisfactory for most purposes, and is to be recommended for use with the small model of the microtome. The movable metal-piece k supports the projecting object-clamp, and runs in a prismatic groove st. It rests on a screw-plate V, by the rotation of which its rise and fall are effected. A binding-screw a fixes it in any position. The rise, exclusive of the slide-way, amounts to 1 cm.

New Heating Apparatus for Mineralogical Investigations.*—This piece of apparatus, designed by R. Brünnée, of the firm of Voigt and Hochgesang, in Göttingen, can be easily fitted to any Microscope. It serves to raise solid preparations or liquids to a high temperature, and, since the flame burns directly beneath the object-carrier, observation can be made by polarized light during the heating. The apparatus has the following arrangement:—Beneath the object-stage B (fig. 74) is a piece bored through in four places. Round the lower, conically turned, part of the piece the arm A is fitted. The latter is movable on the cone, and is fastened to B by a screw c. Between c and B a ring-shaped space o is left, which is contracted internally to a fine slit. The gas and air required for the flame stream through the tubes L and G (fig. 75) into this space. The object-carrier B is provided with a row of outlets L_1. The openings

Fig. 74.

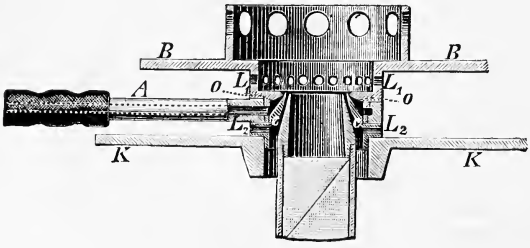
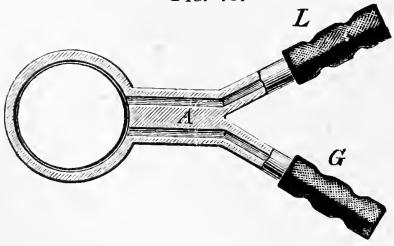


Fig. 75.



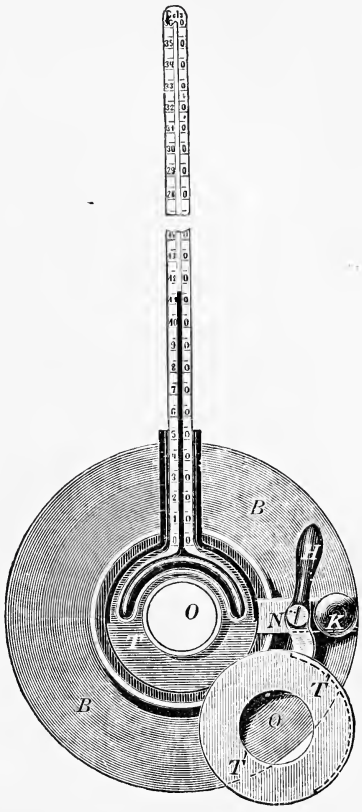
* Zeitschr. f. Instrumentenk., x. (1890) pp. 63-4.

L_2 are for the admission of air. The tube L of the arm A is in connection with a reservoir of compressed air, which effects a quick cooling when necessary.

To connect this apparatus with a Microscope, the lower part of the screw-piece fits into the aperture of the Microscope-stage, so that the stage can be rotated while the arm A with the tubes remains fixed.

For heating up to 360° a drum (fig. 76), which carries a thermometer and the preparation, is added to the apparatus. This consists of two parts T and T_1. The lower part T, carrying the thermometer, is connected with the stage B by a screw K, while the upper part T_1 can be turned to one side about the axis N by means of the lever H. The preparation is placed on a ring in the drum, and is kept at the same height as the thermometer.

Fig. 76.



The apparatus was exhibited at the Exhibition of the Heidelberg Naturforscher-Versammlung, and has been described in the 'Abtheilung für Instrumentenkunde.'* It has already met with considerable success and is particularly suitable for mineralogical-petrographical investigations.

Bolting Gauze.†—Mr. Charles M. Vorce writes that he has "done no microscopical work lately that has any novelty in it, unless it may be the measurement of an assortment of bolting gauze and other goods used for sieves, to ascertain the average and maximum sizes of the particles which pass through the same, and the relation of such size to the rating of the goods which is always by the number of meshes to the inch or centimeter. Bolting gauze of '200 meshes to the inch' will not pass particles of approximately globular form larger than about 1/400 in., and the *average* size of the particles passed will be considerably less, about 1/450."

A Simple Turn-table.‡—Mr. A. S. Elliott describes a simple turn-table. "Procure the frame and running gear of any cheap clock. Fifty cents will cover cost of all materials. Remove the main spring from its place and make the wheel carrying it firm on the shaft. Remove all

* Cf. Zeitschr. f. Instrumentenk., 1889, pp. 359 and 478.
† Amer. Mon. Micr. Journ., xi. (1890) p. 106. ‡ T. c., p. 117.

projecting parts from both top and bottom of frame. Reverse the centre wheel, putting the larger end of shaft uppermost, and making all bearings tight and smooth without oil. Cut a brass plate (soft) 3 inches in diameter; find centre, bore, then bore two more holes $1\frac{1}{4}$ in. from centre; make a pair of light bowed springs, solder to nail fitting such hole and fit tightly through plate, placing the clips in opposition to each other. Cut or scratch three concentric circles 1/4, 1/2, and 3/4, turning table rapidly. Fit the centre shaft firmly to plate without soldering.

The apparent disadvantage of using a cogged wheel in turning with the hand is more than counteracted by the greater ease and consequent steadier rotation, together with greater speed, attained by this table. Carefully made it will do as good or even better work than the ordinary form. If preferred the clips may be soldered fast to plate, but are rather unhandy.

The holes in the bottom of frame can be utilized to secure to firm base and hand-rest in any convenient manner to suit the requirement of the maker."

Cheap Boxes for Slides.*—Mr. Henry Shimer writes:—"W. P. Hamilton's slide-box described in the January number reminds me of a very nice arrangement. A box ready-made is more apt to be used than one made on purpose; for instance, the ordinary cigar-box, costing nothing. The flat ones are most suitable. They vary in size somewhat, but the ordinary one is about $4\frac{1}{2}$ by $8\frac{1}{2}$ by 2 in. inside. It can be filled with cardboard trays like Hamilton's, or with wooden ones made of cigar-boxes. The bottoms and lids will make bottoms for the trays, and the sides and ends sawn into narrow strips 1/8 or 1/4 in. wide and tacked on with brads, will make the margins. Each box will hold five trays. The bottom may be used instead of a tray by tacking a marginal strip on each end. Each of such boxes will store 70 short German slides, which by all odds are preferable, or it will hold 45 to 50 of the 3-in. slides. If we make the trays of cardboard, as per Hamilton, and a 3-in. holds 24, 2-in. holds 16 trays. Then 14 short slides to a tray gives room for 224 slides; 9 3-in. sheets to a tray gives 144 slides, or 7 to a tray will give 112 slides, and allow about 3/4 in. margin on the sides and a little less on the ends. Such boxes are neat, cheap, and convenient. The slides lie flat. These boxes can be numbered or otherwise labelled on the ends and stowed in bookcases."

BRAATZ, E.—**Ein neues Mikrotom.** (A new Microtome.)
Illustr. Monatsschr. d. Aerztl. Polytechn., XI. (1889) p. 159.
GARIEL.—**Chambre claire du Microscope.** (Camera lucida.)
Progrès Méd., VIII. (1888) No. 51.
PETTIGREW, J. B.—**On the use of the Camera Lucida.**
Trans. Manchester Micr. Soc., 1888, p. 80.

(4) Photomicrography.

Mr. Pringle's Photomicrographic Apparatus.—The two figures now given (plates XII. and XIII.) will, without further comment, supplement the description of Mr. Pringle's photomicrographic apparatus which was given on p. 543 of the Journal.

* Amer. Mon. Micr. Journ., xi. (1890) p. 106.

Photomicrography by Gaslight.*—Major Geo. M. Sternberg observes:—Those who have had much experience in making photomicrographs will agree with me that one of the most essential elements of success is the use of a suitable source of illumination.

Without question the direct light of the sun reflected in a right line by the mirror of a heliostat is the most economical and in some respects the most satisfactory light that can be used. But we cannot command this light at all times and places, and it often happens that when we are ready to devote a day to making photomicrographs the sun is obscured by clouds, or the atmosphere is hazy. Indeed, in some latitudes and at certain seasons of the year a suitable day for the purpose is extremely rare. The use of sunlight also requires a room having a southern exposure and elevated above all surrounding buildings or other objects by which the direct rays of the sun would be intercepted. For these reasons a satisfactory artificial light is extremely desirable.

The oxy-hydrogen limelight, the magnesium light and the electric arc light have all been employed as a substitute for the light of the sun, and all give satisfactory results. I have myself made rather extensive use of the "limelight," and think it the best substitute for solar light with which I am familiar. But to use it continuously, day after day, is attended with considerable expense, and the frequent renewal of the supply of gas which it calls for is an inconvenience which one would gladly dispense with.

These considerations have led some microscopists to use an oil lamp as the source of illumination, and very satisfactory photomicrographs with comparatively high powers have been made with this cheap and convenient light. But in my experience the best illumination which I have been able to secure with an oil lamp has called for very long exposures when working with high powers, and as most of my photomicrographs of bacteria are made with an amplification of 1000 diameters, I require a more powerful illumination than I have been able to secure in this way. And especially so because of the fact that a coloured screen must be interposed, which shuts off a large portion of the actinic rays, on account of the staining agents usually employed in making my mounts. The most satisfactory staining agents for the bacteria are an aqueous solution of fuchsin, or of methyline-blue, or of gentian-violet, and all of these colours are so nearly transparent for the actinic rays at the violet end of the spectrum that a satisfactory photographic contrast cannot be obtained unless we shut off these rays by a colour screen.

I am in the habit of using a yellow screen for my preparations stained with fuchsin or methylen-blue, and have obtained very satisfactory results with the orthochromatic plates manufactured by Carbutt of Philadelphia, and a glass screen coated with a solution of tropoline dissolved in gelatin.

But with such a screen, which shuts off a large portion of the actinic light and increases the time of exposure three or fourfold, the use of an oil lamp becomes impracticable, with high powers, on account of the feebleness of the illumination.

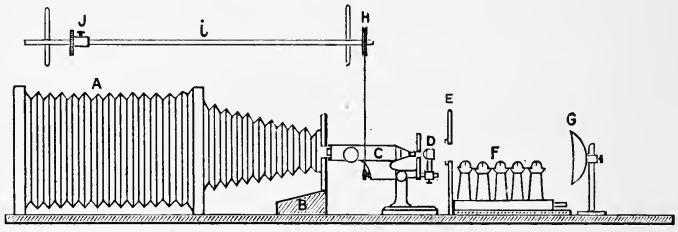
These considerations have led me to experiment with gaslight, and

* John Hopkins University Circulars, ix. (1890) p. 72.

the simple form of apparatus which I am about to describe is the result of these experiments. I have now had the apparatus in use for several months, during which time I have made a large number of very satisfactory photomicrographs of bacteria from fuchsin-stained preparations with an amplification of 1000 diameters. My photographs have been made with the 3 mm. ol. im. apochromatic objective of Zeiss and his projection eye-piece No. 3. I use a large Powell and Lealand stand, upon the substage of which I have fitted an Abbe condenser. The arrangement of the apparatus will be readily understood by reference to the accompanying figure.

A is the camera which has a pyramidal bellows front supported by the heavy block of wood B; this can be pushed back upon the base-board which supports it so as to allow the operator to place

Fig. 77.



his eye at the eye-piece of the Microscope. When it is brought forward an aperture of the proper size admits the outer extremity of the eye-piece and shuts off all light except that coming through the objective. C is the Microscope and D the Abbe condenser supported upon the substage; E is a thick asbestos screen for protecting the Microscope from the heat given off by the battery of gas-burners F. This asbestos screen has an aperture of proper dimensions to admit the light to the condenser D. The gas-burners are arranged in a series with the flat portion of the flame facing the aperture in the asbestos screen E. The concave metallic mirror G is properly placed to reflect the light in the desired direction. I have not found any advantage in the use of a condensing lens other than the Abbe condenser upon the substage of the Microscope. The focusing is accomplished by means of the rod *i*, which carries at one extremity a grooved wheel H, which is connected with the fine-adjustment screw of the Microscope by means of a cord.

The focusing wheel J may be slipped along the rod *i* to any desired position, and is retained in place by a set-screw. The rod *i* is supported above the camera by arms depending from the ceiling, or by upright arms attached to the base-board.

I have lost many plates from a derangement of the focal adjustment resulting from vibrations caused by the passing of loaded waggons in the street adjoining the laboratory in which I work. This has been overcome to a great degree by placing soft rubber cushions under the whole apparatus.

Position of the Light-filter in Photomicrography.*—Since 1866 it has been the generally received doctrine, says Dr. R. Neuhauss, that the position of the filter for producing monochromatic light is of the greatest importance. This doctrine, laid down by Moitessier and followed by all other writers, states that the maximum of absorption is attained when the filter is placed before the collecting lens, and its minimum when inserted between the lens and its focus.

By experiments with a yellow disc placed in the position of the object on the stage and using an ordinary non-orthochromatic silver-bromide-gelatin dry plate covered with a silk-paper sensitometer in the one case, and inserting the yellow disc between the light and the lens in the other, it was found that the two images were exactly alike in every respect. For both the exposure was exactly 15 minutes, and in both negatives the numbers could be read when the layers of silk paper were not more than sixteen.

Similar results ensued from using a layer of a saturated solution of picric acid 3 mm. thick. Hence it is quite indifferent whether the filter be placed near the lens or its focus.

(6) Miscellaneous.

The Microscope in Geology.—A course of twelve lectures on the Microscope in Geology (with special reference to the structure and origin of the stratified rocks), is now being delivered by Professor H. Alleyne Nicholson in the British Museum (Natural History), Cromwell Road, on Mondays, Wednesdays, and Fridays, at 3 p.m., beginning 6th October and ending 31st October, 1890. Admission to the course is free.

β. Technique.†

(1) Collecting Objects, including Culture Processes.

Cotton-wool as a substitute for Silk in Bacteriological Work.‡—Dr. E. Braatz finds that animal products have a much greater affinity for mercury than vegetable, and for this reason advises that cotton-wool threads be used instead of silk threads in bacteriological work.

Effect of highly concentrated Media on Bacteria.§—Prof. H. Buchner replies to Metschnikoff's assertion that the inhibitive influence of the body fluids on micro-organisms is to be ascribed to the greater concentration of these fluids. The author first remarks that the germicidal property of serum is quite extinguished by heating it to 55° for half an hour, although its degree of concentration remains quite unchanged. He then gives the results of experiments made with highly concentrated media, viz. blood charged with 23 per cent., and also with 40 per cent. of cane sugar. In both instances, although there was at the very

* Zeitsch. f. Wiss. Mikr., vii. (1890) pp. 20-2.

† 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.

‡ Centralbl. f. Bakteriol. u Parasitenk., viii. (1890) pp. 8-9. § T. c., pp. 65-9.

outset a slight diminution of the Bacteria, they soon grew well enough.

Other two sets of experiments were made with 10 per cent. sugar and 10 per cent. pepton, each mixed with 10 volumes of blood. Both of these series as compared with a control series without sugar, showed that the addition made practically no difference.

Hence it is obvious that neither the concentration of the medium nor the too sudden transition of the Bacteria to an unaccustomed medium makes any difference to the result.

(2) Preparing Objects.

Method of Preparing Mucous Gland of Prosobranch Molluscs.*—M. F. Bernard found difficulty in obtaining reagents which were not either unable to coagulate the mucus or which were not too energetic, and so disformed the cells. He found, however, three mixtures which acted well, part of the gland being removed from the mantle as rapidly as possible. These were strongly acidulated picro-sulphuric acid; chloride of ruthenium of such strength that the solution is a clear red colour; this was the best of the reagents employed, but unfortunately the author was not able to get as much of it as he wished; it greatly aids dissociation with needles. The third mixture was made of 200 grammes of distilled water, 10 of alcohol at 90 per cent., 5 of glycerin, and 10 of acetic acid; this solution facilitates the staining of the elements with methylen-blue. Fragments thus fixed were teased in 38 per cent. alcohol, osmic acid at 1/10,000, or the acid mixture just mentioned. The last gave particularly good results with animals from Naples which had been already fixed by alcohol or various other reagents.

Mounting Insect Eggs to study the Embryo.†—Mr. E. A. Hill describes a method devised by himself, which he has used for two or three years past, in collecting and preparing the eggs of Lepidoptera for the microscopic examination of the embryo in its various stages of development.

In summer evenings, when working with the Microscope, the window being open, as is usually the case, moths frequently fly in attracted by the light; and when pursuing this line of investigation Mr. Hill has on hand a number of pasteboard pill-boxes (size is not important, but some which happened to be at hand were about 1 in. deep, and 3/4 in. in diameter). The moths are easily captured, after which each is placed in a separate box, with a reference letter on the cover. The next morning a number will usually be found to have laid eggs. These eggs are divided into as many equal parts as he anticipates there are days in the period of incubation, placing each portion in a separate homœopathic phial, the phials being about 1 in. high. The corks are marked with the reference letter entered in the record book, and, in addition, the phials are numbered consecutively from 1 upwards. The corks are inserted lightly, so as to allow air to enter the phials. Phial No. 1 is then filled at once with carbolic acid, filling No. 2 on the second morning, No. 3 on the third morning, and on the last day filling the phial containing the newly

* Ann. Sci. Nat., ix. (1890) pp. 305-6.
† The Microscope, x. (1890) pp. 208-10.

hatched larvæ, entering in the note-book the time required for hatching. Meanwhile, if it is desired, and this is the better plan, the moth is mounted after the usual manner of entomologists, on an entomological pin, and preserved in a cabinet with the same reference letter, so that the species can be determined at leisure. The carbolic acid renders the eggs perfectly transparent, or at least does so in the cases which have come under notice, and hence the embryos can be observed in the various stages of development. Mr. Hill mounts in benzol-balsam direct from the carbolic acid, and to prevent the crushing of the eggs sometimes uses three supports for the cover-glass placed triangularly between it and the slide. Three are better than four, as three points afford a more uniform bearing for the cover than four, on the well-known principle of the three-legged stool.

For the supports either small beads are used, or, if special thicknesses are required for the supports, they can be made by drawing out a fine thread from a piece of glass tube by means of a spirit-lamp, after which small pieces can readily be broken off. Tin-foil also makes good supports. For example, cut a strip about 1 in. square, and roll it into a tight roll 1 in. long; it should then be flattened between two glass slides to a uniform thickness, when little square pieces can be readily clipped off with a pair of scissors and used instead of the beads. The thickness of the roll can be varied, and the little squares can also be reduced in thickness by removing one or more layers of the tin-foil until of the proper size.

Theoretically, a series of eggs beginning with No. 1 and running up consecutively should show a progressive development of the embryo, but practically there is not always as much regularity in the series as we could look for. Probably the eggs first laid develope first, and twelve hours' difference in the time of laying the first and last egg, if the whole period of incubation only amounts to a few days, may make some difference. When, however, we have several eggs in each phial, no trouble will usually be experienced in getting a good progressive series by making a judicious selection from each bottle, in which case the selected specimens may be mounted in proper order on a single slide.

Preparation of Eyes of Lobsters.*—Mr. G. H. Parker describes a method of staining nerve-fibres which he discovered while experimenting with Weigert's hæmatoxylin. The method consists in a cautious use of Schällibaum's fixative; the one employed consisted of three parts of oil of cloves, and one part of Squibb's flexible collodion; the mixture should be allowed to stand a week before being used. A moderate amount is applied to the slide, and the sections in paraffin are placed on it; the slide and the sections are now subjected to a temperature of 58° C. for fifteen minutes, and this is a point which must be carefully attended to. The slide must next, while warm, be thoroughly washed with flowing turpentine, which can be conveniently applied from a small wash-bottle; all the paraffin should be removed from the slide before it becomes cool. When the slide is cool the turpentine may safely be replaced by alcohol, 95 per cent., then 70 per cent, 50 per cent., and

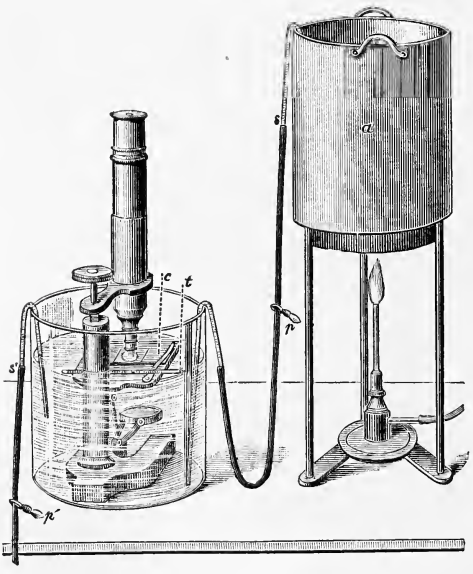
* Bull. Mus. Comp. Zool., xx. (1890) pp. 3-4.

35 per cent., and finally it may be immersed in water. Sections of optic nerve mounted on slides and carried into water must be treated for about half a minute with an aqueous solution of potassic hydrate (1/10 per cent.), then thoroughly washed in distilled water, and transferred to Weigert's hæmatoxylin, in which they should remain for about three hours at 50° C. After distilled water and grades of alcohol they may be cleared in turpentine and mounted in benzol-balsam. Each nerve-fibre so treated has a distinct blue-grey outline.

Methods of Recognizing Cysticerci of Tænia saginata.*—M. A. Laboulbène has a note on the means of recognizing the cysticerci of *Tænia saginata*, which are the cause of "measles" in veal and beef, and which are often so difficult to detect on account of the rapidity with which they dry on exposure to the air. He finds that meat which has become quite leathery will easily reveal the *Cysticerci* if it contain any, by being placed in water acidified with acetic or nitric acids, or in a mixture of water, glycerin, and acetic acid. By this means the parasites can always be detected, and if the meat be carefully heated to 50° or 60° C. it is always fit for human food.

New Method for Examining microscopically the Elements and Tissues of Warm-blooded Animals at their physiological temperature.†—This method, devised by M. L. Ranvier, essentially consists in placing both the Microscope and the preparation to be examined in a bath of warm water (36° to 39° C.) But like most practical things the details are more important than the principle. Thus the Microscope must be of a simple model. As the preparation is to be examined under water an immersion objective with or without correction must be used. The preparation must be carefully protected from water by running paraffin round the cover-glass. Before using the objective it must be warmed up to 40° C., otherwise a thick fog will spread over the face of the lens. The Microscope is placed in a flat-bottomed glass vessel about 0·12 m. high and 0·14 m. in diameter. This contains *distilled* water, heated up to 40°, in such quantity that its surface is from 0·5–1 cm.

Fig. 78.



* Comptes Rendus, cxi. (1890) pp. 155-7. † Op. c., cx. (1890) pp. 66–9 (1 fig.).

above the level of the stage. A thermometer placed by the side of the preparation indicates the temperature of the latter.

The most convenient temperature for observations ranges from 37°–38°, and if observations are to be maintained longer than eight or ten minutes it is necessary not only to add warm water, but to remove the surplus in order that the original level may be maintained. This can be effected as in the illustration by means of two siphons, or by placing the glass vessel within one which is larger but not so high.

By means of this apparatus the author states that he has made more observations in a month than in the past twenty years with the old arrangements.

Microchemical Tests for Alkaloids and Proteids.*—M. L. Errera points out the want of a general test for the discrimination of alkaloids and proteinaceous substances. Although many alkaloids are readily detected by special reactions, yet Raspail's proteid-reaction (a red colour produced by sugar and sulphuric acid), and Millon's reaction, are both also produced by certain alkaloids. The best general distinctive tests for these two classes of substances are their different behaviour towards (*a*) absolute alcohol, (*b*) one gr. of tartaric acid in 20 ccm. of absolute alcohol, (*c*) 0·2 ccm. of hydrochloric acid in 5 ccm. of distilled water and 95 ccm. of absolute alcohol. In these three reagents all alkaloids are readily soluble, while proteinaceous substances are either entirely insoluble, or at all events leave a residue behind, even after very long treatment.

Reactions for Lignin.†—Herr R. Hegler discusses in great detail the various reagents used for the micro-chemical detection of lignified membranes. He divides those already in use into three groups, viz.:—(1) Those which react with vanillin, but not with coniferin,—thallin; (2) Those which react with coniferin but not with vanillin,—phenol-hydrochloric acid, thymol-hydrochloric acid; (3) Those which react with both vanillin and coniferin,—all the other reagents for lignin. Thallin, $C_9H_6NOCH_3H_4$, is an extraordinarily delicate reagent for lignified tissues, the vanillin assuming an intense orange-red colour. A new reagent recommended, with the same properties, is toluilendiamin, $C_6H_3(CH_3)(NH_2)_2$, used in a concentrated aqueous solution with a trace of hydrochloric acid; it stains lignified membranes a dark orange. Vanillin he regards as a product formed out of coniferin by the activity of the protoplasm; the process being of the nature of fermentation with secondary oxidation. The production of lignin, $C_{18}H_{24}O_{10}$, out of cellulose may be represented by some such equation as this:—$4C_6H_{10}O_5 = C_{18}H_{24}O_{10} + C_6H_6O_5 + 5H_2O$; the $C_6H_6O_5$ may then be completely oxidized into carbon dioxide and water, or may pass over into such substances as tannins.

Fixing and Staining of Leucoplasts and Protein-crystalloids.‡—Dr. A. Zimmermann recommends a concentrated alcoholic solution of

* 'Sur la distinction microchimique d. alcaloïdes et d. matières protéiques,' Bruxelles, 1889. See Bot. Ztg., xlviii. (1890) p. 232.

† Flora, lxxiii. (1890) pp. 31–61 (1 pl.). Cf. this Journal, 1889, p. 606.

‡ Beitr. z. Morph. u. Physiol. d. Pflanzenzelle, Heft 1, 79 pp. and 2 pls., Tübingen, 1890. Cf. *supra*, p. 617.

corrosive sublimate for fixing the leucoplasts, e. g. in the epidermal cells of the leaves of *Tradescantia discolor;* the leucosomes themselves not being in any way changed by the sublimate. Good results were also obtained—though not so good—with concentrated alcoholic solution of picric acid, and with alcohol alone. With small pieces this immersion in the sublimate solution is sufficient. To prepare for the microtome they should then be placed first in pure alcohol, then for twenty-four hours in a mixture of three parts xylol and one part alcohol, then as long in pure xylol, then in a solution of paraffin in xylol saturated in the cold, finally in pure paraffin. For staining, Altmann's method * with acid-fuchsin was found to be the best; but a special modification of it is described in detail. Iod-green, cyanosin, and dahlia may also be used.

For fixing the cell-granules the author uses either a concentrated alcoholic solution of picric acid or 3 per cent. nitric acid. They may then be stained with acid-fuchsin by Altmann's method, which colours the granules an intense red, while the chloroplasts and nucleus are left quite colourless.

For staining the proteid-crystalloids, a method is employed termed by the author the acid-fuchsin method B. The section is first of all dehydrated by alcohol, and then placed in xylol or in xylol-Canada-balsam. The leucoplasts are fixed by picric acid or sublimate, and the section then stained with acid-fuchsin. While the nuclei and nucleoli remain perfectly uncoloured, the crystalloids take up an intense red. Good results were also obtained by the ordinary Altmann's acid-fuchsin method; also by fixing with concentrated aqueous or alcoholic solution of sublimate, aqueous or alcoholic solution of picric acid, 5 per cent. solution of potassium bichromate, or with Müller's fluid.

(3) Cutting, including Imbedding and Microtomes.

Imbedding Vegetable Preparations in Paraffin.†—Herr L. Koch discusses at great length and with copious detail the proper method of imbedding vegetable preparations in paraffin. After a critical survey of various methods of paraffin imbedding, the author gives a general outline of his views on the subject, and then proceeds to give the minutiæ requisite for obtaining a satisfactory result in special cases. His views, however, are tolerably simple, and do not seem to differ materially in practice from those of other people who apply themselves to vegetable anatomy.

The general proposition, on which much stress is laid, and the obvious inference therefrom, is one which occurs to any person after a very small amount of practice. It is that the imbedding mass must be made to penetrate into cells and intercellular spaces, and in order to do this the air and water must be thoroughly and completely removed. This is effected by immersing the objects in spirit, the strength of which is gradually increased up to absolute alcohol. The objects are then saturated with paraffin dissolved in chloroform. The saturation is effected by gradually increasing the thickness of the paraffin mixture; when a

* Cf. this Journal, 1888, p. 147.

† Jahrb. f. Wiss. Bot. (Pringsheim), xxi. (1890) pp. 367–468.

suitable consistence is attained, the block is cut up with a medium sized Jung's microtome. The description of this well-known section-cutter seems somewhat superfluous. The sections, which vary from 0·03 to 0·005 mm., are fixed to the slide with the collodion and clove oil mixture and the paraffin dissolved out with turpentine. The turpentine is dissolved out effectually with alcohol, and this in its turn with water. The specimens are then mounted in glycerin or Kaiser's glycerin jelly. Staining and mounting in balsam are passed over in a very few words.

(4) Staining and Injecting.

Laboratory Notes.*—Mlle. Leclerq points out that it is advantageous to stain sections so as to show the micro-organism and the tissues as well. This can be effected by first staining with borax-carmine, and then using Gram's or Bizzozero's method. The steps to be followed are, first stain the section with borax-carmine, followed or not by decoloration with hydrochloric acid according to the result that is desired; washing in water; staining with Ehrlich violet; washing in absolute alcohol followed by the Lugol iodine solution; washing in absolute alcohol followed by decoloration in 1 per cent. chromic acid; then absolute alcohol, oil of cloves, and balsam.

For staining embryonic blood-corpuscles of birds, so as to distinguish them from other embryonic elements, the authoress gives the following method:—(1) Overstain with fuchsin; (2) moderate decoloration with 1/3 to 1/5 aqueous solution of acetic acid; (3) washing in water; (4) rapid staining with weak solution of malachite-green; (5) dehydration in absolute alcohol; (6) clearing up in oil of cloves or origanum oil according to the degree of staining; (7) mounting in balsam.

By this method the malachite-green combines with the fuchsin in the embryonic tissues, which become violet-coloured, while the blood-corpuscles and the karyokinetic figures are red.

The foregoing, although good for birds, is not successful for mammals, and for these the authoress adopts a method of triple staining, wherein she uses Congo red. This method consists (1) in staining for 10–15 minutes in a very weak solution of Congo red; (2) washing in water; (3) staining with Ehrlich's violet, followed by decoloration according to Gram's or Bizzozero's method; (4) staining with alcoholic eosin; (5) Dehydration in absolute alcohol, then oil of cloves and balsam.

In this case the blood-globules are stained an orange-yellow.

Apparatus for Impregnating Tissues, &c., and for making Esmarch Tubes.†—Dr. M. Herman describes an apparatus which is serviceable for histological, pathological, zoological, and bacteriological purposes. It consists of a water-wheel R (fig. 79) which revolves in a box. On one side of its axis is the handle M, and on the opposite side is an open metal case D, the latter being for the reception of a test-tube T, which is intended for the Esmarch cultivation method. The box rests on the

* Bull. Soc. Belge Micr., xvi. (1890) pp. 61–5.

† Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 55–7 (2 figs.).

plate S, and this can be moved up and down by means of the screw V. The hopper E is divided into two compartments *a* and *b*, so that the water, which is introduced into the hopper through a pipe, may pass

Fig. 79.

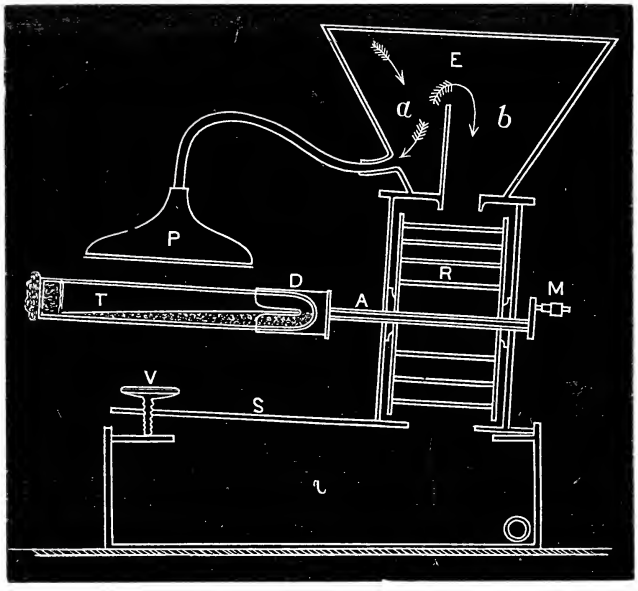
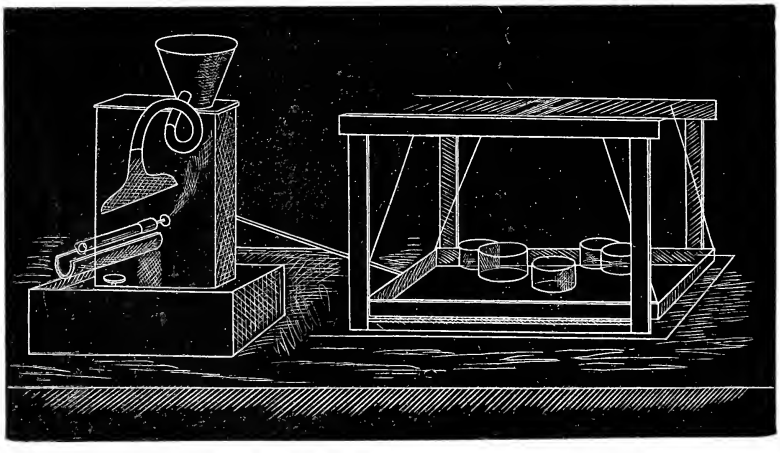


Fig. 80.



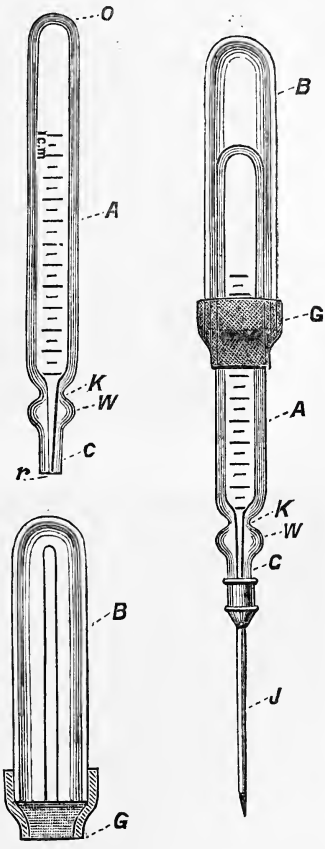
both on to the wheel R and through a tube P on to the test-tube. The surplus water collects in a reservoir, from which it passes out through an overflow pipe (not shown in the illustration).

By means of a thin metal rod, the handle M imparts a to-and-fro movement to a shallow rectangular metal tray, which is suspended by four wires to a wooden framework. The regular to-and-fro movement of the tray is effected by two small metal forks which act as guides. In fig. 80 is given a general view of the apparatus. In the tray are placed glass capsules to contain the pieces of organs or tissues which are to be stained, washed, hardened, or impregnated. In order to set the tray in motion, the plate S is levelled horizontally by the screw V, and water through a lead pipe is run into the compartment *b* of the hopper, so that it strikes against the wheel R and sets it in motion. The rapidity of the wheel's motion is regulated by different calibre of tube, &c.

As an example of how the apparatus works, it is stated that sublimate solutions, &c., can be extracted in two days, the spirit only requiring to be once removed.

To make gelatin tubes for the Esmarch method, the screw V is made to give a greater or less inclination to the apparatus, according as there is more or less gelatin in the tube (see fig. 79). The water stream is then run into the *a* compartment, so that it first runs out through the pipe P to cool the test-tube T, and then passes over the barrier into the *b* compartment, and so sets the wheel in motion.

FIG. 81.



Injection-syringe for Bacteriological Purposes.* — This syringe, which is the invention of E. Stroschein, consists of two glass tubes which are somewhat like ordinary test-tubes though smaller. The inner, narrower tube is prolonged at its front end to a conical point on which to fit the canula; at its posterior end is a small hole. The outer tube simply fits over the inner, and the two are connected with a caoutchouc band.

The syringe is filled by merely dipping the canula into the fluid to be injected, and then drawing the outer tube back as far as the elastic band permits, and so by creating a vacuum the fluid is sucked into the inner tube. Of course the fluid is injected by merely reversing the action. This little instrument, which is very moderate in price,

* Mittheil. aus Dr. Brehmer's Heilanstalt, 1889. Cf. Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 746–7 (3 figs.).

fulfils every requirement for bacteriological work as it is easily taken to pieces, and its constituent parts easily disinfected by dry or moist heat, or by chemical agents.

Staining the Flagella of Bacteria.*—Prof. F. Loeffler communicates a much improved method for staining the flagella of micro-organisms, the key to the procedure consisting in the greater or less acidity of the mordant. The quantitative differences in the reaction of the mordant are extremely slight, and vary with the different bacilli.

The best results were obtained from using 10 ccm. of tannin solution (20 + 80 water) to which had been added 5 ccm. of cold saturated ferrosulphate solution and 1 ccm. of aqueous or alcoholic solution of fuchsin, methyl-violet, or woolblack. This last pigment is used for dyeing wool without a mordant, and when dissolved in water is of a blue-black colour.

The foregoing solution, especially when made up with fuchsin, is to be regarded as the stock solution, and one which will stain the flagella of certain micro-organisms such as *Spirillum concentricum*, but for others the addition of an alkali or an acid is necessary. Thus, for typhoid bacilli 1 ccm. of 1 per cent. caustic soda solution is required, while *Bacillus subtilis* needs 28–30 drops, the bacillus of malignant œdema 36–37 drops, and so on. For cholera bacteria it is necessary to add 1/2–1 drop of sulphuric acid, for *Spirillum rubrum* 9 drops, to the 1 per cent. soda solution, the quantity of which is not however mentioned.

This is the mordant and it differs from that previously given by the author by certain omissions.†

The whole procedure now goes as follows. A small quantity of the pure cultivation is mixed up in distilled water, and with some of this the cover-glass is lightly smeared with a platinum loop. It is of the utmost importance that the cover-glass should be perfectly clean and free from grease or other impurities. The covers should be boiled in strong sulphuric acid, washed in distilled water, and having been immersed in ammoniated alcohol, dried on a clean cloth.

The bacteria, when spread on, are fixed in a flame. For staining flagella this is absolutely necessary, but it is also as important not to over-heat. The correct amount of heat may always be estimated by holding the cover between the thumb and forefinger, instead of using forceps; by this device overheating is avoided. While still warm, the mordant is applied. The cover-glass is then heated until it begins to vaporize (1/2–1 minute). It is then successively washed in distilled water and absolute alcohol.

The staining solution is then dropped on in quantity sufficient to cover the cover-glass, which is again warmed until the solution vaporizes and then the cover-glass is washed in distilled water.

The composition of the staining solution is ordinary neutral anilin water in which solid fuchsin is dissolved to saturation. To this as much of a 1 per cent., or still better 1 per thousand, soda solution is added as to bring it almost to the point of precipitation. Although it is not

* Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 625–39 (8 photographs).
† See this Journal, 1889, p. 711.

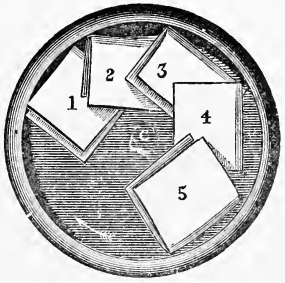
absolutely necessary to add the soda solution better results are thereby obtained.

With regard to the necessary addition of alkali or acid to the mordant, the author points out that there is some connection between this fact and the formation of acids and alkalies by certain bacteria: for the acid-forming bacteria required the addition of alkali, and the alkali-producers the addition of acid before they would stain.

Another interesting observation made by the author was that some bacteria possess tufts of flagella, and these are well demonstrated in the photographs accompanying this paper.

Staining Spinal Cord with Naphthylamin Brown and Examining with the Dark-field Illumination.*—For preparing serial sections of spinal cord, Herr O. Kaiser finds the following procedure useful. The sections imbedded in celloidin are removed from the knife with filter paper and placed at once in the following staining solution:—Alcohol, 100; water, 200; naphthylamin brown, 1. The sections folded up in filter paper are arranged in a glass capsule, as shown in the figure. Herein they may remain for some hours to two days. The sections when removed from the staining fluid are washed with 96 per cent. spirit and then placed on the slide. When the excess of alcohol is removed the sections are fixed to the slide by blowing ether vapour over them through a pipette bottle. As the sections become a little creasy, a few drops of absolute alcohol are run over them, after which the slide is placed in origanum oil, then in xylol, and the specimen finally mounted in balsam. Naphthylamin brown colours the chromophilous cells dark brown, while the chromophobous cells appear as bright objects on a dark ground. The blood-corpuscles are of a coppery red hue. In order to distinguish between the grey and white matter, it is necessary to use the dark-field illumination. This is easily done by inserting a stop in the Abbe condenser. The white substance now shows up as a bright yellowish-brown, while the grey matter is dark brown, all the finer details being quite clear. The blood-corpuscles are of a bright scarlet hue, so that the vessels seem injected.

FIG. 82.



Staining the Endings of Motor Nerves with Methylen-blue.†—Prof. A. S. Dogiel, after recommending this method, and alluding to the usual procedure, states that it may be simplified and improved in the following manner. The tissue removed from living or recently killed animals is placed on a slide or in a watch-glass containing some drops of aqueous or vitreous humour. To this are added two to three drops of a 1/15 to 1/16 per cent. solution of methylen-blue made up with physiological salt solution. In this condition the preparation is left exposed to the action

* Zeitschr. f. Wiss. Mikr., vi. (1889) pp. 471–3 (1 fig.).
† Arch. f. Mikr. Anat., xxxv. (1890) pp. 305–20 (1 pl.).

of the air, but protected from the dust by a large watch-glass. The preparation may be examined from time to time under a low power to see how the staining is getting on. The effect varies extremely: thus the endings of motor nerves stain in 5–10 minutes, while the nerves in the retina require two or three hours or even longer.

As the staining disappears in a comparatively short time, it becomes necessary to fix the pigment. For this purpose picrate of ammonia is advised. This saturated aqueous solution precipitates the methylen-blue in a finely granular condition, rendering the rest of the tissue highly transparent. The length of time required for fixing the stain varies of course with the thickness of the tissue; some specimens are fixed in 20 minutes, while others require as long as 12 hours. The preparations are then mounted and examined in a mixture of equal parts of glycerin and distilled water.

Preparations which have been stained with methylen-blue may be hardened by immersion for 2–3 hours in a saturated spirituous solution of picrate of ammonia and then, having been imbedded in elder-pith or liver, sectioned with a razor. The sections are placed in glycerin. Or the stained tissue may be frozen and then sectioned.

By the foregoing method the author has obtained very excellent results, judging from the illustrations which accompany the text, from muscles of Amphibia and Reptilia. The procedure is less complicated than that where the stainings are obtained by injecting the vascular system with a solution of methylen-blue.

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

Arranging Diatoms.* — Mr. Cunningham states that he arranges selected diatoms by transferring directly from a strewn slide to the exhibiting slide by the aid of a "Kain's mechanical finger" attached to a Beck's 1/2-in. objective, the slide being manipulated by the left hand, and the bristle being directed into the field from the left-hand side. This method, he says, counteracts the effect of reversal of image, enabling every desired movement to be accomplished with ease and certainty. The right hand assists in racking the diatom from the slide high enough to clear the edge of the cover-glass upon which the diatoms are to be fixed. Very minute species are selected and isolated by this means.

New Mounting Dammar.†—A very superior mounting medium was accidentally discovered by adding by mistake liquor potassæ to a thick solution of benzol-dammar. After the lapse of some months, the jar, with a beautifully clear zone of some sort of gummy material superimposed upon a white one, was discovered. The clear zone, some 6 ounces, was drawn off and tested as to drying and other properties. It was found that it dried slowly, but ultimately set very firmly. Placed on a slide heated to a point that instantly vaporized water, it dried without forming a bubble. Used as a mounting medium on a hot slide, no bubbles were formed, and while in bulk the colour is somewhat darker than Canada balsam, in ordinarily thick mounts it is almost imperceptible.

* Journ. N.Y. Micr. Soc., vi. (1890) p. 60.

† St. Louis Med. and Surg. Journ., lviii. (1890) p. 37.

Alcoholic Method of Mounting Bryozoa.*—Miss V. A. Latham, when adopting the alcoholic method of mounting, first rings a cell of the brown cement and allows it to harden thoroughly; then, she says, "cover this entirely with balsam and benzol, and when dry again make it slightly sticky by a thin line of balsam which fastens down the cover-glass. Ring over all another layer of the last cement, and when dry use brown cement to completely seal the mount which, when dry, can be finished as the mounter wishes. Or, instead of the above method, after the organisms have been fixed and coloured, pass them through alcohol 30 per cent., 50 per cent, 70 per cent., and absolute, the last at least twice, and let them stand covered for 24 hours. Replace the spirit by pure benzol, remove about a tenth of the alcohol in which the organisms are placed with a pipette, and replace by the same amount of benzol; repeat this a number of times (about twelve) at intervals from 10 to 30 minutes. Great care must be taken that the benzol mixes thoroughly. After the last addition pour the fluid off and substitute pure benzol. At the end of 24 to 48 hours in the benzol, according to the size of the object, a fifth part of the Canada balsam dissolved in benzol is added; this is repeated at intervals of from a quarter to half an hour; the objects may now be preserved in the tubes till wanted, or mounted at once. In mounting. care must be taken that each drop holds in suspension a sufficient variety of the organisms. The method is not quite so tedious as it appears from the reading."

Kaiser's Glycerin-Gelatin.†—One part of the best French gelatin is macerated in six parts by weight of distilled water for about two hours. To these are added seven parts by weight of pure glycerin, and to every 100 grams of the mixture 1 gram of pure carbolic acid. The whole is then warmed for 10–15 minutes with constant stirring until all the lumps and flakes which form after the addition of the carbolic acid have disappeared. The decoction is then filtered through the finest glass-wool, which has been previously washed in distilled water, and placed still wet in the funnel.

* Microscope, ix. (1889) p. 141.

† Bot. Centralbl., i. p. 25. Cf. Jahrb. f. Wiss. Bot. (Pringsheim), xxxi. (1891) p. 400.

PROCEEDINGS OF THE SOCIETY.

The first Conversazione of the Session was held at King's College on Wednesday, the 27th November, 1889.

The following objects, &c., were exhibited:—

Mr. C. D. Ahrens:—Polarizing Binocular Microscope.

Mr. H. P. Aylward:—Patent Spring Clip for securing the covers of jars, &c.

Educational Series of Botanical Preparations.

Rev. G. Bailey:—Section of Coniferous Wood from Flint, Lewisham.

Mr. C. Baker:—Samoan Deposit under Zeiss' Apochromatic 1/2 in. N.A. ·65 and Abbe's Condenser with dark-ground illumination.

Test Objects under Apochromatic Objectives: Zeiss' 1/6 N.A. 0·95 and 1/8 oil-immersion N.A. 1·40 and Abbe's Achromatic Condenser.

Amphipleura pellucida × 1500 under new formula 1/12 oil-immersion N.A. 1·25 (Student's Series).

New Microscope Lamp, with horizontal and vertical rack movements suggested by Rev. Dr. Dallinger.

Automatic Microtome.

Bausch & Lomb Optical Co.:—Microscopes and Objectives.

Messrs. R. and J. Beck:—Podura Scale with new 1/18 oil-immersion.

Amphipleura pellucida with new 1/20 oil-immersion.

Mr. W. A. Bevington:—Section of Head of Indian Locust.

Mr. A. C. Cole:—Transverse Section of Human Left Median Nerve, stained for Photomicrography; and Photograph of the same slide.

Optical Vesicle of a Human Embryo in the sixth week. T. S.

Mr. Crisp:—Stereo-photomicrographs of Human Embryos.

Mr. Dadswell:—*Coryne pusilla.*

Membranipora pilosa.

Mr. F. Enock:—Slides of various Insects.

Mr. H. Epps:—Section of Bean, *Cacao Theobroma*, showing starch-grains *in situ.*

Mr. H. E. Freeman:—Parasite of Humble Bee, *Trichodactylus* sp.

Mr. C. Haughton Gill:—Diatoms prepared by a new method.

Mr. W. Godden:—Diatoms from Skye, N.B.

Mr. W. Goodwin:—Diatoms illuminated by new superstage illuminator.

Prof. J. W. Groves:—Transverse Section of Root of *Iris florentina.*

Transverse Section of Root of *Acorus calamus*, stained with acid methyl-green and borax-carmine.

Mr. J. D. Hardy:—*Vesicularia valkeria.*

Mr. John Hood:—*Bursaria truncatella*, adult form.

Mr. J. E. Ingpen:—*Licmophora flabellata* mounted in saturated solution of common salt by Mr. J. G. Tatem.

Cephalosiphon, &c.

Mr. R. Macer:—*Melicerta tubicolaria.*

Mr. A. D. Michael:—*Cothurnicella cordieri* from Cherchel, Algeria.

Messrs. Powell & Lealand:—New cheap Oil-immersion 1/12 in. N.A. 1·28.
New cheap Oil-immersion 1/20 in. N.A. 1·26.
Mr. B. W. Priest:—Statoblast of *Uruguaya repens* Hinde, River Uruguay.
Mr. C. Rousselet:—*Anuræa aculeata*, *A. cochlearis*, *Asplanchna priodonta*, *Triarthra longiseta*, *Brachionus angularis*.
Mr. G. E. Smith:—Melaphyre with Agates *in situ*, Oberstein.
Silicified Coral, *Isastræa oblonga*, Portland, Tisbury.
Mr. W. T. Suffolk:—Flea mounted in glycerin in 1858.
Mr. J. J. Vezey:—Multipolar Nerve-cells (Corpuscles) from Spinal Marrow.
Mr. F. H. Ward:—*Nitella batrachosperma*, species new to Britain.
Section of Thorn of Rose.
Portable Stand for Steinheil Lens.
Messrs. Watson & Sons:—Type Slide of Diatoms from St. Peter.
Pollen of *Malope*.
Type Slide of Spines of Echini.
Transverse Section of *Ascaris*, showing Oviducts, Uterus, Alimentary Canal, &c.
Tentacle of Snail, showing Eye.
Section of Wall of Pitcher-plant, showing Glands.
Mr. T. Charters White:—Album of Photomicrographs.
Horizontal Section, Human Scalp.
Cartilage of Sheep.
Dental Exostosis.

The second Conversazione of the Session was held at 20, Hanover Square, on Wednesday, the 30th April, 1890.

The following objects, &c., were exhibited:—
Rev. G. Bailey:—Spicules and Foraminifera washed from base of *Euplectella*.
Mr. C. Baker:—Zeiss's Apochromatic Objectives.
Photomicrographs produced with Apochromatic Objectives.
Zeiss's Stand I*a* with new Mechanical Stage.
Mr. W. A. Bevington:—Polycystina.
Mr. P. Braham:—Crystallization of Metals by Electricity.
Crystals of Gold and Antimony in Carbon Disulphide.
Mr. E. T. Browne:—*Achorutes purpurescens*.
Smynthurus niger.
Mr. C. Haughton Gill:—Diatoms prepared by new process to show markings more clearly.
Mr. W. Godden:—Photomicrographs of Greek and Græco-Roman Gems and Coins.
Mr. J. D. Hardy:—Search-tank and Microscope.
Mr. R. T. Lewis:—New Zealand Coccidæ.
Mr. R. Macer:—*Fredericella sultana*.
Desmids.
Prof. Maskell:—*Inglisia Fagi*, *I. Leptospermi*, and *I. patella* from New Zealand.

Mr. A. D. Michael:—*Uropoda ovalis*, showing side view of spermatheca, perigynum, vagina, &c.
Mr. J. H. Mummery:—Section of Human Tooth, showing the Palps.
Mr. E. M. Nelson:—Photomicrographs of Diatoms, Pine, &c.
Mr. C. H. Oakden:—*Arrenuris caudatus*.
Messrs. Powell & Lealand:—*P. angulatum* and other Diatoms shown with 1/4 in. and 1/6 in. Apochromatic Objectives.
Photomicrographs produced with above objectives.
Mayall's Jewelled Fine-adjustment.
Mr. B. W. Priest:—Surface Organisms, 30 fathoms, Faröe Channel.
Messrs. Ross & Co.:—Wenham's Radial Microscope.
Schroeder's Camera Lucida.
Mr. T. B. Rosseter:—Entozoon from *Cypris cinerea*.
Strongylus from *Bufo vulgaris*.
Mr. C. Rousselet:—Rotifera with observation tank.
Mr. G. J. Smith:—Andesite, Mount Shasta, California.
Headon Hill Limestone, Christchurch Bay.
Lumachella (Fire Marble), Carinthia.
Basalt Dykes in Carboniferous Limestone, Carlingford.
Mr. T. F. Smith:—Photomicrographs of Diatom Structure.
Mr. W. T. Suffolk:—Glandular Hair of *Drosera rotundifolia*.
Mr. J. J. Vezey:—Sudoriparous Glands from the Skin of the Hand.
Mr. F. H. Ward:—*Bacillus tuberculosis* and broken-down Lung-tissue.
Messrs. Watson & Sons:—Type Slide of Eggs of Butterflies, Moths, &c.
Sporocarp of *Pilularia*, showing Spores.
Lieberkühn's Glands in Human Intestine.
Head of Lamprey, Section through Gills.
Section of Dodder on Heath.
Diatoms (about 200 specimens) from St. Peter, Hungary.

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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

F. JEFFREY BELL, M.A.,

One of the Secretaries of the Society
and Professor of Comparative Anatomy and Zoology in King's College;

WITH THE ASSISTANCE OF THE PUBLICATION COMMITTEE AND

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

JOHN MAYALL, JUN., F.Z.S.,
R. G. HEBB, M.A., M.D. (*Cantab.*),

AND

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

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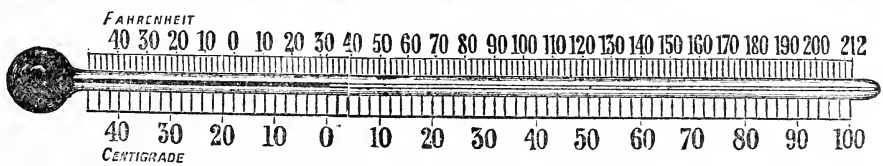
Numerical Aperture. ($n \sin u = a$.)	Corresponding Angle ($2u$) for			Limit of Resolving Power, in Lines to an Inch.			Illuminating Power. (a^2.)	Penetrating Power. $\left(\frac{1}{a}\right)$
	Air ($n = 1{\cdot}00$).	*Water* ($n = 1{\cdot}33$).	*Homogeneous Immersion* ($n = 1{\cdot}52$).	White Light. ($\lambda = 0{\cdot}5269\ \mu$, 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	68·2	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



JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

DECEMBER 1890.

TRANSACTIONS OF THE SOCIETY.

X.—*The Tube-building Habits of Terebella littoralis.*

By Arnold T. Watson.

(*Read 19th November*, 1890.)

Plate XIV.

It is a well-known characteristic of certain Annelids, of the family Terebellidæ, that they inhabit tubes which they have themselves carefully constructed with grains of sand, stones, broken shells, and similar materials cemented together, and their method of building such tubes has, in a general way, been more or less clearly described by Dalyell, Gosse, J. G. Wood, and others. Some of these dwellings are simply tubes of an internal diameter adapted to the worm which inhabits them, and of variable length, the greater portion being buried in the sand, but with a free open end rising above the surface. In certain species (as *Terebella littoralis*) this free end is ornamented with remarkable arborescent or pectinate processes, the delicate

EXPLANATION OF PLATE XIV.

Fig. 1.—Sketch of living Terebella in tube *t*, collecting sand with its tentacles *te*, and showing especially the lips *p* used in building. Ventral view. Tube in section.

„ 2.—Ditto, showing tentacles *te*, lip *p* stretched upward to receive building material, and the tree-like branchiæ *Br* protruding from mouth of tube *t*. Lateral view.

„ 3.—Terebella placing sand on edge of tube by means of lip *p*; grains of sand *gr* shown travelling down tentacles *te*.

„ 4.—Sketch showing hood-shaped prostomium (lip) *p* placing sand-grains *gr* one above another in line to form filaments *ft*. Some filaments already formed. Uncini *u*; setæ *ch*. Ventral view.

„ 5.—Diagram showing lateral view of prostomium *p*. Sand-grains *gr* travelling up inside to be attached in due course.

„ 6.—Sketch of tube with pebbles and broken shells attached, showing flattened bushy head of sandy filaments. Natural size. From a rock-pool.

„ 7.—Sketch of bushy tube with large pebbles and coralline attached, showing close resemblance between the sandy filaments and the coralline. Natural size. From a rock-pool.

„ 8.—Transverse section of tentacle of Terebella, showing the hollow interior *i*, and the ciliated groove *cl*. × 100.

beauty and gracefulness of which render it an interesting question how the animal manages to construct them; and the method actually adopted, which I observed last year, has, I believe, not been previously described. In order to render a clear account of the process, it is necessary to preface a few words descriptive of the animal.

These worms, which are to be found on almost all the sandy seashores of Europe, vary in size from an inch to possibly eight or nine inches in length, according to age. The body is divisible into two main portions—the anterior, which in a large specimen is a quarter of an inch or more in width, consisting of about twenty segments; and the posterior, which is prolonged into a cylindrical tail, of small diameter, composed of numerous segments. The anterior extremity is the prostomium, from the back of which spring a large number of long, simple, filamentous tentacles almost surrounding the mouth. The buccal segment, which follows, is produced in front and forms an under lip. Then come three segments, each bearing a pair of beautiful arborescent red branchiæ, followed by the notopodial fascicles, containing their peculiar setæ. Ventral to these are situate the oval tori, bearing the uncini, which latter are continued throughout the body, the form of the tori varying in the posterior portion of the animal. The tentacles, the prostomium, and probably the lower lip, are the organs employed in the building operations. The tentacles, which in section present a cordate shape (fig. 8), are long, hollow, tubular, very extensile filaments, communicating with the body-cavity, the perivisceral fluid from which travels freely up them, favouring their extension and contraction. These filaments are richly provided with vibratile cilia on the two edges, and also on the central line of the side which is turned towards the mouth of the worm. Their sides are covered with mucus-secreting cells, and the two outer edges of the tentacles are capable of being folded together longitudinally, so as to form either a hollow cylinder or a semicylindrical channel at will.

This power, assisted by the secreted mucus, enables them to grasp at any point small stones or grains of sand, which are then passed forward to the prostomium, either by ciliary, or a kind of peristaltic action (the sides of the tentacle closing up behind the stones), or by sudden muscular contraction of the tentacle, or by a combination of all three. The chief office of the tentacles, in the building work, is to collect and carry materials, though they also sometimes temporarily support large stones, shells, &c., which are being fastened to the edge of the tube. They also collect food for the worm, and are believed to discharge certain other functions, the discussion of which is outside the object of this paper. The large upper lip is a most wonderful organ, capable of assuming an infinite variety of forms, and is, if I may use the expression, the bricklayer.

In what may be called common walling, i. e. building the tube itself, the operation is simple, and easy to observe. Sand-grains,

small stones, &c., are collected by the tentacles, and in the accompanying drawings are shown travelling towards the prostomium. Some of the tentacles are quite short, and it is evidently their duty, when material is brought within their range by the others, to transfer it to the prostomium, which organ stretches up in a most eager manner to receive it, bending expectantly towards the tentacles, and turning now this way and now that until satisfied, reminding one of the action of an elephant's trunk. This attitude is shown in the lateral view, fig. 2. When the material reaches the prostomium it is quickly rolled over within the mouth and covered with a white transparent cement; the animal then bends over and deposits it upon the free edge of the tube, as shown in fig. 3, immediately after which it holds up its lips for a further supply.

