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

R. G. HEBB, M.A. M.D. F.R.C.P.

Physician Pathologist to Westminster Hospital

WITH THE ASSISTANCE OF THE PUBLICATION COMMITTEE AND

J. ARTHUR THOMSON, M.A. F.R.S.E.

Regius Professor of Natural History in the University of Aberdeen

A. N. DISNEY, M.A. B.Sc.

FELLOWS OF THE SOCIETY

AND

A. B. RENDLE, M.A. D.Sc. F.L.S.

Assistant in Botany, British Museum

J. J. DOUGLAS, M.D. F.R.C.P.E.

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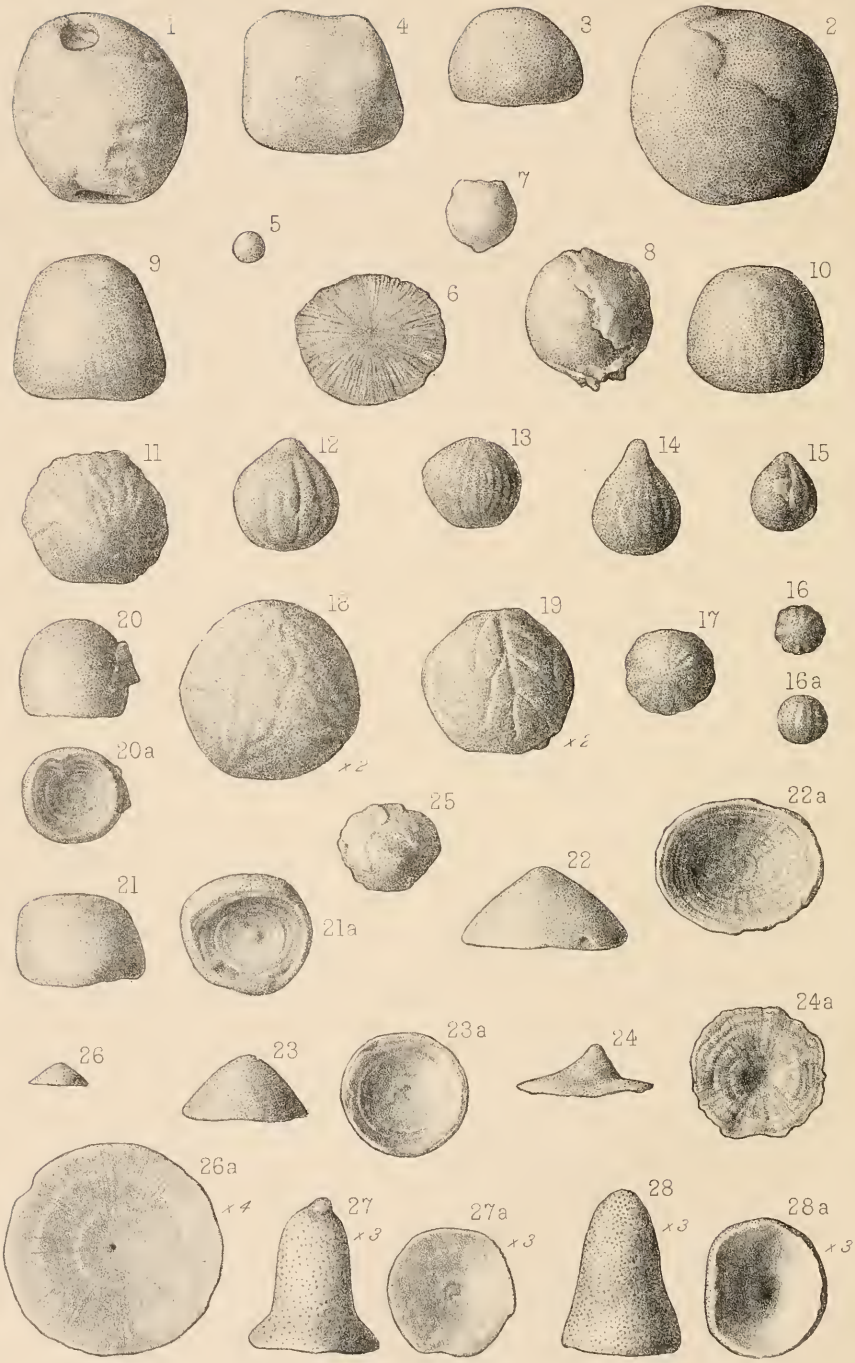

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POROSPHÆRA FROM THE ENGLISH CHALK.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

FEBRUARY 1904.