This operation may be watched for long periods together, but the observation of how the sandy fringe is built is a most difficult matter, and was only attained after about fourteen days of almost constant watching. In building the body of the tube the sand is deposited, sometimes grain by grain, at other times several grains at once, and during the work the body of the worm is usually well within the tube, the fore part protruded only just far enough to work comfortably, the lips constantly receiving new material and placing it, *as received*, upon the growing edge of the tube; but in building the sandy branching filaments a different method is pursued. A moderately large grain of sand is first laid as a foundation stone; then the creature usually retires into its tube, and the tentacles collect and carry down to it a large supply of grains of sand, which is all received by the lips, and no doubt duly coated with the secreted cement. The animal now slowly emerges, and lays first one grain upon the foundation stone; then, whilst still holding this with the lower portion of its lip, it forces a second grain, out of the supply in its mouth, above the first, through the upper portion of its lip. It then slides the whole lip upward to the second grain, which it holds as before, passing forward above it a third grain, and so on until the whole supply is exhausted, the worm keeping hold with its lip all the time, and withdrawing at lightning speed as soon as the last grain is attached, the whole operation occupying, in the cases I observed, from 5 to 10 seconds only. The straightness of the filament is secured by the above means combined with a very steady and gradual advance of the body of the worm as each grain is added. When the top grain is laid the creature has often emerged so far that the whole three pairs of branchiæ are outside the tube. This advance is of course produced by the setæ pushing against the sides of the tube, whilst steadiness is secured by the hold which the uncini have upon its membrane-like lining.

Figs. 4 and 5 will make the above description intelligible. Fig. 4 is a front view, showing the prostomium, as temporarily a hood-shaped organ, clasping with the lower portion of its lip the second of a series of grains which it is fixing, whilst a third grain is

being forced into position through the upper portion. Fig. 5 is a diagram showing a side view of the same organ, with other grains travelling up inside to be attached in due course.

Any long, thin, cylindrical particles, such as spines of *Echini*, spicules of sponges, &c., are utilized for fringe-making, and are deposited separately. The filaments built under my observation consisted of single grains of sand cemented one above the other in a straight or curved line, but those found on some tubes are delicate columns consisting, in cross section, of two or three grains placed side by side and cemented together. It is probable that in these cases a column is first built of single grains and afterwards strengthened or thickened by additional material.

The fringe-building operations appear to be chiefly carried on during the night, and many hours and even days may, and frequently do, elapse between each favourable opportunity for observation.

M. A. de Quatrefages,* writing in 1865, and Messrs. J. T. Cunningham and G. A. Ramage † in 1887, describe the filaments of the fringe as hollow "tubules," and say that "when the head of the worm is protruded the tentacles are partly contained in them, and so protected." This is certainly not the case in any specimen which I have seen, and I have examined a very large number. The filaments are solid columns, along which the tentacles do frequently stretch themselves, but which it is impossible for them to penetrate, for on examining the tube internally no opening to these "tubules" is visible. Moreover, it seems to me that were the hitherto prevailing idea correct, these "tubules" would, so far from protecting the animal, prove rather a source of danger by impeding its hasty retreat. The object of these filaments it is impossible to divine with certainty, but three or four advantages occur to me as possibly connected with them. (1) They may act as snares to catch food; I have several times seen the worm pass its upper lip and tentacles along the filaments. (2) They may form favourable vantage points from which the animal can fish around with its wonderful tentacles, supplying, as it were, rods to the fishing lines. (3) These filaments or fringes are set upon two semicircular flaps, facing each other, and falling together when the water leaves them; so they may be a protection by thus closing the tube. Or (4) it may be a case of protective mimicry, the resemblance to the surrounding growth of coralline being very close.

I have found that the tubes can be preserved as museum specimens by treatment with sea-water saturated with calcium chloride, and subsequent drying, during which the fringe should be carefully lifted and picked out with a needle. I have one such specimen with a spray of coralline attached (just as taken from the pool), in which it is almost impossible to distinguish the one from the other (fig. 7).

* Quatrefages, A. de, 'Hist. Nat. d. Annelés Marins et d'Eau douce,' ii. (1865) p. 346.

† Trans. Roy. Soc. Edinb., xxxiii. (1888) p. 664.

From a sanitary point of view these fringes might be regarded as likely to hinder the free expulsion of refuse matter, but this is not the case. Such matter is thrown with some force quite clear of the tube by the animal doubling itself into a U-shape, and forcing the long narrow posterior portion of its body well out of the mouth of the tube.

I may remark that the semicircular flaps appear to be formed *after* the fringe by a process of shelly plating filling up the spaces between the filaments. Usually the fringed summit only of the tube projects above the sand, but the portion buried is sometimes of very great length. This summer I obtained tubes no less than 19 in. long, and I am not sure that even then the whole length was secured, as it is exceedingly difficult to dig them unbroken out of the loose wet sand into which they descend almost vertically.

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.†

Intensive Segregation.‡—Rev. J. T. Gulick advances from the position maintained in a previous paper on "Divergent Evolution through Cumulative Segregation." There he enumerated no less than eighteen sets of natural causes dividing species into sections which do not interbreed, and sought to show how these causes, often acting in complex combination, tend to produce cumulative segregation and divergent evolution. His object now is to show how separation from the first involves more or less segregation, or how segregation, that at first divides the species into sections with reference to some one endowment, is always tending toward intensified segregation in which the sections present differences in regard to an increasing number of endowments.

Experience in domestication shows that segregation is a controlling factor, whether it be in the deliberate preservation of special varieties, or simply in that prevention of crossing which necessarily results when separate sections of a domesticated species are under the care of distinct tribes of men. But in nature species are similarly divided into sections, which are usually assorted with reference to some definite point or points of character, and divergent evolution results. Division of the species involves some segregation, and whenever the transforming influences of the other factors of evolution begin to operate in the different sections, the initial segregation is inevitably intensified and the divergence increased. For it is in the last degree improbable that change produced

* 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.

‡ Journ. Linn. Soc. Lond.—Zool., xxiii. (1890) pp. 312–80.

by these factors of transformation in sections prevented from crossing should be completely parallel in the different sections, even when exposed to the same environments. The next step which is taken in the latter half of the present paper, is to show "that the relations to each other of varieties, species, genera, and the higher groups are such as would necessarily be presented if all such differences were the result of evolution that is always dependent on some form of segregation, but not always on diversity of natural selection, nor always on exposure to different environments."

Mr. Gulick maintains and cites facts in support of his view that "persistent differences, whether varietal, specific, or generic, are not all adaptational, for some of them have no relation to utility; and that adaptational differences are not all advantageous, for some of them relate to adaptations that would meet with equal success if the organisms should exchange habitats; but that in every case divergence, whether utilitarian or non-utilitarian, whether advantageous or disadvantageous, is not maintained without independent generation," or, in other words, requires the prevention of interbreeding.

The paper contains an interesting discussion of the various (eight) factors of transformation and of the different forms of selection, while the argument is illustrated by an account of divergent evolution in the land-molluscs of Oahu and in a number of insects. But we are not able to do more than give the general argument by which Mr. Gulick shows how segregation is intensified.

Definition of Species.*—Prof. F. Lataste offers the following definition of a biological species. The category of organized beings designated under the name species is composed in space and time:—

(1) Either of two collections of individuals of different sexes, one of which—the female—is generally capable of being fecundated by a male, or of a single collection of non-sexual or hermaphrodite individuals; the individuals of each collection, on the one side, present with one another the same relations of resemblance as with all the normal descendants of any one of them (general case), or at least with some of the descendants (cases of polymorphism and alternation of generation); and, on the other side, the morphological interval between the most distinct individuals of each collection is filled up by intermediate individuals in such a way that we pass from one to the other by an insensibly gradual series of modifications.

(2) And of all the individuals which certainly arise from those comprised either in the single or in the two collections, as above defined, whatever be the degree in which they may differ, either normally and collectively (polymorphism, alternation of generation), or accidentally and individually (monstrosities).

Comparison of Oogenesis and Spermatogenesis.†—Prof. O. Hertwig makes a fresh comparison of oogenesis and spermatogenesis in Nematodes, and finds in this "a basis for the discussion of disputed questions." The mother-sperm-cell corresponds to the immature ovum. During a prolonged resting-state the nuclear substance in both is peculiarly pre-

* Zool. Anzeig., xiii. (1890) pp. 480–3.

† Arch. f. Mikr. Anat., xxxvi. (1890) pp. 1–138 (4 pls.).

pared for two cell-divisions, the second immediately succeeding the first. Before division the amount of nuclear material is the same in the two sets of cells. During the two divisions there is no multiplication of nuclear substance; the results of division have only half as much nuclear material as there is in ordinary nuclei after dividing once. The number of chromatin elements in the nucleus of the mother-sperm-cell and in the germinal vesicle is the same as that of an ordinary nucleus at the middle of division, or double that of a nucleus in the preparatory stage of division. But the morphological value of these (germinal) elements is different, in consequence of an origin divergent from the normal process. For while eight daughter-chromosomata normally arise from the simple longitudinal cleavage of four filaments, here they arise by the double longitudinal cleavage of only two. Yet these two contain the same amount of material as the four formed by transverse division at the beginning of karyokinesis. Since the immature ovum and the mother-sperm-cell go through the same processes of nuclear division, with all their divergent characteristics, in precisely similar fashion, the products of division must also have the same morphological rank. The two daughter-sperm-cells correspond to the ovum and the first polar body; the four spermatozoa are comparable to the ripe ovum, the second polar body, and the two spheres arising from the division of the first; the polar bodies have therefore the morphological rank of rudimentary egg-cells.

Prof. Hertwig then asks whether the processes observed in the spermatogenesis of *Ascaris* occur elsewhere, and whether the formation of polar bodies is genuinely a double division of cell and nucleus. In the second part of the memoir he criticizes the theories of Minot, van Beneden, Weismann, Boveri and others, and enters into a long discussion of the facts and theories in regard to polar bodies. His own opinion is that they are abortive ova, that their production is comparable to that of spermatozoa from a mother-sperm-cell, and that their persistence is explained by the physiological importance of the reduction which they effect in the mass of the germinal vesicle.

Development of the Primitive Kidney in Man.*—Dr. H. Meyer has been able to study the development of the mesonephros in a human embryo of the first month. He describes the mesonephric ridge, which did not exhibit either on its external or internal margin any thickening or double layer of epithelial cells. The proximal part of the Wolffian duct arises from the mesoderm and is at first united to the pleuro-peritoneal epithelium, while its distal portion is united to the ectoderm. It is here, as elsewhere, a tubular communication between the body-cavity and the surface, and its ends are separated by the longitudinal growth of the embryo. The mesonephric canals and the Malpighian bodies are then described. Each segment of the mesonephric blasteme has three connections:—With the elements of the median plate or future peritoneal epithelium, with the cells of the corresponding primitive segment, and with the wall of the aorta. The first two connections show that the blasteme consists of elements both of the median and of the segmental or protovertebral plates.

* Arch. f. Mikr. Anat., xxxvi. (1890) pp. 138–72 (2 pls.).

Theory of the Placenta.*—Prof. C. S. Minot sums up his theory of the placenta of rodents as follows:—The egg fixes itself by the thickened ectoderm of the area placentalis, the ectoderm coalescing with the uterine epithelium; the maternal epithelium, including the glands, disappears by degeneration and absorption, though deeply-situated remnants of the glands may remain; the maternal capillaries of the submucosa become much enlarged, and their epithelium degenerates; the connective-tissue cells of the same layer are modified into decidual cells, and in the rabbit, in part into glycogenic cells; fœtal villi grow in place of the glands; they branch and increase, and penetrate the maternal tissue until there is little more than room left for the maternal blood-courses in the intervillous spaces.

Inversion of the Germinal Layers in Rodents.†—Dr. T. Biehringer discusses the problems connected with this curious process discovered by Bischoff in the development of the guinea-pig, investigated by Kupffer and Selenka in the field-mouse (*Arvicola arvalis*), by Fraser in the rat, by Biehringer in *Arvicola* (*Hypudæus*) *amphibius*, known also in the mouse, and probably occurring in *Dasyprocta*. The author shows that the conditions are simplest in *Arvicola*, next in the domestic mouse, then in the rat, most divergent in the guinea-pig, and describes each of these in turn. He explains how the inversion occurs, indicates clearly how the divergence supports, and does not weaken, the morphological constancy of the germinal layers, and shows what questions still remain unanswered, but the complicated facts of the case we must leave untold.

Development of Superior Incisors and Canines of Sheep.‡—Miss F. Mayo states that at a certain stage in the development of the sheep, the dental lamina exists throughout the canine and incisor regions of the upper jaw. Its anterior portion, which is the last to develope and the first to abort, does not attain so prominent a condition as its lateral portion. After advancing in development for a time, it retrogrades, and finally disappears. In the canine region the dental lamina gives rise to an enamel germ, which never reaches a stage of functional activity; its central cells are not transformed into a stellate reticulum, and the Malpighian layer never produces enamel, while in later stages both disappear. In this region there is no trace of a dentine germ. In the region of the incisors the evidences, even of the beginnings of tooth-development, have almost disappeared. There is every reason for supposing that the disappearance of the teeth has been a progressive process, beginning with the middle incisors and gradually affecting the teeth set further back.

Blastopore of Anurous Amphibia.§—Herr R. von Erlanger gives an account of his own observations on the fate of the blastopore, and comes to the conclusion that when his results are compared with those of Schanz and Morgan, we are justified in believing that the anus arises from the most ventral part of the blastopore, while the most dorsal forms the neuropore and neurenteric canal. In the Anura, that part of the blastopore from which the anus arises becomes temporarily closed, and

* Biol. Centralbl., x. (1890) pp. 114–22.
† T. c., pp. 403–14.
‡ Bull. Mus. Comp. Zool., xiii. (1890) pp. 247–58 (2 pls.).
§ Zool. Jahrb., iv. (1890) pp. 238–56 (2 pls.).

the anus only arises by a later breaking through ; in the Urodela, on the other hand, the most ventral part of the blastopore never closes. The formation of the anus of the Anura is therefore subject to secondary modification. The recent work of Prof. Götte supports this view.

Development of Kidneys in Fat-Bodies in the Frog.*—The following is a summary of the results of the studies of Prof. A. Milnes Marshall and Mr. E. J. Bles, on the development of the kidneys in fat-bodies of *Rana temporaria*. The head-kidney and its duct are mesoblastic structures, in the formation of which the epiblast takes no part; but the cloacal openings of the ducts are formed partly by outgrowth from the gut. In early larval life the head-kidney is a large and complex organ, but it begins to degenerate in tadpoles about 20 mm. in length. The first stage in its degeneration is the great and irregular dilatation of the tubules, accompanied by the destruction of their epithelial lining ; this is apparently due to the blocking of the archinephric duct. Ultimately the head-kidney disappears completely, its three nephrostomes closing up and undergoing atrophy. The peritoneal opening of the oviduct is a new formation, and not a persistent nephrostome. The tubules of the Wolffian body begin to form shortly before the head-kidney degenerates, they develope from behind forwards, and are at first segmentally arranged; they are formed from the mesoblast between the aorta and the archinephric ducts, and arise independently of the peritoneum. Nephrostomes are formed at an early period, and open into the body-cavity. The fat-bodies are formed from the anterior ends of the genital ridges.

Development of Blood-vessels of Frog.†—Prof. A. Milnes Marshall and Mr. E. J. Bles have studied the development of the blood-vessels in *Rana temporaria*. As to the heart, they found that it is developed before any of the vessels of the visceral arches, and before the dorsal aortæ. The muscular wall of the heart is formed from the splanchnic layer of mesoblast; the inner or endothelial wall is derived directly from the hypoblast of the ventral wall of the pharynx and of the hepatic diverticulum. The heart is from the first in connection at its posterior end with the veins of the yolk-sac and of the liver ; its several chambers become marked off by constrictions before its anterior end acquires any connection with blood-vessels. The apparent thickening of the wall of the ventricle is due to the development of an internal muscular reticulum, and the absence of nutrient vessels in this wall is explained by this arrangement. The valves of the truncus arteriosus are established before the metamorphosis. The blood-vessels arise as irregular lacunar spaces in the mesoblast, and these spaces open into each other and so form continuous channels. The mesoblast-cells surrounding the channels become converted into the epithelial walls of the vessels. The further growth of the vessels is sometimes effected by the formation of solid cellular cords, continuing the lines of the vessels. The axial cells of the cord break down and so give rise to tubular vessels. Blood-corpuscles are at first absent; when they do appear they are formed from the walls

* Studies from the Biol. Lab. Owens Coll., ii. (1890) pp. 133 58 (1 pl.).
† T. c., pp. 185-268 (3 pls.).

of the vessels themselves; they are true cells, at first spherical in shape and laden with yolk-granules.

The dorsal aortæ are, with the exception of the vitelline veins and the heart, the first vessels to appear. They arise on each side as a number of isolated lacunar spaces along the roof of the pharynx, which open into one another and so form continuous vessels. In each branchial arch there appears a lacunar efferent vessel at the level of the external gill; this extends dorsally, meets and opens into a diverticulum of the dorsal aorta. Immediately behind the efferent vessels, at the level of the gill, an afferent vessel appears; this is also lacunar and at first independent. After describing in detail the development and fate of the vessels the authors point out that throughout the early stages of development there is a striking resemblance in arrangement, relations, and proportions between the arterial and venous systems of the tadpole and those of an adult Elasmobranch. The external and internal gills apparently form one continuous series of structures. The tadpole undergoes a distinct increase in bulk before the opening of the mouth, and it is suggested that in the early stages, nutriment is absorbed through the sucker.

Process of Maturation in Ova of Selachians.*—Prof. N. Kastschenko points out that the process of maturation of meroblastic eggs has not yet been clearly made out. In one thing only have all investigators agreed, and that is that the germinal vesicle passes to the animal pole of the egg, and then finally disappears. The formation of polar globules was not, as a rule, observed, and was consequently denied, while no explanation was given as to whence came the ovarian nucleus.

Comparatively recently, the admirable work of O. Schultze on the process of maturation in the Amphibian egg has thrown much light on the subject. Although the author's observations are not complete they are, he thinks, sufficient to justify us in concluding that the process of ripening of the Selachian egg is, in all its primary phenomena, exactly comparable to that of holoblastic eggs. During maturation the polar globules are formed by karyomitotic division of the egg-cell; of the two one is separated off in the ovary and the other probably at the time of fertilization. The germinal vesicle, as a whole, is certainly not expelled from the egg, though some of its constituents may be. Prof. Kastschenko has not observed the granular coagulum noticed by several observers, and he thinks it much more probable that the fluid contents of the germinal vesicle, as well as its membrane, are simply dissolved in the yolk of the egg. The chromatin filaments of the polar spindle of the globules and of the ovarian nucleus are the same chromatin filaments (or their descendants) as are to be seen in the resting germinal vesicle long before the maturation of the egg.

Development of Teleostean Fishes.†—Dr. R. Fusari describes the first stages in the development of *Cristiceps argentatus*, and bases on his observations a number of conclusions. During the first stages of segmentation the perivitelline membrane continues to yield elements to the blastodisc, but later on, when the merocytes no longer remain as

* Zeitschr. f. Wiss. Zool., l. (1890) pp. 428–42 (1 pl.).
† Atti R. Accad. Lincei—Rend., vi. (1890) pp. 70–8.

individualized units, it is very doubtful whether elements can migrate from the parablast to the blastodisc or embryo. The majority of the nuclei of the perivitelline membrane, after a period of indirect division, degenerate into chromatolysis. The function of the membrane is to elaborate the lecithin material in adaptation to the nutrition of the embryo.

As to the germinal layers, the primitive entoblast divides into four portions:—(*a*) into a chordal portion which gives origin to the notochord, and (*b*) to the secondary entoblast, (*c*) into the elements of the mesoblast, and (*d*) into the residual or lateral entoblast. The interruption between the chordal and lateral entoblast marks the communication between the archenteron and the peritoneal cavity, where the mesoblastic folds have arisen by an abbreviation of that true evagination seen in *Amphioxus*. But the greater part of the mesoderm arises directly from gastrulation, as a peristomial formation especially on the dorsal lip of the blastopore.

Development of the Lamprey.*—Herr C. Kupffer publishes the first part of an extended memoir on the development of *Petromyzon planeri*. He accepts Böhm's account of the fertilization of the eggs, and emphasizes the fact that the fertilized ovum and its segments exhibit two distinct portions, namely, active "protoplasm" free from yolk lying around the nucleus, and outside this passive "paraplasm" rich in yolk. Kupffer's observations on the first steps in segmentation agree with those of Max Schultze. The time between fertilization and the hatching of the *Ammocœtes* varies markedly with the temperature, being seventeen days at Königsberg but only eight at Naples. It may be divided into five periods:—(1) from the beginning of development till the definite separation of the central nervous system from the ectoderm; (2) till the formation of optic vesicle and the auditory pit, and the segmentation of the mesoderm begin; (3) till the nasal plate begins to be formed and the two anterior gill-pockets are recognizable; (4) till the invagination of the mouth begins, when the gill-pockets are three in number, the auditory vesicle is constricted off from the epidermis, and cross-striped muscle-fibrils appear; (5) from the invagination of the mouth till hatching.

The cells of the most superficial layer of the morula unite into a blastodermic epithelium, beginning in an area on the future dorsal surface and spreading ventralwards. But before this is completed the blastopore is seen, so that gastrulation begins before the blastosphere is finished. A group of cells on the dorsal lip of blastopore, where ectoderm and endoderm are in contact, persists and increases, and determines the growth of the embryo in a caudal direction beyond the anus. This group is called the "teloblast."

Kupffer then describes the "keel," in which the rudiments of central nervous system and notochord are combined, and shows how this becomes divided anteriorly into the paired head-ganglia, the brain, and the notochord. The formation of the central nervous system is peculiar, but it is not so divergent as it seems, for the dorsal portion of the keel which becomes the nervous system is not the product of a "delamination"

* Arch. f. Mikr. Anat., xxxv. (1890) pp. 469–558 (6 pls.).

(as Shipley expressed it), but arises from a folding of the single-layered ectoderm of such a nature that the sides of the fold remain in contact. The teloblast seems like a reserve for both ectoderm and endoderm, as it comes into intimate relations with organs which arise from both layers; but in *P. planeri* it certainly does not give origin to the mesoderm. It is comparable to the "sickle" which Kupffer has described in other Vertebrate embryos.

In the second period, the nerve-cord is separated from the ectoderm, the gut becomes differentiated, and the mesoderm appears. There is a striking want of symmetry in the neural strand at the region of transition from head to trunk. But of most interest during this period is the endoderm in its two portions, the epithelial wall of the gut, and the yolk-cells which function as reserve-material. For now the formation of the dorsal mesoderm and of the segmental plates sets in. In the head-region, where the gut is not surrounded by the yolk-cells, the endoderm forms hollow dorsal folds in true enterocœlic fashion. But in the trunk-region the massive cushions of yolk-cells, lying on each side of the axial organs, change gradually into mesoderm, acquire a cœlom cavity, and are separated from the ventral mass. Yet this apparent combination of enterocœlic and schizocœlic processes is not strange; it depends upon the absence or presence of these endodermic yolk-cells. The open mesodermic fold of the gut in the head-region passes gradually with the thickening of its walls and the obliteration of its cavity into the massive mesodermic cushion of the trunk.

At this stage in his memoir Kupffer ceases to sketch the history of each period in its entirety, and proceeds to trace the rise of the various systems. The remainder of the present paper is devoted to the nervous system and sense-organs. As concerns the peripheral system, Kupffer recognizes at the end of the fourth period five distinct rudiments, which subsequently come into connection:—dorso-spinal and ventral-spinal nerves, lateral ganglia, branchial nerves, and epibranchial ganglia.

β. Histology.*

Intra- and Inter-cellular Ducts.†—Prof. F. Leydig supports the opinion which he expressed many years ago that the roots of a duct proceeding from a cell are continued into spaces lined by spongioplasm, and wonders, not unnaturally, that a recent observer of the intracellular nature of the ducts in the nephridia of the leech has not appreciated the figure in the well-known 'Histologie' of 1857. Some recent observations on the exploding glands of *Brachinus* (along with which *Agonum* must be ranked as another "bombardier-beetle") have convinced the veteran histologist that efferent canals may arise from intercellular ducts, and he recommends the study to those interested.

Cell-Studies.‡—In the present communication Dr. T. Boveri deals with the relation of the chromatic nuclear substance in the formation of the polar globules and in fertilization. From the study of various animals he is led to certain conclusions, which may be thus summarized.

* This section is limited to papers relating to Cells and Fibres.
† Biol. Centralbl., x. (1890) pp. 392–6.
‡ Jenaische Zeitschr. f. Naturwiss., xxiv. (1890) pp. 314–401 (3 pls.).

I. *Formation of Polar Globules.*—The emission of polar globules seems to be always associated with true karyokinetic division, that is, the chromosomes that are present are always divided in the formation of every polar globule, and the halves shared between the two daughter-cells. When the chromosomes are rod-like or filamentar, cleavage takes place in a longitudinal direction. In one and the same ovum the two polar spindles have the same number of chromosomes. The so-called maturation of the ovum presents us with a case in which the fate of the several chromosomes may be followed out during the whole course of the existence of a cell—the mother egg-cell. The fact that the chromosomes which are present in the division of this cell are identical with those which the cell had at its formation, induces us to conclude that the same is the case with those cells where the fate of the several elements has escaped observation. A peculiarity which may often be observed in the chromatic elements of the first polar spindle is that there are four of them. On this point the author dilates at some length. The elements emitted in the two polar bodies are, to our eyes, exactly identical with those which remain in the egg. In such eggs as have the polar spindles composed of two "ray-suns" the poles of the second spindle arise by division of the pole of the first, which remains in the egg.

II. *Fertilization.*—There is a certain variability in the relation of the chromatic substance in fertilization. The most striking point at first sight is the fact that in some cases the egg- and sperm-nuclei fuse, while in others they divide independently and break up in the fusing. The former has, up till now, been erroneously regarded as the more common process. As these differences have been observed in the several nuclei of eggs of one and the same animal, we must suppose that they have no significance. The author points out that if it does not matter whether the nuclear material of a cell is united into one nucleus or divided into two or several vacuoles, it will follow that the ordinary simple "nucleus" is neither morphologically nor physiologically an entity, but is, so to speak, only a common house for a number of equivalent, mutually independent constituents, which are just as well able to exercise their functions separately as together. These independent parts are the chromosomes. The other characters of the nuclei may exhibit considerable variations. There are cases in which the paternal chromosomes (e. g. in *Tiara*) arise directly from the homogeneous chromatin-body of the spermatozoon, and others in which a resting nucleus is first developed from the elements of the sperm-head. It is therefore certain that the paternal chromatin, as it is introduced into the egg, is not always at the same stage of development, and this explains certain differences that have been observed in the relative maturity of fertilized ova and of the fertilizing element. The paternal chromosomes which are given off from the sperm-nucleus to form the first cleavage-spindle agree in number, size, form, and apparent structure with the maternal elements supplied by the egg-nucleus.

III. *Numerical Relations of Chromosomes.*—For every species the number of chromosomes is constant, that is, there are the same number in the karyokinetic figures of homologous cells. There are, however, the most marked differences between the homologous cells of different,

even though very closely allied organisms, as may be seen from the following table :—

	In Polar Spindles.	In Cleavage Spindles.
Ascaris megalocephala (type Van Beneden) ..	1	2
„ „ (type Carnoy)	2	4
Coronilla sp.	4	8
Spiroptera strumosa and *Ophiostoma mucronatum* ..	6	12
Filaroides mustelarum	8	16
Echinus microtuberculatus and *Sagitta bipunctata*	9	18
Tiara sp.	14	28
Pterotrachea, *Carinaria*, and *Phyllirrhoë*	16	32

The number of chromosomes in the first is the same as that in the second polar spindle. The number formed from the egg-nucleus is similar to that of the elements devoted to the egg on the formation of the second polar body. As the egg- and sperm-nucleus give the same number of chromosomes to the first cleavage-spindle it follows that this last has twice as many chromosomes as each polar spindle, and also an even number. The generative cells of an organism contain half as many chromosomes as the first embryonic cell from which the organism arose. There are, it is to be noted, certain irregularities in some of these numerical relations, so that a definite number of chromosomes is not always characteristic of a species.

IV. *Chromatic Substance in Parthenogenesis and the Significance of Polar Bodies.*—The author thinks that the best hypothesis to explain the phenomena of parthenogenesis is that which regards the polar globules as rudimentary ova, and this he calls the phylogenetic or egg-hypothesis. When the second polar spindle is not removed it is clear that the number of chromosomes in such an egg is the same as in a fertilized ovum. He subjects the theories of Weismann and others to a close critical examination, and finds that facts which destroy the value of their hypotheses add strength to his.

Accessory Corpuscle of Cells.*—Dr. Emma Leclercq has made an investigation on the accessory corpuscle of the spermatic cell in which great attention was paid to the mode of fixation. She comes to the conclusion that these cells are more complicated than has hitherto been supposed. As a rule, they may be considered to be cells with two nuclei —the chromatic nucleus or nucleus of authors, which she calls passive, though not in a physiological sense, and the "Nebenkern" or accessory corpuscle which is the active nucleus and corresponds to the archiplasm of Boveri. The latter is a constant element of cells, and plays an important part in the spermatozoon, where it very probably forms the fibrillar axis of Braun, Jensen, and Ballowitz. There is a chromatic axis which is surrounded by achromatic fibrils, while the true nucleus, which is here and there traversed by the axis, forms for it a second envelope in that region which is called the head. This last is preceded by a procephalic achromatic portion which is derived from the accessory corpuscle.

* Bull. Acad. Roy. Belg., lx. (1890) pp., 137-48.

Red Blood-corpuscles.*—Prof. W. H. Howell has made an extended study of the formed elements of the blood of Mammals. He finds that in the very young embryo there are two forms of red corpuscles, one large, oval, and always nucleated, which resembles the corpuscles of the lower vertebrates; and one small, biconcave, circular in outline, and nucleated or not. The latter are the true mammalian corpuscles, and the former possibly represent ancestral corpuscles, The true mammalian corpuscles lose their nuclei by extrusion. In the first half of embryonic life new red corpuscles are produced in the liver from groups of mesoblastic cells outlining the position of future blood-vessels. The central cells of these cords become red corpuscles, while the peripheral form the walls of the veins. It is probable that new red corpuscles are formed in all parts of the body when blood-vessels are being developed. In the second half of embryonic life red corpuscles are formed in the liver, the spleen, and the marrow of the bones. In the Cat the two former lose this function three or four weeks after birth.

Leucocytes and blood-plates do not occur in the circulating blood of young embryos, but make their appearance in later embryonic life. The red corpuscles produced in the red marrow first occur as nucleated cells; these differ in structure with age. Two extreme types may be recognized —one mature and ready to be converted into a non-nucleated corpuscle, and one immature, as shown by the character of the nucleus and the amount of hæmoglobin. This latter multiplies by karyokinesis and the daughter-cells form mature nucleated red corpuscles, which lose their nuclei by extrusion. The liberated nuclei go into solution in the blood-plasma. The immature red cells are derived from spherical colourless cells, erythroblasts, which have a definite histological structure and are found in the marrow; they multiply actively by karyokinesis. These erythroblasts are derived from larger embryonic cells, which are usually described in the adult as ordinary marrow-cells, which also multiply by karyokinesis. The leucocytes of the blood are derived from lymphocytes; these enter the circulation as small corpuscles with vesicular nuclei and scanty protoplasm, and they are not amœboid. They develope into larger cells, with finely granular protoplasm, which possess the power of amœboid movement. These have at first an oval vesicular nucleus which afterwards becomes elongated; from this last form the multinucleated cells are derived by fragmentation of the nucleus.

Giant-Cells of Marrow.†—Prof. W. H. Howell divides the giant-cells of the marrow into two classes. Some are polykaryocytes or multinucleated giant-cells found in developing bone, in pathological formations, or porous bodies kept in lymph-cavities. Others are megakaryocytes or large nucleated giant-cells found in the red marrow of the adult and in the blood-forming organs of the embryo. The former have no special formation, are not related to the latter, and are formed by the fusion of smaller cells in consequence of too rapid growth. The megakaryocytes form a peculiar class of cells; they arise from the growth of small lymphoid cells, and afterwards reproduce by direct division. During their life they form a secreted material which can be seen for a time by the Microscope, but which finally dissolves in the

* Journal of Morphology, iv. (1890) pp. 57–116 (1 pl.). † T. c., pp. 117-29.

plasma. They seem to take no direct part in the production of nucleated red corpuscles or erythroblasts; after a certain period the nucleus alters in such a way that it stains diffusely and then fragments. This seems to be a degenerative change, and probably ends in the total disintegration and total dissolution of the cell.

γ. General.

Production of Light by Animals and Plants.*—M. R. Dubois has been led by a long series of investigations to the conclusion that the production of light in both animals and plants is connected with the conversion of colloidal protoplasmic granules into crystalloidal granules under the influence of respiration.

Origin of Vertebrates from a Crustacean-like Ancestor.†—Dr. W. H. Gaskell proposes to discuss, in a series of chapters, the origin of Vertebrates from a Crustacean-like, or more properly proto-Crustacean, ancestor. He commences by marshalling the evidence given by the central nervous system and pineal eyes of the *Ammocœtes* of *Petromyzon planeri*. The central nervous system of all Vertebrates consists of two parts—one nervous and one non-nervous; the latter is in part free from admixture with nervous elements, and partly helps to form the supporting tissue for them. This non-nervous part forms a canal round which the nervous material is grouped in the same manner as the nervous system is grouped around the alimentary canal. This similarity of grouping is not merely anatomical, but is also physiological; the functions of the supra-œsophageal ganglia, of the infra-œsophageal, and of the ventral chain, correspond to the functions of those parts of the Vertebrate central nervous system which are situated in the same anatomical position, with respect to the non-nervous tube, as the corresponding ganglia of the Crustacean with respect to the alimentary canal. From these facts Dr. Gaskell has already drawn the conclusion that the non-nervous tube of the Vertebrate central nervous system is the altered alimentary canal of the Crustacean ancestor of Vertebrates.

What, therefore, we may expect to find in a very low Vertebrate are more conspicuous vestiges of the mouth, œsophagus, and cephalic stomach than in higher forms; the pineal eye should be easily recognizable, and of a Crustacean type, while the proportion of nervous to non-nervous material should approach nearer to that found in Crustaceans than in higher Vertebrates. Similarly there should be in *Ammocœtes* something comparable to the large glandular organ known as the liver in Crustaceans.

In searching for the cephalic stomach, or for the mouth and œsophagus, Dr. Gaskell thinks his requirements are fulfilled, and further evidence in support is afforded by the relation of the infra-œsophageal and thoracic ganglia to the walls of the cephalic stomach, and the relation of the ventral ganglia to the walls of the intestine. The peculiar tissue, which is different from any other, the cells of which appear degenerated, which contains lines of pigment between its cells, which is found only in lower Vertebrates, and is gradually pushed out of existence in the higher classes as the brain increases in size, fills up

* Comptes Rendus, cxi. (1890) pp. 363–6.

† Quart. Journ. Micr. Sci., xxxi. (1890) pp. 379–444 (4 pls.).

the space around the brain because it represents some pre-existing organ which was of importance to the animal from which the Vertebrate sprung; such an organ is clearly the "liver" of Crustacea. The significance of the pigment is next discussed.

From his study of the optic organs, the author concludes that the original Crustacean-like ancestor had a pair of median eyes, each with its optic ganglia and connections with both supra- and infra-œsophageal ganglia; the right eye remained functional longer than the left.

With regard to the structure of the supra- and infra-œsophageal ganglia, Dr. Gaskell points to the fact that both the Crayfish and the Ammocœtes have giant-cells, large cells, and small cells. It is because the central nervous system of the Vertebrate is the direct descendant of the Arthropod that there is such similarity between them, and not because, as Bellonci supposes, similarity of function requires similarity of structure. The author just quoted has directed particular attention to the close similarity of the olfactory organ of the two groups. In the Ammocœtes the olfactory glomeruli resemble exactly in appearance the reticulated substance ("Punctsubstanz") of the Arthropod nervous system. But the author postpones the discussion on this point to the next chapter, in which the cranial nerves will be examined.

Origin of Vertebrates from Arachnids.*—Dr. W. Patten was first led to suspect that the Arachnida were the ancestors of Vertebrates from the fact that concentration and specialization of head-segments is, among Invertebrates, greatest in the Arachnida. The points which he now attempts to prove are (1) that in the Scorpion the cephalothoracic neuromeres, sense-organs, and mesoblastic somites present, in a general way, not only the same specialization and the same numerical arrangement in groups, but also the same difference as a whole from the body-segments, as do the corresponding parts in the Vertebrate head; (2) that the Arachnid cartilaginous sternum represents the primordial cranium of Vertebrates; (3) that in the Trilobites and Merostomata the internal structure of the cephalothorax resembles in some respects that of *Scorpio* and *Limulus*; (4) that the remarkable fish-like *Pterichthys* and related forms, judging from their external structure, are closely related to the Merostomata, and serve to connect Arthropods with Vertebrates; and (5) that the embryology of Vertebrates in its main features can be reduced to the Arthropod type.

The author brings forward suggestions rather than facts in support of his theory, but his views as to the classification of animals may be of some interest. (See Table, p. 703.)

New Theory of Pterichthys.†—Mr. A. Smith Woodward subjects Dr. Patten's speculations as to fossil fishes to a severe criticism. He says that when it is suggested that the so-called dorsal shield of *Pterichthys* is on the hæmal aspect of the animal, an ichthyologist, at any rate, is unable to regard the statement as anything beyond unjustifiable speculation. The figures copied by Dr. Patten have been shown by Traquair to be inaccurate; the "cervical suture" of *Pterichthys* is nothing more than a superficial slime-canal, and the same remark

* Quart. Journ. Micr. Sci., xxxi. (1890) pp. 317–78 (2 pls.).

† Ann. and Mag. Nat. Hist., vi. (1890) pp. 314–6.

DR. PATTEN'S CLASSIFICATION OF ANIMALS.

Vertebrata.

Urochorda. Cephalochorda.

SIPHONEURA.

Central nervous system tubular.

Eyes on neural surface. Retinas to both median and lateral eyes inverted.

Ichthyoida { *Cephalaspis, Pterichthys, Pteraspis, Bothriolepis.*

Arachnida. Merostomata. { *Limulus. Eurypterus.*

Trilobites.

PELTACEPHALA.

Head shield-shaped. Eyes on hæmal surface.

SYNCEPHALA.

Divided into Head, Body, and Tail.

Head-segments 9–13; in four groups; first three head-segments devoid of appendages. Terminal segments more or less fused to form a urostyle. Eyes median and lateral. Median eyes 2–4, in a common sac or tube; retinas inverted.

Insecta. Crustacea.

Myriopoda.

PSEUDOCEPHALA.

Brain segmented, originally post-oral.

Annelida.

ENCEPHALA.

Brain unsegmented, pre-oral.

SEGMENTATA.

CŒLENTERATA. ECHINODERMATA ?

PROTOZOA.

may be applied to other of the "sutures," when they really exist. In fine, the resemblances which are regarded as homologies are really superficial.

Abnormal Repetition of Parts in Animals.*—Mr. W. Bateson brings forward, for the present without any comment, several instances of the abnormal repetition of parts in animals. Those enumerated here are the cases of a crab (*Cancer pagurus*), in which the endopodite of the third maxilliped was represented by a chela; of repetition of the pincers of chelæ in Crabs; of a beetle (*Chrysomela banksi*) with three complete tarsi on one leg; and of an *Antedon* with abnormal repetition of the brachial structures.

B. INVERTEBRATA.

Zoology of Victoria.†—In Prof. M'Coy's twentieth decade only two plates are devoted to Bryozoa; there are figures of a fine Bombycid (*Chelepteryx Collesi*), of *Ibacus Peronii*, and of three starfishes which have not before been figured of the natural colour; one, *Asterina calcar*, is the commonest of Victorian starfishes.

Zoology of Fernando Noronha.‡—Mr. H. N. Ridley, assisted by a number of specialists, has published a report of the zoological collections made by him during his visit to Fernando Noronha; previous to this expedition, no land or fluviatile species of Molluscs, of which eight are now known, had been obtained from the island; three new Crustacea were collected.

Cellulose-reaction in Arthropoda and Mollusca.§—Dr. H. Ambronn reports that Schultze's solution (chlor-zinc-iodide) gives a violet colour, which is very near to, if not identical with, the colour-reaction of vegetable cellulose, when applied to a body which seems to be nearly always associated with the true chitin of Arthropods. The genera examined consist of *Eupagurus*, *Homarus*, *Scyllarus*, and others; in all these the inner layers of the carapace as well as the tendons give the reaction and exhibit a very strong pleochroism. The reaction may sometimes be hastened by previous boiling in caustic potash. Various Copepods, Ostracods, Spiders, Orthoptera, and Hymenoptera gave similar results. Among other classes of animals they were only seen in Mollusca, and there not commonly.

Mollusca.

γ. Gastropoda.

Revision of British Mollusca.‖—The Rev. Canon A. M. Norman continues his revision of the British Mollusca, and now deals with the Pulmonata; 107 species are enumerated, but the varieties are not given.

Cypræa testudinaria.¶—Dr. B. Haller devotes the second of his studies on the morphology of the Prosobranchiata to *Cypræa testudinaria*. Although Bouvier was acquainted with the nervous system of the Cypræidæ he placed them with the Tænioglossata, far from the Rhipido-

* Proc. Zool. Soc. Lond., 1890, pp. 579–88.
† Proc. Zool. Vict., Decade xx. (1890) pls. 191–200.
‡ Journ. Linn. Soc., xx. (1890) pp. 473–570 (1 pl.).
§ Mittheil. Zool. Stat. Neapel, ix. (1890) pp. 475–8.
‖ Ann. and Mag. Nat. Hist., vi. (1890) pp. 327–41.
¶ Morphol. Jahrb., xvi. (1890) pp. 259–99 (2 pls.).

glossata. Dr. Haller proceeds to discuss the affinities of *Cypræa*. As to the form of its shell it is clear that it is due not to spiral formation, for that is really very slight, but to the great development of the right-hand side of the anterior portion of the shell. This may be correlated with the great elongation of the anterior part of the shell which lies above the gill-cavity. The increase in length leads to the elongation of the left auricle and the liver. The Cypræidæ are allied to the Tænioglossata by the characters of the radula, the separation of the pleural ganglia from the pedal cords and their fusion with the cerebral ganglia, the abbreviation of the enteric canal, the histological differentiation of the two lobes of the kidney, the development of a seminal groove and of a penis in the male, and, finally, the separation of the rectum from the ventricle.

The author thinks the result of his investigations is to show that the Cypræidæ are very old forms of the Tænioglossata, which should be associated with the Rhipidoglossata; they form, in other words, an intermediate link between these two great divisions of the Prosobranchiata. With the Paludinidæ and *Cyclophorus* they form a group which may be called the Architænioglossata. As there is a rudimentary right auricle in the Cypræidæ and perhaps also in their allies, the division of Monotocardia and Diotocardia is shown to be out of consonance with the facts.

Swammerdam's Vesicle in Aplysia.*—Sig. G. F. Mazzarelli finds that the so-called vesicle of Swammerdam, which has been credited with many functions, from that of an ovary to that of a copulatory pouch, is connected, along with a seminal vesicle, to a duct which is the left portion of the divided hermaphrodite duct and opens near the vulva; that it contains spermatozoa in varying abundance, and also ova in many cases, besides free spherules of lecithin, globules of fat, albumen-granules, and much liquid; its function is that of purifying the spermatic fluid from all extraneous matter. This is an important process in these Molluscs and it is probable that some doubtful structures in other Gastropods have a similar function.

δ. Lamellibranchiata.

The Margin of the Mantle.†—Dr. B. Rawitz describes the margin of the mantle in Arcaceæ, Mytilaceæ, and Unionaceæ. In *Arca* it is divided into three folds: from the cleft between the internal and median folds the epicuticula is produced; the median fold bears the eyes; the cells of the outer fold pour forth a secretion utilized in forming the shell. The glands which are variously distributed on the margin are of two kinds, some forming mucin, others secreting a poisonous and protective product. Rawitz describes the compound or conical eyes and the invaginate cups, and differs somewhat from both Carrière and Patten in regard to the details of their structure. As to the function of the former he grants that they are visual, and explains their abundance as the natural result of the loss of the head and of concentration on the only available position—the mantle-margin, where moreover their wide distribution is of use to a passive bivalve like *Arca*, which cannot

* Zool. Anzeig., xiii. (1890) pp. 391–9.

† Jenaische Zeitschr. f. Naturwiss., xxiv. (1890) pp. 539–641 (4 pls.).

turn itself about. The invaginate cups are not supplied by any nerves, and cannot be optic.

In the Mytilaceæ there are also two kinds of glands, muciferous and poisonous. The peculiar knob-like prominences on the mantle-margin of *Pinna* are certainly not eyes but glands, though they are very remarkable in being directly innervated. The characteristics of *Mytilus*, *Modiola*, and *Lithodomus* are described in detail. In Unionaceæ the mucin-forming glands alone are present. According to Flemming, the abundant mucous material of bivalves is secreted by the mucous cells in the meshes of the connective tissue, but Rawitz denies this to be the case in the Ostreaceæ, or in *Arca noæ*, *barbata*, *tetragona*, *lactea*, *Nucula nucleus*, *Mytilus edulis*, *Lithodomus dactylus*, or *Pinna nobilis*, while he allows it for *Arca diluvii*, *Pectunculus glycimeris*, *Modiola barbata*, and the Unionaceæ. It is interesting, however, to notice that the product in Unionaceæ is different from that in the other three forms. Finally, Rawitz points out that the occurrence of amorphous secretions in the connective tissue seems a symptom of degeneration as seen for instance in *Arca diluvii*, and that the younger species in a phylogenetic series show preponderant secretory activity and degenerate sensory structures.

Molluscoida.

α. Tunicata.

Development of Pyrosoma.*—Prof. W. Salensky finds that the embryo of *Pyrosoma* arises from both fertilized and unfertilized elements, since the formation of the cyathozoid is due, not only to the blastomeres, but also to the "kalymocytes," as the author terms the "internal follicular cells" of Kowalewsky. The first differentiation of the germinal layers is seen in the separation of the cells into two strata, an ectoderm and a meso-entoderm, of which the latter is further differentiated into a many-layered mesoderm and a single-layered entoderm. The mesoderm appears in the form of two typical cœlome pouches, but of these only the left developes. It is modified into axial mesoderm and a pericardial sac, while the right pouch breaks up into cells which are afterwards scattered in the body of the cyathozoid.

β. Bryozoa.

Gemmation of Bryozoa.†—Herr O. Seeliger commences his memoir with an account of the development of the entoproctous Bryozoa, as illustrated by *Loxosoma*. The history is very similar to that of *Pedicellina*. Parts of the ectoderm and mesoderm give rise to buds, the endoderm of which is formed from the outer layer by a process comparable to that of gastrulation by emboly. From the basal portion of the invagination the digestive tract is formed, and from that which remains always in connection with the endoderm arises the atrium and the outer covering of the tentacles. On the other hand, there are certain differences; the point at which the buds are formed is different, for in *Loxosoma* it is the body-wall of the upper part, and in *Pedicellina* the stalk. Again, the topographical relations of the body-regions of the buds to those of the

* Biol. Centralbl., x. (1890) pp. 225-33.

† Zeitschr. f. Wiss. Zool., l. (1890) pp. 560-99 (2 pls.).

mother are different, for in *Pedicellina* the dorsal side of the bud is turned towards the ventral, and not, as in *Loxosoma*, to the dorsal side of the mouth. The most striking difference lies in the fact that the buds of *Loxosoma* become set free from the mother and form new points of attachment, while in *Pedicellina* they remain permanently connected with the parent, and a new colony can only be formed from a larva. The possession of a pedal gland by the buds of *Loxosoma* is another point by which this form can be distinguished from *Pedicellina*.

In his study of the gymnolæmatous forms, Herr Seeliger has investigated especially *Bugula avicularia*, while *B. flabellata*, *Membranipora pilosa*, and *Eucratæa Lafontii* (?) have also been used. The process of budding is described as being very simple. The ectoderm and mesoderm give rise to the bud; from the outer layer is formed the body-wall of the bud, and, as in the embryonic development from the blastula, the polypide is formed by a gastrula-like invagination. The latter gives rise to the tentacular sheath, the outer walls of the tentacles, and the digestive tract with all its parts. The basal portion of the invagination is constricted off from the proximal, and at only two points does connection obtain; these become the mouth and anus. While the basal part is divided into the several sections of the enteron, the tentacles rise up from the anterior part. These are at first arranged bilaterally, and are set in the form of a horse-shoe; it is only later on that they form a closed circle.

The mesoderm of the mother is partly arranged around the polypide invagination in the form of a unilaminate epithelium, while other mesenchymatous cells remain scattered in the primitive body-cavity. The mesodermal epithelium gives rise to the tissue which fills the tentacular cavities, and the fine flattened epithelium which forms a peritoneal covering to the enteric canal as far as the base of the tentacles. The author has not followed out the fate of the free mesoderm-cells; it is possible that they give rise to the various muscular bands which traverse the body-cavity, and to the gonads.

Dr. Seeliger points out the close agreement that exists between the mode of development of the ento- and ectoproctous Bryozoa; the sole important difference lies in the relations of the mesoderm, but this is due to the differences in its structure. In the Entoprocta the separate mesenchyme-cells pass into the primary body-cavity of the bud, where they divide, and, during life, have the form of a connective tissue without ever becoming arranged in epithelial lamellæ. In the Gymnolæmata, among the Ectoprocta, the enteric canal has, in its developed stage, a mesodermal epithelial investment, while a similar, at least complete, layer is always absent from the body-wall. For the rest, the body-cavity is, as in the Entoprocta, traversed by connective tissue and other mesodermal organs. The large muscular bands which arise from the mesenchyme have exactly the histological characters ascribed by the Hertwigs to the mesoblast-musculature. In the Phylactolæmata there is not only an epithelial mesoderm-layer around the enteron, but one lies against the ectoderm, so that the body-cavity is truly an enterocœl.

With regard to the character of the mesoderm in the adult, the three groups of Bryozoa form a continuous series. In the Entoprocta a connective-tissue-like mesenchyme lies in the primary body-cavity; in

the Gymnolæmata there is, in addition, an endothelial investment surrounding the enteron; and in the Phylactolæmata a mesodermal epithelium is applied to the ectoderm.

After some remarks on the phylogeny of the Bryozoa, which is a peculiarly difficult problem, Dr. Seeliger points out that the processes of gemmation in the Bryozoa show how tissues which are, histologically, very definitely differentiated, may again take on quite an embryonic character. In them, as in the budding Tunicata, no support is to be found for the doctrines of Heredity propounded by Weismann. The author says that he has sought for but has not been able to find any evidence of a removal of histogenetic plasma from the ectodermal cells that form the polypide-invagination, which might render explicable the return to embryonic relations.

Larva of Flustrella hispida.*—Dr. H. Prouho finds that the larva of this Bryozoon has the same plan of organization as that of the cheilostomatous forms and as the larva of *Alcyonidium mytili*. The most striking points in its structure are the presence of two chitinous valves covering the aboral region, the differentiation of the mesoderm into numerous muscles and cellular layers, the most important of which is situated immediately below the aboral ectoderm, the presence of a nervous system, and the reduction of the hood to a sensory button or aboral organ which is connected with the pyriform organ by a musculo-nervous tract. Several of these characters ally the creature to *Cyphonautes compressus*. The larva possesses two kinds of organs; those which, during metamorphosis, pass directly to the primary zoœcium and appear to be of no use to the free larva, and those which perform functions useful to the free larva, and are destroyed when larval life ceases; they are utilized by the primary individual as reserve nutriment. The internal sac and the parietal muscles belong to the former category, while to the latter three belong the pyriform and aboral organs and the corona.

The fixation of the larva is effected, as in all larvæ that are provided with an internal sac, by the evagination of that organ. The corona, the pyriform organ, and all the integuments, are retracted to the interior; the aboral organ is invaginated below the ectoderm, and the larval organism becomes a closed sac, the free or frontal wall of which is formed by the aboral ectoderm of the free larva, while the basal part is formed by the internal sac.

As soon as the free larva has become fixed, the phenomenon of histolysis commences; this disorganizes much of the larval tissues and converts them into a number of nucleated spheres or histolytes, which become intermingled with the yolk-spheres and are, like them, put to use by the young polypide. The larval tissues which undergo histolysis are the nervous system, all the muscles except the parietal, the pyriform organ, the corona, the aboral organ, and all the oral integuments. The larva then passes into the cystid-stage.

The ectoderm of the cystid secretes a thick cuticle which forms the entocyst of the primary chamber; the aboral mesodermic layer becomes fused with the corresponding membrane which invests the internal sac

* Arch. Zool. Expér. et Gén., viii. (1890) pp. 409–59 (3 pls.).

in the free larva, and a continuous mesodermic membrane is formed which envelopes all the elements which were primitively free in the cavity of the larva, as well as all the products of histolysis. The cystid is also provided at its aboral pole with a thickened disc consisting of two layers; of these, the outer and ectodermic arises from a thickening of the aboral ectoderm, while the internal layer, which is mesodermic, arises from a corresponding thickening of the mesoderm. This meso-ectodermic disc is destined to form the polypide.

Preceding investigators have thought it probable that the aboral organ of *Flustrella* takes part in forming the polypide, but it really does nothing of the kind. The polypide arises altogether from the meso-ectodermic disc, which is formed independently of the aboral organ. The vesicular rudiment results from a simultaneous invagination of the two layers of the disc, and this subcuticular invagination is produced after the degeneration of the aboral organ.

The internal (ectodermic) layer of the rudiment forms the lophophore, the outer wall of the tentacles, the nerve-ganglion, the internal lining of the invaginated sheath, the pharynx, the rectum, and the mesenteron. The outer (mesodermic layer) forms the inner wall of the canals of the tentacles, the outer covering of the invaginated sheath, the retractor muscles of the polypide, the occlusor muscles of the chamber, and the investment of the digestive-tube.

South Australian Polyzoa.*—Mr. P. H. MacGillivray publishes an additional list of Polyzoa, founded on a collection of 119 species, 71 of which were not in his previous list. Three appear to have been hitherto undescribed.

Arthropoda.

Histological Arrangement of Pigment in Eyes of Arthropods.†—Mademoiselle M. Stephanowska has investigated the histological arrangement of pigment in the eyes of various Arthropods under the influence of direct light and complete darkness. She finds that light and darkness do influence the arrangement of the pigment, and that this is shown by the movement of the pigment-cells and the pigment-granulations. The general characters in complete darkness are—the pigment is not distributed uniformly, but there are large, very compact masses, chiefly at the base of the cones; the pigment-cells are more contracted, and are consequently more distinct; they also cover a smaller number of the optic elements, and these latter are more distinct than they are after exposure to light. In good light the pigment is much more uniformly scattered, and there are but rarely localized masses; the pigment-cells are elongated towards the corneæ and towards the retinulæ. In consequence of this, the refractive and sensory elements of the eye are less distinctly visible than in darkness, and the contours of the pigment-cells are themselves also less distinct. The pigment seems paler, for it is extended over a larger surface.

In some Insects the pigment, under the influence of strong light, is changed into droplets of fatty appearance, the size and arrangement of which vary much in one and the same eye. This phenomenon was

* Trans. Roy. Soc. South Australia, xiii. (1890) pp. 1–7 (1 pl.).
† Rec. Zool. Suisse, v. (1890) pp. 151–200 (2 pls.).

observed in *Eristalis*, *Libellula*, and *Stenobothrus*. The varying influences of light and darkness are not manifested equally in the eyes of all Insects, for in some the changes are scarcely noticeable, while in others they are strongly marked.

When we consider the universal presence of pigment in the eyes of all animals, even the simplest, we cannot fail to see that it plays an important part in the physiology of vision. As it is now known that the eyes of both Vertebrates and Arthropods possess the power of adapting the arrangement of the pigment to the quantity of light, we shall not be astonished if it is discovered that the eyes of other animals possess a similar power.

α. Insecta.

Power of Sight of Insects.*—From observations made on the visits of insects to flowers, Herren W. O. Focke and E. Lemmermann conclude that Lepidoptera and Diptera are in many cases attracted to flowers chiefly by the sense of smell; while with Hymenoptera this is much more rarely the case, but occurs in the lime. Insects see clearly in only the immediate neighbourhood of the object; with Apidæ the impression becomes indistinct at a distance of ten cm., and many Lepidoptera and Diptera are even more shortsighted. More distant objects convey to insects only a very indistinct visual impression; but differences of colour can be perceived from a comparatively great distance. A brightly coloured flower one cm. in diameter in green foliage can be seen by Apidæ and Lepidoptera at a distance of 1-2 metres. The perception of colour in insects is developed in very different degrees, and in different directions in different species.

Formation of the Dorsal Region in the Embryos of Insects.†—Dr. J. Nusbaum adds to the five different ways in which Graber showed that the dorsal region might arise, a sixth observed in the embryo of *Meloe*. The entopygma ruptures on the ninth day of development, the ectopygma not before the nineteenth day. The ruptured portions of the entopygma, connected with the ectoderm, lie midway between the dorsal and the ventral surfaces of the embryo, and unite with the wall of the still unruptured ectopygma. Thereafter the ectopygma is ruptured below the point of union, the whole of the lower or ventral portion gradually degenerates, but the dorsal portion with the united part of the entopygma contracts to form the dorsal wall of the embryo. The final boundary of the back, however, is wholly due to the entopygma, for the implicated portion of the ectopygma is invaginated into the yolk as a "dorsal tube," the cells of which are soon scattered in the yolk, and take no direct share in building up the embryo. Unlike Graber, Nusbaum maintains that differences in the relative quantity of nutritive yolk, in its consistence, and in the duration of development, influence the mode in which the dorsal region is formed. He regards the differences in the development of this region as in many respects cenogenetic, and would seek to associate them with the special adaptations of the embryo and larva to various conditions of life.

* Abhandl. Naturw. Ver. Bremen, xi. (1890) pp. 439–43. See Bot. Centralbl., xliii. (1890) p. 36.

† Biol. Centralbl., x. (1890) pp. 110–4.

Closed Tracheal System in Insect Larvæ.*—The late Dr. H. Dewitz was engaged on some observations on the closed tracheal system of larvæ, the chief results of which may be thus summarized. In the young stages of the Odonata and Ephemeridæ there is an open tracheal system, and in some of the families thoracic stigmata are seen at a very early stage. Mature nymphs of Æschnidæ, Libellulidæ, and Agrionidæ were found to be able to inspire as well as expire air by the stigmata. If all the gill-lamellæ of young Ephemerid larvæ are cut off, the animals undergo ecdyses in which gill-lamellæ are newly formed.

Insects Accepted or Rejected by Birds.†—Mr. A. G. Butler has, this year, continued his experiments with insects and birds. He is convinced that the tastes of the latter not only differ in individuals of the same species, but that the same individuals in consecutive years vary as to their likes and dislikes; the largest British spider is not an object of fear to any insectivorous bird; the imago of *Abraxas grossularia* is far from being distasteful, although the larva is distinctly so to many, if not all, insect-eaters. Neither caterpillars nor birds have the same notions of beauty as human beings. Mr. Butler's observations do not afford much support to some recent speculations as to protective coloration.

Evolution of Bristles, Setæ, and Tubercles of Caterpillars.‡—Prof. A. S. Packard has a paper, full of observations, in which he brings together hints as to the evolution of the bristles, spines, and tubercles of certain caterpillars, which appear to result from a change from low-feeding to arboreal habits; these are illustrated by the life-histories of some Notodontians.

He comes to the conclusion that the more prominent tubercles, with the spines or bristles arising from them, are hypertrophied piliferous warts; the warts with the seta or hair which they bear being common to all caterpillars. The hypertrophy or enlargement was probably due in the first place to a change of station from herbs to trees, involving better air, a more equable temperature, and perhaps a different and better food. The enlarged and specialized tubercles developed more rapidly on certain segments than others, because the nutrient fluids would tend to more freely supply parts most exposed to external stimuli. These last were largely due to the visits of Insects and Birds, and the result was a mimicry of the spines and projections on the trees; the colours were due to light and shade, and the general result was protective mimicry or adaptation to tree-life.

The cause of the hypodermic cells at the base of the spines of some forms becoming specialized to secrete a poisonous fluid is not yet known. After primitive forms, members of different families, had become established on trees, a process of arboreal segregation or isolation would set in, and intercrossing with low-feeders would cease. Heredity would cause a succession of generations perfectly adapted to arboreal life, while natural selection would constantly tend to preserve new varieties, species, and genera, and would not cease to act in a given direction, so long as the environment remained the same. Prof. Packard is of opinion that the first steps in the origination of a species, genus, family,

* Zool. Anzeig., xiii. (1890) pp. 500-4 and 525-31.
† Ann. and Mag. Nat. Hist., vi. (1890) pp. 324-7.
‡ Proc. Boston Soc. Nat. Hist., xxiv. (1890) pp. 494-560 (2 pls.).

order, or even class, which cause the appearance of variations, are, in the beginning, due to the primary (direct or indirect) factors of evolution (Neolamarckism), while the final stages are due to the secondary factors, segregation and natural selection (Darwinism).

Biology of Lepidoptera.*—Dr. A. Seitz publishes the first instalment of an account of the general life of Lepidoptera. He speaks first of the manner in which Lepidoptera are distributed; of cosmopolitan forms, like *Pyrameis cardui*, which flies swiftly and far, has a long life and much hardiness, and is moreover able to rest with spread wings upon the water; how others stand or fall with the presence or absence of the food-plants on which their monophagous caterpillars live; what advantages there are in acquiring the habit of polyphagy; how manifold are the means of transportation, e. g. in railway carriages and ships; how some forms are constitutionally prone to wander; and how the family of Psychidæ, in spite of their wingless females, has come to be very widely distributed.

In the second chapter he relates his own observations and those of others on the active wanderings of Lepidoptera over land and sea, singly or in swarms, as adults or as caterpillars, and after discussing the various reasons for this, falls back on the belief in a genuine "Wandertrieb." Then follows a criticism of generalizations in regard to geographical distribution, and a constructive attempt to improve these. He discusses the factors determining the distribution of Lepidoptera in continents, countries, and localities; submits a number of phænological and geographical tables; and notes the characteristics of the Ethiopian, Indo-Australian, and Neotropical fauna. An account is given of a restricted area of woodland in South Brazil, where the great majority of the insects were blue (not the Lepidoptera alone, but Coleoptera, Hemiptera, and Diptera), although but a few miles off a red colour was dominant, and he argues that the facts could not be explained as due either to mimicry or to general protective resemblance. In the fourth chapter the influence of climate and weather on Lepidoptera is discussed, with abundant details as to the effect of mild winters and hot summers, rain and wind; and even the periodicity of the sun-spots is not forgotten.

New Excretory Organs in the Silkworm.†—Prof. E. Verson describes fifteen pairs of cutaneous glands in the larva of *Bombyx*. In the thorax there are two pairs to each ring, one set lying slightly in front of or above the stigmata, the others at the external base of the appendages. There are nine pairs in the abdomen with somewhat analogous positions. In the larva about to be hatched the glands measure only 0·02 mm. by 0·03 mm., but in later stages a maximum diameter of 3 mm. may be attained.

A well-developed gland has an ample cavity, containing some granular material, surrounded by a broad spongy cortex, and leading into a short excretory canal with a large covering cell or with several. In the young larva, however, the future glands are seen to be true cells with large nuclei, and Verson maintains that the cortex of the gland is derived from the protoplasm of the primitive cell, while the cavity

* Zoolog. Jahrb., v. (1890) pp. 281–343.

† Bull. Soc. Entomol. Ital., xxii. (1890) pp. 3–29 (4 pls.).

represents the degenerated nucleus. The spongy cortex is a most notable illustration of that vacuolated structure of protoplasm which Bütschli has described in Protozoa. In the period of activity the products accumulate in the vacuoles, they assume firmer consistence, they are incorporated into the original plasma, and the whole structure swells.

As to the function of these curious glands, it must be noted that they never communicate with the free surface of the silkworm, but that their products have to expand between the hypodermis and the cuticular husk. Prof. Verson shows that these glands, besides facilitating the detachment of the older cuticular husk, function actively and as it were vicariously when the Malpighian tubules are temporarily out of function, and form material which yields on evaporation crystals of oxalate of lime and uric acid—in other words, an excretion like that of the renal tubules.

Evolution of the Hymenoptera.*—Prof. F. Delpino suggests the following scheme of development of the families of Hymenoptera, partly derived from that of the plants on which they feed:—(1) *Tenthredinideæ*, or phyllophagous Hymenoptera; (2) *Siricidæ*, or xylophagous Hymenoptera (contemporaneous with the evolution of the Coniferæ); (3) *Ichneumonidæ*, or pupivorous Hymenoptera; (4) *Fossori;* (5) *Vesparii;* (6) *Apiarii;* (7) *Formicarii*. In this series the biological advances *pari passu* with the morphological evolution. The Siricidæ are all more or less gluttonous of honey. The evolution of a long oviduct advances from the Siricidæ to the Ichneumonidæ; the conversion of this oviduct into a poisonous sting takes place between (4) and (7). The property of pupivorous larvæ connects (3) and (4). The nidifying character connects (4), (5), (6), and (7). The property of socialism connects (5), (6), and (7). The character of producing different castes connects (6) and (7). According to this scheme the family of ants represent the most recent evolution of the Hymenoptera.

Monograph of Sand-Wasps.†—Herr A. Handlirsch publishes the fifth part of his monograph on sand-wasps, including a systematic study of the American genus *Monedula*, in which he distinguishes 44 species, half of them new.

Development of Hydrophilus piceus.‡—Dr. K. Heider makes a reply to the criticisms of Prof. Graber,§ in which he urges that much of his work was done before his critic published the results of his studies; some of the points referred to are merely petty, and were not judged to be worth special notice.

Development of Platygaster instricator.‖—Mr. N. Kulagin has made a study of the eggs laid by this parasitic insect in the larvæ of Cecidomyidæ. The species examined was found to lay from two to five eggs in a cocoon, and these eggs are either not simultaneously developed or some only undergo development. The blastoderm is formed of elements of the division which extends in regular order from the centre to the periphery of the egg; the other elements of division remain in

* Malpighia, iv. (1890) p. 7.
† SB. K. Akad. Wiss. Wien, xcix. (1890) pp. 77–166 (1 pl.).
‡ Zool. Anzeig., xiii. (1890) pp. 428–30.
§ See this Journal, *ante*, p. 451. ‖ Zool. Anzeig., xiii. (1890) pp. 418–24.

the interior of the egg and form the endoderm. The larvæ differed in some points from those described by Ganin. These larvæ do not essentially differ from those of other orders.

Pupal Stage of Culex.*—Dr. C. H. Hurst gives a description of the pupal stage of the Gnat. The pupa does not eat; it floats, throat upwards, by virtue of a large air-cavity which lies under the hinder part of the thorax and the anterior part of the abdomen; in the abdominal part of the cavity there is, on either side, a large stigma which is held open by a fairly well developed cuticular lining and guarded by numerous spines. The cavity and stigmata are mainly, if not exclusively, hydrostatic in function, and serve not only to make the pupa float when at rest, but to make it float in a definite position with the thorax upward and the apertures of the respiratory siphons at the surface of the water. The pupæ seem to be affected not by noise, but by tremors of the water, and the organs by which these movements are felt are probably the setæ on the first segment of the abdomen.

A detailed account is given of the external characters of the pupa. The alimentary canal has no convolution, except in the region of the intestine. At first the general structure is that of the larva, but during the pupal period great changes occur. The most striking is the reduction in thickness of the epithelium, which is best seen in the stomach; changes of form occur in various parts of the alimentary canal.

Three layers were recognized in the wall of the heart—an endocardium, which is an exceedingly thin layer of flat cells, with conspicuous nuclei; a middle layer which consists of encircling fibres, probably muscular; and an outer fibrous layer, the fibres of which are mostly longitudinal in direction. The author denies the existence of the tracheal gills of Palmén.

The nervous system is remarkable for the fact that, in the space of four days, certain ganglia increase enormously in size by the addition of cells, apparently derived directly from the epidermis; while other ganglia, already well developed and functional, shift bodily from their original positions, and in some cases fuse with ganglia originally remote from them. A careful account is given of the formation of the large hemispherical basal joint of the antenna of the imago.

The prostatic glands, though apparently simple, are seen in section to be double, though the cavities communicate posteriorly before opening into the common pouch; this last is a dilatation of the ejaculatory duct at the base of the copulatory organ. The median oviduct is formed by invagination in what seems to be the ninth sternum, and as the anus opens lower down, there is no common cloaca. The author promises to work out in detail the development of the eye.

Hermaphrodite Rudiment of Gonads in Male of Phyllodromia (Blatta) germanica.†—Herr R. Heymons gives an account of some points in the history of the formation of the genital organs in the male of this insect. They first appear at a very early stage in development, for genital cells are to be seen in the germ-stripes which show the

* Studies Biol. Lab. Owens Coll., ii. (1890) pp. 47–71 (1 pl.).
† Zool. Anzeig., xiii. (1890) pp. 451–7.

first signs of segmentation. The author cannot confirm the statement of Cholodkovsky that the genital cells have their origin from yolk-cells.

When the first sexual differences become apparent, the genital rudiment of the female consists of a right and a left elongated cord of cells which, even in the embryonic period, becomes converted into numerous separate ovarian tubes. The almost universally accepted doctrine that epithelial cells and eggs are only modifications of primitively similar elements is not true of *Phyllodromia*. While the genital rudiment of the female is completely converted into the ovary, that of the male is only partly converted into the testis. At the time when sexual differentiation commences, the male rudiment consists of cord-like structures which extend, right and left, from the second to the fifth abdominal segment. Each genital rudiment consists of genital and epithelial cells; the greater number of the latter have the form of elongated cells on the ventral side of the rudiment, and form the anterior widened part of the vas deferens. The genital cells are not regularly distributed within the rudiment, but are collected into larger numbers at four points. These are the first signs of the four testicular follicles of which the gonad of either side consists. Part of the genital rudiment is now seen to consist of the four follicles which are directly connected with the elongated cells that form part of the vas deferens, in a ventral direction only. They have, therefore, no connection with the terminal plate. The second part of the rudimentary gonad consists of those genital and epithelial cells which have not taken part in forming the testicular follicles, and they are directly connected with the terminal plate. By the contraction of the efferent duct the testicular follicles become to some extent pushed out from the genital rudiment and lie below and behind it. That part of the genital rudiment of the male which is not used in forming the testicular follicles may be seen to represent the rudiments of a female gonad; in some cases this is developed so far that both egg-tubes and separate ova become developed; but this female organ has no direct connection with an efferent canal. The presence of this arrangement in so archaic a form seems to prove that the ancestors of insects were hermaphrodite.

Respiration of Decticus verrucivorus.*—M. C. Contejean has studied the mode of respiration of this Grasshopper. He finds that the abdomen alone effects the respiratory movements. Inspiration is passive and is due to the elasticity of the parts of the exoskeleton and to the reaction of the viscera. Expiration is active and lasts longer than inspiration. The respiratory movements increase in frequency with the activity of the animal, and their number is increased by the heat and irritability of the insect. Removal of the head does not put a stop to respiration, the rhythm of which is scarcely slowed. If the abdomen is divided into several parts, each breathes separately. From the experiments made by the author on the influence of the nervous system, he is led to conclude that the lower part of the cord is not sensory and the upper part motor as Faivre has demonstrated for *Dytiscus*. This would show that the organization of the Orthoptera is less elevated than that of the

* Comptes Rendus, cxi. (1890) pp. 361-3.

Coleoptera, a result which seems to be confirmed by the habits of the two groups and their order of appearance in time.

Development of Embryo of Locustidæ.*—Mr. W. M. Wheeler has a preliminary notice of the development of *Xiphidium ensiferum*. The eggs are laid under the scales of galls produced by *Cecidomyia salicis-gnaphaloides*. They are about 5 mm. long and are slightly curved, the convex side being the ventral and the sharper end the cephalic part of the egg. The author states that this differentiation in the form of the egg is of great importance for a correct understanding of its development. The small ventral plate is formed by the parting of the blastoderm cells in the middle of the convex side of the yolk. The very delicate gastrula-groove soon becomes apparent, and at the same time a rounded cellular disc is seen in the middle line in front of the cephalic lobes. This disc is called by the author the preoral plate, and it arises as an independent and isolated centre from the blastoderm by the conversion of a number of flattened cells into closely packed columnar and spindle-shaped elements. The organ does not, therefore, differ from the ventral plate in its mode of origin.

The preoral plate seems to early lose its independence, as it becomes connected with the head of the embryo; it comes to lie between the two cephalic plates. When the embryonic coverings are formed the plate is shut out, although the two cephalic lobes are included in the process.

The author describes the successive stages of development; at last the yolk is found to be surrounded by chorion, yolk-membrane, primary serosa, secondary serosa, secreted layer, cuticle, tertiary serosa, and amnion; later on a larval membrane is added.

The author has not been able to find any description of an organ which can be thought to agree with the preoral plate of *Xiphidium*, but the Crustacea, and especially the Isopoda, have in the dorsal organ a structure which has a certain similarity to this peculiar embryonic organ. If we go beyond the Arthropoda we find in the prestomium of Annelids an organ which at first sight has a resemblance to the preoral plate; but when the whole development of the structure is studied not much support is to be found for such a view. It is possible that in other Locustidæ the organ will be discovered to be more completely retained than in *Xiphidium*.

Leaf-winged Locust.†—Mr. J. J. Quelch describes some remarkable cases of protective colouring in *Pterochroza* and allied forms. The wings are ovate and one side is somewhat wider than the other, according to the depth of the curve of the central vein which is thickened like a mid-rib. From this pass off side veins which branch and reticulate just as in the case of the leaf of a dicotyledonous plant. In one species the shade varies from reddish brown or yellow to a dull purple, and closely resembles the shades to be found on the young leaves of many of the forest trees, and more especially of *Mora excelsa*. In another the tint is deep green, but seems to fade on continued exposurs to light after the death of the insect. In a third it is of a very pale yellowish brown, much like

* Zool. Anzeig., xiii. (1890) pp. 475–80.

† Journ. Roy. Agricult. Soc. Brit. Guiana, 1890, p. 141. Ann. and Mag. Nat. Hist., vi. (1890) p. 275.

the colouring on an old and fading leaf about to fall from the plant; while in a fourth it is a dull, dead brown, like that of a fallen leaf. We require to know much more about the history and habits of these forms which, perhaps, are not rare, but are only accidentally discovered, in consequence of their special coloration.

Living Fly Larvæ in the Stomach and Mouth.*—Herr H. Senator relates the case of a patient who spat out about a dozen still living larvæ, which on examination seemed to be those of the common house-fly. How the ova or the larvæ had been introduced was inexplicable, and as the maggots died, the adult insect could not be exactly determined.

Coloration of Silk by Foods.†—M. L. Blanc finds that some colouring matters, which are very soluble and very diffusible, such as fuchsin, can be absorbed by the intestinal epithelium of the silkworm; these substances may then colour the cells of the silk-secreting organs, but they do not colour the product of secretion.

δ. Arachnida.

The Wolf-spider and its Cocoon.‡—Dr. W. Henking has watched and experimented with *Lycosa amentata* and *Tarentula clavipes*, in order to discover the exact relations between the female and her cocoon. It is well known that mother-spiders guard the cocoon with great care, yet experiments show that this does not depend upon the presence of young in the cocoon, but on its "odour" (?) and definite weight. That odour is one of the credentials is an inference, in regard to which Dr. Henking repeatedly says that he is only prepared to maintain that the spider has some discriminating sensitiveness nearer to smell than to any other human sense. A false cocoon with any sort of contents or with any kind of surface will be carried about by the deluded parent provided that the aforesaid odour be detected. A portion of the genuine envelope is sufficient to render a foreign body acceptable. On the other hand, after carrying an artificial cocoon for a while the spider will throw it away, and this Henking regards as deliberate. Nor has he any doubt as to their memory, for spiders seek patiently for a lost cocoon, and recommence the search even after prolonged interruption. Moreover, they seem to have an instinctive feeling when the hatching of the young is about to occur, and will dip the cocoon in water, as if to hurry the young out. The visual power is regarded as slight, but the tactile and auditory senses are acute. The formation of the cocoon and many more general facts in the life of these spiders are graphically described.

Gall-mites.§—Dr. A. Nalepa continues his systematic study of gall-mites or Phytoptidæ, describing and figuring 12 new species of *Phytoptus*, and 4 of *Phyllocoptes*. In a list of all the forms which he has described, we find 29 species of *Phytoptus*, 7 of *Cecidophyes*, 11 of *Phyllocoptes*, 1 of *Acanthonotus*, and a note of the plants on which they live and of the malformations which they cause. It is generally true that different forms of Cecidia are at once referable to different mites, but Nalepa

* Berlin. Klin. Wochenschr., 1890, No. 7. Cf. Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 150–2. † Comptes Rendus, cxi. (1890) pp. 280–2.
‡ Zool. Jahrb., v. (1890) pp. 185–210.
§ SB. K. Akad. Wiss. Wien, xcix. (1890) pp. 40–69 (7 pls.).

finds some curious exceptions. Herbaceous plants usually harbour only one species of mite, but trees and shrubs almost constantly shelter several. The suggestion of Thomas that there were some free-living Phytoptidæ is confirmed by the strongly developed integuments in the species of *Phyllocoptes* and *Acanthonotus*, and especially by a species of *Phyllocoptes* (*P. schlectendali*), which Schlechtendal found living freely and producing white spots on the leaves of *Pyrus malus*.

Acarina from Algeria.*—Mr. A. D. Michael reports on 44 species of Acarina obtained during a recent visit to Algeria. A second species of the remarkable genus *Cæculus* was discovered, which was noticeable for its size and for the singular arrangement of the hairs on the cephalothorax. *Notaspis burrowsii* sp. n. affords an example of the very wide distribution of these minute creatures, as it has also been obtained in Canada. *Damæus phalangoides* sp. n. has such very long and slender legs that one wonders, when the extreme brittleness of the chitin in this family of Acarina is borne in mind, how they can remain unbroken. *D. patelloides* sp. n. is remarkable for having a pyramidal abdomen. While *Nothrus sylvestris* has the claws monodactyle, the Italian *N. ananniensis* has them didactyle; a variety of this latter, found in Algeria, is tridactyle.

Ontogeny of Limulus.†—Dr. J. S. Kingsley has a preliminary notice of his studies on the development of the King-crab. The result of yolk-segmentation is to divide the egg into a number of yolk-cells, in the centre of each of which there is a nucleus with a thin layer of protoplasm. As the result of migration a blastoderm is at first formed on one side of the egg, the cells of which are smaller and less charged with yolk than those of the rest of the ovum. This blastoderm produces a lighter spot on one side of the egg which strikingly resembles the primitive cumulus of Arachnids. In its centre there appears a small circular pit, which is to be regarded as the blastopore. A second cloud appears behind the first, and soon surpasses it in size. No endoderm is produced by gastrulation.

In fifteen days the germinal area becomes divided by the appearance of a transverse groove into cephalic and postoral plates, and in twelve hours more a second groove appears behind the first, and cuts off a narrow ridge, which is the first postoral somite. Successive somites are added by budding from the caudal until six are formed. Near the outer margins of each of these paired thickenings the rudiments of legs arise. And, almost simultaneously, paired thickenings for the nervous system appear, one in each somite of the body and three in the cephalic plate. A few days later a series of six pairs of segmentally arranged sensory thickenings arise outside the legs; these have different fates. The first gives rise to the median ocelli of the adult; the second to a peculiar and as yet undescribed sense-organ, which occurs on the thin skin just in front of the first pair of appendages; the third soon disappears; the fourth forms the dorsal organ of Watase; the fifth gives rise to the paired compound eyes, and the sixth pair is evanescent. These organs are connected with one another and with the brain by a longitudinal

* Proc. Zool. Soc. Lond., 1890, pp. 414–25 (2 pls.).
† Zool. Anzeig., xiii. (1890) pp. 536–9.

nerve, which takes an undulating course between the organs and the bases of the legs.

There is a precocious separation of ectoderm and endoderm (yolk-cells) during the formation of the blastoderm. The endoderm retains its primitive character as a solid mass of long yolk-cells until the caudal spine appears. The yolk-cells are not true vitellophags; they metabolize the yolk which is contained in each, but the cells themselves are directly converted into the living epithelium of the mid-gut.

In embryos at the time of hatching the sternal artery has arrived at the condition found in the adult scorpion; it consists of a tube which lies on the upper surface of each half of the œsophageal nerve-ring. It is not till much later that it obtains the investing character of the adult. Packard's brick-red gland is of mesodermal origin; it contains in its interior the cavity of the fifth postoral somite; it soon becomes folded on itself and the region of the bend grows rapidly forwards. The outer limb of the fold becomes folded at four points and these new bends grow out in each body-segment, giving rise to the lobes which are characteristic of the organ in the adult. With the folding there is a good deal of fusion of the walls, and this is followed by perforations, the result of all of which is the peculiar anastomosing structure of the adult organ. The author thinks he has afforded further evidence of the close relationship between Arachnids and *Limulus* and reasons for removing the Merostomata more widely from the Crustacea.

ε. Crustacea.

Excretory Apparatus of Decapod Crustacea.*—M. P. Marchal, in continuation † of his studies on the excretory apparatus of Decapod Crustacea, describes that of *Homarus vulgaris*. The antennary gland is large and heart-shaped; the saccule has a cavitary system composed of elegant ramifications which radiate around its orifice. The orifice itself is bordered by clear cells which are very high, and it leads into the second portion of the gland which may be called the labyrinth; this is large and is divided into two lobes forming a U, the outer branch of which communicates with the saccule. The labyrinth is formed of a number of extremely fine canaliculi which anastomose with one another in all directions and so form a close spongy tissue, the innumerable lacunæ of which are invested by an epithelium of striated cells, covered by a cuticle.

In *Palæmon serratus* the saccule is small, reniform, and independent of the rest of the gland, with which it is connected only at its point of communication; its cavitary system is formed of a central space and of short areolar diverticula which are given off from it. The orifice of communication is wide, and bordered with very high granular cells. The labyrinth forms a spongy, rounded mass. The two bladders have numerous prolongations which ramify among various organs. In front of the stomach they unite to form an unpaired suprastomachal bladder which has the form of an elongated sac with smooth walls.

In *Pagurus Bernhardus* the saccule is ramified, and there is the same difference between it and that of the two preceding types as there is

* Comptes Rendus, cxi. (1890) pp. 458 60.

† See *ante*, p. 324.

between the lung of a Reptile and that of a higher Vertebrate. Of the prolongations given off from the bladder one is of special interest as it descends along the intestine and unites with its fellow of the opposite side to form an enormous unpaired abdominal bladder.

In *Galathea strigosa* the gland is deeply divided into several lobes, which are themselves broken up into several secondary lobules; the saccule has ramifications which are much more developed than those of *Pagurus;* the antennary gland has a structure very similar to that of *Galathea.* The bladder of the Brachyura is remarkable for its great size; in *Platycarcinus pagurus, Carcinus mænas, Xantho floridus, Portunus puber,* and others, there is an enormous hind-bladder which communicates with the rest by a narrow tunnel hollowed under the mobile insertion of the adductor of the mandible. In front there is a large suprastomachal paired lobe.

Metallic Brilliancy of Sapphirinidæ.*—Dr. H. Ambronn has investigated the causes of the metallic brilliancy of the Sapphirinidæ, on which Gegenbaur, Claus, and Haeckel have already written. He came to the conclusion that he had to do with the interference colours that appear in very thin layers. There appears to be a layer in which are closely set uniaxal anisotropic structures which are perhaps true crystals. The dimensions of these vary in various species; in *Sapphirina fulgens* they have a transverse diameter of about 0·8–1 μ, while the long diameter is 1·3 μ; in a form allied to *Sapphirina pachygaster* the dimensions are somewhat greater. But as these sizes are too great it is necessary to suppose that between the chitinous investment and the layer of prisms there is a layer of slight refractive power which cannot be morphologically distinguished; the layer of prisms would then increase the intensity of the colours by acting as a strongly reflecting layer. Observations show that the colours are not the spectral colours of a grating.

Minute Structure of Eye of Arcturus.†—Mr. F. E. Beddard gives descriptions of the minute structure of the eye in some shallow-water and deep-sea species of this genus of Isopods. He finds that all the shallow-water species examined have lenses which are perfectly clear and transparent and are characteristically pear-shaped. On the other hand, all those species which appear to have a partly opaque lens are deep-sea forms, and in some there is a reduction in the size and an alteration in the shape of the lens which may be thought to impair its perfection as an organ for the passage of rays of light. Another point of considerable importance in relation to the supposed degeneration of the eye is the smaller amount of pigment which is found in the eye of most of the deep-sea species that were examined by the author.

Development of Amphipoda.‡—In the fourth of her studies Madame Marie Rossiiskaya-Koschewnikowa describes the development of *Sunamphitoë valida* and *Amphitoë picta.* The former does not differ from other Amphipods in the mode of formation of its germinal layers

* Mittheil. Zool. Stat. Neapel, ix. (1890) pp. 479–82.
† Proc. Zool. Soc. Lond., 1890, pp. 365–75 (1 pl.).
‡ Bull. Soc. Imp. Nat. Moscow, 1890, pp. 82–103 (2 pls.).

and in many points it resembles *Gammarus*, while the mode of development of its digestive tract is similar to that of *Caprella*. The history of *A. picta* has already been worked at by Rathke, who does not, however, make any mention of its dorsal organ; on the whole, its history is very closely similar to that of *S. valida*.

Addendum to Monograph of Caprellidæ.* — Dr. P. Mayer has published an addendum to his monograph of Mediterranean Caprellidæ. A large portion consists of systematic work, in which several new genera and species are described. In the anatomical and histological portion some space is given to the appendages, while the phylogenies of the Cyamidæ and of the genera and species of the Caprellidæ are briefly discussed.

Cladocera of Neighbourhood of Moscow.†—Mr. P. Matile has a memoir on the Cladocera found in the neighbourhood of Moscow, in which he enumerates seventy-five species, a few of which are new; this is a considerable increase on the forty-three species reported by the three naturalists who have before written on this subject.

New Cypridinidæ.‡ — Dr. G. W. Müller describes some new Cypridinidæ collected by Hilgendorf on the coast of Japan, and by Chierchia on the cruise of the 'Vettor Pisani.' Most of the members of this family of Ostracods frequent the sea-bottom at slight depths, though at times they may swim on the surface. But a number of species of *Cypridina*, grouped by the author in the subgenus *Pyrocypris*, are markedly pelagic, luminous, and strong in numbers. These surface-forms swallow Radiolarians, Infusoria, minute Heteropods, &c., and their œsophagus must be very extensile; those which frequent the bottom eat diatoms and small organisms. After describing the shell and the appendages, Dr. Müller proceeds to the systematic part of his memoir, where he describes one new species of *Cypridina*, six within his new subgenus *Pyrocypris*, two of *Philomedes*, four of *Asterope*. Some of these species are brightly phosphorescent, and there is some evidence to show that the luminous material is exuded from glands on the upper lip.

Halocypridæ.§—Dr. G. W. Müller describes the Halocypridæ of Chierchia's collection. They are pelagic in habit, though *Conchœcia variabilis* extends from the surface to a depth of 2000 fathoms, and they are among the swiftest entomostracan swimmers. The very uniform shell, the abundant glandular cells usually confined to the shell margin, and the appendages are described at length. Four genera are recognized:—*Halocypris* Dana (1 sp. n.), *Halocypria* Claus, *Conchœcia* Dana (6 sp. n.), and *Euconchœcia* g. n.

* 'Fauna u. Flora des Golfes von Neapel,' xvii., Berlin, 1890, 157 pp. and 7 pls.
† Bull. Soc. Imp. Nat. Moscow, 1890, pp. 104-69, 3 pls.
‡ Zool. Jahrb., v. (1890) pp. 211-52 (3 pls.). § T. c., pp. 253-80 (2 pls.).

Vermes.

a. Annelida.

Descent of Annelids.*—Herr E. Meyer makes this essay a text for some remarks on the origin of metamerism and the significance of the mesoderm. Claus has recently suggested that the jointed Cestoda may be derived from the unsegmented forms owing, primarily, to the metameric repetition of the gonads. The author believes that an analogous process is the cause of the metamerism of the body of Annelids; though it never produces complete individualization of the segments, it does in some cases lead to asexual reproduction by division.

The ancestors of the Annelids appear to have been strong, predatory Turbellaria which lived a pelagic life. Their body was elongated, and they may have had some resemblance to the Nemertines, which, however, were not their ancestors, for they form a distinct side-branch. The gonads were placed in the body-parenchyma, which was partly surrounded and partly traversed by muscles, and were, in the young, a single pair of compact cell-cords, but in the adult long hollow tubes opening at the hinder end of the body by a pair of simple dermal pores. It is conceivable that these tubes, when filled with sperm or ova, would affect the flexibility of the whole body; this may have led to the two tubes being broken up into two rows of metameres of equal size. They would naturally become centres of metamerism, around which the other organs, diffused and scattered through the body, would become metamerically grouped. This grouping would affect the spaces in the parenchyma, and so would give rise to the paired and segmentally chambered secondary body-cavity.

The extension of the gonads would cause the filling up of a large part of the primary cœlom, which in the ancestors of Annelids was probably an irregular system of lymph spaces and ducts; only a small portion would, therefore, remain over to form the definite blood-vascular system. The author offers the following hypothesis with regard to the origin of the neural and hæmal longitudinal muscular areas. Some of the non-productive elements of the walls of the gonads may be looked upon as epithelio-muscular cells, the distal fibrillar portions of which became drawn out into two ends; these fibrillar parts, by their contractions, exerted a pressure on the contents of the follicular cavities, and were, therefore, primitively of use in ejecting the generative products. When the walls of the follicles became attached to the integument and enteron, the fibrils lost their function and disappeared, except in the longitudinal areas of the outer body-wall, where they at first strengthened the primary longitudinal musculature, and subsequently completely replaced it. The author further developes the consequences of this change.

Herr Meyer holds to the opinion that the nephridial tubes should be regarded as parts of a pair of longitudinal canals, such as are possessed by the Turbellaria; the presence of intersegmental constrictions of the body hindered the flow of fluid and caused the formation of metameric orifices. The peritoneal funnels are neomorphs.

* Biol. Centralbl., x. (1890) pp. 296–308.

The definite nervous system is the direct descendant of the arrangement which obtains in the Turbellaria, but the whole larval system is a modification of a still older, primitively diffuse, subcutaneous plexus of nerve-cells. Similarly, the ciliated rings have not the significance which is so frequently attributed to them, but, like the larval form itself, are a secondary peculiarity necessary to a pelagic mode of life.

Although the setal apparatus is characteristic of Annelids, there are in the Turbellaria similar though superficially placed dermal structures, as, for example, in the *Enantia spinifera* described by Graff. The true chætopodia may have been derived from such primitively irregularly arranged dermal weapons. The cephalic tentacles and trunk cirri appear to be outgrowths of specially sensitive parts of the integument, the entrance of blood-vessels into which would give rise to gills.

The conception of Annelid ancestry held by the author has a distinct bearing on the morphology of the mesoderm. If the peritoneal sacs of Annelids, with all their derivates, are to be derived from the gonads of their ancestors, then the secondary or cœlomatic mesoderm of all Metazoa that possess it must have the primitive significance of a gonidial tissue. The primitive gonad-cells formed the rudiments of the secondary or cœlomatic mesoderm, and these do not really belong to either of the two primary germinal layers, but are, for a time, intercalated between the elements of one or other layer, at the beginning of the ontogenetic development of the Metazoa. The author does not regard the embryonic mesenchym as a single structure, but rather as the sum of the undifferentiated rudiments of various organs and tissues, which were primitively quite independent of one another.

Australian Earthworms.*—In the sixth of his communications on Australian earthworms Mr. J. J. Fletcher describes eight new species, treats a number of small perichæte worms as varieties of species previously described, and gives further information as to four known species. As in earlier papers, the question of generic distinctions is postponed for the present. With *Cryptodrilus* are associated *fasciatus*, with a robust body transversely striped; *Smithi*, in which there is an exaggerated condition of the dorsal situation of the outer couple of setæ of each side, *Tryoni*, *semicinctus*, and *simulans*; the affinities of the last two are not quite clear. *Acanthodrilus Macleayi* is not more than 27 mm. long; the new species associated with *Perichæta* are called *macquariensis* and *terræ-reginæ*. Two new varieties of *Cryptodrilus saccarius* are described.

New Genus of Eudrilidæ.†—Mr. F. E. Beddard has a preliminary note on a new genus of Eudrilidæ, which he calls *Hyperiodrilus*. It comes from West Africa, and is most nearly allied to but distinct from *Stuhlmannia*. The setæ are in couples, but the dorsal are closely approximated, while those of the ventral couple are far apart. There is a protrusible penis, which is connected by two grooves with two prominent papillæ. The most interesting organs from a structural point of view are the generative. As in *Teleudrilus*, the funnels of the four vasa deferentia lie in the interior of the sperm-sacs; the ducts open into a

* Proc. Linn. Soc. N.S.W., iv. (1890) pp. 987-1019.
† Zool. Anzeig., xiii. (1890) pp. 561-3.

large glandular atrium which is tubular in form and much like that of *Acanthodrilus*. Each ovary is inclosed in a separate cœlomic sac, which contains a portion of the nephridium belonging to its segment; the two ovarian sacs communicate with each other by a narrow tube-like sac, and also with a large sac which forms a complete ring encircling the œsophagus, and is continued into an extensive sac passing along the dorsal surface of the intestine into the fifteenth segment. The bursa copulatrix is a small globular sac from which arises a slender spermatheca with very muscular walls; this spermatheca is entirely inclosed by the left-hand portion of the pericœsophageal ring and ends blindly in the interior of that cœlomic space.

β. Nemathelminthes.

New Species of Strongylus from Paunch of Ox.*—Dr. R. Ostertag has a preliminary notice of *Strongylus convolutus* sp. n., found in the paunch of a young bull. It was present in considerable numbers and seemed to have caused considerable disturbance of the nutrient processes. The parasites are small (male 7–9, female 10–13 mm. long), and of a yellowish-brown colour; the colour is due to small pigment-grains in the intestine. The form is said to be distinguished by its simple structure, the two glandular organs near the commencement of the enteron, and the bell-like dermal fold over the vulva.

γ. Platyhelminthes.

Northern Turbellaria and Nemertinea.†—Mr. D. Bergendal has a preliminary notice of his studies on northern Turbellaria and Nemertinea. *Uteriporus vulgaris* is the name given to a form which in external appearance has considerable resemblance to *Gunda*. The generic character appears to be the presence of an independent opening to the uterus which is placed near the orifice of the penial sheath. There is a small depression around the genital orifices. The oviducts unite behind the penis into a common duct which runs forward and opens into the cavity of the penial sheath. The arrangement of the organs is almost segmental, it being very rare to find more than one testis in each septum.

A new genus must be made for a large Polyclad which is like *Cryptocelis;* it is distinguished chiefly by the strong muscular glands which lie in a special cavity behind the separate genital orifices. The author proposes to call the form *Cryptocelides Loveni*. About thirty species of Nemertinea were observed in Bohuslan, some ten of which seem to be new; two of the more interesting are parasitic, one living in *Esperia lingua* and the other in *Phallusia mentula*.

Amphibdella torpedinis.‡—Sigg. C. Parona and A. Perugia make some additions to our knowledge of this parasite of *Torpedo narce*. The length of sexually mature forms varies between 1·5 and 5 mm.; as in *Gyrodactylus elegans* the anterior end bears a number of dermal glands; the oral orifice is ventral and lies in a sucker-like organ; the œsophagus

* Centralbl. f. Bakteriol. u. Parasitenk, viii. (1890) pp. 457–60.

† Ofv. K. Vet. Förhand., 1890, pp. 323–8.

‡ Ann. Mus. Civ. Genova, xxix. (1890) pp. 363–7. See Centralbl. f. Bakteriol., viii. (1890) pp. 335–6.

soon bifurcates. What have previously been taken to be testes are now recognized as pyriform dermal glands which are connected with two large excretory canals which open at the hinder end of the body. In the anterior region there is a large spherical or oval testis, from which a short vas deferens leads to a small penis. The oviduct forms numerous loops between the branches of the vitellarium. The hinder ends of this latter are not separated, but are united near the end of the intestine. The caudal end is divided into one unpaired median and two lateral lobes, which again are divided into five smaller lobules, each with a small hook. It is clear that *Amphibdella* has not, as Chatin, its original describer, thought, any relation to the Hirudinea, but that it is a true Trematode and belongs to the Gyrodactylidæ, where it stands between *Calceostoma* and *Tetraonchus*.

Helminthological Studies.*—Sig. P. Sonsino reports the occurrence of *Distomum hepaticum* in the nylghau (*Portax picta*) and in *Bos bubalus*; *D. caviæ* (?) from *Cavia cobaya*; *D. magnum* in *Cervus dama*, &c.; *D. lanceolatum* from *Antilope dorcas*, *Capra hircus*, and the ass; *Trichina circumflexa*, *Trichosoma* sp. (?), &c., from *Mus decumanus*; *Strongylus bifurcus* from several monkeys; *Distomum simile* sp. n. from *Python molurus*; *D. gelatinosum* from *Thalassochelys caretta*; three tailed species of *Distomum* (s. g. *Apoblema*), *D. excisum*, *D. rufoviride*, *D. ventricosum*, from fishes; besides *Anthocotyle merlucii*, *Pleurocotyle scombri*, *Octocotyle arenata* sp. n., *Trochopus longipes*, *Calceostoma elegans* from the same sources.

Structure and Development of Distomum cylindraceum.†—Dr. v. Linstow describes this well-known but very imperfectly investigated Trematode from the lungs of frogs. Its growth is very slow and apparently corresponds with that of its host. The mutual fertilization of two large specimens was observed, but self-fertilization seems also probable. The history of the reproductive elements was followed in detail, and some glimpse of the segmentation was obtained. The eggs pass into the alimentary canal of the frog and out by the cloaca, but Braun has also observed the passage of the entire *Distomum* through the amphibian's nose. In the latter case the parasites die in the water, while their eggs are liberated, and this also happens when female frogs die from the fatal effects of prolonged copulation. Three weeks after the eggs have reached the water, a ciliated sheath may be observed round the embryo, but several months pass before hatching occurs. The liberated embryo finds its way into *Limnæa ovata*, becomes a sporosac, and forms Cercariæ which leave their host about midsummer. These Cercariæ seem then to enter the larvæ of small beetles (*Ilybius fuliginosus*), and cysts containing them are found in the body-cavity of the adults. The beetles are eaten by frogs, and the cysts are dissolved in the stomach, whence the larval Trematodes migrate to the lungs or to other parts of the body.

Trematodes of Gills of Italian Fishes.‡—Sigg. C. Parona and A. Perugia have examined nearly one thousand sea-fishes, twenty per cent.

* Atti Soc. Tosc. Sci. Nat., vii. (1890) pp. 99–114.

† Arch. f. Mikr. Anat., xxxvi. (1890) pp. 173–91 (2 pls.).

‡ Atti Soc. Ligustic. di Scienze Nat. e Geogr., i. (1890) 14 pp. See Centralbl. f. Bakteriol., viii. (1890) p. 310.

of which were found to have Trematodes on their gills. *Diplectanum æquans* and *Microcotyle sayii* were the most common. The *Gyrodactyli*, which are so common on fresh-water fishes, were represented only by *Tetraonchus van Benedeni*.

Cysticercoids Parasitic in Cypris cinerea.*—Mr. T. B. Rossiter describes the presence of cysticercoid parasites in *Cypris cinerea*. The head is about 3/100 in. in diameter, and the suckers are about 1/1000 in. wide and 1/800 in. long. The hooks are not unlike those of *Tænia nana* in their shape, and are not more than 1/1200 in. long.

δ. Incertæ Sedis.

Rotifer Parasitic on Vaucheria.†—M. F. Debray has followed out the life-history of *Notommata Werneckii* Ehrb., which he finds parasitic on *Vaucheria geminata*, *terrestris*, *pachyderma*, and *sessilis*, but not on *V. synandra*. After emerging from the egg within the gall, the young rotifer moves about freely for a time, finally escaping from the gall, and almost immediately again endeavours to effect an entrance into a *Vaucheria*-tube, rejecting all other algæ with which it may happen to come into contact. It at length pierces a tube and wanders about within it for some hours, until it finally settles itself in a gall. It here lays eggs of three different kinds; the first kind during the spring, with thin smooth membrane, followed by two other forms of lasting eggs with spiny membrane. The author has never seen the male rotifer, and believes that this production of eggs takes place parthenogenetically. After depositing its eggs, the rotifer dies and disappears almost entirely. The author dissents from Balbiani's view that the parasite inhabits only modified fertile branches of the *Vaucheria*; he regards the structures in which they are found as true galls, the result of injury to the tube caused by the puncture of the parasite.

Rotifers and Hepaticæ.‡—Prof. F. Delpino records the fact that a rotifer (named by Zelinka *Callidina symbiotica*) is commonly found in the drop of moisture retained by the recurved margin of the leaves of many Hepaticæ, and especially in the pitcher-shaped leaves of species of *Frullania*. No observations have, however, as yet justified the specific name.

Distyla and Cathypna.§—Mr. J. E. Lord suggests that the genus *Distyla* is identical with that of *Cathypna*; and that Mr. Gosse, to whom the latter genus is due, constructed it in mistake, through hurry and "failing powers," out of those specimens of the former genus which he happened to observe in a contracted state. Mr. Lord also gives drawings of two supposed new species of *Cathypna*, which he names *C. Gossei* and *C. Hudsoni*, and which he thinks that Mr. Gosse would have called *Distyla*, had he seen them only in their extended condition. On the point of classification raised by Mr. Lord, it is enough to say that Mr. Gosse's own descriptions and figures of *C. luna*, *C. sulcata*, and *C. rusticula* show that he had seen these creatures extended, and yet

* Journ. of Microscopy, iii. (1890) pp. 241–7 (2 pls.).

† Bull. Scient. France et Belg., xxii. (1890) (1 pl. and 9 figs.). See Notarisia, v. (1890) p. 1058. Cf. this Journal, *ante*, p. 643.

‡ Malpighia, iv. (1890) pp. 32–3 (1 pl.). § Science-Gossip, 1890, pp. 201–2.

considered that they ought to be separated from Eckstein's genus *Distyla*. And the distinction is plain enough: in *Cathypna* the whole trunk is loricated, and the creature, when extended, is dorsally arched; but in *Distyla* only the hinder portion of the trunk is loricated, the fore part having a membranous covering, and the creature when extended is comparatively flat, or, as it is termed, "depressed."

What Mr. Lord's species really are, or whether they are new, it is impossible to say from his imperfect figures and description; but it is easy to see how little competent he is to be a critic of the veteran naturalist, by turning to the Supplement of the 'Rotifera,' and comparing Mr. Gosse's last descriptions and drawings (done only a short time before his death) with those of Mr. Lord's in 'Science-Gossip,' remembering at the same time that Mr. Gosse's descriptions and drawings, in the Supplement, are of those very species which Mr. Lord says were hurriedly observed, and executed with "failing powers—of eyesight at least."

It is hardly necessary to point out the lack of taste and good feeling which leads Mr. Lord to quote scraps from the deceased Mr. Gosse's private letters, in order to help out an adverse criticism on his last work.

Cœlenterata.

Pelagic Anthozoa.*—Prof. E. van Beneden gives a preliminary notice of the results of his studies of the pelagic Anthozoa collected by Prof. Hensen. All were larval forms, and most belonged to the Cerianthidæ. From the abundance and variety of the pelagic larvæ it seems probable that the group is represented by very diverse forms at great depths; this fact is interesting, as the Cerianthidæ are very probably allied to the Rugosa. The special form to which the author calls attention is one which brings to mind the well-known larva of Semper; this form has never yet been subjected to a microscopic examination. The general form of the larva is pyriform, and the oral orifice is placed at the narrow end; the axis is that of the letter C, but it is probable that this shape is due to the action of the preservative fluid. The whole surface of the body is strongly pigmented, with the exception of a median band on the ventral surface; in the middle of this band there is a shallow groove. On the ventral surface there is a vibratile fringe, similar to that seen by Semper in his larva, and the cause of the marvellous iridizations which distinguish the creature. There is no trace of any tentacles around the mouth, and there does not appear to be any second orifice. Bilateral symmetry is obvious.

While in all known larvæ of Anthozoa the ectoderm has the same character all over the body, there is in this new form a sharply differentiated portion, which may be called the flagelliferous plate; the cells of which it is composed are exceedingly narrow and filiform, but there are never in it any glandular cells or any nematocysts; each of the flagellate cells has at its free end a small brilliant plate, which carries the flagellum. The cells are so disposed that the plate seems to form, at right and left, two pads which may be compared to those seen in the medullary plate of certain Vertebrates; in its centre is a widely

* Bull. Acad. Roy. Belg., lx. (1890) pp. 55-99 (1 pl.).

open groove, which in form recalls that of the medullary groove of higher Vertebrates.

The rest of the ectoderm, in stained specimens, breaks up into three differently coloured zones; in the outermost are a large number of nematocysts and of unicellular glands, while in the median the nuclei are very closely packed. Nervous elements could not be made out, but there is no doubt that they are among the various constituents of the ectoderm. The nuclei are larger than those of the flagellate cells, and show well-marked dots, the most apparent of which is, perhaps, the nucleolus. Some of the nematocysts are small, and have the form of cylinders, within which is a thread which describes an extremely regular spiral; others, which are larger, ovoid, rarer, and more deeply seated, have an irregularly arranged spiral. There are also two kinds of glandular cells; some are coarsely but uniformly granular, while others have clear contents and a homogeneous or reticulated appearance.

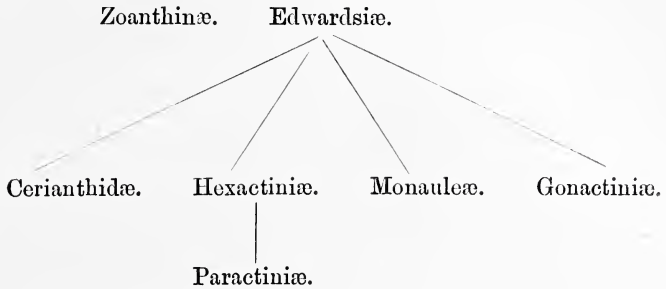
The mesenchymatous layer is remarkably thick, and contains a very large number of cellular elements. Some of the cells are large, and their protoplasm acts energetically on the colouring material; they may be rounded, fusiform, or stellate in shape. Others are much smaller and have always very fine and colourless prolongations. The new form is remarkable among Actinian larvæ for the constitution of its fundamental lamella, which is not simple, but is a well-characterized cellular tissue, while the differentiated cellular strata of endoderm and ectoderm, which are in immediate contact with it, have almost the appearance of the layer of osteoblasts of bony tissue, or the odontoblasts of teeth.

The cœlenteric cavity has about the middle of the long axis of the body the appearance of a transverse cleft; it is broken up at its periphery by three pairs of macrosepts, which have on their free edge a mesenteric swelling, into six spaces, the largest of which, in the transverse direction, is the medioventral. There are also six microsepts, the three pairs of which are unequally developed. The endodermal layer which lines the two surfaces of the mesenchymatous lamella of the mesenteries is delicate and formed of cubical cells, which are here and there replaced by fusiform elements. The mesenteric swellings exhibit no tendency to form convolutions; all the cells that compose them are conical and radiate in all directions around the slightly swollen extremity of the mesenchymatous layer.

In each macrosept a layer of longitudinal muscular fibrils may be seen in the form of a row of shining grains. The microsepts differ from the macrosepts in having their very short mesenchymatous layer almost reduced to the terminal enlargement of the macrosepts, in the delicacy of their endodermal layer, and the absence of the mesenteric swelling.

After describing the appearances of transverse sections taken at different levels, Prof. Van Beneden proceeds to point out the resemblances and differences between this new larva and that of Semper; the former are the general form of the body characterized by its considerable elongation, the existence of six well-developed sarcosepts, the total absence of any trace of tentacles around the mouth, and above all the presence of the median vibratile fringe; the latter are the cylindrical shape of one larva and the pyriform of the other, the difference in the

length of the fringe, which is shorter in the new larva, the absence in it of an aboral orifice, and the apparent differences in the characters of the nematocysts. After a careful review of the different possible groups with which this larva may be associated, the author concludes that it should be placed with the Zoanthinæ. These he regards as an independent branch, and cannot accept the recent views which would derive them from the Edwardsiæ. His opinions as to the affinities of some of the Anthozoa are shown in the following table :—



Habits of Virgularia.*—Mr. E. Thurston, referring to recent doubts as to the truth of the statements that *Virgulariæ* stand up vertically with their bulb planted in the mud, and that they are able to pull themselves in with force, so as to nearly or quite disappear, draws attention to the statement made by his native diver. "The diver described the animals as sticking straight up in the sand, and said that, as soon as he touched them, they went deeper and deeper down in the sand, and sometimes fixed themselves so firmly that he could only secure them by digging them out with a spade."

Septal Budding in Recent Madrepores.†—Herr G. v. Koch corrects a passage in Neumayr's 'Stämme des Thierreichs' in which it is implied that septal budding does not occur in recent Hexacorallia. This mode of multiplication does still occur, especially in Astrææ. It is illustrated by v. Koch in the case of *Favia*, and referred to as occurring in *Stauria*.

Symmetry of Hydroid-Colonies.‡—Dr. H. Driesch continues his studies on the arrangement of the "persons" in hydroid colonies, discussing *Plumularia*, *Aglaophenia*, and the Tubulariidæ. After arranging various Plumularians in a series according to their mode of ramification, he discusses the morphological value of the nematophores, and from his own point of view decides against their ranking as persons. From a technical study of Tubularians, he passes to some general notes on what he calls "comparative blastology" or the comparison of persons, and on the bearing of these studies in ramification on morphological problems.

Development of Hydra.§—Dr. A. Brauer has a preliminary notice of his studies in the development of *Hydra aurantiaca*. He finds that

* Proc. Zool. Soc. Lond., 1890, pp. 462–3.
† Morphol. Jahrb., xvi. (1890) pp. 534–6 (4 figs.).
‡ Jenaische Zeitschr. f. Naturwiss., xxiv. (1890) pp. 657-88 (6 figs.).
§ Zool. Anzeig., xiii. (1890) p. 457.

the polar globules are typically developed at the pole nearer the mother, as stated by Kleinenberg, and not on various points of the surface, as asserted by Korotneff. The granules in the globules are not yolk-spheres, but of nuclear origin. The equal segmentation leads to a blastula, which is composed of cells of equal and not unequal size. The cleavage-cavity is seen in the eight-celled stage. The endoderm is not formed by polar immigration of cells, but is multipolar; blastoderm-cells partly loose themselves from their connections and wander into the cleavage-cavity, partly undergo division, and the inner portions form endodermal cells. The ectoderm is not lost when the egg-shell is formed, but persists; the shell is a cuticular structure.

Porifera.

The Genus Stelletta.*—Dr. R. von Lendenfeld gives a monographic account of the genus *Stelletta*, describing five species, viz. *S. grubei*, *S. dorsigera*, *S. boglicii*, *S. pumex*, and *S. hispida*. They are "siliceous sponges, with triaen and amphiox megascleres, and with rigidly radial asters, with which rhabdodragmata are rarely associated; with small spherical ciliated chambers, and mostly with a rind." It may be noticed that the technical names of sponge-spicules have been recently † arranged, and the forms illustrated, by Prof. F. E. Schulze and Dr. Lendenfeld.

The peculiar "chones" which Bowerbank first noticed, and which Sollas first described with due carefulness, are discussed at some length. "In most Tetractinellids with thick rinds, and also in Monactinellids such as *Sollasella*, the pore-canals unite in groups into larger main-canals, which penetrate the rind. In the lower portion of the main-canal in these sponges there is a marked constriction which divides it into a distal portion (the inhalant main-canal) and a proximal portion (the chonal-cupola of the subdermal space). Sometimes, as in *Stelletta boglicii* and *S. hispida*, the constriction lies at the inferior end of the canal, where it opens into the subdermal space. In these forms the chonal-cupola is absent. The tissue which forms the constriction consists of flat, elongated, or in part spherical cells, forming a thick mass in the neighbourhood of the narrow chonal canal which passes through the constriction. These cells are more or less concentrically arranged, but in the Adriatic species of *Stelletta* there are not simple circular muscle-fibres, as Schmidt and Sollas maintained. As Auchenthaler correctly noted, they are cells which by their turgescence are able to narrow and close the chonal canal, and thus to regulate the stream of water."

Development of the Freshwater Sponge.‡—Dr. O. Maas finds that the egg of *Spongilla* is rich in yolk, that it undergoes total and equal segmentation, and gives rise to a compact morula. The cavity formed at one pole of this morula closes up before the cells have lost the character of blastomeres. The differentiation of the tissues begins simultaneously at all points of the embryo, and so gives rise to a trilaminate larva. The mobile larva consists of an outer layer, formed of cylindrical, ciliated cells; of an epithelial lining, formed of flat spindle-

* Abhandl. K. Preuss. Akad. d. Wiss., 1889 (1890) p. 75 (10 pls.).
† Op. c., i. p. 35. ‡ Zeitschr. f. Wiss. Zool., l. (1890) pp. 527-54 (2 pls.).

shaped cells, which invests the cavity with its duct-like outgrowths and adjoining flagellated chambers, which often extend as far as the innermost layer. This last consists of a cell containing still unused yolk, of a connective substance or mesogloea, in which there are cells and silicoblasts with their spicules. The larva becomes attached by the pole of its cavity, and undergoes an extraordinary amount of flattening; at the same time the cylindrical cells of the ectoderm become more and more flattened, while the cells of the marginal part become amœboid. As soon as the larva is flattened the flagellated chambers come near the surface, and the afferent orifices are formed by the ingrowth of the ectoderm-cells. The efferent system arises by the secondary breaking through of the primitive cavity to the exterior, while the subdermal cavities and the ducts which lead to the chambers are formed by later processes of growth.

Protozoa.

Parasites of the Blood of Birds and Tortoises.*—Herr B. Danilewsky has collected some of his observations on Hæmatozoa in two memoirs † on the comparative "parasitology" of the blood. Among birds, only the Passeres and the Raptores are known to be infected. In the red blood-corpuscles of owls Danilewsky detected *Polimitus sanguinis avium*, and saw it emerge equipped with several cilia from within the cells, though, like Pfeiffer, he regards this emergence as a result of the artificial conditions of his microscopic preparation. Fresh blood contains small spiral protoplasmic structures, which the author believes to be separated cilia of *Polymitus*, and it is possible that similar bodies in the blood of malarial patients, and even the *Spirochæta Obermeieri* of recurrent fever, may have a similar origin. Another curious form is *Trypanosoma sanguinis avium*, which, like Bütschli's Rhizomastigina, has the long flagellum of a Flagellate and the undulating contour of a Rhizopod. It divides longitudinally or transversely, or, rounding itself off, segments like an ovum into thirty-two coherent cells, which acquire flagella and then go apart. Though it is probable that this form may disturb the capillary circulation, and though others destroy the corpuscles, decisively morbid symptoms have not been detected in the host, thanks perhaps to the high temperature or to the inoculating influence of the constant presence of these parasites for generation after generation.

In the blood of tortoises the author describes a species of the flagellate genus *Hexamitus*, which probably passes from the food-canal to other parts of the body. The rest of the second memoir is occupied with an account of *Hæmogregarina*, which lives in the blood-corpuscles of *Emys*. It grows and forms spores, which burst into the fluid of the blood, and probably find their way into the hæmatoblasts. But the origin and complete history of this parasite are still obscure.

Dinobryon.‡—Dr. O. E. Imhof gives a summary account of what is known as to this genus of the Flagellata, ten species of which have been described; all of these are from Europe. Further forms will probably

* Biol. Centralbl., x. (1890) pp. 396-403.
† 'La Parasitologie comparée du Sang,' i. et ii., Kharkoff, 1889.
‡ Zool. Anzeig., xiii. (1890) pp. 483-8.

be discovered when a better survey has been made of freshwater lakes in other parts of the world.

Pigment and Conjugation of Euglena.*—Sig. O. Visart maintains that the red pigment (hæmatochrome of Cohn) of *Euglena sanguinea* has a close genetic relation to chlorophyll, and is probably a derivative thereof. As the red pigment occurs most abundantly at the maximum of light and heat, it seems reasonable to conclude that the intensity of the sun's rays is a factor in its formation. Sig. Visart has also observed and figured the conjugation of two individuals of *Euglena sanguinea*, and their ultimate fusion into a spherical cyst.

Monadine parasitic on Saprolegnieæ.†—Prof. M. M. Hartog gives an account of a monadine which he has observed in his culture of Saprolegnieæ. The mastigopod swarmer or zoospore stage may frequently be found in and about the infected hyphæ of old cultures about nine o'clock in the evening or later. It is from 7 to 10 μ long; each example has a nucleus of the rhizopod or myxomycete type—i. e. vesicular, with the nuclein in a spherical central mass, and there is at least one vacuole anterior to the nucleus. After a long period of active swimming, the parasites settle down on the walls of living hyphæ, glide along them like *Amœbæ*, and finally penetrate into them; the pseudopodia are now radiate and stiffish. After using up the nutrient protoplasm, that of the parasites becomes coarsely granular; the pseudopodia become retracted, and the granules are collected into a highly refractive excrementitious mass, surrounded by a clear vacuole and simulating a gigantic nucleus. These granules are obviously nitrogenous. The body of the parasite now becomes spherical. The nucleus gives rise to daughter-nuclei, and zoospores are, later, found. One bores through the cyst-wall, and the others follow through the same hole. The author calls this parasite *Pseudospora* (?) *Lindstedtii*, and, as its name implies, regards it as one of the Pseudosporaceæ.

Parasites of Malaria.‡—Prof. B. Grassi and Prof. R. Feletti, who have been prosecuting investigations on the parasites of malaria, support the views of those who are in favour of considering the appearances to be due to the presence of a microbe. They are of opinion that the forms described by Laveran, Marchiafava, Celli, and others are really the parasites of malaria, and that in all probability they are amœbiform Rhizopoda, and that there are two genera, *Hæmamœba malariæ*, associated with the regular type of malaria, and *Laverania malariæ*, found in connection with the irregular types of pyrexia. The observations of the authors confirm the actuality of the appearances insisted on by Laveran and others, and their views differ from those of their predecessors merely in their holding that the crescent-shaped bodies, called by them Laverania, and the amœboid pigmented forms (Hæmamœba) are representatives of two different genera, which when young are indistinguishable. Both are possessed of a nucleus which behaves, in reproduction, just as the nucleus of all other living beings does. Directly the plasmodium begins to grow the two genera show signs of difference,

* Atti Soc. Tosc. Sci. Nat., vii. (1890) pp. 92–9 (4 figs.).
† Ann. Bot., iv. (1890) pp. 337–46 (17 figs.).
‡ Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 396–401, 430–5.

the amœboid passing through a resting form, while the crescentiform body soon assumes its characteristic shape.

With regard to the flagellate forms, the authors admit the reality of their existence, but are of opinion that they are involution or degeneration phenomena.

One experiment mentioned may be worth alluding to, à propos of the views of the writers. A person who had suffered for seven months of quartan ague and had recovered without treatment, was injected with 2 ccm. of blood from a patient ill for two months with *Laverania*, i.e. the blood contained many crescent-shaped bodies and few young Amœbæ. An attack of irregular fever followed, accompanied with the development of *Laverania*.

Micro-organisms intermediate between Animals and Plants.*— Mademoiselle Leclercq has published an interesting address under the above title, in which she gives a general sketch of the forms grouped under the head Protista. She concludes by giving reasons for believing in the immortality of protoplasm, and gives a notice of the lowest forms that exhibit the phenomena of death.

* Bull. Soc. Belge de Microscopie, xvi. (1890) pp. 70–131.

BOTANY.

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

a. Anatomy.

(1) Cell-structure and Protoplasm.

Structure of the Cell.*—Dr. C. Acqua has investigated some points connected with the growth of the vegetable cell, in the case of germinating pollen-grains (hyacinth, *Eschscholtzia californica*, *Clivia*). His observations led him to the conclusion that the new cell-walls are a direct product of the activity of the peripheral layer of protoplasm. In consequence of the rupture of the cell-wall, a portion of the protoplasm is forced out, and the portion that still remains inside breaks up into masses united by delicate protoplasmic filaments, which, after a time, become transformed into threads of cellulose. The increase in superficies was seen in many cases to take place by the distension and subsequent laceration of the old layers, while new layers become formed within, which, continuing to grow, are in their turn distended and lacerated. The increase in length of the pollen-tubes is entirely apical. When this growth takes place without interruption, the distension and formation of fresh cellulose may take place without any laceration.

As regards the part played by the nucleus, the author comes to the same conclusion as Palla,† that masses of protoplasm without any nucleus may form a new cell-wall. He was also able to demonstrate the possibility of maintaining the vitality of the nucleus for some days when entirely removed from the cell and completely isolated from the cytoplasm.

Movements of Protoplasm.‡—Ida A. Keller maintains that the currents of protoplasm so often observed in plants are not a normal phenomenon, but are a symptom of approaching death, and the result of pathological conditions. They may be caused by injury, by sudden and great changes of temperature, by the action of chloroform, by solutions of sugar and potassium nitrate, by absence of nitrogen, &c. In *Elodea canadensis* they are ordinarily observed in leaves which are beginning to wither, and do not cease until immediately before actual death. The author derived the same conclusion from the observation of leaves of *Trianea bogotensis* and *Butomus umbellatus*, leaf-stalks of *Alisma Plantago* and *Umbilicus horizontalis*, stems of *Tradescantia virginica*, air-roots of Orchideæ, tentacles of *Drosera*, seedlings of *Vicia Faba* and *Brassica Napus*, and hairs of *Tradescantia*, *Primula chinensis*, &c.