TRANSACTIONS OF THE SOCIETY.

I.—*On the Structure and Affinities of the Genus Porosphæra*, Steinmann.

By George J. Hinde, Ph.D. F.R.S.

(*Read December 16th*, 1903.)

Plates I. and II.

CONTENTS.

I. Introduction.

The genus *Porosphæra* was established in 1878 by Dr. G. Steinmann for certain small rounded fossils widely distributed in the Cretaceous rocks of this country and the Continent, which, in 1829, had been named and figured by Prof. John Phillips, *Millepora globularis*. Steinmann considered the fossils to be nearly allied structurally to *Parkeria*, and he placed the genus in the family Milleporidæ, Moseley, thus in approximately the same systematic position as that to which they had been assigned by Phillips fifty years previously. Very divergent views respecting the nature of these fossils have been held by older authors, and they have been referred in turn to Foraminifera, Sponges, and Cyclostomate Polyzoa. Latterly, Steinmann's determination of their hydrozoal characters has been accepted generally as correct, though some

competent authorities have questioned his conclusions. The general resemblance of *Porosphæra* to sponges, which has led several authors to place the fossils in this group, induced me for many years past to collect and study all the forms I could meet with; for a long time I failed to discover any decisive evidence respecting the original characters of their calcareous skeletal fibres, but at last, about eight years ago, a small specimen, preserved in flint, which was sent to me by Mr. H. Muller of Eltham, clearly showed that the fibres were built up of spicules. On further investigation this spicular structure was recognised in microscopic sections of many other specimens, and it became apparent, as I have already mentioned elsewhere,* that *Porosphæra* belonged to the Lithonine division of Calcisponges, and possessed the same structural characters as the genus *Plectroninia*, Hinde,† from the Eocene Tertiary of Victoria, Australia, and the recent *Petrostroma*, Döderlein,‡ from the Japanese sea.

Other work has prevented me from giving till now a detailed description of the structure of *Porosphæra*, but the delay has been in one respect an advantage, for in the interval my friend, Dr. A. W. Rowe, F.G.S., has carried on a series of researches on the fossils from the different zones of the Chalk on the east and south coasts of England, during which he has met with many hundred examples of *Porosphæra*, all of which he has most generously forwarded to me for examination. The study of this large series of well-preserved specimens, together with those of my own collecting, has enabled me to gain a better knowledge of the real characters of these fossils than hitherto, and, further, to trace out their distribution in the various zones of the Chalk of this country.

II. History of the Genus.

The following is a brief history of the fossils which are now included under *Porosphæra*.

In 1822, Dr. G. A. Mantell figured, in the *Geology of Sussex*, pl. xvi. figs. 17, 18, p. 162, 'Siliceous specimens of a Zoophyte of a pyriform shape, the nature of which is unknown,' from the Chalk near Brighton. These are examples of *Porosphæra nuciformis*, von Hag. sp. Figs. 22–24 of the same plate, referred to *Lunulites* (?), probably belong to *P. patelliformis*. In 1835, they were placed by this author under *Orbitolites lenticulata*, Lam., Trans. Geol. Soc. s. 2, vol. iii. p. 204.

In 1829, Prof. J. Phillips, in the *Geology of Yorkshire*, pt. i. p. 186, pl. i., fig. 12, gave a figure of *Millepora globularis*, and

* Quart. Journ. Geol. Soc., lvi. (1900) p. 57. † Op. cit., p. 51.
‡ Zool. Jahrb., x. (1898) pp. 15–32, pls. ii.–vi.

another (fig. 11) is named *Lunulites urceolata*, Lam. Both specimens are partly imbedded in a slab of hard chalk from Dane's Dike, Flamborough, now preserved in the York Museum. Steinmann has taken the first of these as the type of the genus *Porosphæra*, whilst the *Lunulites urceolata* is now known as *Porosphæra pileolus*. No description accompanied either of the forms figured by Phillips. In the third edition of the *Geology of Yorkshire*, which appeared in 1875, both *Millepora globularis* and *Lunulites urceolata* are placed in the genus *Coscinopora*, Goldfuss, but here again no description is given; the specific name of the latter is, however, changed to *pileolus*.