Callose.§—Under this term M. L. Mangin describes a substance which he believes to be an essential constituent of the cell-wall, although he has not at present been able to isolate it.

* Atti R. Accad. Lincei (Rend.), vi. (1890) pp. 577–9.

† Cf. this Journal, *ante*, p. 475.

‡ 'Ueb. Protoplasma-Strömung im Pflanzenreich,' Zürich, 1890, 47 pp. See Bot. Centralbl., xliii. (1890) p. 196.

§ Comptes Rendus, cx. (1890) pp. 644–7. Cf. this Journal, 1889, p. 538.

Callose is amorphous, colourless, insoluble in water, alcohol, or Schweizer's reagent even on addition of acids, readily soluble in a cold 5 per cent. solution of caustic soda or caustic potash, soluble in cold concentrated sulphuric acid, and in a cold solution of calcium chloride or tin chloride, insoluble in a cold solution of alkaline carbonates and ammonia, the latter giving it a gelatinous consistence. It is stained by anilin-blue and rosolic acid; the iodine-reagents colour it yellow. It is not a product of the decomposition of cellulose or pectic substances; its insolubility in ammonium-copper oxide, even after addition of acids, and its yellow colour with iodized phosphoric acid, distinguish it from the former; its insolubility in a cold solution of ammonia and of alkaline carbonates, and its resistance to the staining reagents of pectic substances, from the latter.

Callose is very widely distributed in the reproductive organs of Phanerogams and of Vascular Cryptogams; the author found it in the pollen-grains of Coniferæ, Cyperaceæ, and Juncaceæ, and in the plugs which interrupt the continuity of the pollen-tubes of *Plantago*, *Caltha* and *Narcissus*. In the vegetative organs of Phanerogams it occurs in the bast-tissue; elsewhere only occasionally, as accumulations in the interior of cells. In Fungi it plays a very important part, forming the membrane of the hyphæ and of the reproductive organs in the Peronosporeæ, Saprolegnieæ, Basidiomycetes, Ascomycetes, and some Saccharomycetes. It is found also in the membrane of the spores and sporanges of the Mucorini, in the mycelial filaments of the Polyporcæ, and elsewhere. In Lichens it exists in the membranes of the hyphæ, but not in those of the gonids. Among Algæ it is not nearly so widely distributed, but was detected in *Œdogonium*, *Ascophyllum nodosum*, and *Laminaria digitata*.

(3) Structure of Tissues.

Periderm.*—Sig. H. Ross adopts de Bary's definition of this term, viz. all the tissues which spring from the generating zone known as the phellogen, and von Höhnel's distinction of the three layers of which it is composed,—the outermost, *phellema*, composed of cork and phelloid; the innermost, *phelloderm*; while between them is the *phellogen*. The principal protecting element is the phellema, composed of a larger or smaller number of layers of cells with walls entirely, or for the most part, suberized. The phellema, like the epiderm, has no intercellular spaces except the lenticels, which here and there break the periderm, as the stomates do the epiderm, in order to allow of the escape of gases. The segmentation of the phellogen takes place in a radial or tangential direction, in five different ways, which are described at length.

The microchemical reactions for suberized cell-walls are described in detail, the best being concentrated sulphuric acid, which attacks all the cell-walls except those that are suberized, and chlor-zinc-iodide, by which the suberized and lignified walls are alike coloured yellow. In the greater number of cases the suberized wall of an isolated cell is composed of three lamellæ, the median layer consisting of suberin, and the innermost of cellulose; suberin consisting probably of a mixture of fatty substances.

* Malpighia, iii. (1890) pp. 513-39; iv. (1890) pp. 83-123.

In some trees the primary or superficial periderm persists through its whole life, in which case the phellema is continually renewed from the phellogen, in proportion as the outer layers peel off. The mistletoe is the only woody Phanerogam in which the formation of periderm is entirely suppressed.

The author then proceeds to describe the structure and development of the periderm and of the bark in a large number of species belonging to the Dicotyledones, Gymnosperms, and Monocotyledones, especially comparing the structure of this tissue in the stem and in the root. In no case was there found any fundamental difference in this respect in the two regions, and in many cases a complete agreement in every particular. Where slight differences are manifested, they are obviously related to the different environment of the root, and to its smaller increase in thickness; and these consist mainly in the greater regularity and simplicity of the phellema in the root as compared to that of the stem.

The Araucarieæ are distinguished from the other tribes of Coniferæ by the remarkable size of the cells of the periderm. All the species examined of the Abietineæ were marked by the greater or less development of phelloid tissue, with thickened and lignified walls, alternating regularly with layers of thin-walled suber. In the Taxodineæ, the Cupressineæ, and in many species of Podocarpeæ, we find an annular bark, and the phelloid tissue is wanting; the suberous cells are large, cubical, uncoloured, and with thin walls. *Gingko* (*Salisburia*), alone among Conifers, has an abundant phellema composed exclusively of large suberous elements.

Development of the Stem of Conifers.*—M. H. Douliot calls attention to the two theories on the mode of growth and structure of the summit of the stem in Conifers. Hanstein distinguishes at the summit of the stem three groups of cells, the dermatogen, the periblem, and the plerome, while the conclusions of Nägeli are diametrically opposed to this. The author then takes several examples, and carefully describes their structure. In *Picea excelsa* the development can be clearly traced, and there can be no doubt that the epiderm and the cortex have a common origin; the initial cell is in this case tetrahedral. In *Torreya nucifera* there is a certain amount of analogy with the Equisetaceæ, and some observers state they can trace three distinct histogenic regions in *Sequoia sempervirens*. This, however, is an error.

Cortical Fibrovascular Bundles.†—Prof. M. M. Hartog describes the occurrence, in *Gustavia* and *Lecythis* (Lecythideæ), of a complete system of cortical bundles external to the pericycle, anastomosing with the leaf-traces of the central cylinder at the nodes. They have often a complete circle of exogenous wood, and are all but concentric. In *Stravadium racemosum* (Barringtonieæ) there are similar bundles, but the orientation of the liber is reversed.

Vascular Bundles of Dahlia.‡—Dr. O. Kruch finds the stem of *Dahlia imperialis* to agree with that of many other species of Cichoriaceæ in the presence of medullary vascular bundles, but presents specialities,

* Journ. de Bot. (Morot), iv. (1890) pp. 206–12 (4 figs.).
† Ann. of Bot., iv. (1890) pp. 299–300.
‡ Nuov. Giorn. Bot. Ital., xxii. (1890) pp. 410–3.

which are described in detail, in the constitution of the vascular cylinder and in the presence of special formations in the cortex. Another peculiarity consists in the presence at the base of the branch of formations, consisting of phloëm only, or of both xylem and phloëm, originating from the endoderm.

Conducting Cells in Gymnosperms.*—Prof. E. Strasburger describes the nature of the cells which, in Gymnosperms, perform the function of the conducting cells in the sieve-portion of the vascular bundles of Angiosperms. In Vascular Cryptogams this function is performed by elongated parenchymatous cells containing more or less protoplasm, which either surround the sieve-tubes or are intercalated between them. In Gymnosperms also similar elements are found; there is always a relationship between the sieve-tubes and certain parenchymatous elements which surround them. In the Abietineæ this function is performed by certain rows of cells in the medullary rays; in a portion of the Cupressineæ and Taxodineæ, by certain rows in the medullary rays, and by others in the bast-parenchyme; in another portion of the Cupressineæ and Taxodineæ, and in the Taxineæ and Araucarieæ, by rows in the bast-parenchyme only. The arrangement in the Gnetaceæ and Cycadeæ resembles most nearly that in the Araucarieæ. The peculiarities of structure in the different suborders is described in detail; the parenchymatous cells which have this relation to the sieve-tubes all agree in being comparatively rich in protoplasm; in containing, when they are most active, no starch, and in the fact that they finally communicate with the sieve-tubes by pits of a peculiar kind.

Assimilating Tissue in Atriplex nummularia.†—According to Prof. G. Arcangeli, in the leaves of this shrubby species of *Atriplex*, the epiderm is alike on both sides, and the palisade-tissue is transformed into an assimilating tissue consisting of cells nearly destitute of chlorophyll, but containing abundance of water; and the sheath of the vascular bundles has undergone a similar transformation, this being apparently the chief seat of the assimilating function. A similar structure occurs also in the wings of the leaf-stalk; and it is probable that it is presented also by other species of the genus which grow in dry sunny situations.

Mucilage-cells in the Seeds of Cruciferæ.‡—M. J. D'Arbaumont states that it is well known that many families, and notably Cruciferæ, contain, in their peripheral and epidermal cells, a mucilaginous substance which has the property of considerably swelling in water. Several opinions have been put forward as to the nature and anatomical value of mucilage-cells. According to several authors, their walls remain thin, and the mucilaginous substance accumulates as a deposit in their cavity, and ends by filling it up entirely. According to others, the mucilage forms solely in the external walls of the cells, which consequently thicken considerably.

The author commences with a careful study of the seeds of *Capsella*. When the seed has arrived at maturity, the epidermal cells lose some of their water; they contract and flatten, and take that consistence which

* SB. K. Preuss. Akad. Wiss., 1890, pp. 205–16 (1 pl.).
† Nuov. Giorn. Bot. Ital., xxii. (1890) pp. 426–30.
‡ Ann. Sci. Nat. (Bot.), xi. (1890) pp. 124–84 (1 pl.).

is characteristic of vegetable mucilages, and form round the seed a colourless, continuous and apparently homogeneous pellicle. When placed in water, a large part of the internal substance of the cells is immediately reduced to mucilage, and swells considerably.

The mucilage-cells of *Sisymbrium Sophia*, *Teesdalia Iberis*, *Hutchinsia petræa*, and *Arabis Thaliana* are constructed on nearly the same plan as those in *Capsella*.

In the various species described, notwithstanding some individual variations, there is a remarkable similarity in the structure of the cell. There is always a wedge-shaped portion of amorphous cellulose, often thin at the summit, and in the remainder of the cell there is a striation, the striæ of which are in the direction of the axis of this column.

The author has embraced in his observations 90 species of the natural order Cruciferæ.

Secretory Apparatus of Papilionaceæ.*—Mr. W. Russell states that secretory cells were first pointed out in the Papilionaceæ by Sachs in *Phaseolus*; but it was Trécul who more exactly determined their precise nature. As a conclusion the author states that tannin is in the Papilionaceæ an excretory product, which is first localized in special cells analogous to laticiferous cells; these appear in the bundles before their differentiation into xylem and phloëm.

Mucilaginous Endosperm of Leguminosæ.†—Herr H. Nadelmann states that in all cases where the seeds of Leguminosæ possess an endosperm, the walls of the endosperm-cells are provided with secondary thickenings, consisting of true mucilage, not cellulose-mucilage. From an examination of the structure of this endosperm in a large number of species, he draws the following general conclusions.

The mucilage in these secondary thickenings serves in the first place as a reserve food-material; they are used up in the germination of the seed. In the cells of the cotyledons of the seeds of Leguminosæ, the secondary thickenings always consist of cellulose or amyloid, not of mucilage; they serve, however, the same purpose. The mode in which the absorption of these secondary thickenings of the endosperm-cells takes place during germination varies in different cases. Whether these thickenings occur in the endosperm-cells or in those of the cotyledons, this absorption is accompanied by the formation of transitory starch in the cotyledons. Where this mucilage is present in large quantities, other reserve-substances, except starch, are nearly or entirely absent. The mucilage may either be directly formed as such, or may be first produced as cellulose, and then transformed into true mucilage; when, in the cells of the ripe cotyledons, the thickenings consist of amyloid, they are formed directly as such.

Anatomy of Saxifragaceæ.‡—Dr. K. Leist treats in great detail of the anatomical structure of the genus *Saxifraga*, describing its variations in the different species. In the stem the course of the vascular bundles presents remarkable deviations according to the species; *S. Cotyledon*

* Rev. Gen. de Bot. (Bonnier), ii. (1890) pp. 341–4.

† Jahrb. f. Wiss. Bot. (Pringsheim), xxi. (1890) pp. 609–91 (3 pls.).

‡ Bot. Centralbl., xliii. (1890) pp. 100–3, 136–42, 161–71, 233–8, 281–8, 313–22, 345–53, 377–82 (6 figs.).

possesses an additional bundle-system in the pith. With regard to the leaves, it is seldom that any anatomical character can be assigned to a particular species, the histological characters of the leaf varying greatly in the same species under the influence of climate and of habitat. The arrangement and distribution of the stomates is very uniform, but they may either be elevated above the surface of the epiderm or depressed beneath it, according as the individual grows in a moist or in a dry situation.

Anatomy of Keteleeria.*—Sig. R. Pirotta has examined the anatomical structure of *Keteleeria Fortunei*, a monotypic conifer; the following being the most important results obtained. The root is characterized by the presence of a primary resiniferous axial canal, and of secondary resin-canals arranged irregularly in the secondary wood, and by the presence of mucilage-bearing idioblasts in the secondary cortex. The branches also contain resin-canals and mucilage-bearing idioblasts in the primary cortex, while these are absent from the secondary cortex and secondary wood. The leaves are of bilateral structure with heterogeneous mesophyll, and contain two lateral and marginal resin-canals and mucilage-bearing idioblasts in the mesophyll. On the under surface of the leaf the stomates form two broad zones on the sides of the mid-rib; there are none on the upper surface of the leaf.

(4) Structure of Organs.

Androecium of Malvaceæ.†—From an examination of the development and structure of a number of plants belonging to the natural order Malvaceæ, and especially to the tribe Malveæ, Herr J. W. C. Goethart derives the following general conclusions. The androecium owes its origin to the activity of intercalary meristem in close connection with the petals, and developed more strongly on their anodic side. These form the "staminalpodes," which produce the rows of stamens on their margins in basipetal succession. The rudiments of stamens, which originally stand in two vertical rows, usually split tangentially, each into two stamens with two-lobed anthers, sometimes into four. Variations occur in the number of the stamens, in the displacement of the staminalpodes, and in other points. The displacement of the staminalpodes is apparently caused by the oblique insertion of the petals. The diminution in the number of stamens in the androecium appears to be due either to climatic influences or to reversion.

Development of the Seminal Integuments of Angiosperms.‡—M. M. Brandza states that in plants where the ovule has two integuments, the constitution and origin of the envelopes of the seed have not been generally described. In most cases the internal integument is not consumed by the development of the embryo. It persists, and often constitutes the lignified part of the seminal envelope. Sometimes the nucellus itself contributes to the formation of the envelopes of the ripe seed. It is only in certain families that the envelope of the seed

* Atti R. Accad. Lincei (Rend.), vi. (1890) pp. 561–5.

† Bot. Ztg., xlviii. (1890) pp. 337–45, 353–63, 369–79, 385–95, 401–9 (1 pl. and 3 figs.).

‡ Comptes Rendus, cx. (1890) pp. 1223–5.

is formed by the outer part of the external integument of the ovule. In plants where there is only one integument, the envelopes of the seed are either formed from this integument only or from the integument and the nucellus. Sometimes the lignified portion of the seed takes its origin from the epiderm of the nucellus.

Extra-floral Nectaries of Sambucus.*—Dr. U. Dammer finds in *Sambucus nigra* four different kinds of extra-floral nectary. Between each pair of leaves are a pair of curved narrow structures with glandular apex, which are metamorphosed stipules. In addition to these, the lower pinnules of the primary pinnæ, and the ultimate divisions or teeth of the pinnæ, may be transformed into nectariferous bodies; and interpolated between the stipular nectaries are occasionally found other bodies of the same character, which may be of the nature of excrescences.

Cladodes of Ruscus aculeatus.†—M. W. Russell describes the development and anatomy of the cladodes of *Ruscus aculeatus*. Formerly this organ was considered as a leaf; but Turpin, in 1820, distinguished it as a leaf reduced to the rudimentary state of a flattened branch. In 1840 Martins gave it the name of *cladodum*, and recent writers, with few exceptions, have considered it as a flattened branch, and of the same nature as those found in *Xylophyllum* and *Mühlenbeckia*. Van Tieghem, however, in 1884, from the disposition and orientation of the bundles, concluded that it represented a leaf united with the axillary branch from which it proceeded. The author then describes the anatomy of a branch of *Ruscus*, and calls attention to the terminal bifurcating cladode, under which is seen the flattened branch. In conclusion, the development shows that the floral peduncle is a branch of the second generation, and the comparative anatomy of the terminal and of the lateral cladode proves that this organ is neither a leaf nor a leaf united to the axillary branch from which it proceeds, but that it is a flattened branch.

Spines and Thorns.‡—Herr H. Mittmann classifies the various forms of spiny protuberances which serve to protect plants from the attacks of animals under the following heads:—(1) Root-spines; (2) Stem-spines, which may be either metamorphosed axillary or supernumerary buds; (3) Leaf-spines, the whole leaf, stipules, or portions of the leaf; (4) Trichome-spines, either from the periblem or from the dermatogen; with transitional forms between these. Examples of each of these forms are described, including the solitary case of root-spines, the palm *Acanthorhiza aculeata*.

The special common characteristics of spiny structures are the strong development and peripheral position of the mechanical tissue, which increases in strength from the base towards the apex, and the strong thickening and lignification of its cells; a corresponding reduction of the assimilating and conducting tissues; and the peculiarity, which is especially characteristic of stem-spines, that growth continues longest at the base of the organ, the apex being the oldest portion, and that which arrives soonest at maturity.

* Oesterr. Bot. Zeitschr., xl. (1890) pp. 261–4.
† Rev. Gen. de Bot. (Bonnier), ii. (1890) pp. 193–9 (10 figs.).
‡ Abhandl. Bot. Ver. Brandenburg, xxx. (1889) pp. 32–71 (2 pls.).

Multiple Buds.*—M. W. Russell points out that multiple buds are in connection through their vascular bundles; that is, the central cylinder of one branches from that which precedes it, as the central cylinder of a branch does from that of another branch; they therefore ought to be considered as normal ramifications.

Structure of the Leaves of Aquatic Plants.†—M. C. Sauvageau describes the minute structure of the leaves in the three genera *Zostera*, *Cymodocea*, and *Posidonia*.

If a transverse section of the leaves of *Z. marina* be made at the base of an adult lamina, the epiderm will be found to consist of a continuous layer of small cells, the inner walls being thin, and the outer wall covered with a thin layer of cuticle, and they contain chlorophyll. The epiderm is never in direct contact with the lacunæ of the parenchyme, being separated from it by one or two layers of cells. The fibrovascular bundles become closer in proportion as they are distant from the median bundle, and are each supported by a layer of large cells which separate them from the neighbouring lacunæ. Between the xylem and the epiderm are three or four rows of cells. The marginal bundle on each side is near the edge, and is surrounded by a less dense tissue. The parenchyme between the bundles contains large lacunæ running the length of the lamina, and parallel to the veins, sometimes bifurcating or fusing, but without changing their disposition or their form, as seen in transverse section.

The leaf of *Z. marina* is characterized:—(1) by its completely closed sheath; (2) by the 5–9 parallel veins; (3) by the prolongation of the median vein to the apex; (4) by the absence of endoderm or of pericycle in the fibrovascular bundles; (5) by the lacunæ being disposed in a single row; (6) by the non-lignified sclerenchymatous fibres, which are subepidermal or surround the fibrovascular bundles; (7) by the absence of secretory cells. In *Z. nana* the general structure is very much the same as in *Z. marina*, but there are only three fibrovascular bundles—one median and two marginal, of which the structure is also the same. Between the bundles on each side are 3–6 lacunæ. The sheath, instead of being closed as in *Z. marina*, is open throughout its whole length, while the ligule is identical. *Z. Mülleri* replaces *Z. nana* in Australia; and, as in that species, there are three fibrovascular bundles.

The genus *Cymodocea* has been divided into three subgenera, *Phycagrostis*, *Amphibolis*, and *Phycoschœnus*. In *C. æquorea*, a Mediterranean plant, the leaves are alternate, distichous, liguled, and with long sheaths. There are nine veins connected together by anastomosing transverse branches, and this species is characterized by the presence at the extremities of secretory cells. The epiderm is alike on the two faces, and is composed of small cells with fairly thick walls. The leaf of *C. æquorea* is characterized (1) by its sheath with free edges; (2) by the lamina being indented at the edge near the summit; (3) by the 7–9 veins; (4) by the median vein not quite reaching the apex; (5) by the presence

* Comptes Rendus, cx. (1890) pp. 1277–9.

† Journ. de Bot. (Morot), iv. (1890) pp. 43–50, 68–76, 117–26, 129–35, 173–8, 181–92, 221–9, 237–45 (38 figs.). Cf. this Journal, 1889, p. 659.

of an endodermal sheath surrounding each fibrovascular bundle, and of a continuous pericycle in the median bundle; (6) by the lacunæ being arranged in three rows at the base of the lamina, and in a single row towards its apex; (7) by the presence below the epiderm of bundles of fibres which are sometimes lignified; (8) by the presence of secretory cells. Two other species of the same genus are described:—*C. rotundata*, with 10-13 veins, and *C. serrulata*, from the Red Sea and Indian Ocean, with 15–17 veins.

The genus *Posidonia* includes two species—one Mediterranean and one Australian. The leaf of *P. Caulini* is characterized (1) by a sheath with free edges, (2) by a large lamina, (3) by 13–17 parallel veins, (4) by the median vein being prolonged but not quite reaching the apex, (5) by a well-developed endodermal sheath round each fibrovascular bundle, (6) by numerous lacunæ, (7) by the structure and position of the fibres of the lamina, (8) by the numerous secretory cells, (9) by the absence of transverse perforated diaphragms. *P. australis* is easily distinguished by its leaf from *P. Caulini*.

Finally, in his conclusions, the author contrasts the three genera described in this paper. The species can be distinguished from each other by the arrangement of the parenchyme and the lacunæ, by the nature of the fibrovascular bundles, by the presence or absence of secretory cells, and by the character of the endodermal sheath when present.

Pitchers of Dischidia.*—Prof. F. Delpino discusses the function of these organs, and comes to a conclusion different from that of Treub, whose observations he conjectures were made on plants growing in unnatural conditions, and to a certain extent atrophied. Delpino finds in the pitchers a large quantity of detritus consisting of the remains of ants, hymenoptera, and other insects, a portion of which he believes to have been truly digested, and to have entered into the composition of the tissues. The principal object of this supply of nutriment appears to be to furnish material for the numerous adventitious roots of this epiphytic plant.

Resinous Leaves.†—Herr G. Volkens has examined the structure of a large number of plants with resinous leaves belonging to many different natural orders, and classifies them under the four following heads:—(1) The secreting organs are internal glands (*Hypericum resinosum* and possibly *Vernonia viscidula*); (2) a hypodermal tissue is filled with resin (*Fabiana squamata*, *Sarcocaulon rigidulum*); (3) the young leaves are covered with resin excreted by the stipules (*Larrea*, Zygophylleæ); (4) the leaves themselves are provided with secreting glands (all the remaining examples). Hanstein's "blastocolla" consists usually of a mixture of mucilage and resin, the former resulting from a decomposition of cellulose, the latter already fully formed in the "colleters." Plants with viscid or resinous leaves are almost invariably natives of arid climates, and the secretion is obviously a provision against excessive transpiration.

* Malpighia, iv. (1890) pp. 13-7 (1 pl.).
† Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 120–40 (1 pl.).

Glaucosity of Leaves.*—According to Prof. F. Delpino, when the formation of wax in the outermost walls of epidermal cells is sufficiently great for it to be exuded in the form of rodlets, it serves the purpose not merely of reducing transpiration and confining this function to the stomates, but has also a protective function in preventing ants and other insects from crawling over them and reaching the organs which they would otherwise injure.

Aerial Roots of Dicotyledons.†—Herr L. Keller has examined the structure of the aerial roots of seventeen species of terrestrial plants belonging to the natural orders Asclepiadeæ, Gesneraceæ, Bignoniaceæ, Begoniaceæ, Marcgraviaceæ, Vitaceæ, Urticaceæ, Piperaceæ, Opuntiaceæ, and Rosaceæ; he finds that they present no analogy to the aerial roots of Monocotyledons. They have no velamen, and the endoderm is not composed of long and short cells. In all important points of structure the aerial correspond to the underground roots of the same species; the differences consist chiefly in the presence in the cortex of sclerenchymatous cells or of crystals, or in details connected with the environment of the organ. Various special points of structure characteristic of the individual species are described in detail.

Splitting of Roots and Rhizomes.‡—Herr L. Jost discusses the phenomena connected with the splitting off of the active and living from the dead tissue, which occurs in the course of their secondary growth in thickness in some roots and rhizomes; those specially examined were *Gentiana cruciata*, *Corydalis nobilis*, *C. ochroleuca*, *Aconitum Lycoctonum*, *Salvia pratensis*, and *Sedum Aizoon*. He finds it to depend on the dying of those portions of tissue which are in direct connection with the new annual organs, the leaves and flower-stalks. The living parts may be cut off from these dead portions by a periderm composed of several layers, or may be surrounded by a single or by a few layers of cork-cell, or there may even be no suberized membrane.

Structure of Sarcodes.§—Prof. F. W. Oliver describes in detail the structure of this little-known genus from California belonging to the Monotropeæ. *S. sanguinea* is a saprophyte growing among roots of pine-trees, but without any organic attachment to them by means of haustoria; its roots are closely enveloped by a mycorhiza, which, differently from what is the case in *Monotropa*, clothes them up to the tips. It is entirely destitute of chlorophyll, but the whole of the aerial portion of the plant is coloured a brilliant crimson, due to the presence in the superficial cells of a soluble red pigment probably allied to tannin. The starch-grains which abundantly fill the parenchyme are undistinguishable, in physical and chemical properties, from those of ordinary green plants. The leaves are reduced to scaly imbricate structures, and stomates are entirely wanting. The filaments of the fungus-mycele never enter the epidermal cells. The lateral roots in *Sarcodes* have an exogenous origin, and differ in this respect from those of *Monotropa*.

* Malpighia, iv. (1890) pp. 17-20.

† 'Anat. Studien üb. d. Luftwurzeln einiger Dikotyledonen,' Heidelberg, 1889, 44 pp. and 1 pl. See Bot. Centralbl., xliii. (1890) p. 149.

‡ Bot. Ztg., xlviii. (1890) pp. 433-45, 453-62, 469-80, 485-93, 501-10 (1 pl.).

§ Ann. of Bot., iv. (1890) pp. 303-26 (5 pls.).

The inflorescence differs from that of other Monotropeæ in being of the indefinite type. The pollen-grains are loose and powdery; the pollen-tubes are provided with large plugs, which cut off the cavity of the younger from that of the older portion. The mode of development of the ovules agrees closely with that in *Monotropa*.

β. Physiology.

(1) Reproduction and Germination.

Anemophilous and Cross-fertilized Flowers.*—Prof. F. Delpino describes the mode of pollination in the following species:—*Bocconia frutescens* (Papaveraceæ) presents an example of an originally entomophilous reduced to an anemophilous normal structure. Similar phenomena are exhibited by *Dodonæa viscosa* (Sapindaceæ), an anemophilous member of a family usually entomophilous. The flowers of *Erica scoparia* are adapted for absolute and exclusive anemophily, in remarkable contrast to the nearly related *E. arborea*. In *Mercurialis perennis*, which is anemophilous and dicœcious, the uppermost leaves on the female plants have a funnel-like form remarkably adapted for catching and retaining the pollen-grains. *Barnadesia rosea* (Compositæ Labiatifloræ) presents a very interesting structure for promoting cross-fertilization. In *Sauromatum guttatum* the arrangements for cross-fertilization within the spathe resemble those in other Araceæ; but the fertilizing insects in this instance are large carnivorous flies.

Parasitic Castration.†—MM. A. Magnin and A. Giard describe the actions of *Ustilago antherarum* and other parasites on *Lychnis vespertina* and different plants belonging to the Caryophyllaceæ; they may be of three kinds:—*androgenous*, which incites the production of male organs in the female host; *thelygenous*, which produces female organs in the male host; and *amphigenous*, which produces the transformation in flowers of either sex.

M. Giard ‡ calls attention to the parasitic castration of *Hypericum perforatum* by *Cecidomyia Hyperici*, and by *Erysiphe Martii*.

M. Magnin § further describes similar phenomena in *Anemone ranunculoides* attacked by *Æcidium leucospermum* (*Puccinia fusca*), resulting in more or less complete atrophy of the various floral whorls, especially of the carpels.

M. Magnin ‖ also calls attention to the androgenous castration of *Muscari comosum* by *Ustilago Vaillantii*. Normally the terminal tuft of the spike in this species consists of perfectly neuter flowers, without a trace of either stamens or pistil. When attacked by the parasite, the flowers of this terminal tuft are deformed, but produce stamens as well developed and as fertile as those of the flowers in the lower part of the inflorescence.

The parasitism of the æcidium of *Uromyces Pisi* on *Euphorbia cyparissias* produces very remarkable results. The axis is elongated and

* Malpighia, iv. (1890) pp. 24–32 (1 pl.).

† Bull. Scient. France et Belgique, 1889, pp. 151–60. See Biol. Centralbl., x. (1890) p. 20. Cf. this Journal, *ante*, p. 208.

‡ See t. c., p. 21. § Comptes Rendus, cx. (1890) pp. 913–5.

‖ T. c., pp. 1149–52.

thickened, the leaves are deformed and thickened, and the inflorescence is altogether aborted. Of these plants the peridium and the spermogones of the parasite develope a honey-like secretion altogether resembling that produced in the glands of the normal flowers, although, of course, it can have no function either nutritive or for attracting insects. It appears to be a means provided for carrying out a necessary physiological function of the plant.

Pollination and Dissemination of Gymnosperms.*—Prof. F. Delpino points out an interesting difference between *Ephedra* and all other genera of Gymnosperms in the structure of the ovule, connected with the mode of pollination. In all Gymnosperms the micropylar tube is filled with a fluid which exudes from its orifice in the form of a drop. In all the genera except *Ephedra* the pollen-grains have a lower specific gravity than this fluid; and in them either the ovules are inverted and the inflorescence erect (*Abies*, *Larix*, *Pinus*, *Podocarpus*), or the ovules are erect and the inflorescence pendent (*Cupressus*, *Biota*, *Thuja*, *Taxus*, *Cryptomeria*, &c.). In *Ephedra* alone the pollen-grains have a higher specific gravity than the fluid; and here the ovules and the inflorescence are both erect.

In many monœcious conifers, cross-fertilization is promoted by the arrangement of the male and female flowers; as, e. g. in *Cedrus Libanus*, where the male flowers are usually borne on the lower, the female flowers on the upper branches. The dissemination of the seeds of many conifers is provided for by their being enveloped in a coloured fleshy pulp, which is eaten by birds. The fruit of *Ephedra* bears a striking resemblance to that of *Taxus;* but the pulp is not in this instance of the nature of an aril, but results from a modification of the uppermost bracts of the inflorescence.

Pollination of the Mistletoe.†—Herr E. Loew throws considerable doubt on the statements which are commonly made, that the mistletoe is anemophilous, and that pollination takes place in the autumn, the pollen-tube penetrating to the neighbourhood of the embryo-sac, but impregnation not taking place till the following spring. The following facts point almost with certainty to the entomophilous pollination of the mistletoe. In the instances observed, the male plants are very much less common than the female. Both male and female flowers are furnished with nectaries, the nectar giving out an odour resembling that of orange-flowers, and most powerful in the male flowers. The pollen-grains are coherent when fresh, and their extine is furnished with minute spines. Both male and female flowers are fully developed in the spring, not in the autumn. The author was unable to determine what are the visiting insects, but suggests that they are bees belonging to the genus *Andrena*.

Fertilization of Bulbophyllum.‡—Mr. H. N. Ridley describes the mode of pollination in *Bulbophyllum macranthum* and some allied orchids at Singapore. The sepals exude a sweet substance resembling honey-dew, which is eagerly sought by a small dipteron. The feet of this

* Malpighia, iv. (1890) pp. 3–9. † Bot. Centralbl., xliii. (1890) pp. 129–32.
‡ Ann. of Bot., iv. (1890) pp. 327–36 (1 pl.).

insect slip from the glassy surface of the sepals, and it clutches at the small curved tongue-shaped lip which hangs between them. The base of this lip is balanced on the apex of the foot of the column; it gives way under the weight of the insect, which is thrown violently on to the column, striking the disc of the pollinia, which become fixed with great precision on the first segment of the abdomen. The insect then flies to another flower, and, going through the same process, places the pollinium on the stigma of this second flower. The author regards the whole group of Bulbophylleæ as specially adapted for fertilization by Diptera; the species of *Dendrobium*, on the other hand, by bees.

Fertilization of Physianthus albens.*—Mr. A. Harvey describes the peculiar structure of this plant, belonging to the Asclepiadeæ, and known in America as the "cruel plant." To the cap which covers the pistil are attached five pairs of stiff appendages; the moths, chiefly *Noctia gamma*, which suck the honey from the nectar-glands, get their proboscis caught between these appendages, are unable to remove them, and perish in large numbers without performing any useful service to the plant.

Mr. C. Armstrong suggests † that in its native country, Brazil, this plant is visited by larger Lepidoptera, or possibly by humming-birds, which are strong enough to break away the stiff appendages, carrying off the pollinia with them, and thus bringing about cross-fertilization.

Dissemination of Seeds.‡—Prof. F. Delpino calls attention to the fact that there are two entirely different kinds of dissemination in the vegetable kingdom, one for short, the other for longer distances. It is not uncommon for the same species to produce seeds adapted for both kinds of dissemination. This is the case with those plants which produce underground seed-vessels from cleistogamous flowers, such as *Lathyrus amphicarpus* and *Linaria Cymbalaria*. Again, in many Compositæ the seeds from the ray-flowers are adapted for dissemination to shorter, those from the disc-flowers for that to longer distances.

Germination of Zostera.§—Herr H. Jensen finds the mode of germination of the seeds in *Zostera* to be very similar to that in *Zannichellia* and *Ruppia*. The dehiscence of the pericarp takes place in water, and is brought about by the swelling of its mucilaginous innermost layer. The lower end of the hypocotyl is expanded into a peltate form, and is densely covered with root-hairs during germination. On the side facing the micropyle it bears a conical projection which is a reduced radicle, but has no trace of a root-cap.

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

Multiplication of Bryophyllum.‖—From experiments made on the leaves of *Bryophyllum*, planted in the soil after subjection to injuries of various kinds, Mr. B. W. Barton comes to the conclusion that the marginal buds are most nearly of the nature of axillary buds of the least preferred kind, comparable to those on branches of the second or third order of ordinary plants, and that they offer an example of an

* Proc. Canadian Inst., xxv. (1890) pp. 226-9 (8 figs.).
† T. c., pp. 230-1.
‡ Malpighia, iv. (1890) pp. 10-3.
§ Bot. Tidsskr., xvii. (1889). See Bot. Centralbl., xliii. (1890) p. 42.
‖ Johns Hopkins Univ. Circular, ix. (1890) p. 62.

axial growing on a foliar structure, and so furnish further evidence of the homology of leaf and stem.

Photographic Demonstration of the Function of Chlorophyll in the living Plant.*—M. C. Timiriazeff has demonstrated the concurrence of the absorption-spectrum of chlorophyll and its physiological function by the following experiment. A leaf still attached to a plant which had been kept in the dark for two or three days, was exposed, in a dark chamber, to a well-defined spectrum, obtained by means of a Silberman heliostat, from an achromatic lens and a direct-vision prism. The invisible image produced by the deposit of starch is developed by means of a rapid decoloration of the leaf by boiling alcohol and subsequent treatment with tincture of iodine. By this process there is produced on the pale-yellow ground of the leaf the image of the spectrum of chlorophyll as if traced by Indian ink. The spectrum which registers in the living leaf the production of starch, corresponds in all respects to the curve which represents the intensity of the decomposition of carbon dioxide obtained by the method of gazometric analysis.

Assimilation of Mineral Salts by Green Plants.†—Herr A. F. W. Schimper publishes the results of detailed observation on the part played by mineral salts in the economy of the plant. Immediately on germination the phosphates begin to leave the seed; in conjunction with organic substances their ultimate goal is the growing point and the mesophyll of the leaves. The mineral acids pass through the long-celled parenchyme of the stem and veins of the leaf containing but little chlorophyll, through which sugar and the amides also pass. Halophytes, and woody plants related to them but not themselves halophytes, have a great tendency to store up chlorides, especially in the leaves.

Inorganic salts are never found in the primary meristem, the sieve-portions of the vascular bundles, the laticiferous tubes, the reservoirs for secretions, the pollen-grains, or the ovules; in the mesophyll of the leaf and the aquiferous tissue they usually occur only in small quantities, the mineral bases having been assimilated, i. e. having entered into organic combinations. The potassium passes out of the seeds in the form of potassium phosphate; the activity of the meristem is connected with the formation of nuclein, nuclein being a compound of phosphoric acid. The leaves of the vine, and probably also of other plants, contain, in addition to calcium oxalate, considerable quantities of calcium tartrate and malate.

The most important processes in metastasis, the synthesis of the carbohydrates, albuminoids, and nuclein, and the formation of protoplasmic substances, can take place without the presence of calcium, but require considerable quantities of potassium and magnesium. Lime compounds are not necessary constituents of protoplasm, nor are they necessary for the formation of new organs, nor in the process of assimilation; the indispensability of lime for the life of the plant depends on the part which it takes in processes which take place in the growing region outside the primary meristem, but not connected with assimilation.

* Comptes Rendus, cx. (1890) pp. 1346-7. † Flora, lxxiii. (1890) pp. 207-61.

Descending Transpiration-current.*—Prof. J. Wiesner finds that if *Capsella bursa-pastoris*, *Bellis perennis*, or *Sempervivum tectorum* is grown in air completely saturated with moisture, the habit of the plant is altered by the greatly increased development of the internodes of the stem. *Taraxacum officinale*, on the other hand, appears to undergo no change under similar conditions.

Ascent of Coloured Liquids in Living Plants.†—Herr F. Goppelsroeder has investigated the phenomena connected with different coloured fluids in a number of different species of plant. When very dilute he states that a large number of such pigments may pass into the plant without apparent injury. The rapidity and extent of this circulation varies with the species of plant and with the pigment employed, some pigments rising to the very summit of the plant, while others again are not absorbed at all.

Prof. G. L. Goodale‡ contests the statement of Goppelsroeder that coloured fluids can be absorbed in this way without any disturbance to the plant itself. Plants with injured roots can live and grow slowly for a considerable time.

(3) Irritability.

Conduction of Irritation in the Sensitive Plant.§—From a series of experiments on *Mimosa pudica*, Dr. G. Haberlandt shows the untenability of the conclusion drawn by previous observers that the irritability of the leaves of the sensitive plant is conducted mainly through the xylem portion of the vascular bundles. He demonstrates, on the contrary, that the stimulus normally travels inside the zone of collenchyme or bast-fibres, but outside the xylem of the bundles, and therefore through their phloëm portion. When a stem is cut through, drops exude from the cut surface, and these can be shown to arise, not from the xylem, but from special cells in the phloëm. This special conducting-tissue is described by the author for the first time. It consists of rows of cells, somewhat larger than the ordinary phloëm-cells, in the transverse wall of each of which is a single large shallow pit, traversed by very delicate protoplasmic filaments. The contents of these cells is a crystallizable substance, probably a glucoside; they replace the tannin-sacs of other Leguminosæ. These special cells form a part of the phloëm, from the pulvinus at the base of the leaf to the larger bundles in the leaflets. Dr. Haberlandt believes that the protoplasmic filaments which penetrate the pits in the walls of these cells, play but a small part in the transmission of the irritation; it is conveyed in a purely mechanical manner from the pulvinus, as a wave or impulse passing along the glucoside-containing cells.

Sleep of Leaves.‖—M. Leclerc du Sablon states that it is well known that the leaves of certain plants, under the influence of external conditions, can take up different positions. For example, in *Oxalis*

* Verhandl. K.K. Zool.-Bot. Gesell. Wien, xl. (1890) SB., p. 30.

† 'Ueb. Capillar-analyse u. ihre verschiedenen Anwendungen,' Wien, 65 pp. See Bot. Ztg., xlviii. (1890) p. 345 ‡ Amer. Journ. of Sci., xl. (1890) p. 173.

§ 'Das reizleitende Gewebe d. Sinnpflanze.' Leipzig, 1890, 87 pp. and 3 pls. See 'Nature,' xlii. (1890) p. 561.

‖ Rev. Gen. de Bot. (Bonnier), ii. (1890) pp. 337–40.

stricta the leaf, composed of three leaflets, is horizontal during the day, but at the commencement of night each of the leaflets turns on its point of insertion. These movements, however, can be brought about in *O. stricta* and various other plants, by three different causes:—(1) by darkness; (2) by strong sunlight; (3) by contact with a foreign body. Nocturnal sleep manifests itself by the same movements as diurnal sleep, but is due to a different cause, viz. to an augmentation of the quantity of water in the pulvinus at the base of the leaflet. In the evening, when transpiration ceases, water accumulates at this point.

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

Action of Diastase on Starch.*—From an extended series of observations on a great variety of starch-grains—seeds of cereals, scales of the hyacinth and other bulbs, Leguminosæ, &c.—Herr G. Krabbe is able to disprove finally the theory that the grains consist of two different substances, granulose and farinose. He shows also that diastase does not penetrate between the micellæ of the starch-grain, but that the destruction of this substance by the diastase takes place in very much the same way as the solution of a crystal by the surrrounding medium.

During germination (in the endosperm of wheat) a number of canals are formed on each side of the discharged starch-grain. These canals gradually extend to the interior of the grain, and have a somewhat spiral appearance (really annular) owing to the varying intensity of the action of the ferment on the different layers of starch, which vary in density. The sharply defined walls of these canals show that they cannot have been formed by an intermicellar action of the diastase on the substance of the starch, but that the molecules of starch are dissolved as such in these regions in centripetal succession. The transformation of starch into sugar is a secondary process not connected directly with the solution of the grain. The canals finally branch and anastomose, and cause the eventual complete breaking-up of the grain; these fragments then finally disappear by solution.

In large excentric starch-grains (potato, *Lilium candidum*, *Orobanche*, *Lathræa*, &c.) the dissolution of the grain takes place in a somewhat different way; it is effected very slowly and nearly uniformly, centripetally, but may be accompanied by local formation of pits or crevices. The smaller grains of the potato are, however, destroyed centrifugally by the formation of canals, and frequently of a hollow in the interior.

The author finds diastase present in the living cells of almost all parts of plants. The dissolution of the starch-grains does not appear to be brought about by microbes or other protoplasmic structures, since these cannot be detected in the canals by the Microscope or by microchemical reagents, and diastase is not immediately killed, as protoplasm is, by alcohol, but retains for a long time, when immersed in it, its fermentative power. Experimental observations on the action of bacteria on starch lead also to the same result.

The cause of the inability of diastase to penetrate between the

* Jahrb. f. Wiss. Bot. (Pringsheim), xxi. (1890) pp. 520–608 (3 pls.).

micellæ of a starch-grain is apparently the large size of its micellæ; it can, however, under sufficient pressure, permeate the cell-wall. The ferment belongs to the class of colloids. As regards its transmission from one part of the plant to another, this cannot take place in the form in which it converts starch into sugar; in order to be transported it must undergo some chemical change, and be again restored to the fermentative form at the spot where it resumes its activity. But it is not certain that it ever is transported from one part of the plant to another.

Gum-ferment.*—From an examination of the processes which take place in the living plant, with the assistance of staining reagents, Herr F. Reinitzer contests the view that the formation of gum and mucilage is due to the action of a definite ferment.

γ. General.

Alternation of Generations.†—Prof. F. O. Bower points out that under this term many writers include phenomena of two different kinds, which he proposes to call *antithetic* and *homologous* alternation of generations. In antithetic alternation we have two phylogenetically distinct generations, i. e. a new stage (the sporophyte) has been interpolated between pre-existing generations (the gametophytes or oophytes); this has probably arisen independently in several distinct phyla, and the results are not perfectly comparable with one another. It occurs in the Archegoniatæ, the green Confervoideæ, &c., the Florideæ, and the Ascomycetous Fungi. In homologous alternation we have two or more phylogenetically similar generations, but differing in the presence or absence of sexual organs. It is found in the Thallophytes, e. g. *Botrydium*, and might be described as a mere differentiation, often a very slight one, of successive gametophytes. The axis and leaf of the gametophyte in the Muscineæ are not the true homologues by descent of the axis and leaf of the sporophyte in Vascular Cryptogams, although performing the same physiological function; and the author proposes restricting the terms caulome and phyllome to the latter, and terming the former "caulidium" and "phyllidium."

The late Mr. J. R. Vaizey‡ expressed views on the whole similar to those of Prof. Bower. He regarded *Chara* as being, in all probability, connected with the Florideæ; and the morphological position of its embryo as that of an embryonic stage in the development of the oophyte, corresponding to a certain extent with the protoneme of true Mosses.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Apical Growth in Marsilea and Equisetum.§—Mr. W. M. Andrews finds the phenomena of the apical growth in roots of *Marsilea quadrifolia* and *Equisetum arvense* somewhat different from those described by de Bary and Goebel.

* Zeitschr. f. Physiol. Chemie, xiv. pp. 453–70. See Bot. Centralbl., xliii. (1890) p. 117.

† Ann. of Bot., iv. (1890) pp. 347–70.

‡ T. c., pp. 371–8.

§ Bot. Gazette, xv. (1890) pp. 174–7 (2 figs.).

In *M. quadrifolia* he states that the transition from the large initial cells into the long narrow cells of the plerome-cylinder is very gradual; from the time when the initial cells are cut off, the three tissues, dermatogen, periblem, and plerome, are distinctly differentiated. The root-cap is formed from segments cut off from the base of the pyramidal apical cell.

In *Equisetum arvense* there is no hypodermal layer as in *Marsilea*; the endoderm divides into two layers at about the fifth or sixth segment, and these two layers are not further divided by tangential walls. The description of the mode of formation and division of the root-cap differs somewhat from that of previous writers.

Fossil Plants of the Coal-measures.*—In his latest contributions to this subject, Prof. W. C. Williamson, after describing certain fossils from the Coal-measures belonging to the genera *Rachiopteris*, *Rhizonium*, and *Lepidodendron*, states his view that in the primeval Vascular Cryptogams we find important histological and physiological phenomena to which no exact parallels are to be found amongst living plants. The development of the medullary area and the coincident annular expansion of the vasculo-medullary cylinder, so characteristic of all the Carboniferous Lepidodendroid plants, he attributes rather to schizogenetic than to lysogenetic action.

Muscineæ.

Braithwaite's British Moss-Flora.—Part XIII. of this publication is devoted to the Splachnaceæ, comprising the genera *Splachnum* (3 species), *Tetraplodon* (2 species), and *Tayloria* (2 species); the monotypic *Œdipodium Griffithii*, which represents the family Œdipodiaceæ; the Funariaceæ, comprising *Discelium* (1 species), *Amblyodon* (1 species), *Nanomitrium* (1 species), *Physcomitrella* (1 species), *Physcomitrium* (2 species), and *Funaria* (6 species); and three monotypic genera of Bryaceæ, viz. *Oreas*, *Stableria*, and *Leptobryum*. It is illustrated by six beautiful plates.

Characeæ.

Antherozoids of Characeæ.†—M. W. Bijelajew has investigated the structure and development of the antherozoids in *Chara* and *Nitella*, and his conclusions differ in some points from those of Guignard.‡ Immediately after the nucleus of the mother-cell has attached itself to the wall, the anterior end of the antherozoid manifests itself as a filament springing from the nucleus; from its attached end arise the two cilia. At the opposite end of the nucleus there is at the same time attached to it a somewhat stronger filiform structure, the posterior end of the antherozoid. The nucleus then also itself elongates, and becomes the middle part of the antherozoid. The cilia spring from the point of junction of the anterior end and middle portion of the antherozoid.

* Phil. Trans. Roy. Soc., clxxx. (1890) pp. 155–68, 195–214 (8 pls.).

† SB. Warschauer Naturf. Gesell., Sept. 27, 1889. See Biol. Centralbl., x. (1890) p. 220.

‡ Cf. this Journal, 1889, p. 417.

Algæ.

Anamorphic State of the Lower Algæ.*—Prof. A. Borzì has investigated the life-history of the green algæ comprised in the family Pleurococcaceæ† of Dangeard and Klebs (*Pleurococcus*, *Raphidium*, *Scenedesmus*, *Dactylococcus*, *Stichococcus*, &c.), and has come to the conclusion that they constitute a stage of development of algæ belonging to other families which he terms "anamorphic."

If the zoospores of *Ulothrix flaccida* are observed at the moment of escape, it is seen that some are endowed with an irregular vortical motion different from the others. These are pairs of zoospores which have coalesced at the extremity opposite to the beak, forming a fusiform body, straight, or more or less curved, or with the form of a V, with a cilium at each extremity. These bodies move rapidly through the water, and ultimately multiply by longitudinal oblique bipartition into fusiform or semilunar cells, having all the characters of *Raphidium;* when still united into colonies they constitute the genus *Actinastrum* Lagh. Similar raphidio-forms were observed of *Protoderma*, *Stigeoclonium*, *Dermonema*, *Chloroclonium*, and *Prasiola*.

A stichococcoid form can be induced in *Ulothrix flaccida* by growing the filaments under conditions of imperfect aeration; the cells lose their close connection with one another and become partially separated, with exceedingly thin walls. Whenever filaments in this condition grow on a substratum of a fungoid nature, a symbiosis or commensalism between the fungus and the alga seems to occur. This bacillar form of *Ulothrix* constitutes the genus *Arthrogonium* A. Br.

Bulbotrichia.‡—M. P. Hariot agrees with Bornet, de Toni, and de Wildeman, in abolishing this reputed genus of Algæ. Two distinct organisms have been included under this name; one is a lichen in the structure of which partake gonids belonging to different groups of algæ, and not merely to *Protococcus;* the other is an autonomous plant belonging to the genus *Nylandera* (Trentepohliaceæ).

New Algæ and Schizophyceæ.§—Prof. A. Hansgirg describes, under the name *Glœotænium*, a new genus of fresh-water Algæ, which he proposes as a member of a new family, Pseudodesmidiaceæ, intermediate between the Desmidiaceæ and the Palmellaceæ. It is distinguished from Palmellaceæ either by the peculiar development of the gelatinous envelope, or by the formation of zygotes; from the Desmidiaceæ by the structure of the cell-membrane, which does not consist of two distinct similar pieces, and by the cell-contents being arranged cylindrically instead of bilaterally and symmetrically. The family will include the genera *Spirotænia*, *Cylindrocystis*, and *Mesotænium*, to which Hansgirg adds *Glœotænium*, although no sexual reproduction has yet been detected in it.

The following new species, from Bohemia, Carniola, Istria, and Dalmatia, are also described:—*Chantransia incrustans*, forming a dark olive-green incrustation on stones; *Endoclonium* (?) *marinum*, on mussel-shells and stone; *E.* (?) *rivulare*, on stones and wood; *Hormospora subtilis;* *Oocystis pusilla*, in springs on limestone and marble; *Glœotænium*

* Nuov. Giorn. Bot. Ital., xxii. (1890) pp. 403-9.
† Cf. this Journal, 1889, p. 96. ‡ Notarisia, v. (1890) pp. 993-6.
§ SB. K. Böhm. Gesell., 1890, pp. 1-20, 29-33 (2 pls.).

Loitlesbergerianum, forming four-celled families, distinguished by a remarkable thick almost black median band; *Trochiscia psammophila; Dactylococcus sabulosus; Leptochæte marina*, the only known marine species of the genus; *Microcoleus polythrix; M. hospita; M. cataractarum; Oscillaria rupicola; Lyngbya investiens; L. longearticulata; Spirulina adriatica; Aphanocapsa concharum*, on shells of *Patella; A. fonticola; Chroococcus fuscoviolaceus.*

The author proposes the following new classification of the Confervoideæ:—A. Vegetative cells multinucleated, Sphæropleaceæ, Confervaceæ (Anadyomenaceæ, Cladophoraceæ, Pithophoraceæ, and Conferveæ), Gomontiaceæ, Botrydiaceæ, and Sciadiaceæ; B. Vegetative cells uninucleated, Cylindrocapsaceæ, Œdogoniaceæ, Coleochætaceæ, Trentepohliaceæ, Ulotrichaceæ (Ulvaceæ, Blastosporeæ or Prasiolaceæ, Ulotricheæ, Chætophoraceæ, and Entocladiaceæ).

Fungi.

Enzyme produced by Parasitic Fungi.*—Mr. A. L. Kean confirms, in the cases of *Rhizopus nigricans, Phytophthora infestans*, and some other species, the statement of de Bary and Marshall Ward that so-called parasitic fungi produce an enzyme which destroys the tissue of the host and prepares the way for the growth of the fungus. It can be obtained by crushing the diseased tissue in a mortar and filtering, and can then be precipitated by alcohol; it is again soluble in water. In demonstrating the destructive effects of this enzyme on vegetable tissues, precautions were taken to guard against the presence of bacteria.

Employment of Parasitic Fungi against the Attacks of Noxious Insects.†—M. A. Giard points to the utilization of the Entomophthoreæ against the attacks of noxious insects. There are, however, one or two difficulties in the way; the chief being that the conidial spores of the Entomophthoreæ, by which propagation takes place most easily, only preserve their power of germinating for a very short space of time. Other groups which ought to be experimented with are the entomorphic Schizomycetes, the Isarieæ, and the Psorospermieæ.

Chytridiaceæ parasitic on Algæ.‡—M. E. de Wildeman describes twenty-one species of Chytridiaceæ found in Belgium, all of them parasitic on different species of freshwater Algæ, viz.:—*Rhizidium Schenckii* on various algæ, *R. bulligerum* and *R. Cienkowskianum* on *Spirogyra crassa, R. acuforme* on *Chlamydomonas, R. apiculatum* on *Glœococcus* sp., *R. Euglenæ* on *Euglena viridis, R. fusus* on a diatom, *R. sphærocarpum* on *Mougeotia genuflexa, R. lagenaria* on *Spirogyra* sp., *Chytridium transversum* on *Chlamydomonas pulvisculus, C. subangulosum* on *Oscillaria* sp., *C. mammillatum* on *Conferva bombycina* and *Stigeoclonium* sp., *C. lagenula* on *Ophiocytium cochleare, C. rostellatum* sp. n. on *Spirogyra crassa, C. globosum* on *Melosira varians, Phlyctidium irregulare* sp. n. on a diatom, *Olpidiopsis Sorokinei* sp. n. on *Conferva bombycina, Olpidiopsis Schenckiana* on *Mougeotia* and *Spirogyra, Septocarpus corynephorus* on a diatom, *Ectrogella Bacillariacearum* on *Gomphonema* sp., and *Synedra* sp., *Polyphagus Euglenæ* on *Euglena viridis.*

* Bot. Gazette, xv. (1890) pp. 171–4. † Rev. Mycol., xii. (1890) pp. 71–3.
‡ Ann. Soc. Belge Microscop., xiv. (1890) pp. 3–28 (7 figs.).

Two new genera of Chytridiaceæ.*—Professor G. v. Lagerheim describes two new genera of Chytridiaceæ, which appear to demonstrate the near affinity of this family with the Ancylisteæ and Saprolegniaceæ.

Harpochytrium Hyalothecæ was found parasitic on *Hyalotheca dissiliens*, not merely on the gelatinous sheath, but piercing the filament itself, which it kills. The ripe zoosporange is curved into the form of a sickle; when the zoospores escape, a new cell is formed within the base of the sporange, which developes into a new zoosporange by a kind of prolification, a phenomenon hitherto known only in *Pythium* and *Saprolegnia*.

Achlyella Flahaultii was grown on pollen of *Typha*. The contents of the flask-shaped sporange, which is attached externally to the pollen-grain, divide, as in *Achlya*, *Aphanomyces*, and *Achlyogeton*, into several portions, which escape as naked masses of protoplasm through an apical opening, before which they lie in heaps. Each of these masses finally invests itself with a thin membrane, through a small opening in which the protoplasm escapes as a ciliated zoospore.

Ustilago Carbo.†—According to Herr E. Rostrup, no less than five distinct species are included under this name, comprising the parasitic fungi which cause "smut" in corn, viz.:—*Ustilago Hordei* on barley; *U. Jensenii* sp. n. on *Hordeum distichon*; *U. Avenæ* on rye, *U. perennans* sp. n. on *Avena elatior*, the mycele being perennial in the rhizome; and *U. Tritici* on wheat.

Lophiostomaceæ.‡—Sig. A. N. Berlese discusses the systematic position and the classification of this family of Pyrenomycetes, distinguished by the presence of a compressed ostiole which is furrowed longitudinally by a more or less open fissure, frequently very narrow, formed of two small lips. In the form of the ostiole some species approach the Sphæriaceæ, others the Hysteriaceæ. The genera described by Saccardo are characterized by the author as follows:—

Sporidia continua fusca	*Lophiella.*
Sporidia bilocularia fusca	*Schizostoma.*
hyalina	*Lophiosphæra.*
Sporidia transverse pluriseptata hyalina	
Perithecia pilosa	*Lophiotricha.*
Perithecia calva	*Lophiotrema.*
Sporidia transverse pluriseptata fusca ..	*Lophiostoma.*
Sporidia muriformia fusca	*Lophidium.*
hyalina	*Lophidiopsis.*
Sporidia filiformia	*Lophionema.*

The 213 species enumerated by Saccardo must, he thinks, be greatly reduced in number. The family exhibits an alliance with the Hysteriaceæ, the connecting link between the Pyrenomycetes and the Discomycetes, rather than with the Sphæriaceæ, especially in the branched paraphyses.

* Hedwigia, xxix. (1890) pp. 142–5 (1 pl.).
† Bull. Acad. Roy. Copenhagen, 1890, No. 1, 16 pp. and 1 pl.
‡ Malpighia, iv. (1890) pp. 40–55.

Structure and Development of Collemaceæ.*—Mr. W. C. Sturgis's observations agree with those of Stahl, that in the Collemaceæ the fructification always arises from an impregnated carpogone, and the paraphyses from vegetative hyphæ. The only exception is in the case of *Hydrothyria venosa*, which the author removes from the Collemaceæ, and places in the neighbourhood of *Peltigera* and *Pannaria*. He differs, however, from Stahl and Lindau in his account of the development of the heteromerous lichens. In those examined, *Sticta*, *Nephroma*, *Peltigera*, *Pannaria*, and *Hippia*, he finds no carpogone, the fructification having a purely vegetative origin, the asci and paraphyses originating from the same hyphal system.

Koji, an Inverting Ferment obtained from Rice.†—In the preparation of wine, spirit, and other fermented liquids, the Chinese and Japanese use koji, a peculiar substance which has the property of decomposing starches; it is obtained from rice which has been steamed and freed from husk, by inoculating with the spores of a fungus not yet properly classified, and developes a luxuriant and snow-white mycele.

According to Ahlborg the fungus belongs to the genus *Eurotium*, and its specific name is *E. Oryzæ*. It has long been known in Japan that koji changes starch into fermentable sugar. According to Atkinson koji contains a ferment which is soluble in water, inverts cane-sugar, and transforms maltose, dextrin, and starch into dextrose.

According to the researches of the authors (Kellner, Mori, and Nagaoko), koji contains a powerful inverting ferment which changes cane-sugar into dextrose and levulose, maltose into dextrose, and starch into dextrin, maltose, and dextrose, while milk-sugar and, apparently, also inulin are not altered by it.

Of the known inverting ferments, koji therefore seems to possess the greatest power.

The authors propose for it the provisional name of "invertase," but are uncertain whether it is a simple body or consists of several ferments, and they further express the opinion that invertase is possibly produced, not only by *Eurotium Oryzæ* Ahlborg, but that other fungi of the same or allied genera are capable of producing the ferment.

Koji is made in the following manner:—The rice, which has been properly bleached and husked, is steamed for about twelve hours, until it is thoroughly softened. It is then spread out on straw mats to cool, and when its temperature has fallen to 28–35°, a small quantity is mixed with the yellowish-brown spores of the fungus, and this mass in its turn mixed with the rest of the material. If at hand koji itself may be used instead of the spores. The mats are then placed in the front part of a sort of cellar, which is either dug out of the ground, or if above, is surrounded by thick walls.

In 18–20 hours the mycele has already developed, and the temperature is at the same time considerably increased. The grains are next worked up with the hands, and then, having been spread on small

* Proc. Amer. Acad. Arts and Sciences, xxv. (1890) pp. 15–52 (8 pls.). See Bot. Ztg., xlviii. (1890) p. 530.

† Zeitschr. f. Physiol. Chemie, 1889, pp. 297–317. See Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 672–4.

trays, are deposited in the warmest parts of the cellar. In 10–12 hours more the grains are again worked up, and are then cooled and moistened with a little water; in about ten hours this is repeated, and after 14–16 hours the koji is ready. The whole process lasts about two and a half days.

Torula spongicola.*—Sig. U. Martelli describes a parasitic fungus which causes dark spots on the surface of a toilet-sponge, or sometimes colours the whole surface. The discoloration is caused by the mycele, the spores apparently retaining their vitality for a very long period.

Parasitism of Tichothecium.†—Herr C. Mäule has followed out the development of *Tichothecium microcarpon*, which appears in the form of black dots on lichens belonging to the genus *Callopisma*. From the mode of their occurrence he concludes that the spores cannot have found their way into the mature lichen from the outside, but must have reached its fructification at the time of its first formation. He further observed the remarkable fact that the spores of *Tichothecium* never germinate in the thallus of the lichen, nor in the neighbourhood of the gonids, but only in the fructification, where alone they appear to find the requisite supply of food-materials, apparently in the transformation of the cellulose of the vegetative hyphæ into the "fungus-cellulose" of the asci.

Pucciniæ parasitic on Veronica.‡—Dr. P. Magnus describes four species of *Puccinia* parasitic on various species of *Veronica* in Europe, viz. *P. Veronicæ* Schröt., *P. Veronicarum* DC., *P. Albulensis* sp. n., and *P. Veronicæ Anagallidis* Oudem. All these species form only teleutospores and sporids on their promycele; and all, except doubtfully the last, belong to the section *Leptopuccinia*, in which the teleutospores germinate as soon as they are ripe; some of them have also deciduous thick-walled teleutospores which do not germinate immediately on maturity, as occurs also with other species of *Leptopuccinia*.

Æcidioform of Uredineæ on two different hosts.§—Herr P. Dietel finds, from culture experiments, that the æcidia parasitic on *Hippuris vulgaris* and on *Sium latifolium*, known as *Æcidium Hippuridis* and *Æ. Sii latifolii* respectively, are both genetically connected with *Uromyces lineolatus*, parasitic on *Scirpus maritimus*.

Fungus-parasites of the Onion.‖—Mr. R. Thaxter gives further description of the life-history of *Urocystis Cepulæ*, and of the injury inflicted by it on the onion-crop in the United States. Infection appears to take place entirely during early stages of the host, and from spores contained in the soil. The spores certainly retain their vitality for five, and possibly even for twenty years.

Peronospora Schleideni is also very destructive to the onion-crop in Connecticut, and is frequently followed by *Macrosporium Sarcinula*.

* Nuov. Giorn. Bot. Ital., xxii. (1890) pp. 463–5.
† Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 113–7 (1 pl.).
‡ T. c., pp. 167–74 (1 pl.).
§ Hedwigia, xxix. (1890) pp. 149–52.
‖ Ann. Rep. Connecticut Agric. Exp. Stat. for 1889, pp. 127–77 (3 pls.). See Bot. Centralbl., xliii. (1890) p. 30.

Lysurus.*—M. N. Patouillard points out that in this genus of Phalloideæ two distinct types have been included, one having the basids on the outer, the other on the inner surface of the lobes of the receptacle. He classifies the genera of Phalloideæ as follows:—I. Phalleæ, glebe covering the outer surface of the receptacle (Mitreæ, Capitreæ, Lysureæ, Kalckbrenereæ); II. Clathreæ, glebe covering the inner surface of the receptacle (Conjugeæ, Anthureæ).

Rabenhorst's Cryptogamic Flora of Germany (Fungi.)—The last three parts (31–33) of the section of this work devoted to Fungi, now edited by Dr. H. Rehm, are still occupied by the Pezizaceæ. The suborder Dermateaceæ (including the Cenangieæ, Dermateæ, Patellariaceæ, and Bulgariaceæ) occupies their greater portion, the section Calicieæ being just commenced. A number of new species and several new genera are described.

Protophyta.

a. Schizophyceæ.

Pure Culture of Green Protophyta.†—Herr M. W. Beyerinck has succeeded, though with great difficulty, in raising pure cultures of *Chlorococcum protogenitum* and *Raphidium naviculare*, free from the countless bacteria which infest stagnant water.

The *Raphidium* was found to throw off an enzyme which slowly deliquesces gelatin.

The *Chlorococcum* presents characters identical with the Zoochlorellæ of the lower freshwater animal organisms, such as *Hydra*, *Paramecium*, &c. The modes of increase are precisely the same in both, and are twofold, viz.:—(1) Occasionally, in large cells under favourable conditions, division takes place by constriction, as in chlorophyll-grains. (2) After the lens-shaped chlorophyll-bodies have divided into 2, 4, or 8 sections, the membrane of the mother-cell is thrown off. The eight (or fewer) free protoplasts round themselves off, containing each a lens-shaped chlorophyll-body, and grow to the normal size. In other morphological characters, such as the presence of a nucleus, and the form of the amylaceous body in the chromatophores, *Chlorococcum* and the Zoochlorellæ agree altogether.

The author describes in detail processes by which he was able to demonstrate that the living green cells can decompose carbon dioxide in a medium containing no oxygen, and can be supplied with free oxygen by means of a Schizomycete, *Mycoderma Sphæromyces*.

Coscinodiscus.‡—Mr. J. Rattray continues his monographs of genera of diatoms with a revision of the genus *Coscinodiscus* and of some allied genera. Of *Coscinodiscus* he describes about 290 species, some of them new. The other genera included in the monograph are:—*Actinogonium* (2 species), *Brightwellia* (6 species), *Stelladiscus* gen. n. (1 species),

* Journ. de Bot. (Morot), iv. (1890) pp. 253–8 (5 figs.).

† Aanteek. Utrechtsch Genoots. Kunst. en Wetensch., 1889, pp. 35–52. See Bot. Centralbl., xliii. (1890) p. 142.

‡ Proc. Roy. Soc. Edinb., xvi. (1888–9) 1890, pp. 449–692 (3 pls.). Cf. this Journal, 1888, p. 861.

Asterolampra (35 species), *Asteromphalus* (24 species), *Liradiscus* (7 species), *Porodiscus* (9 species), *Thaumatonema* (2 species), and *Peponia* (1 species). *Stelladiscus* is separated from *Asterolampra* by the different appearance of the compartments and rays.

β. Schizomycetes.

New Schizomycetes.*—Prof. A. Hansgirg describes two new genera of Schizomycetes:—*Mycacanthococcus*, in which the cells, in the encysted condition, have their membrane covered with spiny or watery protuberances, comparable to *Glochiococcus* among Schizophyceæ. *Microtetraedron* occurs in roundish quadrilateral isolated cells, with a long, colourless, conical spine at each corner; it resembles *Tetraedron* or *Polyedrum* among Schizophyceæ.

The following new species are also described:—*Crenothrix marina*, *Leptothrix subtilissima*, *Bacillus fenestralis*, and *Leucocystis fenestralis*, on the windows of greenhouses; and the following on damp walls in wine-cellars,—*Cladothrix cellaris*, *Bacillus Pfefferi*, *Sarcina cellaris*, *Ascococcus cellaris*, *Myothece urothece*, *Leucocystis schizocystis*, *L. urococcus*, *Mycacanthococcus cellaris*, *Mycotetraedron cellare*, and *Micrococcus oinophilus*.

Bacillus Pfefferi occurs as motionless rods imbedded in a greyish-yellow mucilage on the damp walls of an underground wine-cellar. When exposed to light and a sufficiently high temperature, it passes into a motile condition, but without any formation of cilia; in this respect it differs from *Spirochæte*. The author regards the movements of this organism, of *B. megaterium*, *B. Zopfii*, *Beggiatoa*, and *Spirochæte*, as of a similar character, and to be dependent on similar causes, to those of the Oscillariaceæ.

Hansgirg regards *Mycacanthococcus* and *Mycotetraedron* as true Schizomycetes, belonging, along with *Crenothrix*, *Leuconostoc*, and other genera, to the arthrosporous section, which he treats as an intermediate group between the Algæ (Schizophyceæ) and the endosporous Schizomycetes, and proposes for them the term Mycophyceæ, in contrast to the Eubacteriaceæ. It will include the Crenotrichaceæ, Leptotrichaceæ, Myconostocaceæ, and Mycococcaceæ. Between these and the Mycophyceæ or Cyanophyceæ there are various transitional forms, while none are at present known between the latter and the chlorophyll-green algæ or Chlorophyllophyceæ.

New Bacillar Disease of Plants.†—MM. E. Prillieux and G. Delacroix find the stem of potatoes from various parts of France attacked by a gangrene, which appears to be caused by the presence of enormous quantities of a bacillus in the diseased cells. A similar malady also attacks the *Pelargoniums*, and the disease can be infected from one of these plants to the other. The authors propose for the microbe the specific name *Bacillus caulivorus;* it measures about 1·5 μ in length, and from 0·33 to 0·5 μ in diameter. It is decidedly smaller than the *B. Hyacinthi*, which produces a similar disease in the hyacinth, but may be identical with Comes' *Bacterium gummis*.

* SB. K. Böhm. Gesell. Wiss., 1890, pp. 20-31 (1 pl.).
† Comptes Rendus, cxi. (1890) pp. 208-10.

Micro-organisms of Fresh Vegetables.*—Although the researches of Pasteur, Fernbach, Buchner, and others have shown that under normal circumstances no bacteria are present within vegetable tissues, Dr. Fazio has examined fresh vegetables, such as fennel, celery, lettuce, and endive, in order to ascertain if micro-organisms existed in the interspaces of the buds and leaves. With this object the plants taken from the garden were first externally purified, then superficially charred, and then pieces removed under proper antiseptic precautions with a kind of cork-borer. The pieces were placed in test-tubes containing bouillon, and left for 24 to 48 hours. If obvious clouding occurred, then further examination was made with gelatin plates. In this way four kinds of saprophytic bacteria were constantly demonstrated.

Resistance of Spores to High Temperatures.†—Dr. Lewith, from a series of experiments, finds that the increased resistance of spores to dry heat is due to the fact that, during their formation, an inspissation of the protoplasm occurs from loss of water. From experiments with egg-albumen, he estimates that the most resistant spores contain about 10 per cent. of water; but, stated from a practical point of view, that is, for disinfection purposes, the proportion nearly amounts to this, the less the amount of water in the spores and the more impenetrable the spore-membrane, the greater is the resistance of the spores. Hence, for complete disinfection by heat, moisture is of importance. This, too, holds good for disinfection with chemical substances, such as sulphuric acid, chlorine, bromine, and sublimate, for they can only properly act in the presence of water.

Influence of Carbonic Acid and other Gases on the Development of Micro-organisms.‡—Mr. P. F. Frankland exposed plate-cultivations of *Bacillus pyocyaneus*, cholera spirilla, and Finkler's spirilla in a simple apparatus to the action of carbonic acid, carbonic oxide, sulphuretted hydrogen, sulphurous acid, hydrogen, nitrous and nitric oxide. It was found that three kinds of bacteria were quickly killed by NO, H_2S, and SO_2, that CO and N_2O acted less vigorously than CO_2, and that they were least affected by H. With regard to the experiments with carbonic dioxide, it was found that *B. pyocyaneus* recovered perfectly when exposed to the air, but that the other bacteria did not—a result contrary to that obtained by Fraenkel.

Resistance of living Bacteria and Yeast-cells to Pigments.§—The resistance shown by the living spores, of e. g. *B. anthracis* and *subtilis*, to the inception of watery solutions of anilin dyes, says Herr H. Buchner, disappears, as is well known, after their death. A similar condition of things is presented by the vegetative cell, and the behaviour of these cells to watery solutions of anilin pigments opens up several interesting questions.

Three series of experiments are given, in all of which methyl-violet

* Rivista Internaz. d'Igiene, i. (1890) pp. 1-3. See Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) p. 798.

† Arch. f. Exper. Pathol. u. Pharmakol., xxvi. p. 341. See Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) p. 477.

‡ Zeitschr. f Hygiene, vi. (1889). See Bot. Centralbl., xlii. (1890) pp. 273-4.

§ Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 733-6.

was the pigment used. In the first series beer-yeast was the organism, and in the second and third the typhoid bacillus. The results with regard to the yeasts were that they showed, while alive, great resistance to the inception of dyes, but when killed, either by heat or by chloroform, they were easily stained.

The vegetative cells of the bacteria showed, it is true, a certain resistance, but the degree of this was very variable; that is to say, in some cases there was little or no difference between the dead and living cells, while in other instances it was (e. g. typhoid bacillus) very marked.

Another inference which the author derives, partly from his own experiments and partly from those of Birch-Hirschfeld with phloxin-red, is that the death of the vegetative cell is not necessarily associated with the inception of pigment, although it would seem, to us at least, that it is rather a question of time.

The experiment was as follows. Typhoid bacilli were incubated for 1 hour at 37° in methyl-violet solution 1 : 6000. At the end of this time all the bacilli were stained, and when 5 ccm. were cultivated on a plate, 63,000 colonies appeared. At the end of 2 hours only 10,450 colonies came up, and at the end of the third hour none. Of course this shows that the pigment becomes more and more noxious, and therefore possesses a disinfecting property.

Blue Milk.*—Herr L. Heim finds that the bacillus of blue milk is a short mobile rodlet with rounded ends, and, when stained, shows bright spots which do not impart the notion of their being spores. Neither endogenous nor free spores were observed in drop-cultivations, nor could the club-shaped form of this bacillus be verified by the author, but the interesting observation of the two distinct varieties, when cultivated on plates, was made. These varieties, though breeding true, behaved alike on all other points.

The most favourable for the pigment-formation was ordinary gelatin, to which 0·2–0·3 per cent. of lactic acid had been added; but potato was also a very suitable medium.

The tenacity of the bacillus was tested by drying blue milk, as a pure cultivation, on silk threads. After having been kept for 226 days, the pure cultivations were found to be viable, and the milk threads after 114 days.

To heat the bacilli are very little resistant, being killed in 10 minutes at 55°, and in 1 minute at 80°, a fact which argues against spore-formation.

Between 30° and 40° the bacteria developed no pigment, and their growth diminished on all media.

By the action of disinfecting media it was found that the bacteria were destroyed in 3 hours by 3 per cent., in 5 minutes by 10 per cent. soda solution, in 30 minutes by 1:300 salicylic, while boracic acid had no effect.

Anaerobic pyogenic Bacillus.†—M. Fuchs found in the pleural sac of a rabbit, which had died spontaneously, a large quantity of foul-

* Arbeiten aus d. Kaiserl. Gesundheitsamte, v. pp. 518–36. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 46–7.

† Inaug. Diss., Greifswald, 1890, 8vo, 30 pp. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 11–12.

smelling pus, in which were rodlets 7–10 μ long and 0·75 μ broad. They were best stained with Loeffler's methylen-blue solution.

The bacteria grew best anaerobically between 36° and 38° C. in 10 per cent. gelatin, or in grape-sugar bouillon.

The cultivation gave off the same foul smell as was perceived in the pleural secretion. Inoculation experiments were for the most part a failure, although abscesses were sometimes found at the inoculation spot.

The method by which the author cultivated this anaerobic bacillus was very simple. A test-tube filled obliquely with Loeffler's blood-serum, having had the condensation water poured off, was inoculated, and then inverted over a stream of hydrogen gas from 1/2–1 minute.

The mouth of the tube was then quickly closed with a caoutchouc plug, then smeared with paraffin, and the tube left upside down. This method is not only simple, but quite successful for anaerobic cultivations.

Action of Reducing Agents on Anaerobic Bacteria.*—Messrs. S. Kitasato and Th. Weyl have examined the action of certain reducing agents on the growth of anaerobic bacteria by the bacilli of symptomatic anthrax, tetanus, and malignant œdema. Some of the reagents acted inhibitively; such were the hydrochlorate of hydroxylamin and of phenyl-hydrazin; and in a less degree chinon, acetaldehyd, and benzaldehyd. Others, such as resorcin, hydrochinin, eikonogen, and formate of soda, promoted growth; but the most active was one per cent. of sulph-indigotate of soda when added to the agar medium. As the culture increases the agar becomes decolorized, but on treating it with oxygen the blue colour returns; hence the growth produces the decoloration of a reducing process, and the authors therefore think they have hit upon a means of demonstrating reduction processes when they occur during the development of micro-organisms. Experiments with aerobic bacteria (typhus, cholera, anthrax) showed that they reduced either very little or not at all.

Spore-formation in Anthrax.†—Herr K. B. Lehmann has been able to controvert the widely accepted view about spore-formation in anthrax, from experiments made for the special purpose of demonstrating whether spore-formation were affected for the better or worse by exhausted cultivation media. The doctrine that anthrax required defective nutriment for spore-formation was first promulgated by Buchner, and accepted by all succeeding writers on his *ipse dixit*. The author finds that the contrary is really the case, and that spore-formation takes place far more luxuriantly and favourably on rich and unexhausted media than when the medium is poor or worn out. The experiments were made in two series. In the first, anthrax bacilli were cultivated on media the composition of which varied in nutrient quality, and in the second they were cultivated on media which had been previously used for growing anthrax. Such media were sterilized, neutralized, and the evaporation-water replaced.

Herr H. Buchner‡ replies to the strictures of Lehmann by pointing out that the latter has quite misrepresented his views as to the cause of

* Zeitschr. f. Hygiene, viii. p. 41. See Zeitschr. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 12–3. † SB. Physik.-Med. Gesell. Würzburg, 1890, pp. 34–7.
‡ Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 1–6.

spore-formation in anthrax, owing possibly to the latter having obtained his information second-hand. It is, however, generally supposed that spore-formation in anthrax is in some way associated with the exhaustion of the nutritive medium, and this explanation has usually been fathered on Buchner. The latter now explains that he never meant to say that spore-formation was the result of defective nutrition, but the consequence of some defect or deficiency occurring in the medium. The author then refers to the experiments made by him to show that he knew the facts cited by Lehmann. It is, however, certain that Lehmann's position is that spore-formation in anthrax occurs in media rich in nutrient material, and not in that which is exhausted. The position is entirely different from that taken by the author, and, from other points of view, may be regarded as probably being the more correct of the two.

Morphology of Streptococci.*—In the report of the Local Government Board, 1888, Dr. E. Klein discusses the characters of nine species of *Streptococcus* cultivated in seven different ways, as well as the results obtained from inoculating these same organisms. These micro-organisms were cultivated in tubes and plates of agar and gelatin in peptonized bouillon, all of which media were slightly alkaline. The following points were specially noted:—the appearance of the cultivation a few days after inoculation; the greater or less rapidity of growth of the colonies; the shape of the colonies; their modifications of shape during development; their different appearances in different media; their morphology. By aid of the foregoing characters most of these *Streptococci* could be distinguished from one another. The author concludes that scarlet fever, puerperal septicæmia, and foot and mouth disease, are due to the action of a specific *Streptococcus*. He alludes to the question of what constitutes a species or variety in a pathogenic microbe, and of the possibility of a modification of physiological or pathogenic species. Now, the variations in the action of some of these *Streptococci* on milk goes to support the doctrine of Nägeli, according to which the different forms of Schizomycetes are but phases or variations of one or at most two or three different species. But some, while morphologically and culturably identical, or at least indistinguishable, show diverse and constant pathogenic functions.

Bacteria of Influenza.†—Prof. V. Babes has now concluded the investigation of thirty-one cases of influenza.

The chief motive for these researches seems to have been a desire to show that there exists a series of bacteria, which in their growth or in their shape approximate to, or are identical with Pasteur's sputum bacteria on the one hand, and on the other to *Streptococcus pyogenes*. But a careful examination of the numerous varieties found was surrounded by great difficulties, owing chiefly to their extreme polymorphism, and their tendency to involution and degeneration; and the author seems inclined to think that it is not sufficient to confine the examination to one or two species, such as have been described by various writers during the progress of the epidemic, but that the exami-

* Annales de Micrographie, iii. (1889) pp. 49–52.

† Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 460–4, 496–502, 533–8, 561–8, 598–606. See *ante*, p. 373.

nation should be made to extend to the secreta and the cadaver, a procedure which would involve an immense amount of trouble and care, and also to the discovery of micro-organisms present in the various organs alone, or in combination.

Yet he suggests that bacillus i. might be provisionally accepted as the cause of influenza, and, in conclusion, calls attention to two pathogenic bacteria found in the nasal fossæ.

The communication concludes with a tabular retrospect of the various micro-organisms found during the investigations, and is divided into two parts, the first of which deals with the bacteria of bronchitis, and the second with the streptococci, capsule-bacteria, and allied micro-organisms, found in influenza and its sequelæ. For the details of these experiments, which are both voluminous and important, we must refer to the original.

Herr J. Prior * has examined fifty-three cases of influenza, twenty-nine of which were uncomplicated, while in the remainder there was also pneumonia.

The Fraenkel-Weichselbaum pneumonia-coccus, *Staphylococcus pyogenes aureus*, and *Streptococcus pyogenes*, were constantly found in the secreta of the respiratory passages, and in the exudates of various organs. It was found that the pneumonia-cocci frequently preceded the *Streptococci*, which, having ousted the former, proceeded to undisturbed development, thus producing the phenomena of inflammation. The author, however, does not regard any of the three organisms as the exciting cause, but considers that the influenza simply prepares a favourable medium for their development.

Herr E. Levy † found in seventeen out of eighteen cases of influenza the *Diplococcus pneumoniæ* Fraenkel. The secretions examined were pus from the ear (otitis) and from the pleural sac (empyema); also serous pleural exudations and the catarrhal secretion from the respiratory tract. Besides this, *Streptococcus pyogenes* and *Staphylococcus pyogenes albus* were occasionally found. The results of this observer are worthy of notice on account of the predominating number of the pneumonia coccus, and interesting because at the time of the epidemic there was an unusual number of cases of croupous pneumonia in the place of observation (Strassburg).

Kowalski ‡ has examined sixteen cases of influenza, and from them isolated three hitherto unknown kinds of micro-organisms. (1) The first resembled the typhoid bacillus. The rodlets were easily stained, grew at ordinary temperature on potato, agar, and gelatin. The gelatin was liquefied and the colonies of a brownish hue. (2) The second variety formed snow-white colonies on the surface of the gelatin, which was liquefied. They were from 1–2 cm. in diameter, and only throve at low temperatures. (3) The third kind grew best in agar at incubation temperature, and in twenty-four hours appeared as colourless drops

* Münchener Med. Wochenschr., 1890, Nos. 13–15. See Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 705–7.

† Berlin Klin. Wochenschr., 1890, No. 7. See Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 711–3.

‡ Wiener Klin. Wochenschr., 1890, Nos. 13 and 14. See Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 701–3.

about the size of a pin's head on the surface of the medium, which in forty-eight hours was coated with a firmly adherent layer. In 8–12 days the cultures died all at once. They would not thrive at ordinary temperatures and did not grow on potato, milk, or bouillon. Microscopically these colonies consisted of chains of *Diplococci* and they are denominated by the author jelly-streptococci. This micro-organism was found by the author seven times out of the sixteen cases, and the opinion is rashly expressed that had this microbe been discovered on every occasion there could have been no difficulty about accepting it as the exciting cause of influenza.

Besides the three unknown microbes, the author isolated *Staphylococcus pyogenes aureus*, *albus*, and *citreus*, *Diplococcus pneumoniæ* (Fraenkel-Weichselbaum), *Streptococcus pyogenes*, *Staphylococcus cereus*, *albus*, and *flavus*, and Friedlaender's pneumonia bacillus.

The cultivation medium was made by boiling one kilo of chopped-up calf's lung in 2 litres of distilled water and then adding to the expressed filtrate 18 grm. salt, 9 grm. phosphate of potash, 9 grm. sulphate of ammonia, 25 grm. sulphate of soda, 90 grm. sugar, 25 grm. pepton, and 50 grm. gelatin. When these ingredients were quite dissolved 10–15 per cent. gelatin or two per cent. agar, thoroughly macerated, was added, and the whole boiled to a perfect solution. It was then neutralized with equal parts of caustic potash and soda, and afterwards diluted with $2\frac{1}{2}$ litres of distilled water. Having been cooled down to 58° it was cleared up with the whites of four hen's eggs and then boiled up again for a few minutes previous to being passed through a hot-water filter. To the filtrate 8–10 per cent. glycerin was added and then distributed into test-tubes and flasks, wherein it underwent discontinuous sterilization.

Herr Ribbert,* in a series of further observations on influenza, has constantly found *Streptococcus pyogenes* and once only associated with a coccus which appeared to be a modification of *Diplococcus pneumoniæ*. He is therefore more than ever convinced that this micro-organism has some causal connection with influenza, and also opines that the epidemic agrees in many points with erysipelas. The coccus was always easily demonstrated by cover-glass preparations and also after cultivation.

Dr. Marmerek,† in an examination of the bronchial secretion of eight cases of undoubted influenza, found in seven a micro-organism resembling the Fraenkel-Weichselbaum coccus. In only one case could the diplococci not be demonstrated. In six cases there developed on agar plates colonies about the size of poppy-seeds, of irregular shape, of great firmness, of a blackish-brown colour and with indented outline. These cocci were stainable by Gram's method, and formed chains of two to forty individuals. These bacteria did not grow on gelatin, but did so on agar and on bouillon. The cultivations lasted only a short time. They were not pathogenic to animals.

The author does not regard this micro-organism as being the exciting cause of influenza.

* Deutsche Med. Wochenschr., 1890, No. 15. See Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 700–1.

† Wiener Klin. Wochenschr., 1890, Nos. 8 and 9. See Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 509–10.

Streptococcus and Influenza.*—M. Vaillard states that in two fatal cases of influenza he has found *Streptococcus* in the blood and organs: in one case, in blood of the cephalic vein and in the lung-juice; in the other case, in which there were pleurisy and pericarditis, in the pericardium, in the blood, and in the splenic juice. These two make altogether six fatal cases in which the author has found this micro-organism, either alone or associated with *Staphylococcus pyogenes aureus*. In the excreta and secreta of the living the *Streptococcus* was always found, but never in the blood. Inoculation of white mice with this *Streptococcus* proved fatal in 3–5 days, and it was afterwards found in the blood and in the organs.

Inoculation in rabbits resulted in redness with œdema; and if injected into the circulation death in 8–14 days ensued, changes being found in the pleuræ, pericardium, or in the lungs. The author considers the *Streptococcus* to be identical with *S. erysipelatis*.

Bacteria with Mycele.†—Herr E. Almquist describes three different bacteria belonging to the genus *Streptothrix* Cohn, which were found to possess characters common to fungi and schizomycetes.

The first of these was isolated from a gelatin cultivation of some unknown bacillus. It liquefied gelatin, forming thin flakes, which consisted of very fine non-septate branched filaments about 1 μ thick. Grown in bouillon, the mycele produced small round bacillus-like cells, from which again a new mycele sprang up.

The second *Streptothrix* was found in a plate-cultivation of pus from the base of the brain of a gunner dead of cerebro-spinal meningitis. These slowly liquefied gelatin, forming crusts, which consisted of long non-articulated branched filaments 1/2–1 μ thick. The filaments develope small oval or cuboidal cells (spores). These germinate in such a way that from either end one to four processes may sprout out, developing into filaments. The third kind was found in the water supply of Göteborg. On gelatin and agar it formed thin wrinkled whitish crusts, which consisted of delicate filaments. This variety did not produce any bacillus-like cells, but was characterized by many small branches interposed between the filaments.

Influence of Sunlight on Micro-organisms.‡—Sig. S. Pansini, in experimenting with sunlight in order to ascertain the influence exerted on the growth and development of micro-organisms, used cultivations of *Bacillus prodigiosus violaceus*, *pyocyaneus*, *anthracis*, *choleræ*, *murisepticus*, and *Staphylococcus pyogenes albus*. Recent inoculations and mature cultivations of these bacteria in agar or potato were exposed to sunlight, some of the tubes being protected from the solar action by being covered over with a blackened bell-jar. The temperature to which the tubes were exposed varied usually from 30° to 40°, but occasionally 45° were registered.

The conclusions arrived at were that even diffused light has a retard-

* La Semaine Méd., 1890, No. 7. See Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) p. 408.

† Zeitschr. f. Hygiene, viii. (1890) pp. 189-97. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 141–2.

‡ Rivista d'Igiene, 1889. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 107–9.

ing action on the development of micro-organisms; that direct sunlight possesses an effective sterilizing action on micro-organisms, and also retards their development; that this sterilizing action is most powerful when the sun's rays fall perpendicularly to the surface of the cultivation; that the sterilizing and inhibitory action varies, as to time, with different micro-organisms and with the cultivation medium; cultivated in bouillon, anthrax-spores resist the action of light about equally or rather less than the bacilli; that spores are killed by light, as spores and not as young bacilli; that light retards, but does not prevent spore-formation; that it modifies the production of pigment, usually diminishing the quantity, but sometimes the quality; that it attenuates the virulence of anthrax.

Morphology and Biology of Streptothrix Foersteri Cohn.*—Dr. G. Gasperini describes at some length his experiments with *Streptothrix Foersteri*, an organism first described by Cohn. It was originally found in the concretions of the inferior lacrymal canal, but was afterwards discovered to be quite an ordinary inhabitant of the air of dwelling-houses.

After describing how it grows on various media the author discusses its evolution cycle. The microbe is practically aerobic, for though it will throw out filaments in the absence of oxygen, the presence of this gas is necessary for the development of spores. The temperature most adapted for its growth is between 30° and 37°.

No sensible effect was found to be exerted either on the mycelium or spores by diffused light, while direct sunlight had either an inhibitive or pernicious action. It would seem also that *S. Foersteri* is best cultivated in alkaline or neutral media, which are rendered acid by its development; it is able to live as a parasite on fungi, but does not appear to have much pathogenic action when injected into rabbits or guinea-pigs. Illustrations are given to show the character of the growth in gelatin, &c., and the appearance of the micro-organism under high powers. Here it is represented as a septate mycele, the filaments of which frequently end in a chain of small cells (spores.)

Phases in the Development of the Cholera Microbe.†—Mr. G. F. Dowdeswell describes at length, under the head of phases in the development of the cholera microbe, a series of forms which were obtained by cultivating in moist heat and observed directly under the Microscope. The forms in question are morphological varieties due chiefly to altered conditions of environment, and hence it is possible that this alteration affords an explanation of the absence of the characteristic commas in some cases of cholera. At any rate the author's observations go far to confirm the opinions of Naegeli, expressed thirteen years ago; these were to the effect that the shape of schizomycetes is only invariable for similar external conditions.

The forms described by the author are depicted in an illustration accompanying his paper, and are drawn under magnifications of 800 to 1500. The shapes vary from small globules to large globules, with or without vacuoles, from ovoid and bacillus-like to amœboid masses of

* Ann. de Micrographie, iv. (1890) pp. 449-74 (3 pls.).
† T. c., pp. 529-44 (1 pl.).

protoplasm. It is this amœboid condition showing the plasticity of juvenile protoplasm, which makes the author's observations so interesting.

Bacteriological Examination of Drinking Water in Christiania.*—Herr L. Schmelck gives in chart form the result of his bacteriological examination of the drinking water of Christiania for the years 1888 and 1889. The chart shows that in May and April the number of bacteria found in the water are enormously in excess of what occur at other periods of the year. This increase coincides with the time of the melting of the snow; in other words, there is a direct relation between the spring melting of the ice and snow and the number of bacteria found in running water. The author considers that the explanation of their presence is that the bacteria are swept away from the upper layers of the surface-earth by the snow-water; a similar result ensues after heavy falls of rain. About 30 species of bacteria, some of which were invariably present, while others only appeared at certain seasons, and a few cropped up occasionally, were isolated from the Christiania water.

Chemical analyses of this water were made during the same period as the bacteriological examination, but no connection between the results was observable, except that traces of ammonia were present in the water at times when it contained the largest quantity of micro-organisms.

Germicidal Action of Blood.†—Prof. A. Bonome, in endeavouring to ascertain how far experimental conditions altered the value ascribed to the results obtained in researches on the germicidal action of the blood, made use of pyogenic micrococci and the intravenous injection of water. That is, he used pus of various ages and conditions (acute and chronic abscesses), and diluted the blood with water by injections into the circulation. By using the pure, but old, pus virus (obtained by filtering through porcelain), it was found that the virus increased the germicidal action of the blood towards *Staphylococcus aureus*, *albus*, and *citreus*, but had no influence on the tissues. With fresh pus (acute abscess) the results were quite different, and the virus did not increase the germicidal efficiency of the blood, and diminished that of the tissues. When sterilized virus from cultivations of various pyogenic cells was used, an acquired immunity resulted, and this is ascribed to the greater resistance of the tissue-elements from custom and association.

With regard to the intravenous injection of water, it is only necessary to remark that this procedure considerably diminished the germicidal action, but was not able to suspend it altogether. This seems to depend on the loss of the saline constituents and the deficiency of oxygen.

Prof. H. Buchner‡ has long upheld the virtues of the blood-serum as a germicide, and recently, in conjunction with F. Voit, G Sittmann, and M. Orthenberger, made experiments to show that not only does blood possess a germicidal action, but that this action is due, chiefly at least, to the serum. The method by which these results are obtained is in prin-

* Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 102-6 (1 fig.).
† T. c., pp. 199-203, 234-8.
‡ Arch. f. Hygiene, x. (1890) pp. 84-173. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) p. 183.

ciple quite simple. It merely consists in inoculating pure blood or serum with micro-organisms, and noting the number of colonies or individuals which appear from time to time or at certain intervals after inoculation. The results obtained by these experimenters tend to show that serum and defibrinated blood are quite capable of killing germs, so long as they—the serum and blood—retain their vital action. If, however, their constitution be altered or impaired by the addition of certain substances, or the subtraction of certain constituents by altered environment or physical condition, then the germicidal action also is altered, and this alteration is usually for the worse.

The main inference from these experiments, and that for which they were probably instituted, is to show that the doctrine of phagocytes is untenable, or, at any rate, is not required to explain certain germicidal phenomena.

Prof. Koch's Remedy for Tuberculosis.—If, as we sincerely hope, Prof. Robert Koch has succeeded in discovering a remedy for tuberculosis, our Journal should contain a record which will be permanent, as compared with the reports which the Fellows have read in the daily newspapers. We give, therefore, copious extracts from Dr. Koch's "further communication," published in the 'Deutsche Medizinische Wochenschrift,' of Nov. 14th, and translated in a supplement to the British Medical Journal' of Nov. 15th, 1890.

"In an address delivered before the International Medical Congress I mentioned a remedy which conferred on the animals experimented on an immunity against inoculation with the tubercle bacillus, and which arrests tuberculous disease. Investigations have now been carried out on human patients, and these form the subject of the following observations.

It was originally my intention to complete the research, and especially to gain sufficient experience regarding the application of the remedy in practice and its production on a large scale before publishing anything on the subject. But, in spite of all precautions, too many accounts have reached the public, and that in an exaggerated and distorted form, so that it seems imperative, in order to prevent all false impressions, to give at once a review of the position of the subject at the present stage of the inquiry. It is true that this review can, under these circumstances, be only brief, and must leave open many important questions.

Nature and Physical Characters of the Remedy.—As regards the origin and the preparation of the remedy I am unable to make any statement, as my research is not yet concluded; I reserve this for a future communication. The remedy is a brownish transparent liquid, which does not require special care to prevent decomposition. For use this fluid must be more or less diluted, and the dilutions are liable to decomposition if prepared with distilled water; bacterial growths soon develope in them, they become turbid and are then unfit for use. To prevent this the diluted liquid must be sterilized by heat and preserved under a cotton wool stopper, or more conveniently prepared with a half per cent. solution of phenol.

Manner of Using the Remedy.—It would seem, however, that the effect is weakened both by frequent heating and by mixture with phenol solution, and I have therefore always made use of freshly prepared

solutions. Introduced into the stomach, the remedy has no effect; in order to obtain a reliable effect it must be injected subcutaneously. For this purpose we have used exclusively the small syringe suggested by me for bacteriological work; it is furnished with a small india-rubber ball, and has no piston. This syringe can easily be kept aseptic by absolute alcohol, and to this we attribute the fact that not a single abscess has been observed in the course of more than a thousand subcutaneous injections. The place chosen for the injection—after several trials of other places—was the skin of the back between the shoulder-blades and the lumbar region, because here the injection led to the least local reaction—generally none at all—and was almost painless.

Effect of Injections in Healthy Individuals.—As regards the effect of the remedy on the human patient, it was clear from the beginning of the research that in one very important point the human being reacts to the remedy differently from the animal generally used in experiments—the guinea-pig—a new proof for the experimenter of the all-important law that experiment on animals is not conclusive for the human being, for the human patient proved extraordinarily more sensitive than the guinea-pig as regards the effect of the remedy. A healthy guinea-pig will bear 2 cubic centimetres, and even more, of the liquid injected subcutaneously without being sensibly affected. But in the case of a full-grown, healthy man 0·25 cubic centimetre suffices to produce an intense effect. Calculated by body weight, the 1500th part of the quantity, which has no appreciable effect on the guinea-pig, acts powerfully on the human being. The symptoms arising from an injection of 0·25 cubic centimetre I have observed after an injection made in my own upper arm. They were briefly as follows:—Three to four hours after the injection there came on pain in the limbs, fatigue, inclination to cough, difficulty in breathing, which speedily increased. In the fifth hour an unusually violent attack of ague followed, which lasted almost an hour. At the same time there was sickness, vomiting, and rise of bodily temperature up to 39·6° C. After twelve hours all these symptoms abated. The temperature fell until next day it was normal, and a feeling of fatigue and pain in the limbs continued for a few days, and for exactly the same period of time the site of injection remained slightly painful and red. The lowest limit of the effect of the remedy for a healthy human being is about 0·01 cubic centimetre (equal to 1 cubic centimetre of the hundredth solution), as has been proved by numerous experiments. When this dose was used, reaction in most people showed itself only by slight pains in the limbs and transient fatigue. A few showed a slight rise of temperature up about to 38° C. Although the dosage of the remedy shows a great difference between animals and human beings—calculated by body weight—in some other qualities there is much similarity between them. The most important of these qualities is the specific action of the remedy on tuberculous processes, of whatever kind.

The Specific Action on Tuberculous Processes.—I will not here describe this action as regards animals used for experiment, but I will at once turn to its extraordinary action on tuberculous human beings. The healthy human being reacts either not at all, or scarcely at all—as we have seen—when 0·01 cubic centimetre is used. The same holds good

with regard to patients suffering from diseases other than tuberculosis, as repeated experiments have proved. But the case is very different when the disease is tuberculosis; the same dose of 0·01 cubic centimetre, injected subcutaneously into the tuberculous patient, caused a severe general reaction, as well as a local one. (I gave children aged from two to five years one-tenth of this dose—that is to say, 0·001 cubic centimetre; very delicate children only 0·0005 cubic centimetre, and obtained a powerful, but in no way dangerous, reaction.) The general reaction consists in an attack of fever, which, generally beginning with rigors, raises the temperature above 39°, often up to 40° and even 41° C.; this is accompanied by pain in the limbs, coughing, great fatigue, often sickness and vomiting. In several cases a slight icteric discoloration was observed, and occasionally an eruption like measles on the chest and neck. The attack usually begins four or five hours after the injection, and lasts from twelve to fifteen hours. Occasionally it begins later, and then runs its course with less intensity. The patients are very little affected by the attack, and as soon as it is over feel comparatively well, generally better than before it. The local reaction can be best observed in cases where the tuberculous affection is visible; for instance, in cases of lupus: here changes take place which show the specific antituberculous action of the remedy to a most surprising degree. A few hours after an injection into the skin of the back, that is in a spot far removed from the diseased spots on the face, &c., the lupus spots begin to swell and to redden, and this they generally do before the initial rigor. During the fever, swelling and redness increase, and may finally reach a high degree, so that the lupus tissue becomes brownish and necrotic in places. Where the lupus was sharply defined we sometimes found a much swollen and brownish spot surrounded by a whitish edge almost a centimetre wide, which again was surrounded by a broad band of bright red.

After the subsidence of the fever the swelling of the lupus tissue decreases gradually, and disappears in about two or three days. The lupus spots themselves are then covered by a crust of serum, which filters outwards, and dries in the air; they change to crusts, which fall off after two or three weeks, and which, sometimes after one injection only, leave a clean red cicatrix behind. Generally, however, several injections are required for the complete removal of the lupus tissue. But of this more later on. I must mention, as a point of special importance, that the changes described are exactly confined to the parts of the skin affected with lupus. Even the smallest nodules, and those most deeply hidden in the lupus tissue, go through the process, and become visible in consequence of the swelling and change of colour, whilst the tissue itself, in which the lupus changes have entirely ceased, remains unchanged. The observation of a lupus case treated by the remedy is so instructive, and is necessarily so convincing, that those who wish to make a trial of the remedy should, if at all possible, begin with a case of lupus."

Dr. Koch next discussses the "local and general reaction to the remedy," "the diagnostic value of the method," and "the curative effect of the remedy."

Its Action on Tuberculous Tissue.—In what way this process occurs cannot as yet be said with certainty, as the necessary histological

investigations are not complete. But so much is certain that there is no question of a destruction of the tubercle bacilli in the tissues, but only that the tissue inclosing the tubercle bacilli is affected by the remedy. Beyond this there is, as is shown by the visible swelling and redness, considerable disturbance of the circulation, and, evidently in connection therewith, deeply seated changes in its nutrition, which cause the tissue to die off more or less quickly and deeply, according to the extent of the action of the remedy.

To recapitulate, the remedy does not kill the tubercle bacilli, but the tuberculous tissue; and this gives us clearly and definitely the limit that bounds the action of the remedy. It can only influence living tuberculous tissue; it has no effect on dead tissue, as, for instance, necrotic cheesy masses, necrotic bones, &c., nor has it any effect on tissue made necrotic by the remedy itself. In such masses of dead tissue living tubercle bacilli may possibly still be present, and are either thrown off with the necrosed tissue or may possibly enter the neighbouring still living tissue under certain circumstances. If the therapeutic activity of the remedy is to be rendered as fruitful as possible, this peculiarity in its mode of action must be carefully observed. In the first instance, the living tuberculous tissue must be caused to undergo necrosis, and then everything must be done to remove the dead tissue as soon as possible, as, for instance, by surgical interference. Where this is not possible, and the organism can only help itself in throwing off the tissue slowly, the endangered living tissue must be protected from fresh incursions of the parasites by continuous application of the remedy.

The Dose.—The fact that the remedy makes tuberculous tissues necrotic and acts only on living tissue, helps to explain another peculiar characteristic thereof, namely, that it can be given in rapidly increasing doses. At first sight, this phenomenon would seem to point to the establishment of tolerance, but since it is found that the dose can, in the course of about three weeks, be increased to 500 times the original amount, tolerance can no longer be accepted as an explanation, as we know of nothing analogous to such a rapid and complete adaptation to an extremely active remedy. The phenomenon must rather be explained in this way, that in the beginning of the treatment there is a good deal of tuberculous living tissue, and that consequently a small amount of the active principle suffices to cause a strong reaction; but by each injection a certain amount of the tissue capable of reaction disappears, and then comparatively larger doses are necessary to produce the same amount of reaction as before. Within certain limits a certain degree of habituation may be perceived.

As soon as the tuberculous patient has been treated with increasing doses for so long that the point is reached when his reaction is as feeble as that of a non-tuberculous patient, then it may be assumed that all tuberculous tissue is destroyed. And then the treatment will only have to be continued by slowly increasing doses and with interruptions, in order that the patient may be protected from fresh infection while bacilli are still present in the organism.

Whether this conception and the inferences that follow from it be correct the future must show. They were conclusive, as far as I am concerned, in determining the mode of treatment by the remedy."

Details are then given as to the treatment of lupus, tuberculosis of bones and joints, and of phthisis, from which we will only quote two paragraphs.

"The action of the remedy in cases of phthisis generally showed itself as follows:—Cough and expectoration generally increased a little after the first injection, then grew less and less, and in the most favourable cases entirely disappeared; the expectoration also lost its purulent character and became mucous.

As a rule, the number of bacilli only decreased when the expectoration began to present a mucous appearance; they then from time to time disappeared entirely, but were again observed occasionally until expectoration ceased completely. Simultaneously the night sweats ceased, the patients' appearance improved, and they increased in weight. Within four to six weeks patients under treatment for the first stage of phthisis were all free from every symptom of disease, and might be pronounced cured. Patients with cavities not yet too highly developed improved considerably, and were almost cured; only in those whose lungs contained many large cavities could no improvement be proved objectively, though even in these cases the expectoration decreased, and the subjective condition improved. These experiences lead me to suppose that *phthisis in the beginning can be cured with certainty by this remedy.*"*

BAUMGARTEN AND OTHERS.—**Jahresbericht üb. die Fortschritte in der Lehre v. den pathogenen Mikro-organismen, umfassend Bakterien, Pilze u. Protozoën.** Unter Mitwirkung mehrer Fachgenossen bearb. u. hrsg. v. P. Baumgarten. (Annual Report on the progress of our knowledge of Pathogenic Micro-organisms, inclusive of Bacteria, Fungi, and Protozoa. 4th year.)
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Arch. de Physiol., 1890, pp. 625–7.

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Paris, 1890, 2 vols. 8vo, 385 figs. and 12 pls.

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Annal. de l'Institut Pasteur, 1890, p. 427.

„ „ **Contribution à l'étude des phagocytes.** (Contribution to the study of phagocytes.) T. c, pp. 432–9.

GABRITCHEWSKY.—**Contribution à l'étude de la parasitologie du sang.** (Contribution to the study of parasites in the blood.) T. c., p. 442.

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* "This sentence requires limitation in so far as at present no conclusive experiences can possibly be brought forward to prove whether the cure is lasting. Relapses naturally may occur; but it can be assumed that they may be cured as easily and quickly as the first attack. On the other hand, it seems possible that, as in other infectious diseases, patients once cured may retain their immunity. This, too, must for the present remain an open question."

KABRHEL, GUSTAV.—**Ueber das Ferment der Milchsäuregährung in der Milch.** (On the ferment of lactic fermentation in milk.)
Allgem. Wiener Med. Zeitung, 1889, Nos. 52 & 53.

„ G.—**Ueber die Einwirkung des künstlichen Magensaftes auf pathogene Mikro-organismen.** (On the action of artificial gastric juice on pathogenic micro-organisms.) *Archiv f. Hygiene*, X. p. 283.

KAUPE, W.—**Studien über die Wirkung einiger Desinficientia.** (Studies on the action of some disinfectants.) Thesis, Würzburg, 1889.

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Berlin (Hirschwald), 1890, large 8vo, 15 pp.

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Arch. f. Pathol. Anat. u. Physiol., CXX. (1890) pp. 541–60.

LEUBUSCHER, G.—**Einfluss von Verdauungssekreten auf Bakterien.** (Influence of digestive secretions on Bacteria.)
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RIBBERT.—**Der jetzige Standpunkt der Lehre von der Immunität.** (On the present state of the doctrine of immunity.) *Deutsche Med. Wochenschr.*, 1890, pp. 690–4.

SMITH, T.—**On the influence of slight Modifications of Culture Media on the Growth of Bacteria as illustrated by the glanders bacillus.**
Journ. of Compar. Med. and Veter. Arch., 1890, pp. 158–61.

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Wiener Klin. Wochenschrift, 1890, Nos. 6–10.

WINOGRADSKY, S.—**Recherches sur les organismes de la nitrification.** (Researches on the organisms of nitrification.)
Annal. de l'Institut Pasteur, 1890, pp. 257–75.

WYSSOKOWITSCH, W.—**Ueber den Durchgang von Bakterien durch die Lungen.** (On the passage of Bacteria through the lungs.)
Ejened. Klin. Gaz., 1889, pp. 595, 621, 650 (Russian).

MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

BACHMANN, O.—**Unsere modernen Mikroskope und deren sämtliche Hilfs- und Nebenapparate für wissenschaftliche Forschungen.** Ein Handbuch für Histologen, Geologen, Mediziner, Pharmazeuten, Chemiker, Techniker, und Studierende. (Our modern Microscopes and their accessories for scientific inquiries. A handbook for histologists, geologists, medical men, pharmaceutical and other chemists, technical and general students.) München and Leipzig, 1890.

ERRERA, L.—**Microscope d'excursion de M. Amrhein.** (Amrhein's Travelling Microscope.) *Bull. Soc. Belge de Micr.*, XVI. (1890) p. 48.

(2) Eye-pieces and Objectives.

On Glass-smelting for Optical and other Scientific Purposes.†—Dr. Schott gives an account of the attempt, undertaken by himself and Prof. Abbe, to determine the mutual relations of optical effect and chemical composition for all possible amorphous compounds produced by solidification after fusion. It is now seven years since the idea of the work was first entertained. A year after the commencement of the undertaking sufficient data had been acquired to render it possible to predict that a systematic investigation of the question would lead to a considerable advance in practical optics. A building in Jena, suitable for carrying out the experimental work, was placed at the author's disposal, and was provided with furnace, blast, &c. Here, during the next two and a half years, the chief practical work of the investigation was effected. What remained to be done was to render the results obtained of service to practical optics. In furtherance of this design it was decided to once more renew in Germany the production of optical glass. This industry had been brought to a high state of perfection by Fraunhofer, but was, after his death, allowed to languish. It was foreseen that a long and costly series of experiments would be required before success could be attained, and that little aid could be expected from foreign sources. A grant of 60,000 marks from the Prussian Government, supplied on patriotic as well as on scientific grounds, met the cost of the apparatus for the first two years.

Fraunhofer had made experiments on the improvement of optical glass with much success. After his death, an English clergyman named Harcourt was the only one who undertook experiments of a similar kind, but the results obtained, although of interest, were of no practical utility. The following passage in a communication on the optical resources of the Microscope made by Prof. Abbe to the Exhibition of Scientific Apparatus in London in 1876, shows the condition of optical glass-smelting at that time:—

"It is not difficult to determine the fundamental grounds from which this want arises. The impossibility of getting rid of the chromatic differences of spherical aberration is dependent on the fact that, with

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

† Central-Ztg. f. Optik u. Mech., x. (1889) pp. 221-3, 232-4.

the crown and flint glass now at our disposal, the dispersion always goes hand in hand with the mean refractive index, so that the higher dispersion always belongs to the higher index, and *vice versa*. The aberration would be completely or at least approximately compensated if we possessed materials in which a relatively low refractive index was combined with a high dispersion, or a high refractive index with a relatively slight dispersion. It would then be possible, by a suitable combination of such a material with the ordinary crown and flint glass, to remove the chromatic and spherical aberration independently of one another, and thus to fulfil the essential condition on which the removal of the chromatic difference depends."

The perfecting of delicate optical instruments appeared, therefore, to depend on an advance in the art of glass-smelting, so that it should be possible to produce glasses suitable for the removal of the secondary spectrum, in which dispersion and mean refractive index would be differently related than in the glasses then used.

The uniformity in optical properties which characterizes most kinds of glass is due to the small number of materials used in their manufacture, viz. silica, alkalies, limestone, lead, and, in lesser degree, clay and thallium. The great aim of the authors was to advance beyond these narrow limits, and, directed by a methodical study of the optical characters of various chemical elements, to make use of such as appeared suitable to the end they had in view. They were in their work chiefly guided by the following considerations:—

(1) The composition of the glass must be regulated so that it shall not have too strong an action on the walls of the containing vessel, and thus lead to the introduction of foreign matter.

(2) It must be kept homogeneous by energetic stirring while in the melted state, so that it may be free from striæ of different refractive indices to that of the main mass.

(3) It must be kept free from cloudiness, crystal formation, and blisters during the processes of melting and cooling.

(4) It must bear reheating up to the melting-point without cloudiness or crystal separation.

(5) It must be kept free from strain by a suitable process of cooling.

(6) It must offer sufficient resistance to atmospheric agencies, and especially must show no signs of hygroscopic properties.

(7) It must be colourless.

(8) It must have sufficient hardness to allow the grinding, polishing, and shaping of the refractive surfaces.

Only relatively few inorganic anhydrides give rise to amorphous bodies when fused with certain metallic oxides and cooled. Hitherto silica was the only one which answered the above requirements, but boric, phosphoric, and arsenic acids were known to give glassy bodies in certain of their compounds. The authors accordingly first turned their attention to phosphoric and boric acids, and combined them with a great number of metallic oxides, in order to discover a combination without hygroscopic properties. The fusions were conducted in quite small porcelain crucibles of 20 to 30 ccm. contents with an ordinary laboratory blow-pipe. In spite of constant stirring during the fusion, pieces of

glass of sufficient size and homogeneity for complete spectroscopic measurement could not be obtained in this way. Nevertheless, these small pieces afforded proof that the above acids yielded glasses of extraordinary variety, and thus showed that considerable gradations in refractive index and dispersion could be obtained by their use.

The next advance was to prepare larger samples of glass. For this purpose a Fletcher gas furnace was found to be of the greatest service. With this furnace a rise in temperature up to the melting-point of metallic nickel could be obtained in about a quarter of an hour. The furnace consists of the usual heating chamber made of firebrick, and, in addition, of a so-called injector burner. The latter is formed of an iron tube, with the end towards the furnace covered with wire gauze, and the other pierced by a twyer through which the compressed air is forced. A pressure of air of 4–8 cm. of mercury is sufficient to effect the complete combustion of the gas admitted through a side-tube. The wire gauze at the end of the tube prevents the flame from passing backwards and causing an explosion of the combustible mixture in the tube. With this apparatus samples of glass of 150 grm. weight, and, later, up to 10 and 25 kgrm., were obtained, and they were found to satisfy all requirements, not only for scientific, but also for practical purposes.

By these means the optical characters of a large number of metallic oxides and acids were soon recognized, and it was found possible to incorporate in the glass, in amounts above 10 per cent., twenty-eight other bodies besides the five hitherto used. These were:—boron, phosphorus, lithium, magnesium, zinc, cadmium, barium, strontium, aluminium, beryllium, iron, manganese, cerium, didymium, erbium, silver, mercury, thallium, bismuth, antimony, arsenic, molybdenum, niobium, tungsten, tin, titanium, uranium, and fluorine.

The first object of the investigation—the power of obtaining gradations in refraction and dispersion—was soon attained. For the removal of the secondary spectrum, however, only comparatively few elements were found to offer suitable variations from the ordinary course of the dispersion. Of these boric acid produced a contraction of the blue and widening of the red end of the spectrum, while fluorine, potassium, and sodium had an opposite effect. For all other elements the course of the dispersion was the same as with silicate glass. Accordingly, since the ordinary flint glass shows an extension of the blue end of the spectrum as compared with crown glass, as high a percentage of boric acid as possible must be incorporated with it in order to obtain a perfect compensating effect. Thus boric acid has become the fundamental constituent of all flint glasses destined to diminish the secondary spectrum. The conditions are less favourable when it is desired to effect the compensation by widening the blue end of the spectrum of a crown glass. Of the three elements—fluorine, potassium, and sodium—suitable for this purpose, the last can only be introduced into silicate glass in very small quantities, and the potassium in amounts not exceeding 25–30 per cent.; this is because of their hygroscopic effect.

The chief characteristic of phosphoric acid—that of yielding glasses of comparatively slight dispersion with high refractive index—was made use of to solve the problem; for it had been found that, with equal ratio of refraction and dispersion, glasses of higher refractive index showed

an extension of the blue end of the spectrum. Thus by the use of phosphoric acid for the crown glass and a glass containing a high percentage of boric acid for the flint, it was found possible to almost completely remove the secondary spectrum.

While introducing material to produce certain optical effects, an important point to be considered was the modification of the composition of the glass, so that its external characters should remain satisfactory. Thus with phosphates and borates the alkalies must be used very sparingly, or deterioration of the polished surfaces under the influence of the atmosphere is unavoidable. It was ascertained, however, that certain glasses, which in themselves were hygroscopic, could be made serviceable by the introduction of large percentages of clay, zinc oxide, or other compounds. Great care, nevertheless, had to be exercised in these cases, since, as a rule, very slight changes in the percentage composition were sufficient to induce a partial or complete crystallization. On this ground many of the apparently numerous possibilities of borate and phosphate glass had to be excluded. After surmounting various obstacles the authors succeeded in producing a series of phosphate-borate, and borosilicate glasses in small samples. For the phosphate, observation showed that magnesia, clay, and potash offered the least dispersion, so that a crown glass could be produced with dispersion far less than that seen in any yet made. The use of baryta with phosphoric acid in a crown glass caused a decrease of refractive index of 1·53 to 1·59, and at the same time gave a lower dispersion. An aluminium-sodium-baryta-borate gave a borate crown glass, whose ray-path is useful for many purposes. The borate flint glasses, containing as much as 50 per cent. of boric acid, were made by the addition of clay, zinc oxide, and barium oxide, to satisfy all requirements, and to show no sign of hygroscopic characters.

Apparatus for the production of material on a large scale had now to be prepared. A special form of stirrer had first to be devised. This was made of porcelain, and was provided with two cross-bars. Besides the ordinary motion of rotation, an up and down motion extending over 5–10 cm. was also simultaneously communicated to it by a special mechanism. In spite of this, apparently, very effective arrangement the homogeneity obtained was not sufficiently perfect to enable the greater part of the mass to be used in large pieces for telescopes. Corrosion of the porcelain of the vessel, evaporation from the upper surface, &c., caused groups of striæ to form in the last portion poured out of the crucible. Accordingly it was determined to replace the porcelain crucible and stirrer by a crucible of platinum of 3 litre contents, and a platinum stirrer weighing about 1½ kgm. The result was, however, at first peculiarly unsatisfactory; for, during the cooling, an extraordinary number of bubbles were developed, and after being used three or four times, the platinum of the crucible became brittle and cracked. Later experiments with a smaller and thicker platinum crucible, which showed no sign of cracks, and did not give rise to any gas-bubbles, proved the adaptability of platinum to the end in view. The use of platinum was only applicable to the borate glass, since phosphoric acid attacks the metal.

The problem of the removal of the secondary spectrum having been

satisfactorily settled by the production of the phosphate and borate glass, attention was now directed to the improvement of the ordinary silicate glass. By the introduction of boric acid, zinc oxide, magnesia, baryta, and clay, silicate crown and light flint glasses were obtained with very varied relations of refraction and dispersion. Many combinations of light crown glass and light baryta flint glass were found to be of great service in aplanatic constructions for photographic purposes: for, owing to their increased transparency for the chemically active rays and their slight dispersion, they gave plane and sharp images in the camera.

The effect of strain produced in glass on cooling had next to be considered. Ten years ago Dr. Schott had made some experiments in this direction in relation to the so-called "Hartglas." He proved that the hardening of the glass proceeds inwards layer by layer so that, the internal part solidifying later than the outer, a state of strain was induced which manifested itself by diminished specific gravity and phenomena of double refraction.

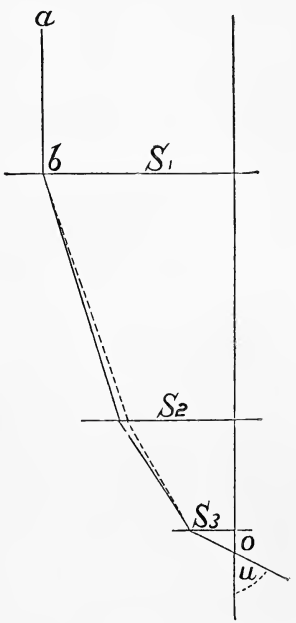
Now the lowering of the density of a substance is constantly accompanied by a diminution in the refractive index, so that this subject naturally becomes of the utmost importance in relation to delicate optical instruments. A strain becomes especially harmful when it is developed not in the centre of an objective, but excentrically. The effect of this is that the focal length varies in different parts just as if it were not spherical, but irregularly cut in the direction of the strain. Repeated experiments, made in the kind of furnace hitherto used, showed that the ordinary technical process of cooling no longer corresponded to the requirements of the improved kinds of glass. Accordingly, two years ago other experiments were undertaken. Success was attained by automatically regulating the source of heat to which the glass was subjected, and by very gradually allowing it to fall in temperature. Hitherto a thick cylindrical copper cauldron had been used as a cooling vessel. This was placed in the course of a large gas flame, and was connected with a mercury vapour pressure thermometer. In the improved form of apparatus, the expansion of the mercury was used not only to give the temperature, but also to regulate the flame. By this means it was possible to keep up a constant temperature over long periods of time, and also to effect a very gradual fall in temperature down to that at which experience has shown that the movement of the smallest particles ceases. The maximum temperature at which any of the glasses lost all signs of strain, and entered into a very slightly soft condition, was 465°; and on the other hand, the minimum temperature at which any of them hardened was about 370°. This fall of 95° was then extended over periods varying from a few days up to four weeks, and more successful results of cooling were obtained than by the old method under the most favourable conditions.

On the Removal of the Chromatic Difference of the Spherical Aberration in Microscope Systems.*—Dr. Arthur Kerber states that for systems of three lenses, the chromatic difference of the magnification is removed by having the upper lens under-compensated, and the middle one strongly over-compensated. By dispersion of the white ray *a b*

* Central-Ztg. f. Optik u. Mech., xi. (1890) pp. 217-9.