In 1833, S. Woodward figured in the *Outline of the Geology of Norfolk*, pl. iv., figs. 10–12, several examples of *Millepora globularis* from the Chalk of Norwich and near Holt, which are placed with other fossil sponges under the heading Polypi. It is doubtful if the *Lunulites urceolata*, pl. iv., fig. 9, belongs to *Porosphæra*. I have not been able to trace the originals of the figures.

In 1839, F. von Hagenow described and figured in the 'Monographie der Rügenschen Kreide Versteinerungen' (*Neues Jahrbuch für Mineralogie*), as a new species of Polyzoa, *Ceriopora nuciformis*, the same pear-shaped forms of *Porosphæra* which had been already figured by Mantell in 1822. He regarded them as a more complete development of the rounded forms, i.e. of *P. globularis*, Phill. sp., though he does not mention this species (p. 286, pl. v., fig. 9). In the same work (p. 260) a description is given of another rounded fossil from the Chalk of Rügen, named *Achilleum globosum*, which appears to have been partly based on specimens of *P. globularis*, and partly on small round siliceous sponges subsequently named by v. Zittel, *Plinthosella squamosa*.

In 1844, A. E. Reuss, in *Geognostische Skizzen aus Böhmen*, vol. ii., p. 140, quoted *Ceriopora pisum* = *Millepora globularis*, Phill., from the Plänerkalk of Kutschlin and near Bilin; and shortly after (1845–6), in *Die Versteinerungen der böhmischen Kreideformation*, Abth. 2, p. 78, pl. xx., fig. 5, he described and figured the same form as a sponge under the name of *Tragos globularis*.

In A. d'Orbigny's *Prodrome de Paléontologie*, vol. ii. (1850) p. 284, *Tragos globularis*, Reuss (= *P. globularis*, Phill.) is placed in the genus *Coscinopora*, Goldfuss.

John Morris, in the second edition of the *Catalogue of British Fossils* (1854) pp. 27, 28, follows d'Orbigny in placing *P. globularis* under *Coscinopora*, and to the same genus he refers *Lunulites*, Mant., *L. urceolatus*, Phill., and *Orbitolites lenticulata*, Mant. These forms are placed with a query as synonyms of Lamarck's species (*O.*) *pileolus*.

In the *Ann. and Mag. Nat. Hist.*, s. 3, vol. vi. (1860) p. 30, W. K. Parker and T. R. Jones described *P. globularis*, Phill. sp., as a Foraminifer, and placed it in the genus *Orbitolina*, d'Orbigny,

whilst the allied conical, hemispherical, and depressed forms are definitely assigned to *O. concava*, Lamk. sp.

F. A. Roemer, in 'Die Spongitarien des Norddeutschen Kreidegebirges' (*Palæontographica*, vol. xiii. (1864) p. 56), placed *Tragos globularis*, Reuss (= *P. globularis*, Phill.), as a synonym of *Achilleum globosum*, v. Hag.

In the 'Seeschwämme des mittleren und oberen Quaders' (*Palæontographica*, vol. xxii. (1872–5) p. 4), H. B. Geinitz pointed out that the resemblance in outer form between *Ceriopora nuciformis*, v. Hag. (= *P. nuciformis*) and *Achilleum globosum* (= *Plinthosella squamosa*, v. Zitt.) is so close that they may readily be mistaken for each other. Geinitz placed this latter sponge with the Lithistidæ, where it rightly belongs.

H. J. Carter, in the *Ann. and Mag. Nat. Hist.*, s. 4, vol. xix. (1877) p. 64, and s. 5, vol. i. (1878) p. 298, described under the names, first of (?) *Bradya tergestina*, and afterwards of *Millepora Woodwardi*, a new species of *Porosphæra*, characterised by branched canals which radiate from points on the surface. It is regarded as a Hydrozoön with a structure similar to that of *Parkeria*. The forms occur in the Grey Chalk near Dover, and the types are now in the British Museum (Natural History), South Kensington.