(fig. 83) in the upper under-compensated lens S_1, the blue ray (punctuated in the figure) cuts the middle lens S_2 at a shorter distance from the axis than the yellow. Consequently by sufficient over-compensation of the middle lens, the blue and yellow rays on emergence from the front lens can be made to converge to the same point *a*. Then the angle of convergence *u* for both rays is the same, and therefore the difference of the magnification is removed. In seeking to apply this method, however, it was found that the chromatic difference of magnification is so connected with the chromatic difference of the spherical aberration that a diminution of the one leads to an increase in the other. Tracing the path of a yellow and blue ray (very near to the axis) and the yellow and blue marginal ray from the eye-piece to the point of emergence from the front lens S (fig. 84), the two yellow rays *d o* and *d o'* and the blue circumpolar ray *f o* converge to the same point on the axis, when the system is spherically and chromatically corrected for this. On the other hand, the blue marginal ray *f' o'*, in consequence of the chromatic difference of the spherical aberration, cuts the axis behind the point *o* (in *o'*).

Fig. 83.



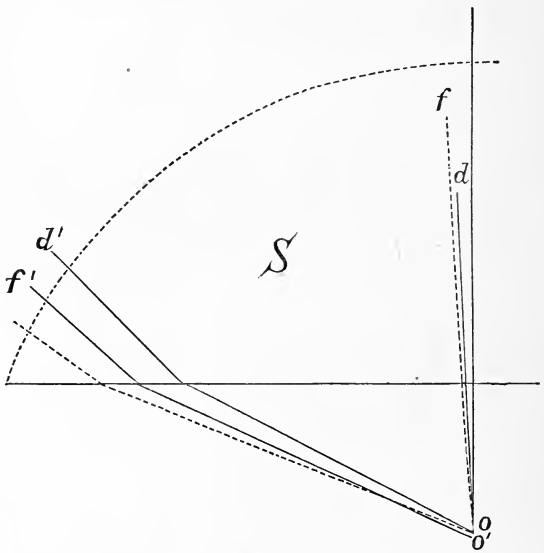
Now consider the system changed so that in the upper lens the dispersion of the crown glass is diminished, and that of the front lens increased, in both cases without change of refractive indices (for D). If this is done in such a way that the colour-aberration of the circumpolar ray is still removed, then the path of the two yellow rays suffers no change. On the other hand, the two blue rays, in consequence of the stronger over-compensation of the upper lens, cut the end face of the front lens at a greater distance from the axis than in the first system. By increasing the dispersion of the front lens, the blue circumpolar ray will cut the axis in the same point *o* as before, while the blue marginal ray, in consequence of the greater spherical aberration, cuts it in a point above *o'*. Accordingly, by sufficient over-compensation of the upper lens, the blue marginal ray can finally be also made to cut the axis in *o*.

Thus in systems of three or four members of determined form and refraction the chromatic difference of the spherical aberration is reduced by chromatic over-compensation in the hinder members, accompanied by increased dispersion of the front lens. But, as seen from the figure, this must produce an increase of sin *u*, so that the diminution of the spherical aberration of the blue rays goes hand in hand with an increase of the chromatic difference of the magnification and *vice versa*. The method of under-compensation of the upper lens (fig. 83) is therefore not to be

recommended, since by it a strong spherical aberration of the blue rays is produced which can in no way be removed by the eye-piece. An improvement in the geometrical focus is rather to be sought in the opposite direction, viz. by removing the spherical aberration of the blue marginal ray by means of the objective, and the resulting magnification error by a compensating eye-piece. In this way, if care be taken to remove the secondary colour aberration as much as possible, a completely colourless image can be obtained.

It is only possible to simultaneously satisfy many conditions in Microscope systems, by keeping the spherical and chromatic corrections distinctly separate. In order to be able to do this it is necessary to have at one's disposal a series of glasses with very varied dispersions for the

Fig. 84.



same refractive index. For, to correct for chromatic aberration a system already spherically corrected, without changing its form, glasses are necessary which have approximately the chosen indices and possess the dispersions determined by calculation.

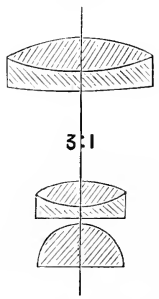
Since the diminution of the aberration of the blue marginal ray depends on the strong chromatic over-compensation of the hinder members of the system, the question arises whether the middle or the upper lens or both are to be over-compensated. Now a strongly over-compensated middle lens and *under-compensated* upper lens lead to a system (fig. 83) with slight difference of magnification and strong aberration of the blue marginal ray, while a strongly over-compensated middle lens and more or less chromatically *over-compensated* upper lens give a system with excessively under-compensated front lens. Thus strongly over-compensated middle lenses are to be avoided, and it is best

to combine a strongly chromatically over-compensated upper system with a strongly chromatically under-compensated front system.

As regards the choice of refractive indices for the individual lenses, fluor spar ($n = 1{\cdot}434$) is best for the convex lenses of the upper system, and for the concave, refractive indices (e. g. $1{\cdot}57$) which belong to a series of glasses of very varied high dispersions. For the middle lens, on the contrary, glasses with slight difference of dispersion, and as large as possible difference of the refractive indices, are to be chosen; and, finally, for the front lens a glass with strong colour aberration is to be used. The spherical correction of the system is made in the usual way. For the chromatic correction it is necessary to choose from a series of glasses with the determined indices those by which the colour aberration of the blue marginal and middle zone ray is removed, and at the same time the secondary aberration reduced as much as possible.

A Microscope System of 3·9 mm. focal length of Jena glass.*—Dr. Arthur Kerber has calculated the system he describes after the model of a 1/6 in., made by a well-known firm, with the idea of either establishing or altering the rules hitherto laid down for Microscope systems.

FIG. 85.



The marginal and central zone rays are of the wave-length $0{\cdot}55\ \mu$, and of height of emergence $h' = 2\frac{1}{2}$ and $1\frac{1}{4}$ mm., and the yellow and clear-blue rays are brought into union on the other side at the distance

$$h^* = 1{\cdot}9 \text{ mm. approximately.}$$

The elements of the system, represented in fig. 85, are given in the following table, in which r denotes the radius, d the thickness, y the air-space, and h' the half-aperture of the glass lenses, while No. 8, No. 39, and No. 38 indicate the kind of glass used in the lenses, and refer to the lists of the laboratory at Jena:—

	r.	d.	y.	h'.
Cover-glass (No. 8)	—	0·2455	—	—
Front lens (No. 8)	1·9	1·85	0·5383	—
Middle lens:—				
Flint lens (No. 39)	∞, − 4	0·8	0·1	—
Crown lens (No. 8)	+ 4, + 4	1·1	0	—
Upper lens:—				
Flint lens (No. 38)	32·5, − 5·5	0·8	4	2·5
Crown lens (No. 8)	5·5, + 7·5	1·45	0	2·5

The focal length of the system is 3·9 mm., the numerical aperture 0·65.

I.—The distance of union (z) and height of emergence ($h = z \tan u$) of the yellow rays, whose angle of inclination is determined by $\sin^2 \alpha$

* Central-Ztg. f. Optik u. Mech., xi. (1890) pp. 73-5, 86.

$= 0{\cdot}105, 0{\cdot}210, 0{\cdot}315, 0{\cdot}420$, are given with six-figure logarithms, as follows:—

$\sin^2 \alpha$	z_D	h_D
0·105	165·49	1·23589
0·210	162·86	1·74886
0·315	16_·47	2·14060
0·420	163·13	2·46455

If by the help of these data the distance of union is brought in the usual way into the form $Z = A - B h^2 + C h^4 - D h^6$, we have with the exactness to be attained by six-figure logarithms,

$Z_D = 171{\cdot}51 - 5{\cdot}307 h^2 + 0{\cdot}9765 h^4 - 0{\cdot}05431 h^6$, and similarly:

$$Z_C = 175{\cdot}87 - 6{\cdot}087 h^2 + 1{\cdot}0342 h^4 - 0{\cdot}05906 h^6.$$
$$Z_F = 166{\cdot}73 - 3{\cdot}827 h^2 + 0{\cdot}9941 h^4 - 0{\cdot}05164 h^6.$$

From this follows the general expression for the distance of union of the system:—

$$\begin{aligned}(1)\quad Z = {} & A_1 + A_2(\lambda' - \lambda) + A_3(\lambda'^4 - \lambda^4) \\ & - [B_1 + B_2(\lambda' - \lambda) + B_3(\lambda'^4 - \lambda^4)] \cdot h^2 \\ & + [C_1 + C_2(\lambda' - \lambda) + C_3(\lambda'^4 - \lambda^4)] \cdot h^4 \\ & - [D_1 + D_2(\lambda' - \lambda) + D_3(\lambda'^4 - \lambda^4)] \cdot h^6 \\ & = A - B \cdot h^2 + C \cdot h^4 - D h^6.\end{aligned}$$

where λ is the reciprocal of the wave-length in micra, $\lambda' = \lambda_{0{\cdot}55}$, and

$A_1 = 169{\cdot}16$	$A_2 = 45{\cdot}237$	$A_3 = -1{\cdot}2$
$B_1 = 4{\cdot}779$	$B_2 = 5{\cdot}166$	$B_3 = -0{\cdot}0395$
$C_1 = 0{\cdot}9593$	$C_2 = 0{\cdot}9774$	$C_3 = -0{\cdot}03854$
$D_1 = 0{\cdot}05218$	$D_2 = 0{\cdot}06117$	$D_3 = -0{\cdot}002018$

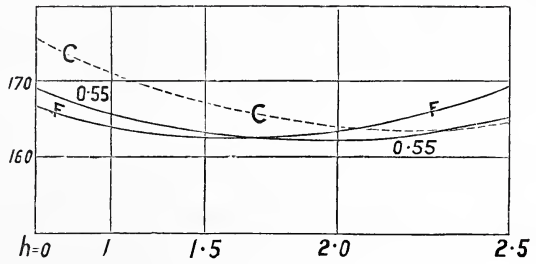
From this formula the distance of union of the rays C and F is calculated for $h = 0{\cdot}1, 0{\cdot}3, 0{\cdot}5$, and so on.

h	z_C	z_D	$z_{0{\cdot}55}$	z_E	z_F
0·1	175·81	71·46	69·11	67·99	66·69
0·3	75·34	71·04	68·74	67·64	66·40
0·5	74·41	70·25	68·03	66·98	65·84
0·7	73·13	69·14	67·04	66·07	65·09
0·9	71·59	67·83	65·90	65·03	64·26
1·1	69·94	66·45	64.72	63·98	63·49
1·3	68·36	65·07	63·57	63·00	62·86
1·5	66·74	63·90	62·67	62·28	62·57
1·7	65·49	63·02	62·10	61·93	62·73
1·9	64·60	62·52	61·95	62·04	63·44
2·1	64·07	62·44	62·26	62·64	64·75
2·3	63·87	62·73	63·01	63·72	66·67
2·5	63·81	63·23	64·03	65·13	69·04

In fig. 86 the path for the red, yellowish-green, and clear-blue rays is represented with h^2 (not h) as abscissa, and z as ordinate.

II.—The plane of the circle of least confusion of the brightest rays is reckoned as the focal plane of the system. Its position could then be determined, by the method of Aug. Kramer,* from the expression for the distance of union. But Kramer foresaw that the least section through the light-particles may be bounded by two zone-rays of opposite

Fig. 86.



inclination, and not always by a marginal and a zone-ray. Since, however, nothing definite can be known on this point, the author contents himself with determining the distance of the focal plane (ζ') from the simple relation $z = a - b\,h^2 + c\,h^4$.

The latter was deduced from the four-termed relation by the method of least squares. But z is to be so determined that the error of the transversal aberration

$$d\,\sigma = (z - \mathrm{Z})\frac{h}{z} = \frac{(a - \mathrm{A})\,h - (b - \mathrm{B})\,h^3 + (c - \mathrm{C})\,h^5 + \mathrm{D}\,h^7}{z}$$

shall be kept within the narrowest possible limits. This will be the case if the three maxima and the positive limit of that error determined by the marginal ray are equal to one another.

Now, in the function

$$y = m\,x + n\,x^3 + p\,x^5 + q\,x^7,$$

its positive limit (for $x = x'$), and its three maxima are equal to each other, for

$$m = -\frac{7}{64}\,q\,x'^6, \quad n = +\frac{7}{8}\,q\,x'^4, \quad p = -\frac{7}{4}\,q\,x'^2.$$

This introduced into $d\,\sigma$ leads to the determination

$$a - \mathrm{A} = -\frac{7}{64}\,\mathrm{D}\,h'^6, \quad b - \mathrm{B} = -\frac{7}{8}\,\mathrm{D}\,h'^4, \quad c - \mathrm{C} = -\frac{7}{4}\,\mathrm{D}\,h'^2;$$

or, since

$$\mathrm{A} = 169{\cdot}16, \quad \mathrm{B} = 4{\cdot}779, \quad \mathrm{C} = 0{\cdot}9593, \quad \mathrm{D} = 0{\cdot}05218, \quad h' = 2{\cdot}5:$$
$$a = 167{\cdot}77, \quad b = 2{\cdot}995, \quad c = 0{\cdot}3886,$$

so that

$$(2)\quad z_{0\cdot55} = 167{\cdot}77 - 2{\cdot}995\,h^2 + 0{\cdot}3886\,h^4.$$

* 'Allg. Theorie der Fernrohr-Objektive,' § 31.

From the following table it is seen that making use of this three-termed relation, the error of the transverse aberration $(z - Z)\,h : z$ is not greater than 3 μ.

h	$d\sigma$	h	$d\sigma$
0·3	− 2·2 μ	1·5	+ 3·0 μ
0.5	− 2·9	1·7	+ 2·7
0·7	− 2·7	1·9	+ 0·8
0·9	− 1·6	2·1	− 1·8
1·1	0	2·3	− 3·0
1·3	+ 2·0	2·5	+ 3·0

Thus in the correction of such a 1/6 in., it is justifiable to make use of the rules drawn from the three-termed relation, and to proceed by the same relation with the approximate determination of the focal plane.

The distance of this plane (ζ') is therefore found as follows:— Comparing

$$z = a - b\,h^2 + c\,h^4 \text{ and}$$

$$z = \alpha - \beta\gamma\frac{h^2}{h'^2} + \gamma\frac{h^4}{h'^4},$$

we have $c = \gamma : h'^4$, $\gamma = c\,h'^4$: thus with central illumination ($h' = 1{\cdot}25$); $\gamma = 0{\cdot}949$; by use of all zones ($h' = 2{\cdot}5$); $\gamma = 15{\cdot}18$. Further we have from equation (2) as distance of union of the yellow-green rays of height of emergence $h^* = 0{\cdot}866\,h'$:

for	$h' = 1{\cdot}25$	$z^* = 164{\cdot}79$
	$h' = 2{\cdot}50$	$162{\cdot}27$

and consequently, since $\zeta' = z^* + \frac{1}{16}\gamma$, as distance of the focal plane:

for central illumination: $\zeta' = 164{\cdot}85$
by use of all zones: $\zeta' = 163{\cdot}22$

The difference of 1·63 mm. corresponds to a lowering of the objective system (whose magnification N = 43) of $1{\cdot}63 : N^2 = 0{\cdot}0008$ mm. which is smaller than its penetrating power. For the rest see Dippel, 'Mikroskopie,' p. 344. The transverse aberration (σ) in the focal plane can now be calculated. It is given by the formula

$$\sigma = (z - \zeta')\frac{h}{z}.$$

1. For direct light ($\zeta' = 164{\cdot}85$):

h	σ_C	σ_D	$\sigma_{0{\cdot}55}$	σ_E	σ_F
0·1	+ 6·3μ	+ 3·9μ	+ 2·5μ	+ 1·9μ	+ 1·1μ
0·3	+18·1	+10·9	+ 6·9	+ 5·0	+ 2·8
0·5	+27·6	+16·0	+ 9·5	+ 6·4	+ 3·0
0·7	+33·7	+17·9	+ 9·2	+ 5·2	+ 1·0
0·9	+35·5	+16·0	+ 5·7	+ 1·0	− 3·2
1·1	+33·0	+10·6	− 0·8	− 5·8	− 9·1
1·3	+27·1	+ 1·7	−10·1	−14·7	−15·8

2. For two oblique cones ($\zeta' = 163 \cdot 22$):

h	σ_C	σ_D	$\sigma_{0 \cdot 55}$	σ_E	σ_F
0·1	+ 7·3μ	+ 4·9μ	+ 3·6μ	+ 2·9μ	+ 2·1μ
0·3	+20·9	+13·8	+ 9·8	+ 7·9	+ 5·7
0·5	+32·3	+20·8	+14·4	+11·3	+ 7·9
0·7	+40·2	+24·6	+16·0	+12·0	+ 7·9
0·9	+44·0	+24·8	+14·6	+ 9·9	+ 5·7
1·1	+43·6	+21·4	+10·1	+ 5·1	+ 1·8
1·3	+39·7	+14·6	+ 2·8	− 1·7	− 2·8
−1·3	−39·7	−14·6	− 2·8	+ 1·7	+ 2·8
−1·5	−31·6	− 6·2	+ 5·0	+ 8·6	+ 6·0
−1·7	−23·3	+ 2·1	+11·7	+13·5	+ 5·1
−1·9	−15·9	+ 8·2	+14·9	+13·8	− 2·6
−2·1	−10·9	+10·1	+12·4	+ 7·5	−19·5
−2·3	− 6·9	+ 9·2	+ 5·2	− 4·8	−45·4
−2·5	− 9·0	− 0·2	−12·4	−28·9	−86·7

The radius of the circle of least confusion (87 μ for F) is thus not greater than for telescope objectives of great focal length. Besides, with Microscope systems, the marginal zone is best used for resolution, i. e. for the representation of striæ, and for fine structures limitation of the illuminating cone (with change of adjustment) becomes necessary.

Further, the above table shows that for the yellow-green rays, with central illumination the maximum of the transverse aberration, and with the combined effect of all zones the two maxima, deviate somewhat from the positive limit. Thus, by change of the spherical correction (of B_1 in equation 1) and ζ', a further diminution of the spherical circle of least confusion can be obtained. On the other hand, the incomplete coincidence of the yellow and blue circles of least confusion is not to be removed by change of the chromatic correction (of A_2 in equation 1), because by lessening this error, for example, for direct light, it only becomes worse for the other forms of illumination. In order to obtain a distinct image in the focal plane, the rays with strong diffusion, which only form the ground on which the real image is seen, are completely cut off. These are:—

(1) All red rays since they are spread over ten times as large a surface as the image proper.

(2) The blue rays at distance 2·1 to 2·5 mm.

(3) The bright rays with great transverse aberration, which increases or diminishes rapidly and so produces a strong dispersion. These are the yellow rays of height of emergence 1·3 to 1·5 mm. and the green marginal rays.

On the other hand, the rays which take part in the production of the image are:—

(1) The weak rays with slight transverse aberration, which increases very slowly, so that there is a strong concentration of light. These are the blue rays at a distance of 0 to 2 mm.

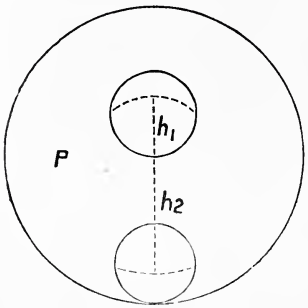
(2) The bright rays with great but slowly increasing aberration, e.g. the yellow-green rays of height of emergence 1·7 to 2·1 mm.

(3) The weak rays with small transverse aberration, even if this increases rapidly, e. g. the yellow marginal rays.

The image of a point with direct light is a disk of about 19 μ in diameter, surrounded by a pale yellow ring (on red and violet ground) about 8 μ broad.

For two oblique pencils, every individual image corresponding to the length of arc of the zone in the light parts of the "Austritts-pupille" is a circular arc of the same angular aperture.

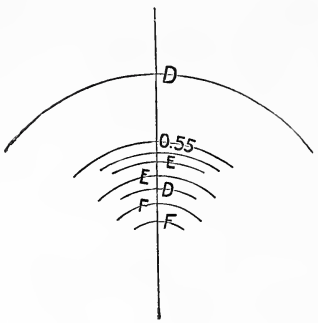
Fig. 87.



In the following table this angle (ϕ) is given for the zones 0·1, 0·3, 0·5, and so on.

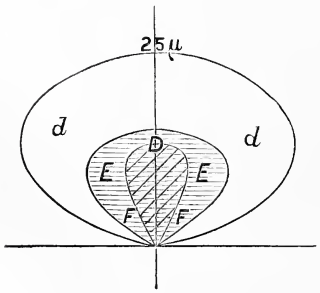
h	ϕ
0·1	166°
0·3	152°
0·5	134°
0·7	113°
0·9	88°
1·1	56°
1·3	18°
1·5	35°
1·7	39
1·9	38°
2·1	33°
2·3	25
2·5	0°

Fig. 88.



The image will be in this case represented by a number of arcs, which, with the transverse aberration σ, are inclosed in the angle ϕ, corresponding to the height of emergence. In order to simplify this representation of the image, those rays are to be taken in which the value of σ remains stationary, i. e. the maxima of the transverse aberration (e. g. $\sigma_D = 24{\cdot}8$ for $10{\cdot}1\,\mu$, $\sigma_E = 12$ for $13{\cdot}8\,\mu$).

Fig. 89.



Representing these as circular arcs, it is seen from the figure that with two oblique pencils the image is represented as a disc D E F with oval nucleus, which at E is coloured yellow-green, at D wine-yellow (yellow on red and violet ground), at F violet (blue and yellow-green predominating), and is surrounded by a large oval pale-yellow ring (*dd*).

The same result is obtained if the transverse aberration of all rays at the distance 0·1, 0·3, 0·5, &c., so far as they take part in the formation of the image, is represented by a number of circular arcs, and the

total image resulting in this way is divided into fields of different intensity.

The greatest diameter of the image proper D E F amounts to about 17, the greatest width of the pale-yellow border to 8 μ. A further concentration of the light is only possible by diminution of the effective aperture or of the object-distance.

Introduction of a Universal Scale of Magnification of Microscopical Figures.*—M. P. F. Reinsch complains that every micrographer makes use of an arbitrary scale for his figures. The camera obscura gives, for the same combination of objective and eye-piece, a constant magnification of the object figured; but the Microscopes of different makers differ widely, and the magnifications of the systems of objectives and eye-pieces do not vary in the same proportion. Consequently the statement as to the eye-piece and objective employed, made by authors on their figures, conveys little meaning to those who have not the same Microscope at their disposal.

In the systematic description of microscopical plants, it is of the utmost importance to give the dimensions in absolute value. For microscopical work such as this, the micron μ has been chosen as the unit of measure. A scale of magnification should be also based on the same unit. Measurements are indispensable in order to compare specimens of algæ and microscopic fungi with the published figures, but the work is complicated by the variety of magnifications used by authors, and long calculations are often necessary in order to find the absolute numerical values required.

To draw figures in conformity with the base of the measurements, the Microscope must be brought to the desired magnification.

Taking μ as unit, the following magnifications are recommended:—

Magnifications in μ.		Coefficients.	
2500	(dimens. of the figure) divided by	2·5	= $n\,\mu$ (absolute value).
2000	„	2	= $n\,\mu$
1500	„	1·5	= $n\,\mu$
1000	multiplied by	1	= $n\,\mu$
500	„	2	= $n\,\mu$
250	„	4	= $n\,\mu$
200	„	5	= $n\,\mu$
125	„	8	= $n\,\mu$
100	„	10	= $n\,\mu$

Only those coefficients are practicable which, multiplying or dividing 1000, give whole numbers as product or quotient. Magnifications greater than 1000 are obtained by multiplying, those less than 1000 by dividing 1000 by the coefficient. The above scale, which represents the magnifications which it is in this way possible to express in whole numbers, will answer all the requirements of microscopical figures.

* Bull. Soc. Bot. France, xxxvi. (1889) p. ccvii.

(3) Illuminating and other Apparatus.

Substages for Students' Microscopes.—The following interesting correspondence appeared in the pages of the 'English Mechanic':*—

"Under this heading Messrs. Watson and Sons reproduce, if I mistake not, a figure of the underpart of the stage of one of their Microscopes, which was published in the 'E.M.' a year or two ago. They appear to claim for it some originality of design, and bring it forward again, as if it wholly superseded the necessity for Swift and Sons' rival production, notwithstanding the fact that such rival production is recommended by the Secretary of the Quekett Microscopical Club (vide Report of Proceedings Q.M.C., 'E.M.,' p. 185).

Examining Messrs. Watson's figure with a somewhat experienced eye, I note that the substage is not mounted on a substantial tail-piece, but is merely connected with the stage proper by a screw, on which it pivots out of the axis, the axial position being roughly secured by a stop-pin; the centering is then effected by the two projecting screws on the circumference of the substage acting upon a movable inner ring or tube in which the condenser or other apparatus is applied.

This system of pivoting the substage has long been in use on the Continent for all classes of Microscopes, from the most elaborate down to the commonest types of so-called students' instruments. It is a bad system—bad in the Johnsonian "leg-of-mutton" sense—bad from every point of view.

A focusing and centering substage can hardly be too substantially connected with the Microscope, for it has to suffer more rough handling than any other part of the instrument. The fewer movements it has beyond those actually needed for use, the better; for every additional joint or slide-bearing brings in its quota of unsteadiness, making additional demands on the observer's watchfulness and patience in securing exactness of adjustment.

The only satisfactory arrangements of substage yet devised act by rack-and-pinion on a fixed tail-piece.

Many attempts have been made, both in Europe and America, to devise means for focusing the condenser of a less expensive character than the rack-and-pinion; but they have all been found radically bad in practice by those who were familiar with the conveniences of the rack-and-pinion, and who have been called upon to test the various systems devised in substitution.

In the older models of drum Microscopes (*Microscopes à tambour*) of Georges Oberhäuser—who was probably the first to apply mechanism to focus the substage condenser of the achromatic Microscope—the substage socket was a fixture beneath the stage, and the condenser tube sliding in it was provided with stud-pins on either side, on which a forked lever engaged, the free end of the lever projecting slightly through a vertical slot in the drum base, so that by its movement up or down the condenser was adjusted beneath the object. This arrangement was generally combined with some primitive means of centering the condenser with a screw-driver, such centering being on the "once for all"

* Engl. Mech., lii. (1890) pp. 228, 229, 251, 271.

principle, not to be altered during the process of observation, the very moment when it was most essential that it should be possible to alter it. In later constructions Oberhäuser applied a sort of gimbal to the forked lever to secure an easier sliding motion to the condenser for focusing; but the system of direct push or pull of the condenser tube within the substage socket, with or without gimbal, was always bad, and frequently ended in injury to the mechanism.

Nachet and others improved upon Oberhäuser's arrangement by applying under the stage a tail-piece having a dovetail groove in which a slide carrying the substage was actuated by a stud-pin and lever projecting laterally.

More recently, and particularly in America, the lever has been omitted by many opticians, and the microscopist has had to slide the fitting up or down the tail-piece by small knobs on either side. Even the most recent student's Microscope—that of Swift and Son, to which I have above referred—has this most inconvenient arrangement.

It would be too tedious to describe the various other systems that have been applied to avoid the expense of the rack-and-pinion. They consist generally of some form of screw-action, and probably the best of them is now made by a leading Paris optician.

Probably one of the worst focusing arrangements recently designed for the substage condenser is that proposed—if not invented—by Mr. E. M. Nelson. It consists of a substage socket fixed to the under face of the stage; a spiral slot is cut in the socket, in which a stud-pin on the side of the condenser tube moves up or down as this tube is rotated by hand. The focal adjustment of the condenser obtained by this motion in a spiral direction is very unsatisfactory. I suppose Mr. Nelson himself now recognizes its inferiority.

Until our opticians face the matter by applying the rack-and-pinion motion to a fixed tail-piece for students' Microscopes, I fear we cannot credit them with the serious intention of meeting the present requirements of students. It would appear that English makers are constantly handicapped by their own desire to supply a superabundance of "finish" in non-essentials, to the neglect of much-needed focal and centering substage adjustments, which every student would soon learn to appreciate.

If a beginner now asks the advice of an expert as to the microscopical outfit he should obtain, on explaining his requirements to the optician, he will probably be met at once with some such statement as follows:—"You can have a substage with rack-and-pinion and centering adjustments; but these things are only fitted to the better class of Microscopes commencing at the price of £*x*"—the *real* drift of which is to force the student into a larger outlay—to make what is commonly known in business as a "substantial transaction."

The fact seems to be that in England the manufacture of fairly good Microscopes is in the hands of so few opticians that they believe they can wholly control the trade. It is for responsible teachers in medical schools to combine and authoritatively formulate the *desiderata* of a student's Microscope—the laws of *demand* and *supply* will do the rest, though they should lead us to engage foreign opticians to drive English Microscopes of the students' class out of the field. Such a course does not seem patriotic; but I fear our opticians are proof against friendly

council on the matter. They can only be made to move in a popular direction when they find such firms as Zeiss's establishing themselves—as they are now doing—in London.

Microscopists naturally want the highest class of optical appliances they can acquire with the outlay at their disposal. They feel that inferior means conduce to inferior results only. The demand for the improved instruments—apochromatic objectives, compensating eye-pieces, projection eye-pieces, &c.—exists. The supply of these novelties by English opticians has been so extremely limited, and withal so tardy, that it has amounted to nothing of any importance, so we have to rely mainly on Zeiss, of Jena. That great firm, employing some four hundred people, has now established two representative houses in London, and it behoves our opticians to look to their laurels, for the competition promises to be the most serious that has occurred during this generation. Moreover, the competition will not be limited to the production of microscopical apparatus. The firm of Zeiss has now brought out a series of new photographic lenses which will, no doubt, demand and obtain the keenest attention of those who are interested in the progress of photography.—Microscopist."

"In submitting the student's Microscope, made by Messrs. Swift, at the last meeting of the Quekett Microscopical Club, I expressly disclaimed any idea of novelty in the parts of the instrument. My sole intent was to show how easily some better form of centering fitting could be applied in place of the makeshift understage tube, which is, *pace* Messrs. Watson, after all, the only thing provided in the vast majority of students' instruments. These gentlemen state that the form adopted by them in their Edinburgh model was designed by Dr. Edington, about two and a half years ago; but Messrs. Crouch have, for a much longer period, made a very similar form, and so has Reichert, of Vienna. The great drawback, in my opinion, to this arrangement is that it is in the way when turned aside; and, moreover, I do not think it can be contended that a substage supported by, and swinging on a single screw, is as steady and free from tremor as one with long bearings moving in a dovetailed guide. Mr. Nelson, whose criticism in these matters is always deserving of great respect, drew attention to the absence of a rack-and-pinion focusing adjustment in Messrs. Swift's instrument, but one is very easily fitted if required, and for the class of work this instrument is intended for it is by no means necessary.

I shall be very pleased if a discussion on this subject leads to the abolition of the non-centering substage tube, and the substitution of a more scientific arrangement, by whomsoever it may be designed.—George C. Karop."

"When writing previously on this subject we had no thought of inducing a controversy; but we must, in justice to ourselves, repudiate the inference of your correspondent, 'Microscopist,' that the substage of the Edinburgh Student's Microscope is not rigid. One would imagine, from your correspondent's letter, that it is a useless arrangement; but his information is evidently gleaned from the engraving that accompanied our previous letter, which he has not correctly interpreted, and certainly not from any practical working with one of our instruments. We would point out that when the substage is in the axial position, it fits into a

special collet, which grips it from beneath, so that there cannot be any shake; it is not merely 'roughly secured by a stop-pin,' as 'Microscopist' assumes. In fact, his remarks consist of an expression of superficial opinion, formed from an incorrect conception of the build of the instrument.

In proof of our assertion as to the rigidity of the form of substage, as fitted by us to the Edinburgh Student's Microscope, we may say that the sale of this class of instrument has now run into hundreds, and it is in frequent use by many leading microscopists, from whom we have received letters expressing great satisfaction with the rigidity of working parts. Further, a great deal of the demand for the instruments is from the very men that 'Microscopist' considers are best able to 'formulate the desiderata of a student's Microscope'—viz. the teachers in medical schools. From these, throughout the world, we have received orders, not only for ones and twos, but for "ties," and in nearly every instance the instruments have been preferred on account of their rigidity and the convenience and perfection of substage.

If any one required a substage on a fixed tail-piece we should supply it; but never, since we have made the Edinburgh Student's Microscope, have we been asked for such.—W. Watson & Sons."

"Allow me to supplement my letter (see above) by a few observations, which I trust will forward improvements in the construction of students' Microscopes.

I have suggested that responsible teachers in medical schools should combine and authoritatively formulate the desiderata of a student's Microscope, and that the laws of demand and supply would do the rest.

On the question of the need of such combined action for this purpose, I hardly expect a dissentient voice. But as to the best means of bringing this action to a focus, that is matter on which I must only touch with diffidence. The fact that Mr. G. C. Karop, secretary of the Quekett Microscopical Club, avows his special interest in the subject would point clearly in his direction as a possible centre of action. No great difficulty should be found in forming a committee of men of similar tastes and aims, who would cordially strive to bring out a Microscope to meet the modern wants of students both as to efficiency and economy.

Such a committee would require the co-operation of a skilled mechanician, having considerable manufacturing resources at his command, and who would boldly face the outlay of developing what would be recommended. The prospect of the large business that would naturally follow upon the successful production of a student's Microscope, under such favourable auspices, would, no doubt, be quite sufficient to bring forward the right mechanician.

It may be asked why the requirements of students at this moment do not induce an optician to produce exactly what is wanted? On this it may be said that up to the present time the teachers in medical schools have never attempted any concerted action in the matter; they have been content, individually, to make suggestions here and there to the opticians, and these latter have only felt safe in carrying out the suggestions when they emanated from an influential man whose personal authority sufficed to insure a demand for the instrument large enough to

recoup the experimental outlay. Thus it has happened that each optician has had to secure for himself one or more of these patrons, each of whom has had his own pet schemes to promote, and there has been no sufficient inducement of probable commercial success to warrant the planning of the manufacture of Microscopes on a thoroughly economical basis, by which the most efficient instruments could be produced at a minimum price. The want of concerted action on the part of teachers has thus led to an immense waste of production—a waste amounting in many cases to 50 per cent. or more. It should also be noted that the optician is not, as a rule, catering directly for medical students; he has first to secure the good offices of an influential medical patron, who will instruct his pupils to purchase the apparatus he recommends. Unless, therefore, he is willing to forego his own independence of action, and carry out strictly the orders of his patron, the patronage is transferred to a more willing agent. It is wholly beside the mark to urge that the optician is not bound to follow such orders, that he may use his own discretion on the matter. In practice it may happen that Dr. Microtome, professor of microtomic biology at half a dozen medical schools, whose patronage is good for the sale of some scores of Microscopes per session, knows nothing whatever about the construction of Microscopes, or he may have just the smattering of interest in mechanical design that finds outlet in pressing forward novelties *quâ* novelties, regardless of their practical value; but he is keenly alive to the importance of having his name connected with some form of student's Microscope, and he knows the value of his patronage; the optician is, therefore, obliged to accept the terms proposed to him, and to produce Students' Microtomic Bacteriological Microscopes according to instructions. To add to the confusion of the circumstances, nearly every medical session is accompanied by changes in the medical staff; new ideas crop up or old ones are revived; the optician is appealed to for this or that petty modification in the design of the Microscope, and thus his skill and experience are too often frittered away in carrying out trumpery suggestions which would not stand a moment's discussion before a jury of experts. To meet this incessant order of change one optician in London has made upwards of twenty different forms of students' Microscopes during the past ten years.

My impression is that the present requirements of students do not really necessitate the construction of an entirely new design of Microscope, but only the combination or adaptation of a number of useful points which already exist either together or separately in known models. The student wants a stand that will enable him to get the best work out of his optical means. High-class instruments exist which appear to satisfy the demands of the most fastidious microscopists. It would appear, then, that there is no need for the invention of a new model: we want only the application of common sense to the process of selecting and embodying in the most economical way the points of construction which experience has shown to be the most essential in the high-class Microscopes.

It may be, however, that the majority of teachers in medical schools have no particular claim to be regarded as experts in the use of the Microscope, and hence that a committee of them would carry no very

special weight in their recommendations. A committee of this kind would naturally be guided to a great extent by the more experienced of the members; and these latter would not hesitate to call in the assistance of any one who was known to be specially qualified to advise on the matter—I think that might well be taken for granted.

With reference to the construction of students' Microscopes, where experience informs me that English opticians are very apt to go astray:—If we take a general survey of the various kinds of students' Microscopes produced in England, we shall be struck with the fact that they are too light in build, and consequently too liable to become loose and shaky in their bearings throughout. Take an average English stand of this class as it leaves the maker's hands, put it on a laboratory table to be used by students for a session or two, and it will then show such signs of wear and tear as to need radical renovation. This rapid deterioration of the mechanism of our students' Microscopes is, in great measure, due to the inferior quality of the metal employed, which is not selected for its durability, but mainly for its low price and the ease, and consequent cheapness, with which it can be fashioned. Thus instruments are put together with a considerable amount of accuracy in the bearings, and with rack-and-pinion work moving with all desirable smoothness, and, above all, with a most lustrous polish wherever the lathe can be brought to bear on the parts—the whole so artfully and cleverly finished that we are all deceived into commending the results. We examine critically all the movements and they pass muster with applause. But the question of the durability cannot be settled by mere inspection. We are apt to suppose that well-fitted metal-work must necessarily be durable because it *is* metal; whereas, durability depends to a very large extent on the quality of the metal. Many of these modern Microscope-stands are made of a quality of brass that is specially chosen of just that degree of hardness to enable the work to be done with the maximum speed, and, consequently with the minimum outlay on the production of the instruments. The question of durability is wholly ignored. The policy seems to have been to make the utmost haste in the business of manufacturing, and let 'the devil take the hindmost.'

Judicious concerted action on the part of class-teachers should put an end to this chaotic state of things, by giving the opticians reasonable assurance that those who can succeed in meeting the desiderata most efficiently will meet with the desired commercial success.

I have been informed, on reliable authority, that some months ago a project was discussed by sundry amateurs in London for a competition among opticians relative to the production of the most efficient Microscope-stands of certain classes, and substantial prizes were to be offered. The matter went so far that the secretary of one of the most prosperous societies in London was ready to inaugurate the competition formally. But wiser counsels prevailed. It was plainly foreseen that the difficulties of settling the conditions of the competition and the selection of the jury would lead to endless bickering and dissatisfaction, and so the matter was dropped.

The scheme we now have at heart is much less ambitious, and, I hope, more practical; and I think it should have the support of Mr. Karop and his fellow-workers.—Microscopist."

"The question between Messrs. Watson and myself relates to the advisability or not of retaining the pivoting movement of the mechanical substage in their Edinburgh Student's Microscope, as shown in the figure they reproduced with letter 31741, p. 207. They point to the numbers of these Microscopes sold in proof that the system must be good; whilst I, on the other hand, point to the mechanism itself in proof that the system is bad, and I will explain my views.

The chief aim in the application of focusing and centering movements to the substage is to enable the worker to adjust the illumination with all desirable accuracy. Experts have long been striving to popularize the fact that unless a mechanical substage is provided the student is placed at a serious disadvantage, for he cannot otherwise get the best work out of his optical battery.

In the most perfect Microscopes hitherto constructed, no efforts have been spared to make the mechanical substage thoroughly substantial and accurate, and its attachment to the main instrument as rigid as possible; hence the outlay on the substage is a large item of the total cost of these instruments.

In the less perfect Microscopes, which are also less costly, less expensive forms of mechanical substages have to be applied, and as the outlay is reduced, the construction naturally reaches a lower grade of general stability, until finally, in order to cut down the cost to the lowest point, the optician gives up the substantial connection of the fitting with the main instrument, and attaches the substage to the under face of the stage proper by a screw-pivot, as shown in Messrs. Watson's figure. The prime motive for adopting the pivoting system originally—I do not say the prime motive of Messrs. Watson, but of the real originators, the French or German manufacturers of low-class Microscopes for toy-shops, &c.—was to reduce the cost, for the attachment is of so inexpensive a character that I suppose it may be done for a shilling, and then carry a profit of 50 per cent. Such a system may be tolerable in toy Microscopes, where the substage is intended as a mere diaphragm carrier, and it was formerly much in vogue even for dissecting Microscopes, as made by Chevalier and others; but when the substage has to carry centering arrangements on a rack-and-pinion movement on a tail-piece, the whole purpose of these appliances is frustrated by the speedy development of 'wobble' and general instability that disgust the critical worker.

Good substage appliances are most essential adjuncts for all serious work, and they merit that the substage shall be soundly and substantially attached to the Microscope, with reasonable assurance that the condenser, &c., shall focus and centre accurately in the optic axis of the Microscope with the minimum of collimation error. These are the well-known conditions that should guide the optician in the application of an efficient substage to a student's Microscope; and they are not properly met by attaching it to the stage proper by a pivoting arrangement such as that figured by Messrs. Watson.

The student cannot too soon learn that the firmness of his mechanical substage, its rigid attachment to the Microscope, either by a tail-piece or other fitting, is infinitely more important in practice than the liberty of swinging it aside. He may take it for granted that the construction

of his low-priced substage will be quite unsteady enough in itself without the addition of a pivoting motion.

As to the pivoting system being recommended by Messrs. Watson's medical patron at "Modern Athens," that fact suggests to me only the probability that the recommendation is based on very limited experience of high-class work; whilst their own approval of it, according to the tone of their letter, seems largely due to commercial reasons which are not in my province to discuss.

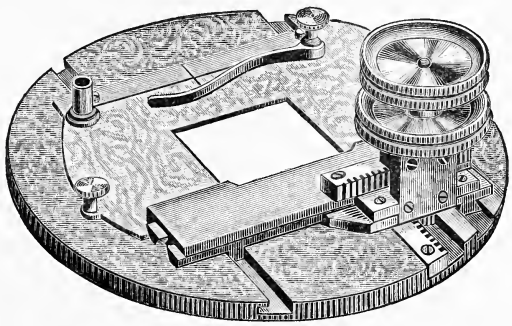
I condemn the system on its merits as totally unfit to be combined with a mechanical substage. I see in its application only the evasion of the recognized good and durable methods of attaching the substage to the Microscope, which are adopted wherever such matters have been seriously aimed at.

We have had, in all conscience, enough, with over-measure, of inferior constructions of students' Microscopes. Let us now aim at something altogether better.—Microscopist."

An Illuminating Cell.*—Mr. F. O. Jacobs describes a cell made of any white metal that will take a bright polish, and shaped so as to reflect the light it receives from the mirror to the object, which is mounted on an opaque ground. The cell completely covers the object but is perforated by an opening of the same size as the ground on which the object is mounted, which should be just large enough to inclose the field. The arrangement is completed with a small cover-glass. The advantage of this cell is, that it saves time in adjusting the light and condensing lens, the same lighting being used as with a transparent object.

Bulloch's Mechanical Stage with Vertical Pinions.—In the various constructions of this form of stage since its comparatively recent intro-

Fig. 90.



duction by the late R. B. Tolles, the mechanism has generally been defective in the matter of durability; in the endeavours to secure extreme thinness of the support for the slide, the attachment of the

* The Microscope, x. (1890) p. 281.

mechanism to the solid part of the stage has been so reduced in strength that with very little use it has become so loose and shaky as to be unserviceable.

In the new stage here shown (fig. 90) it has been the aim of Mr. W. H. Bulloch to correct the defects above noted by the application of dovetail slides to the forward and backward motions, which also provide a firmer support for the lateral motions.

(4) Photomicrography.

Photomicrography at Medical Congress of Berlin, 1890.*—In his review of the photomicrographic apparatus and photographs exhibited at Berlin during the sitting of the International Medical Congress, Dr. R. Neuhauss does not seem to have found much that was worth more than a general description. The well-known makers Zeiss, Leitz, Klönne and Müller, and Hartnack were, of course, in evidence with their well-known apparatus. A. Stegemann exhibited a base-board by which the camera could be moved from the horizontal to the vertical position; P. Thate, a magnesium flash-light apparatus; and Carl Günther, a cabinet for drying plates, capable of holding 24 plates 13 × 21 cm. in size. A strong current of air, kept up by means of a lamp fitted to the lid, dries the plates in 3 to 6 hours. Among the photographs may be mentioned those of Prof. Loeffler, showing the flagella of bacteria; the instantaneous photographs of living infusoria obtained with the flash-light of Duncker. The difficulty experienced with the ultra-violet rays was avoided by filtering through a Chinin filter. Prof. Babes, of Bucharest, is severely handled by the writer, who attributes to the photographs almost every possible fault. It would seem, however, that taken all round, photomicrography is greatly advancing.

Marktanner-Turneretscher's 'Photomicrography.'†—This recent manual on photomicrography is specially addressed to those who are desirous of showing the results of their own work by means of photography, and of attaining this object with the least expenditure of time and trouble. After reviewing and discussing the various apparatus necessary for photomicrography the author proceeds to the chief methods and explains the dry-plate, the wet-plate and the positive processes, and then indicates certain defects which frequently occur, and the means for their avoidance. The work ends with describing how to show photographic preparations by the aid of the magic lantern. The book is copiously illustrated, and contains an excellent list of works of reference.

Absorption-plates.‡—In order to absorb ultra-violet rays A. Miethe employs gelatin plates made as follows:—Gelatin 2 grm., glycerin 2 grm., water 25 ccm., æsculin 0·059. The gelatin is dissolved in 15 ccm. water, then are added the glycerin and the æsculin, dissolved in 10 ccm. water; the whole is then filtered through flannel. Glass plates are covered with a pretty thick layer of this mixture, which is then allowed to set and dry in a dust-free place. In order to completely absorb the ultra-

* Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 145-50.

† 'Die Mikrophotographie,' Halle, 1890, 344 pp., 195 engravings, and 2 pls.

‡ Photogr. Wochenbl., 1890, No. 18. Cf. Zeitschr. f. Wiss. Mikr., vii. (1890) p. 187.

violet rays, the æsculin plate is combined with another which contains 0·02 grm. of fluorescin instead of the æsculin. These two plates are stuck together and their edges united with black paper. As the æsculin becomes embrowned with time it must be replaced by a fresh plate.

Application of Photography to the demonstration of certain Physiological Processes in Plants.*—Mr. W. Gardiner states that it is possible, by taking advantage of their sensitiveness to light, to obtain prints from *Protococci*, or the free-swimming swarm-spores of many green algæ. Into one end of a water-tight box a thin glass plate is securely fixed. The negative to be printed is then placed next the glass, film side nearest. The box is filled with water containing a fairly large quantity of swarm-spores, and the lid is shut down and the whole exposed to diffused light. In the case of a strong well-developed negative, the swarm-spores swim towards the most highly illuminated parts, so that, after some four or six hours, on pouring out the water and removing the negative, a print in green swarm-spores can be obtained.

(6) Miscellaneous.

Deceased Honorary Fellows. Mr. Ralfs and Prof. Parker, F.R.S.—Our Fellows will be glad to have memorial notices of the two eminent honorary Fellows whom we have recently lost. That of Mr. John Ralfs is extracted from the notice by Messrs. H. & J. Groves in the 'Journal of Botany,' xxviii. (1890) p. 289.

"Only those who have come into close contact with the man or have carefully studied his works, can realize the greatness of the intellect of the veteran botanist who died at Penzance in July last. Had not his health and eyesight failed, there is little doubt that John Ralfs would have ranked as one of the greatest botanists of the century. His clearness of perception, his conciseness and exactitude of expression, added to his indomitable energy, his enthusiasm, and his wonderful memory, made him the very ideal of a naturalist.

He was born on Sept. 13th, 1807, at Millbrook, near Southampton. He came of an old Hampshire family, being the second son of Samuel Ralfs, of Mudeford, near Christchurch. His father died in 1808, and the young family was brought up by the mother, who disposed of the property at Mudeford, and removed to Southampton. Young Ralfs's first school appears to have been that of Dr. Buller in this town; he afterwards went to Mr. Jennings's at Bishop's Waltham, and subsequently to the Rev. J. Jenvey's at Romsey. To the last-named gentleman he became much attached, and to him he dedicated his first botanical book. As a lad Ralfs was studious and painstaking, and showed an early inclination to scientific pursuits which first developed in the direction of chemistry. At about the age of eighteen he was articled to his uncle, a surgeon at Brentford, with whom he remained two years and a half, after which he studied at Winchester Hospital for two years. In 1832 he passed the examination qualifying him as a surgeon, and in this examination we find that he distinguished himself by his knowledge of botany. He went into partnership with a surgeon in Shoreditch, and

* Ann. of Bot., iv. (1889) p. 163.

Mr. Marquand tells us that he practised at Towcester. During the few years that he was able to follow his profession he was very successful. While on a visit to Torquay he became acquainted with Miss Laura Cecilia Newman, daughter of Mr. Henry Newman, of London, and in 1835 was married to that lady. They had one son, John Henry, who was born in 1836. The marriage did not prove a happy one, for within two years Mrs. Ralfs (with her infant son) went to live with her parents, who were then residing in France; she afterwards travelled in Italy, but returned to France, where she died in 1848.

In 1837 Mr. Ralfs's health became so bad, his lungs being found to be seriously affected, that he was obliged to relinquish his practice and to reside in one of the health-resorts on the south-western coast. After visiting Torquay, he settled down, in November 1837, at Penzance, which continued to be his home during the rest of his life. In 1838 he contributed the botanical portion of a guide to Ilfracombe by Banfield. In 1839 he published his first book, 'The British Phænogamous Plants and Ferns; arranged on the Linnæan System, and analysed after the method of Lamarck'; this consisted of a dichotomous key to the genera and species, with an analysis of the natural orders. It did not pretend to compete with the larger "Floras," but was intended as a guide to the quick determination of species; and the simple straightforward language employed, the judicious selection of practical characters, and the small compass of the book admirably adapted it to the purposes of a pocket manual. At the commencement of 1841, Mr. Ralfs opened a correspondence with the Rev. M. J. Berkeley, whom he had met some years previously; this resulted in a close friendship, and Ralfs and Berkeley appear to have constantly consulted one another on questions connected with the Algæ and Fungi. Berkeley's correspondence (preserved in the Botanical Department of the British Museum) contains some hundreds of letters from Ralfs, many of them consisting of four closely written quarto pages, and containing pen-and-ink drawings. Ralfs seemed then to have settled down to the study of the Desmids and Diatoms, but continued to give a general attention to Fungi and other plants.

The summers of 1841 and several subsequent years were spent in visits to Ilfracombe and various parts of Wales, his longest stay usually being at Dolgelly. In 1842 he was accompanied on his Welsh trip by Borrer. In this year Ralfs sent a description of *Desmidium compressum* (a new species) to Dr. Balfour for the Botanical Society of Edinburgh. In 1843–4–5 he contributed to the same Society a series of papers on the Desmids and Diatoms, and in one of them he mentioned that the total number of Desmids previously recorded in the British Floras was four—two *Desmidia* and two *Euastra*. These papers were published in the 'Annals of Natural History' and in the 'Transactions' of the Society. They contain figures and descriptions of a number of species of Diatoms, and over sixty Desmids, of which sixteen were new. In 1845 also appeared his paper, 'On the genera *Spirulina* and *Coleochæte*,' A. N. H., xvi. p. 308. . . .

In 1848, after several delays occasioned by illness, his great work was published, 'The British Desmidieæ,' probably the finest monograph

which has appeared of any group of British plants. The descriptions are complete and lucid, the synonymy is very carefully worked out, and the analyses are in Ralfs's characteristically terse style. Particular attention is given to the reproductive states of the plants, which had been previously observed in very few species. An appendix contains descriptions of the species not known to occur in Britain, and the small number of these is an evidence of the leading position Ralfs had taken up as an authority upon the group. In a few years he had raised the number of known British Desmids from four to 180. Mr. E. Jenner's beautiful drawings contributed much to the value of the work, for he was not only an excellent draughtsman, but a good botanist, and well acquainted with the Desmids. During the preparation of the works Ralfs had extensive correspondence with Brébisson, Kützing, Montagne, and other leading foreign algologists. Berkeley seems to have been of great assistance in many ways. . . .

In 1856 he undertook the arrangement of the Diatoms and Desmids for the fourth edition of Pritchard's 'Infusoria,' but, through repeated illnesses, was only able to complete the Diatomaceæ, and this contributed to the delay in the publication of the book, which did not appear until 1861. His work, however, was very thorough, and gave an account of the whole of the known Diatomaceæ, both recent and fossil.

The sudden failure of his eyesight about this time rendered future microscopical research impossible, thus putting a stop to the great work of his life, and he does not seem to have recovered from the shock for many years. He turned his attention more and more to working out the flora of West Cornwall. . . .

Mr. Ralfs bequeathed his collection of microscopic plants to the Botanical Department of the British Museum, but his will was not witnessed, and had consequently no legal force. His son has, however, in consideration of his father's wishes, generously resolved to place the collection in the British Museum."

That of Prof. Parker is an anonymous notice, clearly from the hand of one who knew him well, which appeared in the 'Times' of 7th July last.

"By the sudden death, on the 3rd inst., of Mr. William Kitchen Parker, F.R.S., formerly Hunterian Professor of Comparative Anatomy at the Royal College of Surgeons, science in this country has lost one of its unique investigators, a man of the order of Faraday, if lacking his great constructive powers. The son of a farmer in South Lincolnshire, his schooling was of a very limited character except for three-quarters of a year spent at Peterborough grammar school, after which he became an assistant to a chemist at Stamford. He had already been attracted to the mysteries of anatomy as they chanced to come under his notice in farming life, and with no instruction whatever he had made skeletons of many animals. While at the chemist's, engaged at business from 7 a.m. to 10 p.m., he rose several hours before his morning's work began, and with a fellow-apprentice scoured the neighbourhood for botanical specimens. Thus in two summers he formed and preserved a collection of 500 species of plants.

After a few years he came up to London as a surgeon's assistant

and, still continuing to make progress in anatomy, he became assistant to Professor Todd at King's College, and qualified for medical practice in 1849. He made during these years many beautiful injected preparations of organs, and also laid the foundation for his later microscopical work on the Foraminifera. Indeed, it was as a student of the latter minute organisms that he first came before the scientific public in 1857, when he began to publish, in conjunction with his friend Professor Rupert Jones, a long series of important papers in the 'Annals and Magazine of Natural History,' in which many significant facts as to their variability and polymorphism in parallel series were first brought forward.

A few years later, ill-health, the result of much unremunerative scientific work combined with a laborious medical practice, began to make serious inroads on Mr. Parker's physical strength, and he had to give up much of his professional work. In the intervals of the severest pain he accomplished some of his most striking researches, which were often taken up as an anodyne. Many valuable monographs, such as those on the skulls of the common fowl (1869), of the frog (1871), of the salmon (1873), of the pig (1874), were the result of his labours, and when in 1874 he was appointed one of the Hunterian Professors of Comparative Anatomy it was felt that the mantle of Professor Huxley had fallen on a worthy successor.

Professor Parker lectured at the College of Surgeons until 1884, giving in his own quaint and discursive way the results of successive years of work. He had already been President of the Royal Microscopical Society in 1871–2, and this honour was followed by the award of a Royal medal by the Royal Society, of which he was already a Fellow. When the Government grant of 4000*l.* came to be distributed by the Royal Society it was generally felt that there could be no more fitting recipient of a considerable grant than Mr. Parker, and this was continued for many years, being at last partially replaced by a Civil List pension. No man ever worked from a purer love of science and of the beauty of the Creator's handiwork, which he delighted to acknowledge. He had grown up when minute naked-eye dissection had not been displaced by microscopic section-cutting, and it was a marvel to see him handle embryonic skulls a third of an inch in length and patiently dissect them under a simple lens till he had revealed features characteristic of some very diverse creature in the scale of development, or of some ancient animal which combined in itself characters now split up among various extreme branches of the vertebrate kingdom.

Altogether he wrote more than twenty memoirs of first-class importance, illustrated by many hundred plates from his own careful drawings, and published by the Royal, Zoological, and Linnean Societies. Unfortunately they are a sealed book to all but skilled anatomists, for notwithstanding brilliant flashes and quaint conceits and illustrations, Mr. Parker's style of exposition by no means did justice to the value of his matter. One portion of his work was, however, summarized and brought out by him in 1877 with the aid of his friend, Mr. G. T. Bettany, under the title 'The Morphology of the Skull,' and another portion formed the subject of a volume, issued in 1885, on 'Mammalian Descent,' being the Hunterian lectures for 1884. But his friends will remember,

even more than his scientific labours, the charms of his ingenuous enthusiasm and the warmth of his scientific ardour. For many years a great sufferer, he had been much shaken by the recent death of his wife, but his health did not appear worse than usual when he suddenly expired at the house of his second son, Professor W. Newton Parker, of the South Wales University College, Cardiff, at the age of 67."

β. Technique.*

(1) Collecting Objects, including Culture Processes.

A Homely Zoophyte-trough.†—Dr. J. Anderson Smith remarks, "The constant trouble I had with the usual glass zoophyte-troughs, either from leakage, too great depth, or too large size, led me to try something else. And first I tried cork rings of various diameters and depths, but the difficulty of cutting evenly, and the occasional perforation in the cork allowing air-bubbles to get into the cell, soon caused me to abandon these. I now use indiarubber rings, which give me perfect satisfaction. I take an ordinary glass slide, find the centre, and then fix on to it by means of Canada balsam, an indiarubber ring, 5/8 in. diameter, 1/8 in. deep, and 1/8 in. thick. Rings of any required size or depth may be used. Filling the inclosed space with the water and weed to be examined until the surface of the water is slightly convex above the plane of the upper surface of the rings, I then place a cover-glass of the requisite size on the top, and the trough is ready for examination. Capillary cohesion holds the cover-slip perfectly tight, so that the trough may be turned upside down without spilling the contents.

The advantages I claim for this little trough are:—First, its cheapness; second, the facility and rapidity with which it can be made. Moreover, by choosing various sized rings, troughs of any depth and size can be made, and such a trough may be readily used at the pond-side for rapid examination of small portions of the material collected. Lastly, it is less cumbrous than the glass trough and more useful in my experience. The rings I have chiefly used are such as one gets from certain mineral water bottles; the dimensions given are those of a ring labelled "Matlock Mineral Water Co."

A New Collecting Net.‡—Mr. Charles S. Fellows has recently devised a collecting net for small organisms, consisting of a silk mull (or bolting cloth) funnel whose largest diameter is about 12 in., kept open by a stiff brass ring. It is 15 in. deep and tapers off to 3/4 in. at the smallest end. In this (the apex of the cone) is fixed a brass ferrule about 3/4 in. in diameter and 2 in. long, made with a shoulder on each end, one to prevent it from slipping off the net and the other to prevent a *silk bottle* from becoming detached.

This silk bottle can be made of any size, but is most convenient for use about 3/4 in. in diameter by 2 in. in height, and made of the

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous. † Journ. of Microscopy and Nat. Sci., iii. (1890) pp. 254–5.

‡ The Microscope, x. (1890) pp. 247–8.

Fig. 91.

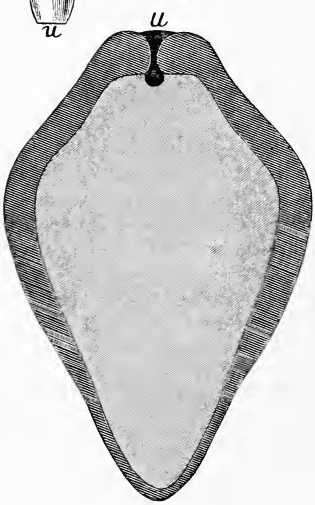
Fig. 92.

same kind of silk as the net. To use the apparatus, first tie the little silk bottle on the ferrule, then drag the net after a boat, or through the water from the shore, by tying it to the end of a fishing rod or walking-stick. As soon as the "catch" is in the little silk bottle it is untied from the ferrule, using the same string to tie up its mouth, and put into the alcohol bottle. Each silk bottle is numbered so that a record of time and locality can be kept. This is much superior to the use of a glass bottle, for in pouring out enough of the contents of the glass bottle in order to insert the cork, one often loses very interesting forms, especially the *Cladocera*, on account of the bubble of air which usually is in the shells and which causes them to float to the top.

A useful net is simply made from fine silk mull, 15 in. in diameter and 30 in. long."

Suction Capsule.*—The suction capsule, the invention of Mr. N. A. Cobb, is made from glass tubing, 2–5 mm. thick. The tubing is heated in a blow-pipe flame in two places and drawn out (fig. 91). One end is then broken off and heated until the aperture becomes minute. The other end is drawn out to the form shown at *t* (fig. 92). If after stopping *u*, fig. 92, with glue suction be made at *r*, while the tube at *t* is melted with a blow-pipe flame, the suction capsule results (fig. 93). The use of this little instrument is to hatch eggs of parasitic entozoa in the alimentary canal. The eggs are placed within the capsule, and when swallowed, the gastric juice dissolves the glue and hatches the eggs. The capsule is easily recovered at the other end of the alimentary canal.