In his memoir 'Ueber fossile Hydrozoen aus der Familie der Coryniden' (*Palæontographica*, vol. xxv. (1878) p. 120, pl. xiii., figs. 8–12), Dr. G. Steinmann referred *Millepora globularis* to a distinct genus, *Porosphæra*, belonging to the Hydrocorallinæ. The skeleton is stated to consist of anastomosing calcareous fibres, like those of *Parkeria*, and their microstructure is distinctly radiate. The author recognises the close resemblance in outer form of *Porosphæra* to Sponges, but stated that the definite connected calcareous skeleton is quite unknown in existing sponges, though it occurs in numerous fossils. The various forms of *Porosphæra*, including *P. Woodwardi*, Carter, are regarded as belonging to a single species, *P. globularis*, Phillips.

In the *Elemente der Palæontologie* (1888) p. 77, fig. 73, by the same author and Dr. Döderlein, *Porosphæra* is retained in the same systematic position. The Gastroporen are stated to be radial and numerous, in other respects like *Millepora*.

Dr. F. A. Quenstedt, in the *Petrefaktenkunde Deutschlands*, vol. vi. (1879) p. 262; Atlas, pl. 153, figs. 1–12, referred a series of the usual forms of *P. globularis* to *Ceriopora nuciformis*, v. Hag., and considers them as Bryozoa. Quenstedt further mentioned that amongst a suite of specimens sent to him direct by v. Hagenow as examples of his *Achilleum globosum*, some were genuine forms of *Ceriopora nuciformis*, whilst others were definite sponges.

In the *Handbuch der Palæontologie*, vol. i. (1879) p. 288, Prof. v. Zittel accepted Steinmann's determination of *Porosphæra*, and placed the genus in the family Milleporidæ; in the same

author's *Grundzüge der Palæontologie* (1895) p. 102, it is placed next to *Parkeria* in the Order Tubulariæ; and in the English edition of the work (1900) p. 111, it is retained in the same position.

Treating of the affinities of the genus *Parkeria*, Carpenter, *Ann. and Mag. Nat. Hist.*, s. 6, vol. i. (1888) p. 11, the late Prof. H. A. Nicholson stated that microscopic sections of *Porosphæra globularis* show that its minute structure differs from that of any Hydrozoön, and that it has no special relationship with *Parkeria*. The author thinks that it will be found to belong to the group of the Lithistid sponges, and to be related to the genus *Hindia*, Duncan. The same opinion is also expressed in the *Manual of Palæontology*, 3rd ed. (1889) vol. i., p. 200.

Prof. A. Fritsch gives a description of *Amorphospongia globosa*, v. Hag. sp., in *Studien im Gebiete der böhmische Kreideformation*, iv. Die Teplitzer Schichten (1889) p. 108, fig. 52. It is stated that the inner skeleton appears to consist of a plait-work of calcareous spicules, and that there is a surface layer which likewise seems to be of spicules. Through the kindness of Dr. Fritsch, I have examined a microscopic section of the specimen which he has described, and can confirm his statement of the spicular character of the interior skeleton, which is similar to that of *Porosphæra globularis*; but I failed to recognise any spicular structure in the outer crust. The specimen seems to me to belong to *P. globularis*, Phill.

G. J. Hinde stated in the *Quart. Journ. Geol. Soc.*, vol. lvi., Feb. 1900, p. 57, that *Porosphæra*, Steinmann was a Calcisponge in which the spicules of the skeletal mesh were fused together as in *Plectroninia* and *Petrostroma*, and that it belonged to the Lithonina.

Dr. G. Steinmann, in the *Einführung in die Paläontologie* (1903) p. 95, places *Porosphæra globularis* in the Lithonina as a group of the Pharetrones.

The varied opinions respecting the nature of *Porosphæra* indicated in the references given above may to some extent be accounted for by the minute and delicate structure of the fibrous skeletal mesh of the organism, which appears in the majority of microscopic sections, even of well-preserved specimens, as a continuous network in which scarcely any traces of the constituent spicular elements can be recognised. Another source of error arises from the fact that certain zones of the Chalk in which *Porosphæra* is plentiful likewise contain specimens of the siliceous sponge, *Plinthosella squamosa*, v. Zitt., which closely resemble *Porosphæra globularis* in form and size, and the two kinds of sponges appear to have been confused together by von Hagenow and other authorities.

III. Mode of Occurrence and Zonal Distribution.

In this country *Porosphæra* is met with most commonly in the Chalk cliffs of the coasts of Yorkshire, Kent, Sussex, Isle of Wight, Dorset, and South Devon. It is by no means uniformly distributed in the Chalk, for whilst in some beds and horizons specimens are very plentiful, in others they are rare or apparently absent altogether. They are usually seen slightly projecting from the weathered face of the cliff, from which they can readily be picked out with a blunt knife or chisel. When naturally weathered out of the cliff and fallen to the beach, they are soon worn smooth and their surface characters are partly obliterated. As a rule, they are seldom found in inland areas, either in Chalk pits or on downs and other places where the Chalk outcrops at or close to the surface; but their apparent scarcity in these positions may be due to their generally small size and to their close resemblance to rolled fragments of Chalk. As an instance of their occurrence in such places when carefully searched for, I may mention that within the limits of a moderately-sized garden situated on the slope of a Chalk down at Croydon, Surrey, I have during the last sixteen years picked from the surface soil 632 specimens of different forms of *Porosphæra* which have all been derived by slow weathering from the underlying Chalk.

With the object of tracing the development of *Porosphæra* at various horizons in the Chalk, the collections made by Dr. Rowe and by myself from each zone and locality have carefully been kept separate, and in the list below details are given of the number and range of size of each species from the respective zones, which will show approximately the relative proportions of the different forms which occur together. About two-thirds of the total number of specimens in this list have been obtained by Dr. Rowe.

It will be seen from this list that the earliest appearance of *Porosphæra* in the Chalk of this country is in the zone of *Holaster subglobosus* at Dover and at Durdle Cove, Dorset. There are only very few specimens present on this horizon, and they all belong to one species, *P. Woodwardi*, Carter, which, so far, has not been found in any higher zone.

In the next higher zone of *Rhynchonella Cuvieri*, the predominant species, *P. globularis*, Phillips, occurs for the first time—it is represented by only a few small specimens; with it are some diminutive forms of *P. arreeta*. *P. globularis* is more abundant in the succeeding zone of *Terebratulina gracilis*, but the specimens are still small generally; in this zone the limpet-shaped *P. patelliformis* is first met with.

At the base of the Upper Chalk, in the zone of *Holaster planus*, the thimble or inverted cup-shaped *P. pileolus* makes its first appearance.

In the succeeding zones of *Micraster cor-testudinarium* and *M. cor-anguinum*, we find *P. globularis* more numerous and of larger size; in the latter zone, the ribbed, pear-shaped *P. nuciformis* has been first noted. *P. pileolus* and *P. patelliformis* are more common than in the Middle Chalk; but they form only a small percentage in comparison with the numbers of *P. globularis*.

It will be noticed that the forms from South Croydon, which I have placed in the zone of *Micraster cor-anguinum*, differ considerably in their maximum size from those of the same zone on the Thanet coast, and approach more nearly in this respect to those obtained by Dr. Rowe from the *Marsupites* zone of Margate. This fact has led me to question whether the Chalk at South Croydon has been correctly referred to the *M. cor-anguinum* zone; but I have hitherto failed to find in it any remains of *Marsupites*. I have, however, found a single specimen of *Offaster pillula*, Lam., associated in the same area with the large specimens of *P. globularis*; and as this echinoderm, according to Dr. Rowe, also occurs, though rarely, in the *Marsupites* zone of Thanet, there is some probability that the Chalk at South Croydon may be correlated to this zone.

From the zone of *Marsupites*, at Margate more particularly, and also at Flamborough, *Porosphæra* is very common, and Dr. Rowe has obtained a large series of the different species. The greater number were found in the lower part of this zone, the *Uintacrinus* Band of Dr. Rowe. At this horizon, in Kent, the specimens generally are notably larger than those from the lower zones of the Chalk, some of *P. globularis* reaching a maximum diameter of 34 mm.; the larger forms also are in part loaf- or cushion-shaped, a feature still more strongly pronounced in specimens from the higher zone of *Belemnitella mucronata*.

At various places on the Sussex coast, and at Sewerby on the Yorkshire coast, *Porosphæra* is very abundant in the next higher zone of *Actinocamax quadratus*. *P. nuciformis* is numerous in the Sussex cliffs. The specimens are generally smaller than those from the *Marsupites* zone, and approximate in size to those from the *Micraster cor-anguinum* zone on the Thanet coast.