Fig. 93.



Böhm, A., und A. Oppel.—**Taschenbuch der mikroskopischen Technik.** (Manual of microscopical technique.) München und Leipzig, 1890.

* Proc. Soc. Linn. N.S.W., v. (1890) pp. 163-7 (3 figs.).

(2) Preparing Objects.

Demonstrating the Cell-Granula.*—Herr R. Altmann recommends as fixative for tissues to be examined for the cell-granula a mixture of equal volumes of a 5 per cent. solution of bichromate of potash and 2 per cent. solution of osmic acid. After twenty-four hours the pieces, which are of course very small, are washed in running water for several hours; then alcohol (75, 90, 100 per cent.); paraffin imbedding, for which they are placed, after the spirit, in a mixture of three parts xylol and one part alcohol; then xylol, xylol-paraffin, lastly paraffin, with a melting-point of 58°–60°. The sections made with the "Support-Mikrotom" are from one to two μ thick, and are stuck on the slide with a thin layer of caoutchouc (caoutchouc dissolved in 25 vols. chloroform). This solution is poured on the slide, drained, and after evaporation of chloroform heated gently, the paraffin sections are then stuck on and brushed over with a mixture of gun-cotton in aceton and alcohol (2 grm. gun-cotton dissolved in 50 ccm. aceton; of this 5 ccm. are diluted with 20 ccm. alcohol).

Acid fuchsin is recommended for staining and picric acid for differentiating the granula. The former solution is made by dissolving 20 grm. acid fuchsin in 100 ccm. of a cold saturated aqueous solution of anilin; the latter is a mixture of 1 vol. saturated alcoholic solution of picric acid and 2 vols. water. The sections are stained by pouring the fuchsin solution on the slide and carefully heating; this done, it is washed and treated in a similar way with the picric acid solution; after which alcohol, xylol, and dammar.

Another fixation method, by which the staining is rendered more brilliant, though the sections are thicker and the preparations less permanent, is as follows:—A saturated solution of red oxide of mercury is made in 30 per cent. nitric acid. Immediately before use one vol. of the foregoing is mixed with three vols. water and one vol. 50 per cent. formic acid. In this solution the fresh pieces are placed for several hours, after which they are transferred to alcohol, and thereupon the paraffin procedure.

A quite novel method, but which for mechanical reasons is as yet difficult and imperfect, is introduced by the author. It consists in freezing fresh pieces of organs and then drying them in vacuo over sulphuric acid at a temperature of less than 20° C. By this means no alteration in volume occurs in the pieces, which differ from the recent condition merely in the absence of water. The next step is to saturate the pieces, still in vacuo, with paraffin.

Demonstrating the Elastic Fibres in the Skin.†—Sig. V. Mibelli stains the sections in a solution made as follows:—(1) safranin 0·59, warm H_2O (80°) 50; (2) safranin 0·59, alcohol (90°) 50. When cold these two solutions are mixed.

After having been immersed in the solution for thirty-six to forty-

* 'Die Elementarorganismen und ihre Beziehungen zu den Zellen,' Leipzig, 1890, 145 pp., 2 figs., and 21 pls. Cf. Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 199–203.

† Monitore Zool. Ital., i. pp. 17–22. Cf. Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 225–6.

eight hours they are transferred to hydrochloric and spirit (absolute alcohol 100 grm., HCl 10 drops). The acidulated spirit is constantly renewed, until the dye is no longer given off, when the sections are allowed to remain five to ten minutes longer, after which they are removed to absolute alcohol for twenty-four hours. Then bergamot oil and xylol dammar.

By the foregoing method the author claims that elastic fibres are well stained, but only if the solution be made in the manner prescribed.

Demonstrating the finer structural relation of the Liver.*—Herr A. Oppel applies Golgi's method to the liver as follows :—A small piece of rabbit's liver is treated with bichromate of potash quickly increased from two to five per cent. In three weeks' time the piece is placed in 3/4 per cent. nitrate of silver solution. In a few days the ultimate bile-ducts are stained.

The author gives the result of his procedure with monochromate of potash (0·5 per cent.) and silver nitrate on objects kept in spirit for a long time. Three per cent. solution of bichromate and 0·5 per cent. chromic acid were, however, found to show the biliary network quite as well.

Killing and hardening Pelagic Animals.†—Herr B. Friedlaender finds, from the experience of a few months, that the most efficacious fluid for killing sea animals (Siphonophora, &c.) is a mixture of water 1000, zinc sulphate 125, copper sulphate 125. The solution is placed in one vessel, and the animals in sea water in another of similar size. The contents of the former are simply poured into the latter vessel.

For hardening, a 1 per cent. solution of osmic acid in sea water is recommended, while for delicate objects osmic acid may be added or even used alone as a 1/5 per cent. solution.

Preserving lower Organisms in Microscopical Preparations.‡—Pure blood-serum is recommended by Dr. W. Migula as a suitable medium for examining and preserving delicate animal and vegetable objects. He uses the commercial blood-serum, and filters in an ice-box through bibulous paper frequently changed. The filtrate is mixed with 10 per cent. pure glycerin and incubated at 45° to 50° C. When all the water has been evaporated, the glycerized jelly is preserved in stoppered vessels. When required for use, a small quantity is dissolved in 10 to 15 times its volume of distilled water, and a large drop placed on the slide. Into this drop the living organism is pipetted and then the slide is placed in an incubator at about 50°, in order to thicken down the fluid. When of the right consistence, the cover-glass, moistened with a mixture consisting of 40 parts glycerin, 20 parts absolute alcohol, and 40 parts water, is imposed. The preparation is again heated for a couple of hours, and then ringed round.

Preparing Blood of Arthropoda and Mollusca.§—According to Sig. G. Cattaneo the methods usually adopted for examining the blood of

* Anat. Anzeig., v. (1890) pp. 143–5. Cf. Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 222–3.

† Biol. Centralbl., x. (1890) pp. 483–91.

‡ Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 172–4.

§ Bollet. Scient. di Pavia, xi. (1889) pp. 3–29, 33–57 (2 pls.). Cf. Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 213–5.

mussels are imperfect, either because they are too slow, or they allow the blood to mix with water. He advises that the mussel should be well cleaned and dried, and without being opened its heart should be pierced with a needle. Some blood is then collected and examined at once under the Microscope, because after one minute obvious pathological changes take place in the corpuscle.

Control preparations are made of blood preserved with osmic acid or palladium chloride (1 per cent.) and obtained either by the direct action of the reagents, or by injecting the animal in the organ of Bojanus with 1/2 to 1 ccm., using a Pravaz syringe. Other reagents mentioned do not appear to have given satisfactory results.

When examining the blood of Arthropoda, rapidity is still more urgent, since degeneration begins to set in in 10 seconds. From *Palæmon* blood is best obtained by perforating the posterior third of the body, in spiders by an incision in the thorax, from Libellulidæ larvæ by cutting off the head, and from insects by tearing off a wing. One device mentioned is to drop the blood or dab the organ exuding blood in a small drop of the fixative fluid previously placed ready on the cover-glass.

Blood of Arthropoda should be treated in a manner similar to that used for Mollusca, i. e. with one per cent. osmic acid or palladium chloride. If 3 per cent. acetic acid be used at once, it will fix the amœboid forms, but if the addition be delayed until the first or second stage of degeneration, these appearances are lost.

Preparation of Sections of Ammocœtes.*—Dr. W. H. Gaskell mainly relied on serial sections, the whole head having been imbedded in paraffin, or the brain was dissected out and then imbedded. 1 per cent. osmic acid, Perenyi's fluid with alcohol afterwards, with subsequent staining in boro-picro-carminate or picro-carmine and eosin were used; for staining on the slide anilin colours and hæmatoxylin were used. The sections were mounted in order; when they were so large that they were apt to be crumpled, the folding was got over by simply floating the series of sections on the surface of warm water and then transferring them to a slide previously coated over with albumen and glycerin.

Arrangement of Pigment in Eye of Arthropods.†—Mdlle. M. Stefanowska, in studying the arrangement of pigment in the eyes of Arthropods exposed to varying quantities of light, decapitated the animals, and at once divided the head longitudinally. The pieces were placed in a 1 per cent. solution of osmic acid. The time required to fix the histological elements varies, and can only be determined by trial; on the whole, however, the time varies between one and four hours. The eyes were next placed in a 25 per cent. solution of oxalic acid with alcohol; they were then washed in 70 per cent. alcohol and put into absolute.

After inclusion in paraffin, sections were made with Schanze's microtome; these demanded much time and patience, as the sections break easily. The richness in pigment forms one of the great difficulties in preparing sections, which must, therefore, be very fine; those made were generally 1/100 mm. in thickness, and it was only with some of

* Quart. Journ. Micr. Sci., xxxi. (1890) p. 382.
† Rec. Zool. Suisse, v. (1890) pp. 155–9.

the Muscidæ that a thinness of 1/200 mm. was obtained. Staining with hæmatoxylin was found useful in bringing out the contours of some of the cells.

Preparing Intestinal Canal of Ephemeridæ.*—Herr Ad. Fritze recommends that Ephemeridæ be fixed in absolute alcohol, imbedded in paraffin, and the sections stained with hæmatoxylin and borax-carmine. The intestine of *Bætis* larvæ should be prepared in physiological salt solution, gradually hardened in alcohol, and stained with borax-carmine.

Examining Cypridæ.†—For examining in physiological salt solution, Herr C. G. Schwarz fixed the animals in 30 per cent. spirit, heated to 70°, and afterwards hardened them in alcohol, increased from 70 to 100 per cent. They were decalcified in concentrated picric acid in six hours at 54°, and then washed in boiled water and imbedded in paraffin. Hot sublimate, Flemming's mixture, and also a mixture of 2 per cent. osmic acid 1 part, 2 per cent. acetic acid 5 parts, distilled water 4 parts, gave good results. The sections, which were stuck on with glycerin-albumen, were stained with picro-carmine and hæmatoxylin, hæmatoxylin and eosin, borax-carmine, and acetic acid carmine.

Isolation of the chitinous framework and of the muscular fibrillæ of the organs known as the seminal pump was effected by maceration in Moleschott's potash-solution.

Preparing Lumbricus terrestris.‡—After killing the animal by gradually adding spirit or hot water, Herr G. Goehlich examines freshly prepared organs in 0·5 to 1 per cent. salt solution. If the seminal sacs be left for one day in spirit their contents coagulate, and can be removed as firm lumps. In order to make sections, the intestinal canal is cleaned of earth and sand by the animal being starved for two or three days; it is placed in a covered glass vessel containing water and its excrement carefully removed. Fixation in cold sublimate solution or in absolute alcohol. Staining with alcoholic carmine. Paraffin imbedding.

Preparing Cestoda.§—Very good preparations of Cestoda, says Dr. F. Zschokke, can be obtained by staining them for six to twelve hours in extremely dilute Kleinenberg's hæmatoxylin (then washing in water to which a drop of alum solution or acetic acid has been added), as well as by the use of alum or borax-carmine. Then dehydration; oil of cloves and balsam. For sections, after fixation in corrosive sublimate, Mayer's carmine is to be preferred. Paraffin imbedding.

The marine Cestoda can be kept alive for twelve to twenty-fours in a mixture of sea-water and the intestinal mucus of their host.

Investigation of Development of Fresh-water Sponge.||—In his study of the development of the freshwater Sponge, Dr. O. Maas put large cover-glasses to float on the surface of the water of the aquarium

* Ber. d. Naturf. Gesellsch. zu Freiburg, iv. (1889) pp. 59–82 (2 pls.). Cf. Zeitschr. f. Wiss. Mikr., vii. (1890) p. 212.

† Ber. d. Naturf. Gesellsch. zu Freiburg, iii. (1888) pp. 133–58 (2 pls.).

‡ Zool. Beitr. (Schneider), ii. (1888) pp. 133–67 (2 pls.). Cf. Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 209–10.

§ Mém. de l'Inst. Nat. Genevois, xvii. (1888) p. 396 (8 pls.). Cf. Zeitschr. f. Wiss. Mikr., vii. (1890) p. 209.

|| Zeitschr. f. Wiss. Zool., l. (1890) pp. 530–1.

in which the Sponge was developing. Numerous larvæ attached themselves to these, which could be easily taken out of the water and examined. With the aid of silver nitrate they formed excellent permanent preparations, which may be set up between two cover-glasses in Canada balsam. The sponges were hardened by absolute alcohol; for the larvæ the best preparation was found to be chrom-osmic-acetic acid. Borax-carmine and hæmatoxylin were the staining reagents. The anilin colours, Lyons blue and malachite green, were the best for staining sections in which it was desired to differentiate the yolk. Imbedding was effected with paraffin; when the larvæ had attached themselves to *Elodea*-leaves this was quite easy, but when free they must first be fixed to a bit of liver by albumen, on account of their very small size —scarcely larger than a large Infusorian. Very high magnification is necessary to make out the component cells.

Preparing Fungus-spores.*—Herr P. Hennings recommends a modification of Herpell's plan † for fixing and preserving the spores of fungi. The discoloration of white spores which frequently takes place when this method is employed, can be prevented by saturating with alcohol. Coloured spores can be best preserved by making the paper absorb from below a solution of colophone in alcohol.

Study of Saprolegniaceæ.‡—Prof. M. Hartog recommends the following processes for fixing and staining this family of fungi. The reagent used for fixing is a saturated solution of corrosive sublimate; the preparation is then washed with water and placed in absolute alcohol. The best staining reagent is a solution of the Naples boracic carmine, and the excess of colour is removed by an alcoholic solution of crystallized acetic acid. The staining succeeds best after the objects have been slightly acted on by a very slightly acidulated alcoholic solution of nigrosine, and is completed by a second more complete staining with nigrosine. The preparation may be mounted either in a solution of equal parts of sulphophenate of zinc and glycerin; in Canada balsam, after placing in absolute alcohol, to which is added, drop by drop, phenicated xylol in the proportion of 3 parts of xylol to one of phenic acid; or in essence of sandal-wood oil.

Preparation of the Lower Algæ.§—For cultures of the lower Algæ, *Chlamydococcus*, *Eudorina*, *Gonium*, &c., M. P. A. Dangeard uses Van Tieghem's moist chamber, consisting of a ring of glass fixed to the slide, and covered by a cover-glass, on the lower face of which is a drop of water containing the objects to be cultivated. The chambers are kept in a constantly moist atmosphere. The fixation may be effected by concentrated picric acid, 1 per cent. chromic acid, absolute alcohol, or 1 per cent. osmic acid. For studying the vibratile cilia or flagels, chromo-osmic acid is best employed, which admits of an immediate observation, or the object may be fixed on the slide by concentrated osmic acid; it is then covered by a cover-glass and stained by a trace of methyl-green or by hæmatoxylin. To study the internal structure it

* Verhandl. Bot. Vereins Brandenburg, xxx. (1889) pp. 136–7.

† Cf. this Journal, 1882, p. 122.

‡ Bull. Soc. Bot. France, xxxvi. (1889), Actes du Congrès de Bot., pp. ccviii.–ccix.

§ Notarisia, v. (1890) pp. 1001–6 (16 figs.).

is often advisable to fix with absolute alcohol for 24 hours, and stain with picro-carmine or aqueous hæmatoxylin. For spores or cells, the walls of which are not penetrated by these reagents, Tschirch's borated carmine may be used. When coloured to the right extent, the preparations should be studied in glycerin, Canada balsam, or essence of clove, after dehydrating by alcohol of about 80 per cent.

Preparing Sections with Elder-pith.*—Herr J. W. C. Goethart recommends the following method, where very thin sections are not required. A vertical slit is made in a cylindrical piece of pith, the pith being left much longer on one side of the slit than on the other, and the longer side is thoroughly soaked with alcohol. The object of which sections are to be made is then placed in the slit, and a thin platinum wire firmly bound round the whole. The whole is now moistened with alcohol, and placed in the microtome. The sections are then placed and examined in glycerin.

Mounting Algæ and Fungi.†—From practical experience, Mr. J. E. Humphrey strongly recommends, in the preparation of slides of Algæ and Fungi, the discarding of all fluids and cements, and the use of glycerin-jelly as recommended by Dr. L. Klein,‡ which he finds applicable to all classes of Thallophytes, after hardening with osmic acid. Even the colour of the pigments is, in most cases, perfectly preserved by this process.

The Preparation of Vegetable Tissues for Sectioning on the Microtome.§—Mr. A. J. M'Clatchie says, "Vegetable tissues vary so much as to the amount of protoplasm, cellulose, and other substances contained, that the methods used for obtaining good sections from them must vary greatly. I have prepared and sectioned fungi, lichens, the cotyledons, plumules, hypocotyledonary stems, roots, root-tips of the cucumber, young pine-cones, young wheat-blades, lilac-buds, and bean-stems, with varying degrees of success.

Lichens and the young firm cotyledons of the cucumber could be dehydrated, and permeated with paraffin much more rapidly than young meristemic tissue, or tissue composed largely of cellulose and water. The former may be placed in 50 per cent., 75 per cent., 90 per cent., and 100 per cent. alcohol, chloroform, chloroform and paraffin, and finally in paraffin at a temperature of 55° C., remaining in each from two to twelve hours, and good results will be obtained. But the meristemic and the thin-walled watery tissue must be treated differently, or the tissue will come through very much shrunken and distorted, worthless biologically.

I have had the most success following the method described by Dr. J. W. Moll, in the 'Botanical Gazette' for January 1888. I have obtained good sections from all the material that I have treated in this way. I used a 1 per cent. solution of chromic acid and 20 per cent., 35 per cent., 50 per cent., 75 per cent., and 90 per cent. alcohols for

* Bot. Ztg., xlviii. (1890) p. 354 (1 fig.).

† Bot. Gazette (Crawfordsville), xv. (1890) pp. 168–71.

‡ Cf. this Journal, 1889, p. 140.

§ Amer. Mon. Micr. Journ., xi. (1890) pp. 190–1. From Amer. Naturalist, July 1890.

dehydrating. The chromic acid seems to fix the protoplasm, and macerate the cellulose, allowing the alcohols to pass more freely. I allowed the specimens to remain in the several per cents. of alcohol from two to twenty-four hours, according to their size and texture. As a rule, I found that the more gradually the specimens were dehydrated the better. From absolute alcohol, the specimens were placed in a solution of equal parts turpentine and paraffin. The solution containing the specimens was then raised gradually from a temperature of 20° C. to about 45° C. They were then placed in melted paraffin, kept as nearly at 50° C. as possible. Small specimens will be permeated in one or two hours, but large specimens require from four to six hours.

From the 75 per cent. alcohol I placed the specimens in a stain. The stains I tried were alum-cochineal, hæmatoxylin, fuchsin, methyl-green, methyl-blue, methyl-violet, and ammonia-carmine. I found alum-cochineal a good stain for fungi, plumules, stems, roots, and root-tips, but it would not penetrate the cucumber cotyledons. Fuchsin would penetrate anything I tried; but as it is soluble in alcohol, it is necessary to overstain the specimens, and then allow the colouring to come out until it is about right. Hæmatoxylin stained all the tissue that I tried except the young cucumber cotyledons. This stain gives large specimens a dark blue colour on the outside, and a purplish-pink colour on the interior. The nuclei and the cell-walls are brought out clearly. I did not have good success with the methyl colours, as they were easily dissolved out by the alcohol.

If specimens have not taken sufficient colour, or if the alcohol has removed too much of the colour, sections can be stained upon the slide, after they are cut. Any stain can be used, but none that I tried differentiated the parts sufficiently. Fuchsin will give enough colour in a few seconds. The sections must stand in hæmatoxylin from two to ten minutes, and in alum-cochineal from ten to twenty minutes. If it is intended to stain upon the slide, an alum fixative will be found better than collodion.

I heated the slides in the gas-flame to melt the paraffin, and poured on turpentine to wash it out. The specimens were then mounted in balsam dissolved in chloroform. Air-bubbles that appear when sections are first mounted, will disappear after the slides stand a few hours. If the razor or knife used for cutting is very sharp, small specimens may be cut 1/2500 or even 1/5000 in. in thickness. But larger specimens cannot be cut more than 1/600 to 1/1500 in. thick without crowding the tissues together and giving them the appearance of being shrunken."

Preparing, Preserving, and Mounting Objects of Natural History for the Microscope.*—Mr. N. Pike says his own method of procedure in selecting, preparing, and preserving small delicate specimens (excepting eggs) is as follows:—

"I first procure the most perfect live specimens and drop them in strong alcohol, and let them remain about twenty-four hours. This not only instantly destroys life without injuring the objects, but also hardens them a little. They are then taken from the alcohol and placed in small narrow tubes, which I have for this purpose, just large

* The Microscope, x. (1890) pp. 266-8.

enough to receive them, and are then covered with the following solution:—Chloral, in crystals, 1 oz., dissolve in 5 oz. of distilled water; alcohol, 1½ oz.; glycerin, 1½ dr.; rock salt, 15 gr.; saltpetre, 30 gr. Dilute the glycerin, salt, and saltpetre in the alcohol, and when well mixed add to the chloral solution. Shake well till thoroughly incorporated, filter, and it is ready for use. The liquid, if properly and carefully made should be bright and sparkling. Larvæ, spiders, &c., when prepared according to the above formula, are really beautiful objects, and can be examined with a low power of the Microscope. If wanted for dissection, they can be removed from the tube and be returned to it without any difficulty. I have thousands of specimens of soft-bodied animals now preserved in this solution, as fresh as the day I collected them.

If the objects are required for immediate anatomical examination they can be preserved for an indefinite time, and brought to the dissecting table as fresh and flaccid as possible, by omitting the alcoholic bath.

I have always by me a jar filled with the above-mentioned fluid, in which I place specimens I intend for dissection and minute microscopical examination. This jar is always very carefully corked, as the preparation deteriorates when allowed to evaporate.

The preserving of small objects in these tubes of pure white flint glass is far preferable to the building of glass cells, which are often leaky and easily get out of order. When very small objects are required I make a slight difference in the solution, but only long practice can give the precise methods for each article, as different specimens require different manipulation.

Goadby's solution makes fine preparations, but in time the corrosive sublimate in it produces white deposit on the specimen and spoils it. All solutions containing much glycerin are apt to affect calcareous substances when present.

Among many of the freshwater and marine Algæ I have succeeded in preserving specimens, to my perfect satisfaction, in the following solution:—Distilled water, 1 oz.; rock salt, 2 gr.; alum, calcined, 1 gr.; carbolic acid, 1 drop.

Some specimens of Algæ, now twelve years in this solution, are as fresh and bright as when first prepared.

Chloride of zinc solution is very useful, and has proved satisfactory in the preservation of animal tissues; it must be made of varying strengths, according to the softness of the parts to be preserved. It is recommended to use twenty to twenty-five grains of the fused chloride to one ounce of distilled water, and ten drops of phenic acid added to it. This is a capital solution for the larvæ of insects, and if stored in an air-tight tube or cell, will keep perfectly for years without deterioration."

Bachmann, O.—**Leitfaden zur Anfertigung mikroskopischer Dauerpräparate.** (Instructions for making permanent microscopic preparations.)
München und Leipzig, 1890.

Loewenthal, N.—**Zur Frage über die Anwendung von Terpentinöl in der histologischen Technik.** (On the use of turpentine-oil in histological work.)
Centralbl. f. Physiol., XXV. (1889) 2 pp.

(3) Cutting, including Imbedding and Microtomes.

Improvement in Thoma's Sliding Microtome.*—Prof. R. Thoma has recently made an improvement in his microtome (fig. 94) whereby the

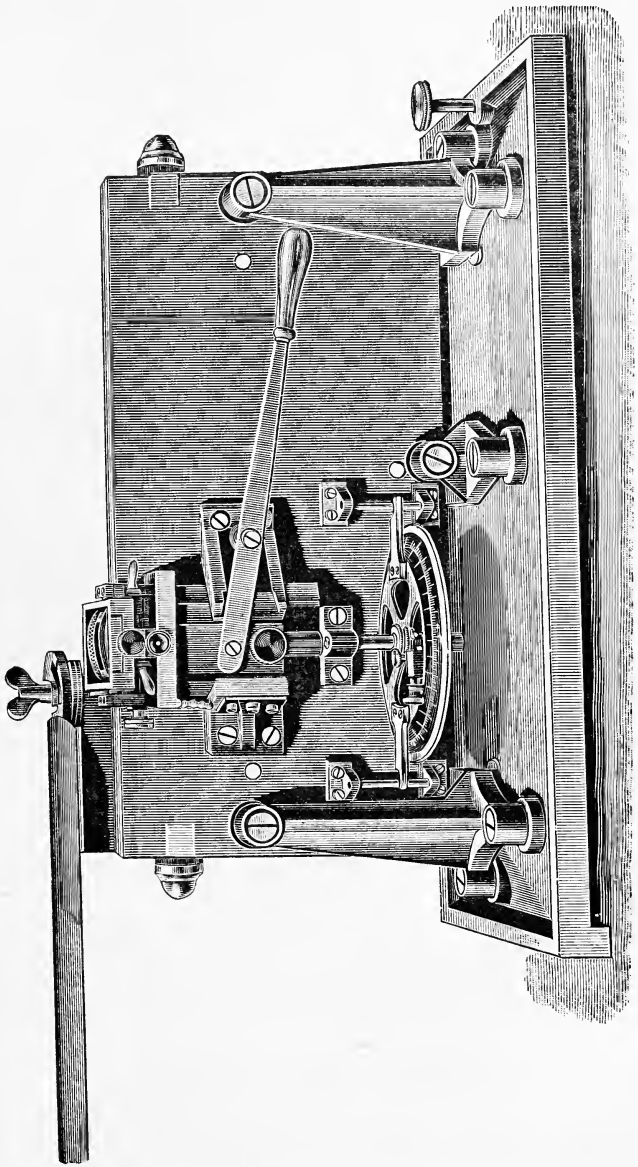


Fig. 94.

* Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 161–4 (1 fig.).

advantages derived from the slides resting on five supports are still secured. Under previous constructions it was impossible to cut an object more than 1 cm. high without moving either the knife or the preparation. The new arrangement allows continuous sections to be made from objects 3 cm. high. The object slide is now vertical, and the holder movable about two horizontal axes. In consequence of all these changes the instrument is considerably larger and heavier.

Apparatus for preparing Sections of Crystals cut in definite directions.*—Dr. E. A. Wülfing gives a description of this apparatus. It consists of three entirely separate parts:—(1) a "grinding tripod," with adjustable screw-feet and a carrier for the crystal; (2) a "levelling tripod," with micrometer screw-feet; (3) a levelled glass plate.

(1) Grinding tripod.—A brass plate *a* (figs. 95 and 96), 2/5 in. thick, and in the form of an equilateral triangle of 4 in. side, is provided at each corner with an adjustable steel screw *b*. These screws have square heads, on which the key E fits, and they permit of the plate being inclined about 15° in any direction. In the centre of the plate is a tube

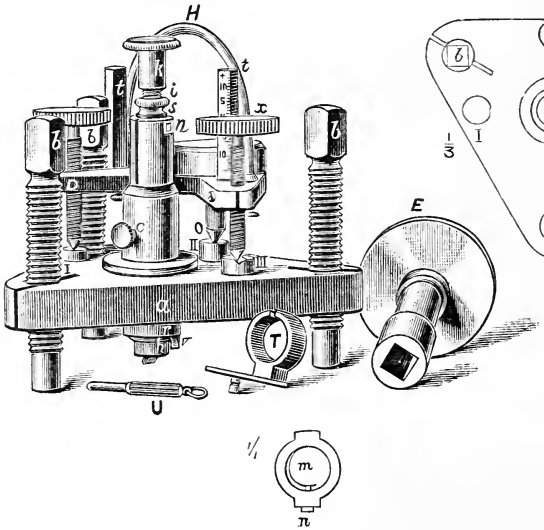


Fig. 95.

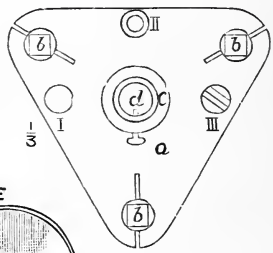


Fig. 96.

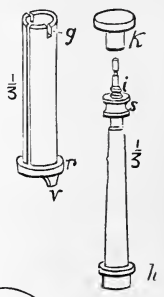


Fig. 97. Fig. 98.

Fig. 99.

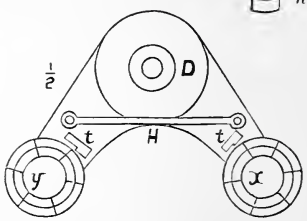


Fig. 100.

c, provided with a lug *d* (fig. 96) internally, which fits into a corresponding groove in a steel cylinder capable of free motion up and down, but not of rotation on its axis. The steel cylinder (fig. 97) is flanged at *r*, and the flange bears a projection *v*, the object of which will appear subsequently. The cylinder bears two lateral slots *g*, and its internal cavity is slightly conical. The brass cone (fig. 98) fits inside it, and is furnished at *h* with a flange and a broad disc-like base, whilst at top it bears a

* Zeitschr. f. Krystallographie, xvii. (1890) pp. 445–59.

screw-thread i with a nut s above, which is filed square to receive the detachable milled head k. The base of this brass cone serves as face for attachment of crystal, and the cone can be rotated within the cylinder and clamped firmly to it when in any position. In order to prevent the cone from rotating whilst it is being clamped by the nut s, a steel ring m (fig. 99) is firmly attached to the cone just below the screw-thread by tightening the small set-screw n. This steel ring has two lateral lugs, which fit into the slots g before mentioned of the steel cylinder, and thus prevent the cone from rotating. The brass plate a (fig. 96) bears three small circular steel discs I, II, III in the figure, which are destined to receive the feet of the levelling tripod, and are so arranged as to occupy the angles of an isosceles triangle right-angled at II.

(2) Levelling tripod.—A circular spirit-level D (fig. 100) is provided with two arms, each of which is bored and threaded at one end to receive a micrometer-screw x and y respectively. Immediately beneath the centre of the spirit-level is a third but non-adjustable leg, seen in fig. 95 above disc II. The legs occupy the angles of an isosceles triangle right-angled at II as before described. On turning the screws x or y the level is inclined about the point o, i. e. the extremity of the middle leg of the levelling tripod. The amount of inclination δ in each "screw-plane," i. e. the plane passing through o (above II) and either of the screw-axes, can be found if the pitch of the screw (h), the distance of the screw from the centre of rotation (λ), and the number of rotations (n) are known, for

$$\tan \delta = \frac{n.h}{\lambda}.$$

For practical reasons the inclination in the screw-plane is not measured in degrees on a divided circle, but by means of the tangent of the angle expressed in the number of rotations of a screw. For small angles, the angle and its tangent are interchangeable, e. g. if

$$n \text{ rotations} = 1^\circ\ 0'\cdot 0,$$

then

$$\begin{aligned} 5\ n &= 4^\circ\ 59'\cdot 3 \\ 10\ n &= 9^\circ\ 54'\cdot 1. \end{aligned}$$

The distance of the screws from the centre of rotation of the tripod and the pitch of the screws are so arranged that one rotation of the screw corresponds approximately to 1° of inclination in the screw plane. Each screw bears a divided head, permitting of 1/12° being read off and a single minute being estimated, whilst complete degrees (rotations) are indicated by the vertical scale t.

(3) Levelled glass plate.—This consists simply of a plate of mirror plate-glass, 6–8 in. square, supported on the top of a wooden bracket firmly fixed to the wall. Three brass screws with milled heads support the plate, and in conjunction with the spirit-level permit of its being accurately levelled.

(4) Method of preparing the apparatus for use.—The use of the discs I, II, III (fig. 95) is to permit the levelling tripod to be brought into a perfectly definite position on the top of the grinding tripod without

permanently connecting the two. During the grinding process the levelling tripod is lifted off by means of the handle H and put on one side to save it from damage or derangement. Before using the apparatus the three legs of the levelling tripod are brought to the same length by turning the screws x and y down to the zero of the scale t. The levelling tripod is placed in position on the top of the grinding tripod, and the two combined on the top of the levelled glass plate. The bubble of the spirit-level is brought to its central position by turning the screws b of the grinding tripod, and then the levelling tripod is laid aside. A small flat face F (not shown) is then ground (with emery and water on a glass plate) on the projection v of the steel cylinder, the brass cone being laid aside. After ascertaining that the three screws b have worn equally during the grinding, which is shown by the bubble being still in the centre when the two tripods combined are again tested on the levelled glass plate, the face F is polished. The screw x of the levelling tripod is next to be brought to one of its extreme positions, e. g. $+ 12°$ on the scale t, the bubble is again brought to its central position by means of the screws b, the levelling tripod is lifted off, and a second face f' is ground on the projection v. Similarly, after turning the screw x to its other extreme position at $- 12°$, a third face f'' is ground. These three faces must lie in a zone, if the apparatus acts properly, and their angles will be very nearly twice 12°.

(5) Theory.—Assuming that we know the position of two faces A and B of a crystal, it is required that a new face C shall be ground which shall make with A and B the angles b and a. The face F ground on the projection v of the steel cylinder serves for orientation.

For the orientation of the crystal with regard to the plate on which it is to be ground, we require to determine the inclination of A and B to the steel face F, for this latter face is parallel to the glass grinding plate when the levelling-tripod screws stand at zero. In order to arrive at the desired face C from the face F the crystal must be so inclined that in its new position the grinding plate comes to lie at the same angle to the faces A and B as that at which C is required to lie, or, in other words, that C takes the place previously occupied by F.

The crystal is cemented in approximately the required position, judged by eye or with the aid of a hand-goniometer, to the base of the brass cone (fig. 98) at h. The brass cone is then rotated within the steel cylinder until one of the known faces, e. g. A, falls in the zone of the steel faces f' F f'' [not figured]. After this adjustment has been made, and A thus brought to a position at right angles to the screw-plane passing through the screw x, the angles a' and b' which B and A make with F are measured on a goniometer. The corrections necessary to be made in the position of the crystal are then calculated. For the details of the method of calculation we must refer our readers to the original paper. Our means of correcting the position of the crystal depend on our being able to incline it in two planes at right angles to one another, which we may assume to be the screw-planes of the levelling tripod. We carry out these corrections by turning the micrometer-screws in the reverse direction to that which would be required if the crystal occupied the position of the spirit-level. We then place the so adjusted levelling tripod again on the top of the grinding tripod—which latter we assume

to be still perfectly level—and bring the bubble of the spirit-level to its central position by turning the screws *b*. We have thus brought the crystal into the required position for grinding the face C, which, laying the levelling tripod aside, we proceed to do.

The adjustment of the face A in the zone of the faces *f'* F *f''* is made on a reflecting goniometer with a horizontal limbus, such as that of Websky-Fuess No. II. or III. A ring T (fig. 95) serves to hold the cylinder on the goniometer. Instead of depending upon calculation, the correction in the position of the crystal can be often sufficiently accurately made by two or three trials, a small surface being ground and polished, and its accuracy being tested on the goniometer without detaching the crystal from the brass cone or the latter from the cylinder.*

Obregia, Al.—**Serienschnitte mit Photoxylin oder Celloïdin.** (Serial sections with photoxylin or celloidin.) *Neurol. Centralbl.*, 1890, No. 10, 3 pp.

Ross, J. F. W.—**Paraffin Method as used by Prof. Gaule, Zurich.** *Canad. Pract.*, XIV. (1889) p. 409.

(4) Staining and Injecting.

Staining with Chloride of Gold.†—Prof. A. S. Underwood writes:—"I have long regarded this agent as one of the most useful for the observation of the dental tissues. I know of no other stain which so clearly marks out the minute anatomy of the soft tissues which penetrate bone and dentine; in fact, its excellence as a selective stain would long ago have obtained for it a much more widespread popularity were it not for the fact that it has been generally regarded as specially liable to failure in manipulation. Almost all the recognized text-books speak of it as a very difficult stain to employ successfully, and as requiring a very lengthy and troublesome method of procedure, and as only applicable to perfectly fresh tissues. I have found, after some eight years of pretty constant use, that the subjoined method is easy to employ, does not take long, and is, moreover, both certain and fairly permanent in its results.

First, about the tissues to be stained. They do not require to be very recently dead; the fresher they are the more quickly they take the stain, but I have stained scores of sections of teeth and bone that had been severed from the living body for a long time, sometimes for weeks. It is better to avoid as far as possible the use of metal instruments, bone, wood, or quill being preferable; the use of steel does not, however, doom the staining to failure. The method I adopt is as follows:—

(*a*) Wash the sections in solution of bicarbonate of soda.

(*b*) Put some 1 per cent. solution of chloride of gold in a watch-glass, test it with litmus-paper, and if it be acid add bicarbonate of soda by drops till it is neutral; place the sections in the solution and cover the watch-glass with some lid to keep it in the dark (the lid of a china pot such as is used for potted meat serves very well) for from half an hour to an hour, until the sections look straw-coloured.

(*c*) Remove sections from staining fluid to distilled water, and leave

* We understand that this instrument is only to be obtained from Herr Zimmermann, Hauptstrasse, Heidelberg.

† Journ. Brit. Dental Assoc., xi. (1890) pp. 696-7.

them covered over (they must never be exposed to light for more than a few seconds) for a few minutes.

(*d*) Put some 1 per cent. formic acid in a watch-glass, float the glass in hot water, put the sections in the acid, cover them over, and keep them in the dark and fairly hot until they turn crimson. This generally takes about an hour, but the operator must be guided by the tint of the sections, which he must look at from time to time. A simple way to do this is to fill an old china anchovy paste-pot with hot water, place it on a stove, float the watch-glass containing the acid and the sections in it, and cover it up with its own lid.

(*e*) When stained, immerse the sections in cold distilled water for about half an hour.

(*f*) Dry sections and mount them in glycerin-jelly. Avoid Canada balsam. I have always found specimens mounted in Canada balsam go wrong. The bottle of gold chloride must always be carefully kept in the dark.

I have found this method very successful and very easy; moreover, I have many sections now in my possession which are quite eight years old and have not faded in the slightest degree."

Vital Reaction of Methylen-blue.*—Herr H. Kühn obtained specially purified methylen-blue for injecting into the dorsal lymph-sac of frogs. The reaction was obtained in about thirty-six hours by injecting every twelve hours one ccm. or three ccm. all at once of the strong solution.

When the animals were opened no effect was visible, but after five to ten minutes, all the organs, especially liver and kidneys, became blue from exposure to the air.

The preparations do not keep long, so they are useless as permanent microscopical preparations.

Influence of Colouring Matters on Spermatozoa.†—Dr. Emma Leclercq gives the following tabular statement as to the effects of various reagents on spermatozoa.

Colouring Matter.	Results.	
	On Nucleus.	On Accessory Corpuscle.
Carmine alone (Frenzel)	Light carmine	Pale rose
„ „ (Flemming)	Rose	Red
Renault's hæmatoxylin	Violet	Deep violet
Ranvier's picrocarmine	Rose	Orange
Ehrlich's violet and eosin	Violet	Rose
„ „ and carmine	Violet	Rose
Picrocarmine and methyl-green	Violet	Carmine yellow
	(The spermatozoa being green)	

Preparing Nerves stained by the Vital Methylen-blue Method.‡—Herr B. Feist injects frogs with three or four ccm. of a strong solution

* Arch f. Anat. u. Entwickelungsgesch., 1890, pp. 113-5. Cf. Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 230–1. † Bull. Acad. Roy. Belg., lx. (1890) p. 138.

‡ Arch. f. Anat. u. Entwickelungsgesch., 1890, pp. 116–84 (2 pls.). Cf. Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 231–4.

of pure methylen-blue. The pigment is dissolved in physiological salt solution. The stain is fixed by means of the iodide and iodine solution or Hoyer's picrocarmine.

Such preparations are examined and mounted in glycerin. If, however, the pieces are imbedded, then platinum chloride must be used as fixative, since the picrocarmine and iodine are easily dissolved out by the various reagents used for imbedded specimens.

A still better method is to fix with picrocarmine for fifteen minutes, followed by one per cent. osmic acid for the same time, and then glycerin for some hours. The specimen can now be imbedded by the gum arabic method. This consists in taking a watchglassful of a solution of pure gum arabic having the consistence of thick syrup. To this are added six to ten drops of glycerin, and the whole stirred up with a glass rod. In this mixture the sections are placed and the whole left to dry until it has assumed a consistence suitable for cutting (about eight days). The imbedded object is then clamped in elder-pith and sectioned.

The chief objection to this method is that when the mass has acquired the proper consistence it must be cut at once, otherwise it becomes too hard.

New Method for Staining Sections of Central Nervous System.*—For staining sections of central nervous system, A. Breglia uses extracts of Campechy or Pernambuco wood. The former contains hæmatoxylin $C_{16}H_{14}O_5$, the latter brasilin $C_{22}H_{20}O_7$.

The extract is made as follows:—7 to 10 grm. of the wood in small pieces are soaked in 90 to 95 per cent. alcohol for five or six days. The mixture is then shaken up and the fluid is ready for immediate use.

Sections of nervous tissue hardened in Müller or Erlizki's fluid are placed for ten to fifteen minutes in 15 ccm. of 90 per cent. alcohol to which has been added three to seven ccm. of a saturated aqueous solution of neutral acetate of copper. The sections are next immersed for five to ten minutes in a saturated watery solution of lithium carbonate. They next come into ten ccm. of the extract for 18 to 24 hours. Decoloration is then effected with aq. dest. 100 grm., ferricyanide of potash 1 grm., borax 1 grm. When the grey and white matters have become differentiated to the naked eye, the sections are washed in distilled water, and then mounted in the usual way. For the Pernambuco wood extract, the method of manufacture and the manipulative procedure are the same, with the exception that the decolorizer acts very much more rapidly.

Staining Central Nervous Tissue with Palladium Chloride.*—Prof. G. Paladino recommends the chloride of palladium for staining sections of the central nervous system. The procedure is as follows:—To a 1 per thousand solution of chloride of palladium a few drops of hydrochloric acid are added in order to insure its complete dissolution. In this solution pieces of spinal cord 5 mm. thick are immersed†. The cord has of course been previously hardened in bichromate salts, chromic acid, or in sublimate. In the palladium solution, of which a large quantity (150 to 200 ccm.) are used for each piece, the objects are

* Giorn. d. Assoz. dei Naturalisti e Medici di Napoli, i. (1889) pp. 169–72. Cf. Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 236–7.

† Journ. de Micrographie, xiv. (1890) pp. 142–8.

left for two days, and are then transferred for twenty-four hours to a 1 per cent. solution of iodide of potassium. The pieces are next dehydrated in spirit from 80° to 96° successively, and when completely freed from water they are treated with chloroform and then imbedded in paraffin. The paraffin is removed from the sections with xylol, and these are then mounted in balsam.

This method, which is extremely simple, is applicable to peripheral as well as central nerves; the results obtained from it are extremely favourable. The hue imparted by the reaction of the iodide on the palladium is brownish, and allows the finer structural details, both of nerves and nerve-cells, to be easily seen.

Method for Staining Sections of Spinal Cord.*—Dr. R. Haug finds that the following method is simple and satisfactory for preparing and staining sections of spinal cord.

Fresh pieces of spinal cord of half to one cm. thick are immersed for two days in a saturated solution of neutral acetate of copper. After this they are placed for one to one and a half days in a five per cent. solution of bichromate of potash. After washing off the superficial deposit of chromic acid salt, the pieces are placed in the dark in 70 per cent. spirit for thirty-six to forty-eight hours, then for a similar period in absolute alcohol. They are now ready for imbedding in paraffin or celloidin. The paraffin having been removed, the sections are placed in the following solution (hæmatoxylin 1, in alcohol 30, plus ammonia-alum 1 in 300 H_2O), for fifteen to thirty minutes, or until they are of a deep black colour. After having been washed in water, the sections are toned down in muriatic acid 0·5 to 1·0, alcohol 70·0, H_2O 30·0. When sufficiently decolorized (fifteen minutes at most), the now red sections are washed for a long time in pure water until all the acid is removed and the colour is blue.

The sections may be contrast-stained by immersing them for a moment in undiluted neutral carmine solution, or in the following, which imparts a very pretty tone:—To 100 ccm. water, 0·25 carbonate of magnesia and 15–20 drops of liq. ammon. fort. are added. The mixture is heated, decanted off, and filtered. To the filtrate 0·59 carmine are added.

Should Weigert's method of differentiating be preferred, this may be effected by decolorizing the sections in the borax-ferricyanide of potash solution, and then proceeding in the usual manner.

The author claims for his method that it is not only not very complicated, but that it allows of a satisfactory examination of the cord in a comparatively short time.

Method for Staining the Gregarinæ of Molluscum contagiosum.†—Dr. R. Haug recommends the following procedure for demonstrating the Gregarinæ of Molluscum contagiosum. Fix for twenty-four hours in absolute alcohol, to which 1 per cent. of glacial acetic acid has been added. The specimen is then washed in running water for twelve hours; it is now hardened again in absolute alcohol (six to twelve hours), and then imbedded in paraffin. The sections are first stained with hæmatoxylin (hæmatox. 1 to 30 alcohol, added to ammonia-alum 1 to 300 H_2O). The sections are first over-stained and then differentiated with

* Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 153–5. † T. c., pp. 152–3 (1 pl.).

hydrochloric or oxalic acid alcohol. They are then placed in water for fifteen minutes. The sections are next momentarily immersed in ammonia-carmine solution, then in water, and lastly placed for ten to fifteen minutes in absolute alcohol, to which 2 per cent. of formic acid has been added. After this they are transferred to picric acid alcohol for fifteen minutes. Thus prepared the sections have a bluish-green hue; the gregarinæ are greenish, the cells blue, and the rest of the tissue rose-coloured.

Carmine Stains for Normal and Pathological Preparations.*— Dr. R. Haug prepares a double carmine stain for staining pieces *in toto* as follows:—2 grm. of carmine are rubbed up with 4 grm. of borax-carmine, and then boiled in a flask with 300 ccm. distilled water until the fluid is evaporated down to 280 ccm. After this, and when the solution has cooled down a little, from 10 to 15 ccm. of a 10 per cent. solution of acetic acid (glacial) are added by means of a pipette. The addition of the acid renders the solution transparent and of a bright red hue. Next day it is filtered and some crystals of thymol added. For staining *en masse* a piece of 0·5 cm. in width, two to four days is required. After this it is differentiated with hydrochloric acid alcohol (changed every half hour). This takes one to four hours. After this it is placed in a mixture of picric acid and alcohol for about twelve hours.

Ammonia-lithia-carmine.—This solution is made by dissolving 3 grm. carmine in 100 ccm. of cold saturated carbonate of lithia solution and then adding 5 ccm. of ammonia. It stains quickly and deeply. Wash in water and then differentiate in hydrochloric acid alcohol. Sections may be after-stained by immersing in picric acid alcohol.

In many cases when the specimen has been hardened in chromic acid, the following modification acts well:—1 to 1½ grm. carmine and 2 grm. bicarbonate of soda are boiled in 150 ccm. of water, and then 10 to 15 ccm. of a 5 per cent. glacial acetic acid added. When cold 5 ccm. lithium solution. The subsequent treatment as before.

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

A new Pressureless Mounting-clip.†—Mr. T. Pace writes: "I notice Mr. Bryan's note in the December number of 'Science-Gossip,'

Fig. 101.

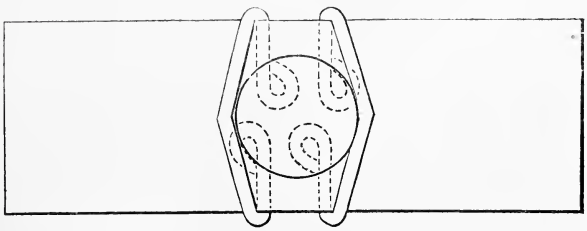


Fig. 102.

suggesting a new form of mounting-clip designed to hold the cover-glass without pressure, thus being a great improvement on the spring-clip

* Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 151-2.
† Science-Gossip, No. 303 (1890) p. 56.

commonly used; and as I have devised one which I think has some advantages over his, I inclose you a sketch of it, thinking it may interest some of your readers. Fig. 101 is an illustration of the clip in use as seen from above, and Fig. 102 is an end view of the same as seen from a section through the cover-glass. The clip should be made of rather stout springy wire, so as to grasp the slide firmly. This clip will be less liable to shift or become detached from the slide, and it has the advantage of being suitable for rectangular as well as circular cover-glasses."

Use of Gold Size.*—Mr. F. Disnett writes:—"Gold size as a foundation ring for coloured cements answers much better than shellac in mounting insects whole or in parts, or other materials where a thick layer of balsam is needed. Much trouble is caused in finishing with alcoholic cements, because the alcohol softens the thin crust of hardened balsam at the edge of the cover, air-bubbles appear, and the same often happens again in finishing with coloured cements. The colours will run in and spoil the mount. All this is avoided with gold size. Another advantage is that in the final cleaning the last trace of balsam on cover or slip can be washed off with alcohol. Gold size answers much better than arabin in protecting the ring for cleaning with alcohol, as the latter has no affinity for it, and arabin is well known to be one of the strongest cements we have. Before putting on the foundation ring, mounts should be carefully examined, to see whether the balsam extends to the edge of the cover. Small cavities often exist where an air-bubble has made its final exit. The cement will inclose the air, the thin film will collapse and leave the balsam unprotected. Gold size is slow in drying, but if one builds a number of cells to-day, they will be exactly a month old a month from now, and in time will get as hard as glass. Make them with one or two, seldom three, successive coats, and always aim to have a lot of old cells on hand. When I wish to mount in one I put on a light coat of fresh gold size, drop in the glycerin, and dissect whatever it may be in the cell. I use 3/4-in. cells mostly, and as I disentangle and separate different structures I push them aside, and keep on till I have material enough to fill the cell. I arrange what I have as well as possible, fill up with glycerin, and cover. Lots of handling and transferring are done away with."

Laboratory Notes.—Mr. A. F. Stanley Kent writes to us:—

(*a*) *Farrant's Medium.*—In making Farrant's medium for a large class it is desirable to modify the usual mode of procedure. The following method I have found satisfactory.

Make a solution with picked gum arabic to about the consistence of ordinary glycerin, mix it with an equal bulk of Price's glycerin and place it in an ordinary plaited filter, a few pieces of glass rod being placed in the funnel to keep the paper from lying too closely against the glass. Now close the mouth of the funnel by means of a glass plate on which vaseline has been smeared, place a flask under the funnel so as to fit the neck as closely as possible, and put the whole away for some weeks. A beautifully clear and bright solution will filter through into the flask.

* The Microscope, x. (1890) pp. 281-2.

I always add, before fitering, about 1/20 of a strong solution of thymol in absolute alcohol to the gum and glycerin (i.e. about one part of alcoholic solution of thymol to 20 parts of gum and glycerin solution). This, of course, precipitates some of the gum, but it soon becomes redissolved, and Farrant prepared in this way has kept sweet for many months.

The use of the glass plate is, first, to exclude dust, and secondly, and chiefly, to prevent evaporation.

(β) *Staining with Picrocarmine.*—In the histology courses at Oxford we use this stain very largely, as it is very convenient, easy to make, and preparations made with it are permanent. We stain the sections on the slide, remove some, *but not all*, of the stain with blotting-paper, and mount in Farrant; the surplus stain becomes mixed with the Farrant, but in a few days the section absorbs nearly the whole of it and as a result exhibits a better differentiation than can be obtained by any other means with which I am acquainted. I first saw the stain used in this manner by Professor Stirling, in the Owens College, Manchester.

(γ) *Connective Tissue.*—It is often difficult, in a class of histology, to demonstrate by means of the ordinary reagents the presence of connective tissue corpuscles in preparations of areolar tissue.

The following method has been found satisfactory:—Snip out a small piece of the subcutaneous connective tissue of a recently killed rabbit, spread it upon the slide by means of two needles *without the addition of any reagent*, then flood it with absolute alcohol for about one minute, remove alcohol, stain with hæmatoxylin, dehydrate, and mount in balsam.

Excellent preparations may also be made with methyl-green, but this reagent is not usually supplied to students in a class, requires special skill in its use, and is not permanent.

(δ) *Aspinall's Enamel.*—As a cement for ringing slides and making cells Aspinall's enamel has proved of great use. I have used it for some time and find that the white keeps well when used for balsam and Farrant mounts; but I have not used it for a sufficient length of time to know whether it possesses any advantages over zinc white cement.

The Differentiator.*—Mr. N. A. Cobb describes an improved form of the differentiator, or instrument for avoiding to the greatest possible extent those annoying and often destructive contractions which occur in delicate organisms while they are being killed and preserved. The instrument is made of glass tubing with an internal diameter of five or more mm.; two forms are shown in figs. 103 and 104. *a* or *a'* is the reservoir, *b* the object-box, and *c* the filter; these are three pieces of glass tubing joined by caoutchouc tubing. The filter is made by taking a piece of glass tube twice the required length, heating it red hot, drawing it out to arm's length, and breaking in two in the middle; the extremity should be drawn out very fine and a minute orifice alone left.

Taking an example of objects fixed by corrosive sublimate which are to be studied in balsam after staining with borax-carmine, the author directs us to proceed as follows. Fill the filter with perfectly clean sublimate

* Proc. Linn. Soc. N.S.W., v. (1890) pp. 157-63 (1 pl.).

solution, and insert a plug of cotton (boiled in water to remove the air) at the U-bend. Join the object-box to the filter, fill up with sublimate solution, and push a plug of cotton into the lower end of the box. Put the objects into the box, plug the upper end, and join the box and filter to the empty reservoir *a*. Now mix equal parts of sublimate solution and 33 per cent. alcohol (solution 2); mix equal parts of solution 2 and sublimate solution (solution 1). Mix equal parts of solution 2 and 33 per cent. alcohol (solution 3). Add solution 1 to the reservoir until it is one-fourth full, solution 2 till it is half full, solution 3 until it is three parts full, and fill up with 33 per cent. alcohol. If the solutions are carefully added the difference in specific gravity will prevent them mixing; if forced rapidly in, a nearly uniform mixture of about equal parts of sublimate and 33 per cent. alcohol will be formed. It is desirable to get an intermediate condition, when we shall have a uniform gradation or differentiation from sublimate solution to 33 per cent. alcohol in passing upwards through the reservoir. The objects should next be passed through borax-carmine, 50 per cent., 70 per cent., 90 per cent., and absolute alcohol; and finally to thin balsam. The differentiator should be used throughout the operation.

Fig. 103.

Fig. 104.

Objects which contract unexpectedly may be rendered insensible by the use of alcohol from 5 per cent. to 30 per cent., or through chloral hydrate, when they will be found insensible and outstretched.

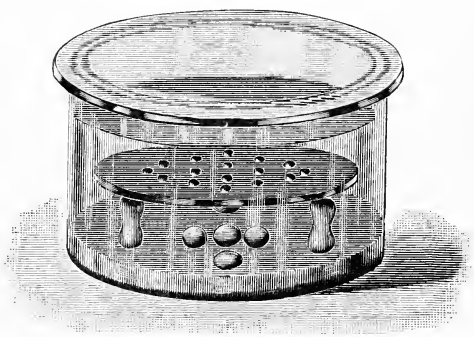
For further hints in manipulation, and a list of the mixtures used, we must refer to the author's detailed account.

How to clean old Slides and utilize spoiled Mounts.—Dr. H. M. Whelpley, in a paper read at the St. Louis Club of Microscopists, said, "For two years past I have permitted soiled slides and spoiled mounts to accumulate in a box set aside for that purpose. The process I have recently followed in reclaiming them has been successful. I first placed the unsightly rubbish in a dish of clean water, where it remained until all of the labels were readily removed. With an old knife I next scraped off the cells and all cement that could be easily removed in this manner. All slides where glycerin or other substance soluble in water had been used as a mounting medium were again washed, and then the entire pile spread out and dried. I separated those that were clean, and placed the rest in alcohol for several days. This solvent cleaned another

portion of the slides, so that all they required to render them as good as new was a washing in water. The remaining dirty ones were treated to a bath of oil of turpentine, where they rested for a few days. From this they were washed with alcohol, and then finished in water. The few refractory ones that held out during all this time were made as clean as ever with benzol. Although considerable time elapsed before the last slide was cleaned, it required but a few minutes of actual labour in the entire process. The time consumed is in letting them stand in the different liquids. Nor is the process expensive, as the oil of turpentine did most of the work. Hereafter I shall divide my old slides into three classes, and clean them separately, so that less alcohol will be required. The first box will contain slides that can be washed clean with water; the second lot will be those that alcohol will clean, and the third the ones requiring benzol. Cover-glasses are so cheap that I do not save them unless they are easily cleaned with water. I find it very difficult to properly clean thin cover-glasses that have cement on them."

Anilin Oil in Microscopical Technique.*—The brown colour of anilin oil, says Dr. Suchannek, the result of oxidation, is no bar to its use as a clarifying medium, or if intended for mixing with absolute alcohol. It is, however, of importance that it should be quite free from water, and it is advised that the oil should be distilled in the usual way and that the first 10–12 ccm. of distillate should be removed. The rest of the distillate should be received in a dry flask in which have been placed pieces of caustic potash. By this means the last traces of water will be effectually removed. The chief use of this medium is as a hydrant and clarifier, but it is also employed as a substitute for oil of cloves in paraffin imbedding.

Fig. 105.



The author describes a glass capsule (fig. 105) which he uses for dehydrating preparations in the anilin oil. In the capsule is placed a glass tray perforated with sixteen holes and supported on three legs. Underneath the tray are placed some pieces of caustic potash, and the anilin oil rises above the plate-level some millimetres. This device allows the preparations to be thoroughly dehydrated.

Piersol, G. A.—**Fixing Paraffin Sections to the Slide.**
Univ. Med. Magazine Philadelphia, II. (1889–90) p. 149.

Stirling.—**Dry Cover-glass Microscopical Preparations.**
Journ. of Anat., XXIV. (1890) p. 160.

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* Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 156–9 (1 fig.).

(6) Miscellaneous.

Some Practical Business Applications of the Microscope.*—The man who has learned the use of the Microscope has certainly gained a great deal; but the man who claims to be a scientist without knowing the practical value of the Microscope, and without having learnt its use, ought not to be classed as such. The Microscope when first invented was considered as an accessory or a plaything. But since 1820, and later (1840), the first European oculists and scientists began to make microscopical researches, not only in the medical profession, but also in botanical, geological, and other studies. Since 1860 and 1870, the world over, the Microscope has been applied to almost every study and analysis. Had Galen, Celsus, and Hippocrates, and other ancients, had the use of the Microscope they would not have advocated the theory that the arteries in the human being contained air during life, instead of oxygenized blood. They were of the erroneous opinion that the blood simply acted as a humour in lubricating the tissues. Had it not been for the Microscope, James Paget, the great English surgeon and physician of St. Bartholomew's Hospital, in the year 1834, would not have discovered the *Trichina spiralis*, which had already slaughtered its thousands, dating as far back as the time of Moses.

The Microscope is certainly the greatest aid a scientific and a professional man can have. A physician without a Microscope is like a man without his hands: he is uncertain and unprotected. He cannot arrive at a correct and positive conclusion in diagnosing and prognosing his cases. It is important to have the Microscope at hand for examining the sputa of human beings, so as to be able to state positively whether or not the man is suffering with consumption (tuberculosis). It is important to be able to determine with certainty, at an early date, whether or not a man is suffering with cancer of the stomach by examining the vomits. A Microscope magnifying from 1 to 5000 diameters is a most simple piece of apparatus. Every person can learn its use in a few hours. Every person should learn to use a Microscope, not only the professional man and scientist, but every business man, even the grocer, butcher, farmer, and the housewife.

Everything that concerns a medical examination in a legal sense, or a legal examination in a medical sense, can be determined accurately by the use of the Microscope. For example, in the Cronin case of Chicago, where the medical experts demonstrated to a certainty that the blood, hair, and brain matter found in the Carlson cottage and sewer trap was that of a human body. Not only that, but they determined accurately and positively that the hair and blood found in the cottage and in the fatal trunk were that of Dr. Cronin, only in a modified condition; all with the aid of the Microscope.

Within the last decades scientists have demonstrated to a certainty the possibility of determining dried and old human blood-spots from that of animal blood, whether on clothing, wood, iron, or otherwise.

Pathologists and histologists have also demonstrated the great value of the Microscope in determining positively the skin, hair, blood, brain-matter, also the excretions and secretions of the human being from that of the lower animals.

* By Dr. F. Gaertner, Pittsburg, Pa., in Amer. Mon. Micr. Journ. See Engl. Mech., li. (1890) p. 483.

Again, the Microscope is applied in a medico-legal view, especially in malpractice, suits of damages, suits involving, rather than determining, the adulteration of foods and drink as to their purity, and finally, in determining whether or not food or drink has spoiled, undergone fermentation and the accumulation and development of micro-organisms, such as germs, microbes, and bacilli. Also, in the examination of oleomargarine and in the adulteration of drugs, liquors, milk, groceries, sausages, &c.

The application of the Microscope in a legal point of view is altogether new. We anticipate surprising effects from the application of the Microscope in the examination of legal documents, U.S. currency, and printed matter.

The following lines are from a very ample paper read by G. E. Fell, M.D., before the American Society of Microscopists, entitled "Examination of Legal Documents with the Microscope."

More than once has investigation with the Microscope cleared up the path of the attorney, ferreted out the work of the contract-falsifier, and shielded the innocent from the unjust accusations of interested rogues.

The range of observation in investigations of written documents with the Microscope is a broad one. We may begin with the characteristics of the paper upon which the writing is made, which may enable us to ascertain many facts of importance; for instance, a great similarity might indicate, with associated facts, that the documents were prepared at about the same time. A marked dissimilarity might also have an important bearing upon the case.

The differences in the paper may exist in the character of the fibres composing it, the finish of the surface, whether rough or smooth, the thickness, modifying the transmissibility of light, and the colour, all of which may be ascertained with the Microscope.

The ink used in the writing may be examined. If additions have been made to the document within a reasonable time of its execution, it is well to examine it microscopically with a great probability of detecting the differences of the original and additional inks. These differences may be present as follows: Some inks in drying, assume a dull or shiny surface. If in sufficient quantity the surface may become cracked, presenting, when magnified, an appearance quite similar, but of a different colour, to that of the dried bottom of a clayey pond after the sun has baked it for a few days. The manner in which the ink is distributed upon the paper, whether it forms an even, somewhat regular border or spreads out to some extent, are factors which may also be noted. The colour of the ink, by transmitted or reflected illumination, is a very important factor. This, in one case, proved of great importance, and demonstrated the addition of certain words, which completely annulled the value of the document, involving several thousand dollars. And in a case where the lines of a document were written over with the idea of entirely covering the first written words, the different colours of the ink were revealed by the magnified image as seen under reasonably low powers of the Microscope.

Special attention is desired to the examination with the Microscope of written documents, United States currency, printed matter, &c., as to their genuineness from a legal standpoint. The principal feature in the examination of written and printed documents is in the erasures and the

additions, in the different colouring of different inks applied, and the mode of their execution.

Erasures can be accomplished either with a knife or by a chemical preparation. The former process is the one commonly resorted to, and is effected in the following manner: With a well-sharpened knife-blade the surface of the paper is carefully scraped until all objectionable lettering and wording is supposed by the naked eye to have disappeared. With a microscopical examination you can at once detect the impression made by the stroke of a pen. Even the different colours of the ink are still to be seen with the Microscope.

The second method being by a chemical preparation, the ink is made soluble and then easily removed from the paper by means of a blotter or absorbent cotton. This method is also an incomplete one, and the letters can easily be made out by close observation where a chemical preparation has been used for erasing. In most cases it leaves a stain, and the fibres of the paper are more or less injured by the chemicals used, always leaving evidence that the document has been tampered with.

Geo. E. Fell, in his paper, says the eye of the individual making the erasure is certainly not sufficient, and even with the aid of a hand magnifier the object might not be effectually accomplished. The detection of an erasure made by the knife is a very simple matter, and may be accomplished by the novice. An investigation may be made by simply holding the document before a strong light, and this is usually all that is necessary to demonstrate the existence of an erasure of any consequence. This is, however, a very different matter from making out the outlines of a word or detecting the general arrangement of the fibres of the paper, so as to be enabled to state whether writing has been executed on certain parts of the document. Again, when we enter into the minutiæ of the subject, we find that the compound Microscope will give us results not to be obtained by the simple hand magnifier.

On several occasions I have had the opportunity of demonstrating with the Microscope additions made to certain documents, two of which were wills. The additions were made in the following manner (which the Microscope revealed): First an erasure must have been produced, then there was a writing over the erasure. With the Microscope you could at once detect the erasures and the additions; also the different colours of the inks used, and, next, the most important characteristic of the microscopical examination being in the close observation of the stroke of the pen of the original lettering and the additional lettering, and, finally, the general mode of their execution.

In the examination of legal documents, U.S. currency, printed and mutilated documents, including forgeries, &c., involving a legal question and investigation, the principal features in the microscopical examination, as already stated, are the erasures, additions, colour of the ink, stroke of the pen in the original lettering and additional lettering, and, finally, the mode of their execution. This includes the general and comparative expression of the original writing—that is, in the observation of the letters constituting the document. Especial attention is needed in the observation of the shading, and in the general formation of the letters by the stroke of the pen, either in a downward or upward movement. This applies not only to the capital letters, but also to the

smaller letters, even to the punctuation, grammatical and orthographical relationship, and in comparative differentiation. All these things must be taken into consideration.

In the examination of papers, documents, such as wills, notes, cheques, &c., as to whether or not they were mutilated and forged, the Microscope will certainly be the most reliable test, much the easiest and simplest.

This is the way of determination, and an expert microscopist and observer can at once arrive at a correct and positive conclusion as to the genuineness of the autograph, &c.

In the examination of U.S. currency the same will hold good as in the examination of written and printed matter, with the exception that additional observation is necessary in order to differentiate a genuine bill from a counterfeit. This lies in the microscopical examination (1) of the quality of paper used; (2) in the execution and finish of the bill; (3) the grade and colour of the ink; (4) the printed condition of the bill, including the autograph; (5) the most important and characteristic means of determining a genuine bill from a counterfeit bill being in the observation of the red line which runs lengthwise across the bill, and it will be necessary to notice that the two red lines in a genuine bill are simply red silk thread interwoven in the paper of the bill, when in a counterfeit the red lines are simply red ink stripes, and no silk lines whatever.

Medico-Legal Microscopy.*—The thirteenth annual meeting of the American Society of Microscopists was opened with a discussion on the "Proposed Standing Committee on Medico-Legal Microscopy," by Prof. Ewell of Chicago. The professor began the discussion by declaring that the Microscope was by no means the simple instrument usually imagined. On the contrary, he stated that it was an exceedingly difficult instrument to handle. Some of the pointed stories about the Microscope are the strongest points in favour of a medico-legal committee, as this would have a tendency to stop the circulation of stories exaggerating the powers of the Microscope. He called attention to an article in a scientific paper, telling how the brain-matter found in a Chicago sewer was identified as coming from Dr. Cronin's head. No one had previously heard of Dr. Cronin's brain being exposed until the autopsy. This Dr. Ewell deprecated in the highest degree. To assume for the Microscope a position of infallibility, from a medical standpoint, is an absurdity, and goes a long way towards injuring the general standard of the profession.

Dr. Frank L. James, Prof. Seaman, Mr. H. L. Tolman, Dr. Stillson, and Prof. Claypole were in favour of such a committee to correct these wrongs. Newspapers have often spoken about the identification of blood by aid of the Microscope, but the best microscopists know that they cannot positively tell human blood. They can tell the difference between the blood of amphibians, mammalia, and fowls. They were of opinion that the committee would do a very great work if it could curb the enthusiasm of those who over-estimate the field of the Microscope. Courts should be given a standard by which the power of the Microscope can be judged.

* Amer. Mon. Micr. Journ., xi. (1890) p. 199.

When the discussion was finished, the President appointed Professors Ewell, Seaman, and Claypole, Mr. Tolman, and Dr. Stillson as a committee to map out the work of a standing committee on this branch of microscopy.

Millon's Reagent.*—Signor A. Poli calls attention to the unsatisfactory quality of this reagent as obtained from some of the leading manufacturers, its property of imparting a rose-colour to proteids being often only very feebly displayed. He believes this to arise from the fact that it is not a stable compound, and it should therefore always be prepared fresh by the operator himself. Millon's prescription for preparing the reagent is as follows:—Mercury is dissolved in an equal weight of nitric acid diluted by 4·5 equivalents of water. The solution is commenced in the cold, and finished by heating slightly until all the mercury is dissolved. Crystals are then formed, and the liquid is decanted and diluted with two volumes of water. The solution thus obtained contains mercurous nitrate $Hg_2(NO_3)_2$, mercuric nitrate $Hg(NO_3)_2$, and free nitric acid, and is thus a mercurous-mercuric nitrate. In consequence of the difficulty of obtaining nitric acid perfectly free from water, Signor Poli prefers Poulsen's method, as follows:—10 grm. of mercury are dissolved in 25 grm. of nitric acid of sp. gr. 1·185, heating not above 50° C.; this solution is then mixed with another obtained by dissolving 10 grm. of mercury in 22 grm. of nitric acid of sp. gr. 1·25–1·30; the reagent should be prepared and employed as much as possible in the cold.

Tests for Mineral Acids and Mineral Bases in Plants.†—Herr A. F. W. Schimper recommends the following microchemical tests for detecting the presence of mineral acids and mineral bases in the ash of plants:—

Lime.—The production of crystals of calcium sulphate by addition of sulphuric acid; also, in certain cases, the formation of crystals of calcium oxalate by addition of ammonium oxalate, or of calcium carbonate by ammonium carbonate.

Chlorine.—Precipitation by silver nitrate or thallium sulphate. Where present in large quantities, potassium or sodium chloride may be crystallized out of an aqueous solution of the ash.

Potassium.—The production of potassium-platinum chloride, insoluble in water and alcohol.

Magnesium.—The formation of ammonium-magnesium phosphate by addition of sodium phosphate or sodium-ammonium phosphate with the addition of ammonia. The formation of magnesium-sodium uranate, by the use of uranacetyl.

Sodium.—The same as the last.

Oxalic Acid.—Formation of calcium oxalate.

Phosphoric Acid.—The production of ammonium-phospho-molybdate by the addition of ammonium molybdate and nitric acid. Formation of magnesium-ammonium phosphate.

Nitric Acid.—Formation of an anilin-blue with diphenylamin. An extraordinarily delicate reaction. Production of calcium nitrate.

* Nuov. Giorn. Bot. Ital., xxii. (1890) pp. 446–50.
† Flora, lxxiii. (1890) pp. 210–20.

Sulphuric Acid.—One of the most difficult determinations, as the occurrence of a precipitate with barium chloride by no means proves the presence of sulphuric acid. Crystals of potassium sulphate may be obtained from a solution of the ash.

Tartaric Acid.—May be precipitated by potassium acetate or calcium chloride.

Behaviour of Fossil Teeth to Polarized Light.*—Dr. J. Schaffers obtained from experiments made on fossil teeth with polarized light results perfectly analogous to those previously obtained from fossil bone, and considers that the explanation of this optical effect is due to the fibrillar structure of both substances. The author's results do not accord with those of Valentin, who found that fossil and recent teeth behaved in the same manner to polarized light, while the author considers that the reverse is the case.

Böhm and Oppel's Manual of Microscopical Technique.†—This little work is intended for beginners; it is divided into two parts, the first of which deals with the Microscope and its manipulation, the second part is subdivided into general and special sections. In the former are considered methods of preparation, fixation, hardening, imbedding, sectioning, and staining. The special section deals systematically with the various organs and tissues.

* SB. K. Akad. Wiss. Wien, xcix. (1890) pp. 146–52.

† 'Taschenbuch der Mikroskopischen Technik.' München, 1890, 8vo, 155 pp. Cf. Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 175–6.

PROCEEDINGS OF THE SOCIETY.

MEETING OF 15TH OCTOBER, 1890, AT 20, HANOVER SQUARE, W., THE PRESIDENT (DR. C. T. HUDSON, LL.D., F.R.S.) IN THE CHAIR.

The Minutes of the meeting of 18th 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
Jelly, E. C., A Synonymic Catalogue of the Recent Marine Bryozoa, including Fossil Synonyms. xv. and 322 pp. (8vo, London, 1889)	*Miss E. C. Jelly.*
Marktanner-Turneretscher, G., Die Mikrophotographie als Hilfsmittel naturwissenschaftlicher Forschung. vii. and 344 pp., 195 figs. and 2 pls. (8vo, Halle a. S., 1890).. ..	*The Author.*
200 slides of Marine Bryozoa	*Miss E. C. Jelly.*
12 Photomicrographs of Diatoms, &c.	*Dr. Giorgio Roster of Florence.*

Attention was called to a donation of special importance, consisting of 200 slides of Marine Bryozoa, from Miss E. C. Jelly, who had recently published a catalogue of Bryozoa.

A work on photomicrography, in German, by Herr G. Marktanner-Turneretscher, by whom it was presented to the Society, was referred to by Mr. J. Mayall, jun., who said the author had dealt somewhat fully with descriptions of the various forms of heliostats, commencing with that designed by Meyerstein. This heliostat was, he thought, one of the simplest and least expensive in commerce, and he exhibited one and explained its construction. The modification required in the construction in order to meet Mr. Comber's suggestion, contained in his paper on a new heliostat published in the August number of the Journal, was to substitute for the existing mirror—which was simply of glass silvered at the back, and consequently gave two reflections—a more perfect reflecting surface. Mr. Comber recommended a plane mirror of speculum metal; but as such mirrors were difficult to obtain and costly, and, moreover, required great care in handling, Mr. Mayall thought that possibly a right-angled prism of white glass might be applied with advantage. Such a prism might be freely handled, and the internal reflection from the hypothenusal face would be extremely bright and free from colour. Another such prism might replace Mr. Comber's fixed speculum mirror for deflecting the light from the heliostat mirror into the axis of the Microscope supposed to be horizontal. Probably the most efficient way of dealing with the matter practically would be to bring it to the notice of the mechanician who supplied Meyerstein's heliostat, which he (Mr. Mayall) would endeavour to do.

Mr. Mayall also directed attention to the donation of 12 photomicrographs by Dr. Giorgio Roster, of Florence, some of which appeared to him excellent specimens of work produced with Zeiss's apochromatic

objectives, using sunlight with an achromatic condenser in the axis. The inspection of these photographs reminded him that in discussing the production of such work recently with Mr. Comber, they were agreed upon the advantage of using sunlight, as compared with the oxy-hydrogen lamp, from the fact that when the image of the sun was focused on the object by a properly constructed achromatic condenser, the illumination was perfectly even over the whole field from centre to margin; but with the oxy-hydrogen light, focusing the illumination really resulted in the projection upon the object of an image of the incandescent spark and its immediate surroundings in the lime-cylinder, which image always consisted of a brightly luminous point encircled by a more or less mottled or cloudy appearance, representing the adjacent parts of the lime-cylinder that were not so highly luminous, on which the gas-jet was not so active. Doubtless, in the hands of a skilled manipulator the difficulties in the use of the oxy-hydrogen light were corrected as far as practicable; still, there always remained an element of uncertainty in its use, demanding incessant watchfulness; the light would vary in momentary intensity, or would flicker and become decentered, and the resulting photograph would embody not only an image of the object, but very frequently this would be mixed up with irregular mottled appearances which were in reality projections of the ever-varying condition of the source of light—the more or less incandescent parts of the lime-cylinder. The evenness of the solar illumination was well shown by Dr. Roster's photomicrographs, though he thought in some of them—notably in that of *Surirella gemma*, the condenser was not quite accurately centered. The greyness in some of them was probably due to errors in the photographic manipulations.

Mr. G. F. Dowdeswell's note on "A Simple Form of Warm Stage" was read, and the apparatus exhibited. It consisted of a thin, flat, quadrangular plate of copper, having a projection of about 6 in. at one of the front corners; an aperture was made in the centre to correspond with the aperture of the Microscope stage, and a copper tube was soldered across the surface near the back edge, in which a clinical thermometer could be inserted. In use the copper plate was to be clamped on the Microscope stage, and a spirit-lamp adjusted to heat the metal projection, and, by conduction, the preparation on the stage.

Prof. C. Stewart inquired if the copper plate was intended to rest upon the metallic stage of the Microscope? If so, he thought there was likely to be a considerable loss of heat by conduction.

Mr. G. C. Karop said that a piece of flannel or cloth was usually placed between the two. He thought the great fault of all such things was that no means existed for controlling or maintaining the temperature at any given point, so that when the observer was looking closely at some object of great interest he was very apt not to notice the rise of temperature, and the result was that it got so hot that the thermometer would break, to say nothing of what became of the object. What was wanted was a self-regulating warm stage, which would maintain a given temperature, supplied at a price within the reach of the bulk of medical students.

The President said he had, with great regret, to record the deaths of two Honorary Fellows of the Society—Mr. Kitchen Parker and Mr Ralfs. The former gentleman was so well known to them by the work which he accomplished, and for the enthusiasm with which he entered upon his researches, as well as from having been at one time President of their Society, that it was unnecessary for him to refer to him at any length on that occasion. They would all feel that, in losing him, they had lost a very valuable friend and fellow worker. Mr. Ralfs was elected an Honorary Fellow of the Society only a short time ago, and, in fact, died before he had received an intimation of his election. In place of these two gentlemen, the Council had nominated as Honorary Fellows—Dr. Henry Brady and Prof. Williamson, FF.R.S.

Referring to the explanation he had given at the June meeting regarding the new objective of 1·6 N.A., presented to the Society by the firm of Carl Zeiss, of Jena, **Mr. Mayall** said he must ask the indulgence of the meeting to enable him to clear himself from possible ambiguity. In notifying the fact that at the first photographic trials of the objective, the visual and actinic foci were found by Mr. Nelson and himself to be not coincident, and that when the objective was returned to Jena immediately after, Dr. Czapski, of the firm of Zeiss, found the foci were coincident, the explanation of the extraordinary divergence on the point seemed to him of the nature of a puzzle, which, for the moment, appeared inexplicable. He had, therefore, hazarded what he had imagined would appear a mere playful admission of the state of general puzzlement of both sides by suggesting that *the transit of the objective from London to Jena had somehow got rid of the "chemical" focus.* That sentence had unhappily been construed, both in England and abroad, into a reflection upon the good faith of Dr. Czapski, or upon Dr. Abbe, or upon the firm of Zeiss. Whatever blame was due to himself for the ambiguity of the expression, he must of course accept. At the same time he thought the Society would be interested to learn that upon his conveying his explanation to Dr. Czapski and Dr. Abbe, those gentlemen had expressed their complete satisfaction with it. The interchange of correspondence on the subject had led him to consider closely the whole circumstances, and he believed the existence of the "chemical" focus was probably due to a slight difference in the adjustment of the front lens, the mounting of which was partially unscrewed from the body of the objective when it first reached his hands, and which he might not have set exactly in the normal position in which it left Jena. On his suggesting this explanation of the difficulty to Dr. Abbe, its possibility was at once admitted, especially, as Dr. Abbe pointed out, in view of the fact that with an objective of such large aperture the colour-correction was, as it were, "balanced on a needle-point" in the matter of an alteration in the distance of the front lens from the posterior combinations; and that a very minute alteration in that distance, though producing no perceptible difference in the visual image, was quite competent to lengthen or shorten the focus of the violet rays to such an extent as to exhibit a "chemical" focus non-coincident with the visual focus when tested photographically. It appeared that when the objective was returned to Jena, it was not examined optically in the precise con-

dition in which it was received, but was first put on the lathe and all the lens cells unscrewed and separately examined, which was the usual course adopted when an objective was returned for inspection. In setting the objective up again the foreman intrusted with the task would, no doubt, screw the lens cells together again exactly as they were originally when the objective was first despatched from Jena, and it was in that condition when Dr. Czapski tested it and reported that the visual and actinic foci were coincident, which was subsequently confirmed by the second photographic trials made with it in London. Mr. Mayall read portions of the correspondence he had had with Dr. Abbe and Dr. Czapski relating to the subject; but he thought the matter would hardly require extended publication. The point of interest to the Society was to be informed of the progress of the report of the committee on the new objective. The committee had not been able to meet during the vacation, and he regretted to have to state that the new slide forwarded by Dr. Van Heurck, in June, had become partially opaque like the one originally received with the objective. Dr. Van Heurck had recently found that the flint cover-glass became injured by the prolonged exposure to the great heat required in mounting the objects in the dense yellow medium, and he had promised to forward another slide prepared with a different kind of flint cover-glass, with which he anticipated less difficulty in securing permanency in the mounting. Until the arrival of the new slide, the committee could not usefully proceed with the examination of the new objective.

The President gave formal notice that a special general meeting would be held in the Library at 5 p.m. on Wednesday, the 22nd inst., for the purpose of considering alterations in the bye-laws, the terms of which he read.

Mr. G. C. Karop exhibited and described an improved student's Microscope, made, at his suggestion, by Swift and Son. The new instrument embodied Nelson's "horse-shoe" stage for convenience of readily seeing the condenser, and for estimating by the touch the approximation of the focus on the slide; on this stage the Mayall mechanical stage was easily applied. A centering substage was also adapted, which focused by sliding on the tail-piece. The whole instrument was of superior workmanship and design, and supplied at a moderate price.

Mr. E. M. Nelson entirely approved of the aim of the design of the instrument. The general strengthening of the bearings throughout the mechanism was an important element in a Microscope for the use of students. He thought the plan of focusing the condenser by sliding it on the tail-piece was not good; but should be replaced by a rack and pinion, which would add little to the cost.

Mr. T. F. Smith said that all his own work in photomicrography had been done with a similar instrument; but he thought that for high powers some rather more delicate kind of focal adjustment for the condenser would be essential.

Prof. J. W. Groves read a note by Mr. Percival C. Waite "On a New Method of Demonstrating Intercellular Protoplasmic Continuity."

A specimen in illustration was exhibited. He remarked that though most microscopists were anxious to get rid of air from their specimens, Mr. Suffolk, who had looked at this one before leaving the meeting, said that he had found its presence in some cases desirable, and for this purpose, having prepared his section, he placed the slide upon his hand and, after allowing the air to enter, he mounted it in Canada balsam. Specimens like the one exhibited could by this process be multiplied *ad infinitum*.

Mr. J. D. Aldous exhibited some early forms of Microscope slides made of boxwood, similar to those which were formerly made of ivory with the objects between pieces of talc. In those shown, cylindrical cavities were cleanly bored in the boxwood slip, and the objects stuck upon paper at the bottom of the wells so made. Some of the objects were excellent specimens, a beetle being particularly well set up.

The President called attention to some original drawings of a new Rotifer by Mr. W. B. Poole, of South Australia, who was present at the meeting. He also mentioned that a specimen of *Œcistes mucicola* was exhibited by Mr. G. Western. This rotifer had also been found by Mr. Parsons. With regard to *Trochosphæra* he might say that it was really an *Œcistes*, and that it had been found in Australia together with the male. These things had such a way of appearing in different parts of the world that, as had been the case with some others, now that it had been found in Australia, it would doubtless be found in London before long.

Mr. E. M. Nelson exhibited upon the screen a series of 31 photo-micrographs, which he described.

The President felt sure he should be right in expressing to Mr. Nelson the great pleasure which it had given them to see these beautiful illustrations, accompanied as they had been by his vigorous explanations.

Mr. H. B. Brady's paper "On a New Type of Foraminifera" was taken as read, as it was published in the current number of the Society's Journal.

Dr. Maddox's paper, "Some observations on various forms of human Spermatozoa," was postponed until the next meeting, in consequence of the lateness of the hour.

The President took the opportunity of congratulating the Fellows upon the improvement which had taken place in the appearance of the room since they last met, and expressed a hope that it might be taken as an earnest of many pleasant meetings to come.

The following Instruments, Objects, &c., were exhibited:—

Mr. T. D. Aldous:—Series of early Micro-slides.
Mr. G. F. Dowdeswell:—Warm Stage for the Microscope.
Prof. J. W. Groves:—Radial Section of Stem of Horse-chestnut.
Mr. G. C. Karop:—Swift Microscope.

Mr. E. M. Nelson:—Photomicrographs of Diatoms.

Mr. J. Mayall, jun.:—Meyerstein's Heliostat.

Mr. W. B. Poole:—Drawings of a new Rotiferon from South Australia.

Mr. P. C. Waite:—Longitudinal Section of stem of Horse-chestnut.

Mr. G. Western:—*Œcistes mucicola* Kellicott, from Richmond and Staines.

New Fellows:—The following was elected an *Ordinary* Fellow:—William Ombler Meek, M.B.

Meeting of 19th November, 1890, at 20, Hanover Square, W., James Glaisher, Esq., F.R.S., Vice-President, in the Chair.

The Chairman having declared the meeting to be made special for consideration of matters adjourned from the special meeting held in the Library on Wednesday, October 22nd, at 5 p.m.,—

The Minutes of that special meeting were read and confirmed, and were signed by the Chairman.

Prof. Bell said that the meeting would understand from the minutes just read that the object of the special meeting was the making of a new rule, to be called Rule 54, which, if adopted, would make certain alterations in the powers of the Fellows of the Society. He could only say that the matter referred to was still under the consideration of the Council, who were at present unable to make any recommendation concerning it. Under these circumstances it would, perhaps, be advisable to defer it to a future meeting.

It was then moved by Mr. J. M. Allen, seconded by the Rev. Canon Carr, and resolved, "That this special meeting be adjourned until Wednesday, December 17th, at 8 p.m."

The Chairman having declared the special meeting adjourned and the ordinary meeting constituted,—

Prof. Bell announced that the President was confined to his bed by bronchitis.

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
Dick, A. B., Notes on a New Form of Polarizing Microscope. 56 pp. and 1 pl. (8vo, London, 1890)	*Mr. F. Crisp.*
Giltay, E., Sept Objets regardés au Microscope. xi. and 67 pp. and 6 pls. (8vo, Leyde, 1890)	*The Author.*
Neuhauss, R., Lehrbuch der Mikrophotographie. xi. and 272 pp., 3 pls. and 65 figs. (8vo, Braunschweig, 1890) ..	*Mr. H. Bruhn.*
Shells from West Indies	*Mr. T. Christy.*
3 Photomicrographs and 4 Negatives	*Surg. V. Gunson Thorpe, R.N.*
Slide of Marine Annelid	
Photomicrographs of *Bacterium Termo*	*Mr. A. Pringle.*

Mr. J. Mayall, jun., created some amusement by reading from 'Nature' an advertisement of a newly-invented Microscope, and exhibiting the article to which it referred, with comments upon his experience as a purchaser.

Mr. Andrew Pringle having sent to the meeting two photographic prints showing the flagellum of *Bacterium Termo*, they were handed to Dr. Dallinger with a request for his opinion.

Dr. Dallinger said that there was no doubt that the flagellum was quite clearly seen in these photographs, but it was, as indeed was always the case in photographs, prolonged wonderfully, and presented an extremely rotten or imperfectly defined edge. Prof. Abbe had taught them that in looking at an object so minute as this, they were really looking upon a diffraction image of it rather than upon the thing itself, and that this image was always seen as something larger than the real object. How this affected the photograph he was unable to tell, from want of a thorough knowledge of the process, but he knew that when looking at such an object with any power from 1/8 in. up to 1/50 in. with a numerical aperture of 1·47, a clear and sharp definition was obtained of the flagellum, which appeared to be about one and a-half times the length of the body. Here in the photograph it extended a long way beyond this, giving him the impression that there might be two interlocked. At any rate, there was great skill shown in the production of these pictures.

Prof. Bell said no doubt the Fellows of the Society had carefully read an article in the last number of the Journal on the Retinal Image of the Insect Eye, in which mathematical formulæ were given and woodcut illustrations to show the nature of the image produced by the compound eye of an Insect. Prof. Exner, the author of the memoir noted, had sent to Dr. Sharp a photograph of the image so produced, and Dr. Sharp, in the most friendly manner, had placed it at Prof. Bell's use for exhibition that evening. It would be remembered that, as a result of his investigations, Exner arrived at the conclusion that a single erect image was thrown upon the retina of the compound eye of an insect. From time to time various theories have been advanced, but that of Johannes Müller, that patches of images on a kind of mosaic plan were produced, seemed to still "hold the field." The photograph exhibited shows—and its evidence is corroborated by mathematical calculation—that it is perfectly certain that the retina of an insect does receive a single image just as we ourselves receive a single image on the retina of each of our eyes. In our own case we have to learn rightly to estimate the position of objects, for the image which we receive is inverted, but in insects it seems that the image which is received is single and is also erect. In that it is single it is the same as our own, but in that it is erect it differs. In the taking of the photograph the eye of the insect was pointed towards a window—the letter R was put on one of the window-panes, and there was a church outside. In the photographed image the letter R is plainly seen, and the church is visible. The photograph was handed round for inspection.

Mr. A. T. Watson's paper, "On the Tube-building habits of *Terebella littoralis*," was read by Prof. Bell, and drawings and museum specimens in illustration were exhibited to the meeting.

Dr. Dallinger said that he had watched for hours together with Mr. Watson in observing the development of these tubes in much earlier stages than had been mentioned in the paper; this was about four years ago, and since then the author had done very valuable service, some of the results being embodied in this paper. It was also of much interest, as showing how a man not specially devoted to biological work might adapt himself to it, so as to attain very useful results.

Prof. Bell thought this was just the kind of paper their President would have been glad to hear, as it seemed to fulfil the idea that he had in his mind when he gave his last annual address.

The Chairman said they were extremely indebted to Mr. Watson for his very interesting paper, and also to their Secretary for having induced him to write it.

The thanks of the Society were voted to Mr. Watson for his paper.

Surgeon V. Gunson Thorpe's paper, "On a New Marine Annelid," was read by the Secretary, who regretted that Surgeon Thorpe, R.N., was unable to be present, having been suddenly called away for service on the West Coast of Africa—though happily not in the 'Serpent.' The specimen exhibited was brought home from Australia, having been obtained, in 1887, off Gloucester Island, on the coast of Queensland. It had the appearance of a very curious tube-building Rotifer; but there seemed some doubt as to whether it might not be an Annelid.

Dr. Maddox's paper, postponed from the last meeting, entitled, "Some Observations on Various Forms of Human Spermatozoa," was read by Prof. Bell, drawings and photographs in illustration being passed round for inspection.

Mr. Dowdeswell's note on the same subject was also read, and a photograph by Mr. Andrew Pringle was exhibited.

Mr. E. M. Nelson said he had worked a good deal at this question some time ago, and then found many curious points in the structure of these bodies, which he found to be constant, but which were passed over in these drawings. There was one thing which he thought most important, as to the shape of the head; it was really shaped as if set in a kind of cup, and it had a small spike upon the top. This feature was not represented, but then, as Mr. Pringle's specimen was stained, it was therefore utterly destroyed for all purposes of minute examination, though the staining made the filament more distinctly visible. There was also a distinct joint at the foot, which was not shown, and there were also what he called vacuoles—though perhaps they were not vacuoles at all—and he had not only seen the nucleus in the vacuoles, but he had seen the divided nucleus as well. When he first saw the filament on the head he recognized at once the analogy to that which he had seen in the spermatozoa of the newt, where it was shown to have a distinct bulb, which was no doubt the means by which it attached itself to the ovum. In order to discover if this also existed in the human spermatozoon, he had worked at it for a whole week until he succeeded

in finding the barb on the end. This barb he thought clearly showed the analogy which ran all through the whole of those things. He might also mention that Dr. Gibbes had demonstrated a curious thing on the tail of a spermatozoon, a kind of spiral thread encircling it. Mr. C. Beck and Dr. Gibbes had made this out, and shown nine turns in this curious wiry thing. This had on a former occasion been exhibited at the Society in one of Dr. Gibbes' preparations.

The Chairman said he felt sure they would give all due credit to Dr. Maddox for the way in which he had worked at this somewhat difficult subject, although he might not have noted some of the things mentioned by Mr. Nelson. Personally, he found that with advancing age his own eye had lost something of its delicacy of perception. Their thanks were due to the author for the paper which they had heard read, and also to Mr. Dowdeswell for his note on the subject, and to Mr. Nelson for his further explanations and remarks.

Mr. E. M. Nelson then exhibited and described—

(1) An elementary centering apparatus for use on the substage of cheap students' Microscopes.

(2) Photographs illustrating the secondary structure of *Navicula*, taken with a 1/8 in. objective N.A. 1·4, × 1430; also another of the same × 800, taken with direct light; also of proboscis of blowfly, with Zeiss's new apochromatic 1½ in., and the same taken by an ordinary cheap object-glass, which really produced the better picture of the two, in consequence of the very small angle in Zeiss's lens; also the same by a new apochromatic lens, by Reichert; also three photographs to show the same diatom as seen with 1 in., 1/2 in., and 1/4 in. objective; also a high-power view, showing the test on the proboscis of the blowfly; also one of *Navicula spectabilis*, showing new structure, with Powell's 1/4 in. apochromatic, and one of *Synedra*, taken with a 1/8 in. objective.

(3) "A Note on Bacteria," showing by means of photographs the flagellum of *Spirillum* × 1350 as single, and as divided into two and into four.

The thanks of the meeting were given to Mr. Nelson for these communications.

The following Instruments, Objects, &c., were exhibited:—

Dr. H. L. Maddox:—Photographs in illustration of his paper.

Mr. J. Mayall, Jun.:—Premier Microscope.

Mr. A. Pringle:—Photomicrographs of *Bacterium Termo*.

Surgeon V. Gunson Thorpe:—(1) Photomicrographs and negatives in illustration of his paper; (2) Slide of Marine Annelid.

Mr. A. T. Watson:—Specimens and photographs in illustration of his paper.

Mr. G. Western:—*Dinops longipes* Hudson.

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. Wynne E. Baxter, J.P., Henry Berger, William Rutherford, M.D., F.R.S., D. E. Haag, M.D., Henry R. Saunders, and J. Christie Wright. Dr. Henry B. Brady, F.R.S., and Prof. W. C. Williamson, F.R.S., were elected *Honorary* Fellows.

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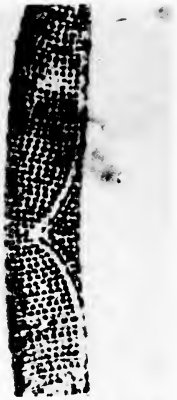
Fig. 2.

Fig. 3.

Fig. 7.



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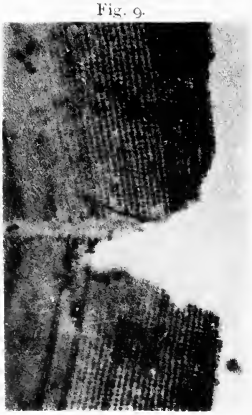

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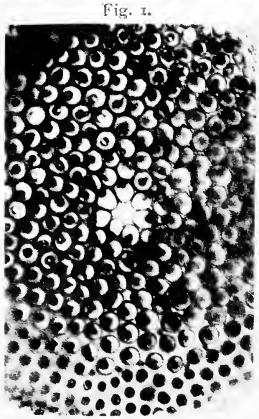

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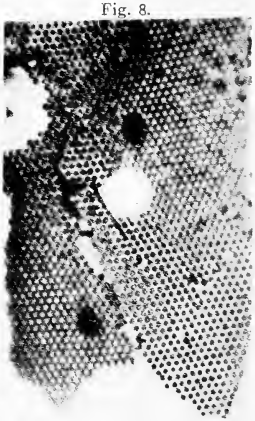

Fig. 5.

Fig. 4.

Fig. 6

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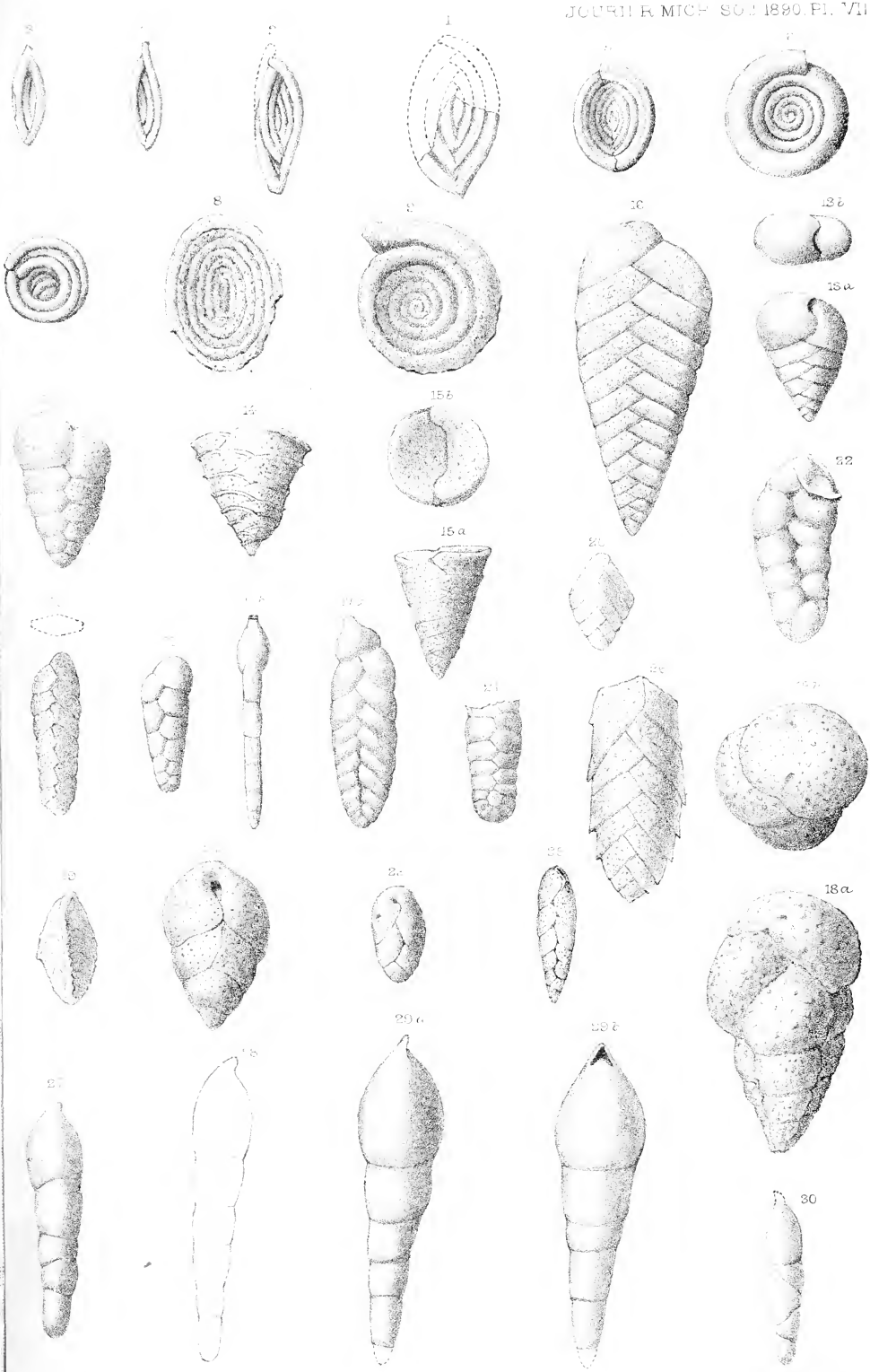
Diatoms charged with Mercurous Sulphide, &c.

By C. Haughton Gill.



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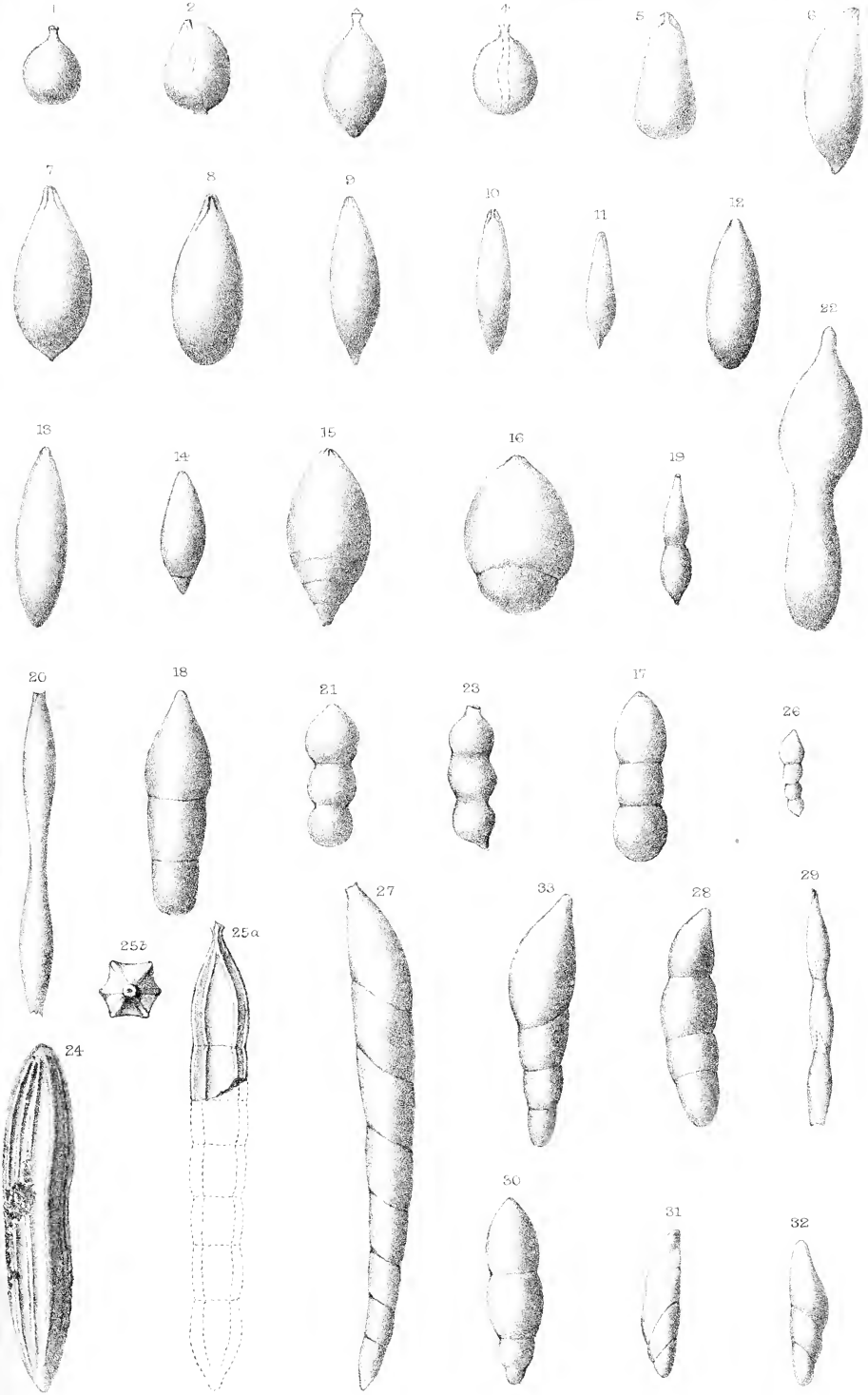

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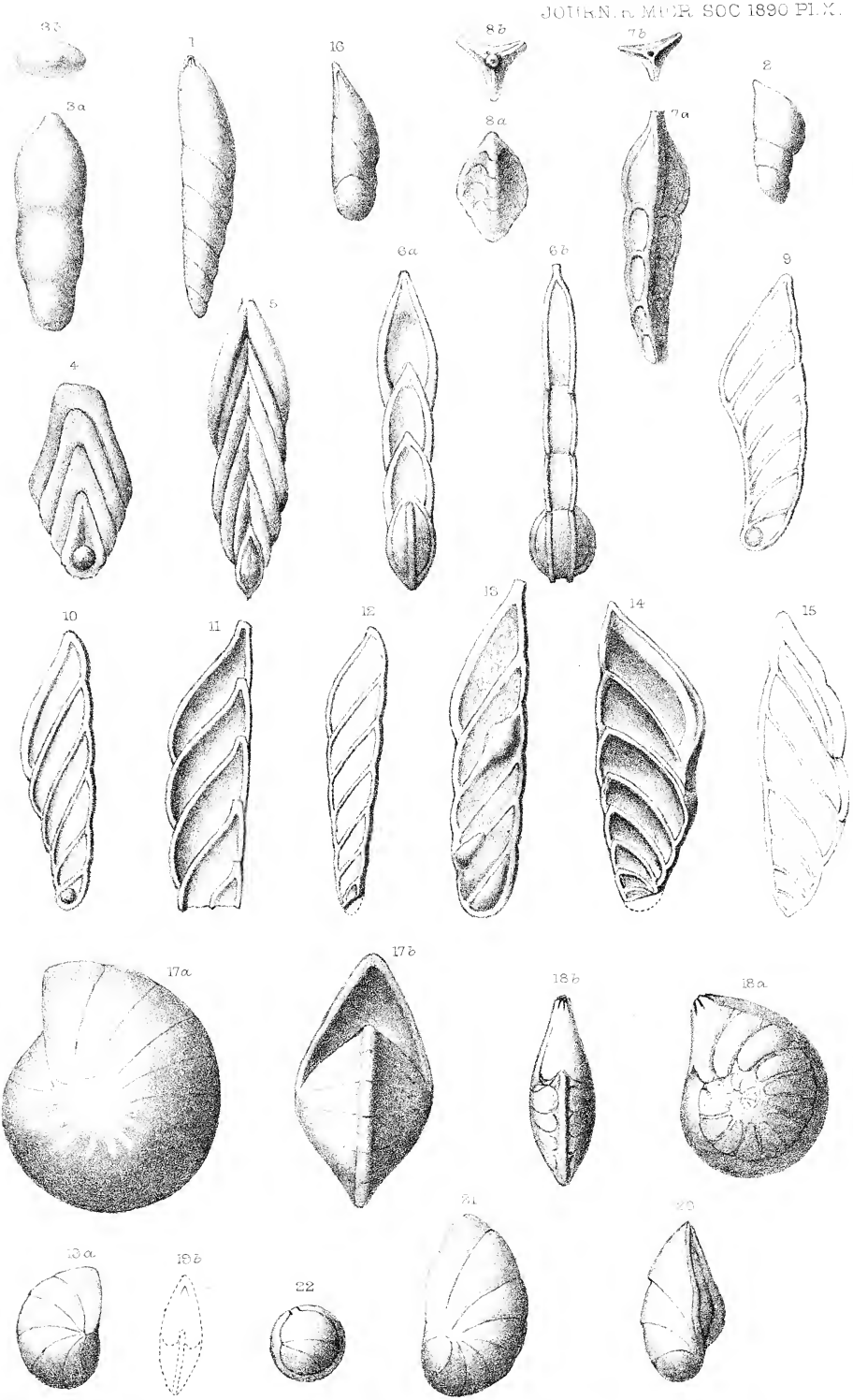

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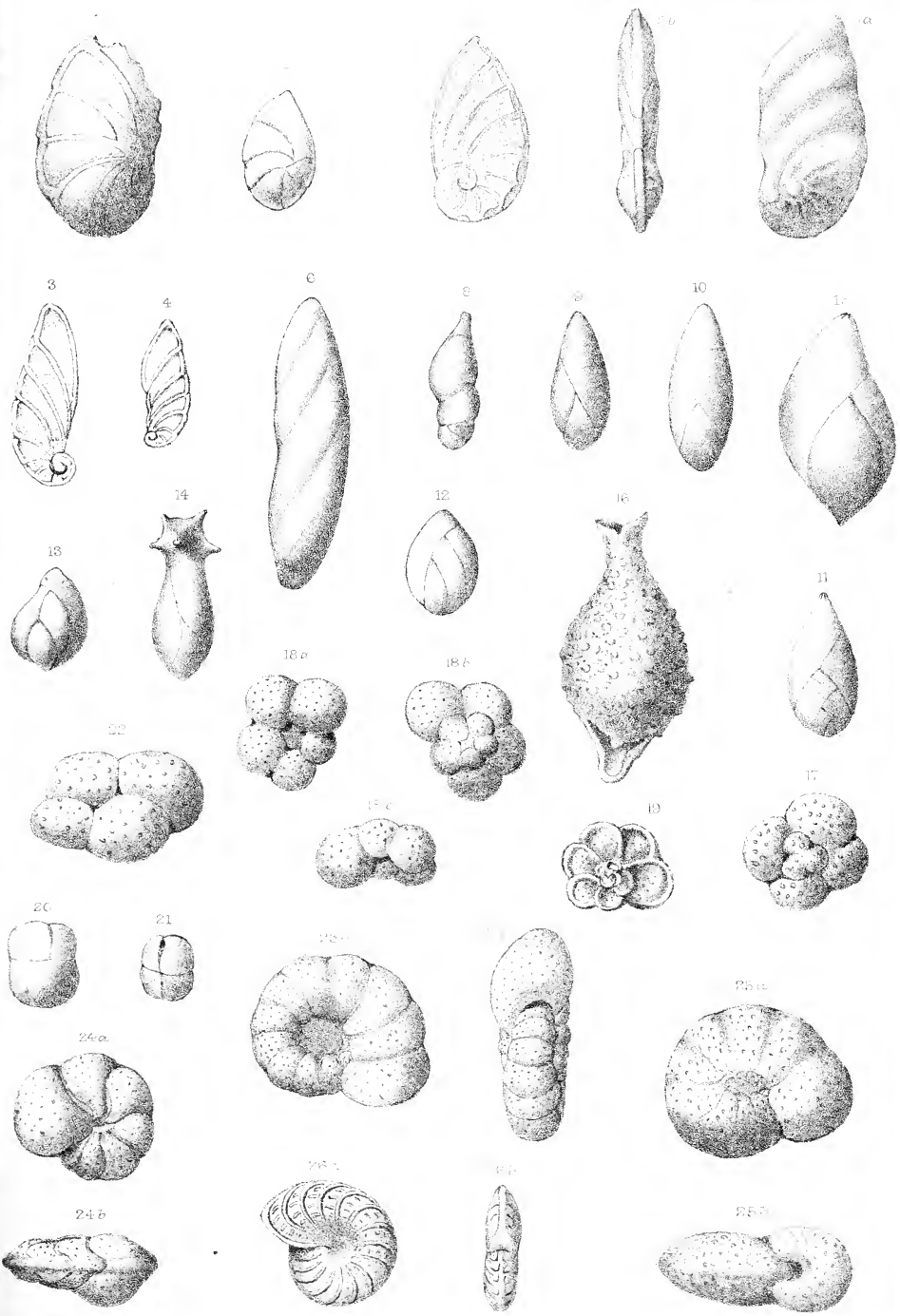

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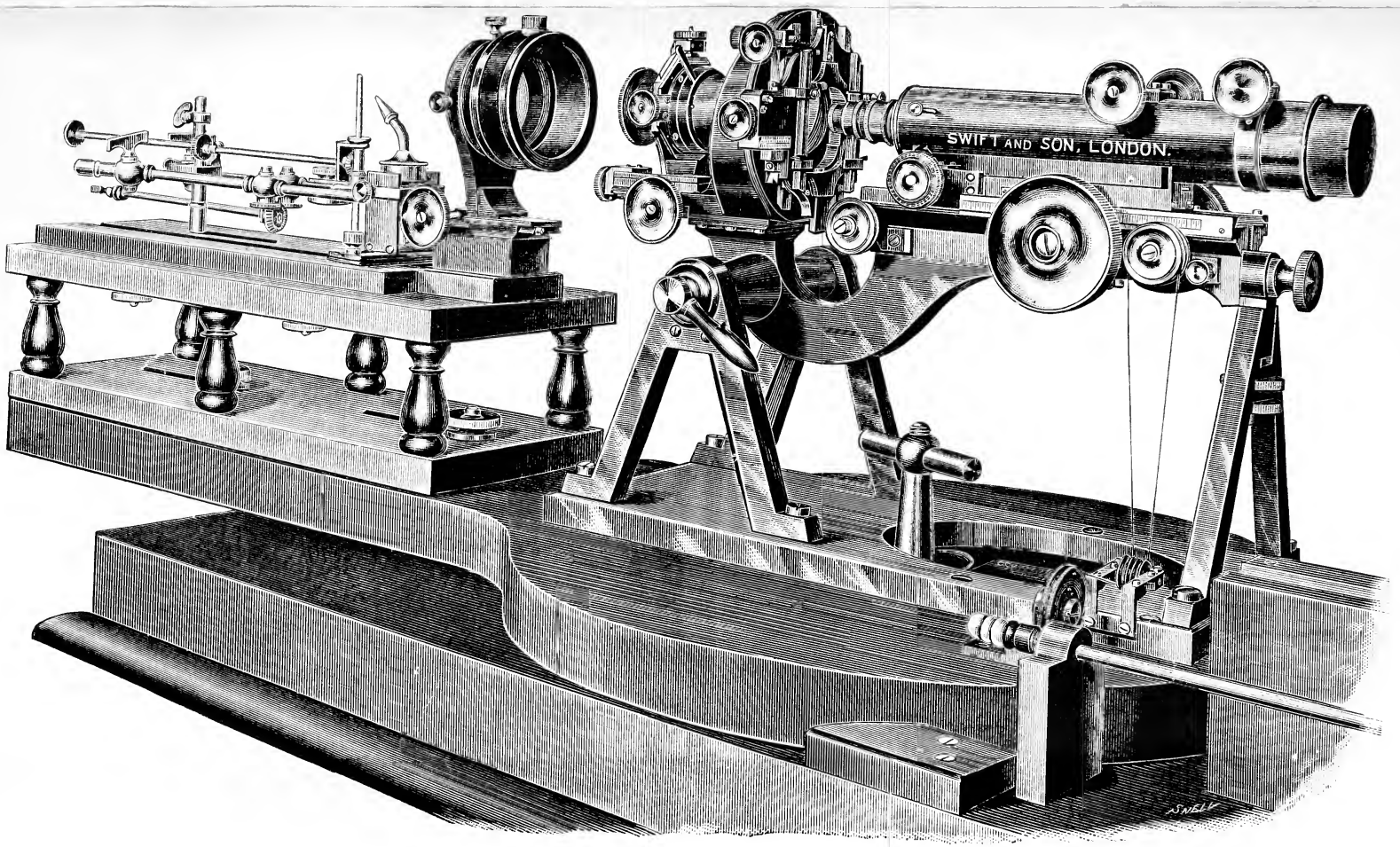

Mr. Pringle's Photomicrographic Apparatus.

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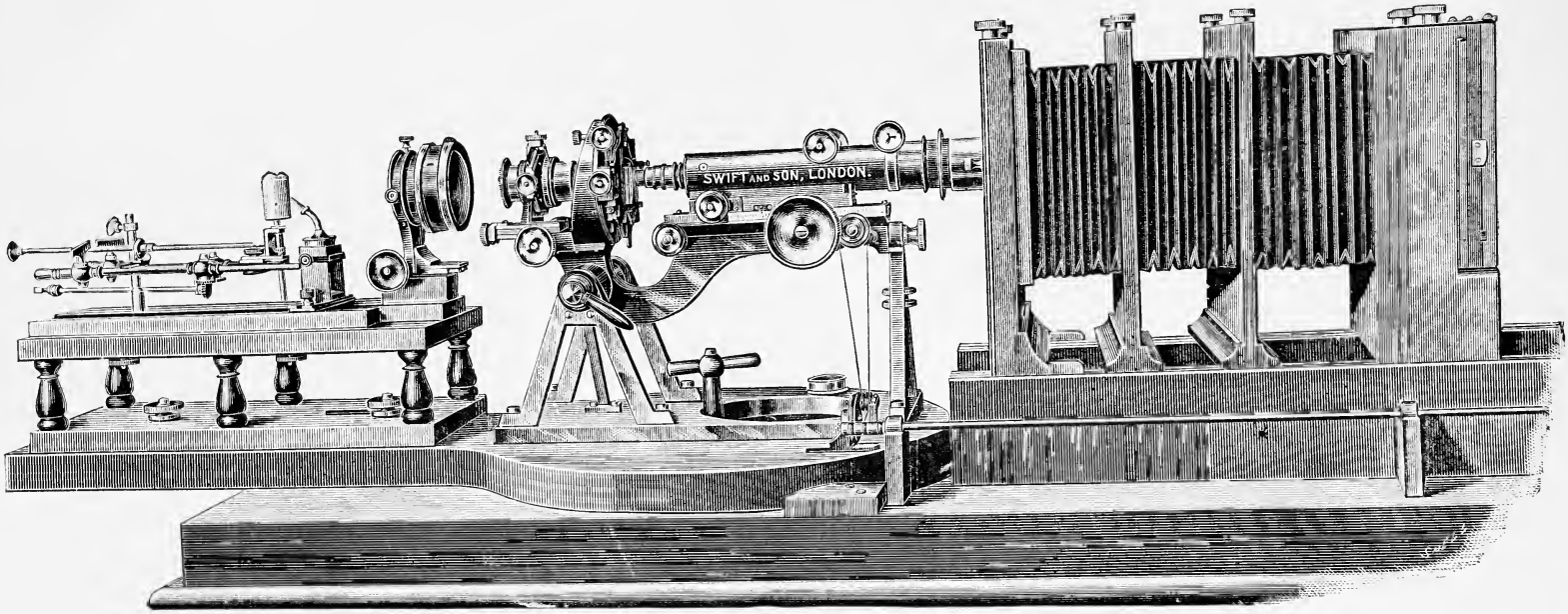

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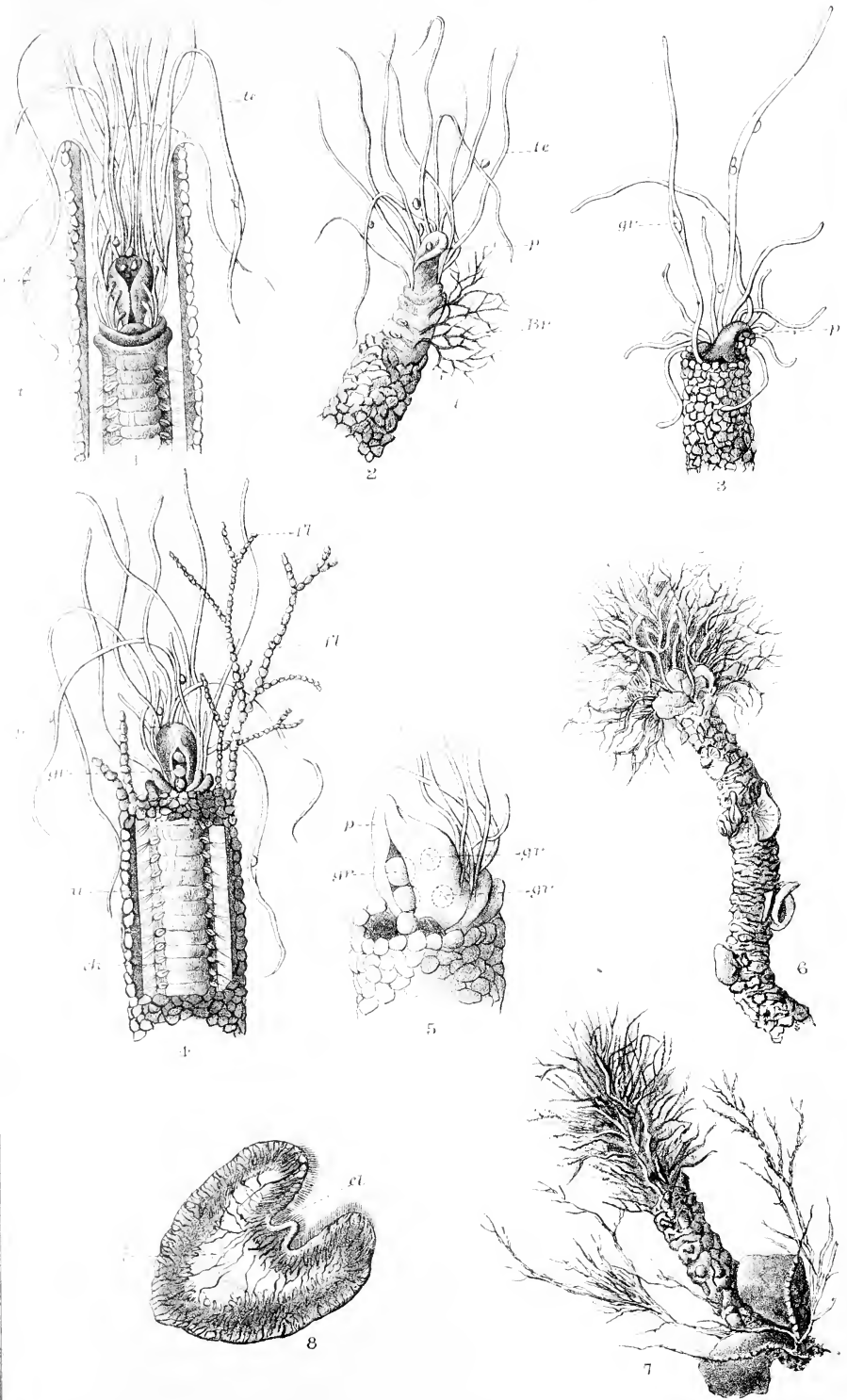

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Tubes of Tereballa littoralis.