In the zone of *Belemnitella mucronata*, the highest in the English Chalk, an interesting series of forms was collected by Dr. Rowe at Ballard's Cliff and at Studland Bay, Dorset, and also from the Norfolk coast. The Dorset specimens are characterised by their fairly large size, the abundance of loaf- and cushion-shaped forms of *P. globularis*, and the relatively large proportion of *P. nuciformis*.

Summing up the zonal distribution of *Porosphæra* in the Chalk: the genus is first noted in the Lower or Grey Chalk, of the zone of *Holaster subglobosus*, by a few specimens of the rare *P. Woodwardi*; the principal species, *P. globularis*, appears for the first time in the zone of *R. Cuvieri*, the lowest horizon of the Middle Chalk, accompanied by *P. arrecta*. In the zone of *T. gracilis*, we first meet

LIST SHOWING THE NUMBER AND RANGE OF SIZE OF THE DIFFERENT FORMS

		Porosphæra globularis.	*Porosphæra nuciformis.*
Lower Chalk. Cenomanian.	Zone of *Holaster subglobosus.*		
	Dover	..	..
	Durdle Cove, Dorset Coast	..	..
Middle Chalk. Turonian.	Zone of *Rhynchonella Cuvieri.*		
	Dover	8 (2–4 mm.)	..
	Branscombe and Berry Cliff, S. Devon Coast	12 (1·5–5 mm.)	..
	Zone of *Terebratulina gracilis.*		
	Dover, East Cliffs	..	..
	Dover, West Cliffs	34 (2–4 mm.)	..
	Seaton, S. Devon Coast	43 (2–7 mm.)	..
	Flamborough, Yorkshire Coast	2 (2 mm.)	..
Upper Chalk. Senonian.	Zone of *Holaster planus.*		
	Dover, East Cliffs	29 (3–7 mm.)	..
	S. Devon Coast	6 (3–4 mm.)	..
	Zone of *Micraster cor-testudinarium.*		
	Chatham	18 (2–4 mm.)	..
	Dover, East Cliffs	50 (2–9 mm.)	..
	Seaford Head and Newhaven	266 (1–15 mm.)	..
	S. Devon Coast	..	..
	Zone of *Micraster cor-anguinum.*		
	Gravesend	..	..
	Chatham	3 (6–9 mm.)	..
	Thanet Coast	51 (2–14 mm.)	5 (7–9 mm.)
	Dover, St. Margaret's	..	..
	Dorset Coast	..	3 (9–13 mm.)
	S. Devon Coast	..	..
	South Croydon, Avondale Road	579 (4–27 mm.)	28 (6–20 mm.)
	Croydon, near	33 (1·5–25 mm.)	..
	Flamborough, Yorkshire Coast	77 (3–13 mm.)	2 (7–9 mm.)
	Zone of *Marsupites testudinarius.*		
	Uintacrinus Band.		
	Thanet Coast	35 (7–23 mm.)	36 (4–15 mm.)
	Margate	129 (2·5–34 mm.)	25 (5–20 mm.)
	Flamborough	35 (2–13 mm.)	4 (5–13 mm.)
	Marsupites Band.		
	Sussex Coast	7 (13–31 mm.)	1 (12 mm.)
	Dorset Coast	1 (2 mm.)	1 (13 mm.)
	Sewerby, Yorkshire Coast	53 (2·5–12 mm.)	3 (5–10 mm.)
	Zone of *Actinocamax quadratus.*		
	Seaford Head and Newhaven	72 (3–17 mm.)	69 (5–14 mm.)
	Sussex Coast	12 (9–23 mm.)	14 (7–14 mm.)
	Brighton, East of pumping station	181 (2·5–13 mm.)	20 (4–9 mm.)
	Isle of Wight, Scratchells Bay	56 (2·5–9 mm.)	8 (4–14 mm.)
	Dorset Coast	..	..
	Winchester	..	5 (7–12 mm.)
	Sewerby	166 (2·5–15 mm.)	8 (6–10 mm.)
	Zone of *Belemnitella mucronata.*		
	Ballard Cliff and Studland Bay, Dorset Coast	62 (6–24 mm.)	23 (5–12 mm.)
	Sheringham, Weybourne, Overstrand, Norfolk	6 (7–24 mm.)	..
	Trimingham, Norfolk Coast	16 (2–12 mm.)	2 (6, 7 mm.)
	Norwich, near, Catton Pit	1 (14 mm.)	..
	Zones unknown.		
	Surrey and Kent	8 (1–12 mm.)	..
	Hampshire and Wiltshire	6 (1–15 mm.)	..

OF POROSPHÆRA OBTAINED FROM THE ZONES OF THE ENGLISH CHALK.

Porosphæra Woodwardi.	*Porosphæra pileolus.*	*Porosphæra patelliformis.*	*Porosphæra arrecta.*	*Porosphæra.* Irregular forms.	Totals.	
2 (12, 14 mm.)	..	..	..	..	2	
1 (9 mm.)	..	..	..	..	1	
					—	3
..	..	..	..	..	8	
..	..	..	7 (3–6 mm.)	..	19	
					—	27
..	..	3 (2–8 mm.)	..	..	3	
..	..	..	..	..	34	
..	..	..	..	..	43	
..	..	..	..	..	2	
					—	82
..	1 (7 mm.)	1 (10 mm.)	..	..	31	
..	..	..	..	..	6	
					—	37
..	2 (3 mm.)	3 (4–6 mm.)	..	..	23	
..	..	..	..	..	50	
..	10 (2–9 mm.)	23 (2–11 mm.)	..	5 (1–5 mm.)	304	
..	2 (4 mm.)	..	..	..	2	
					—	379
..	..	2 (16 mm.)	..	..	2	
..	..	..	..	..	3	
..	..	2 (8–10 mm.)	..	..	58	
..	..	1 (8 mm.)	..	..	1	
..	..	..	..	..	3	
..	2 (7–14 mm.)	..	..	..	2	
..	23 (7–17 mm.)	2 (14–17 mm.)	..	..	632	
..	1 (10 mm.)	..	..	..	34	
..	9 (2–11 mm.)	9 (3–15 mm.)	1 (3 mm.)	..	98	
					—	833
..	22 (4–17 mm.)	22 (4–23 mm.)	3 (6 mm.)	..	118	
..	10 (5–18 mm.)	3 (11–13 mm.)	2 (3–6 mm.)	..	469	
..	2 (7–13 mm.)	10 (7–11 mm.)	..	..	51	
					—	638
..	4 (12–16 mm.)	1 (21 mm.)	..	..	13	
..	2 (7–9 mm.)	..	..	..	4	
..	8 (3–8 mm.)	..	..	..	64	
					—	81
..	25 (7–18 mm.)	2 (10 mm.)	1 (7 mm.)	3 (8–10 mm.)	172	
..	8 (7–13 mm.)	6 (11–22 mm.)	..	..	40	
..	11 (5–13 mm.)	..	..	2 (7–9 mm.)	214	
..	2 (2–5 mm.)	1 (7 mm.)	..	5 (5–12 mm.)	72	
..	1 (7 mm.)	..	..	..	1	
..	..	..	..	..	5	
..	4 (5–13 mm.)	3 (2·5–13 mm.)	..	..	181	
					—	685
..	..	3 (6–11 mm.)	..	..	88	
..	..	..	..	..	6	
..	..	..	..	4 (7–12 mm.)	22	
..	..	..	..	..	1	
					—	117
..	..	4 (8–12 mm.)	..	1 (14 mm.)	13	
..	1 (13 mm.)	..	..	..	7	
					—	20
						2902

with *P. patelliformis*, whilst *P. pileolus* first comes in at the base of the Upper Chalk in the zone of *Holaster planus*. The well-marked *P. nuciformis* has not been found until reaching the zone of *Micraster cor-anguinum*.

In the lower zones of the Chalk the examples of *Porosphæra* are comparatively rare and generally small, the large majority not exceeding 6 mm. in diameter, but in the higher zones in the South of England the various species are more numerous, and there is a gradual increase in size, which reaches its maximum in the zone of *Marsupites*, where some forms of *P. globularis* are 34 mm. in diameter. In the next higher zone of *Actin. quadratus* the specimens are smaller, but there is a reversion to larger forms in the *Bel. mucronata* zone.

In the Chalk of the vicinity of Flamborough, Yorkshire, the various species of *Porosphæra* are uniformly of small dimensions in all the zones, in marked contrast to those from the higher zones on the South coast.

IV. Mineral Character and Condition of Preservation.

The large majority of the specimens of *Porosphæra* from the Upper Chalk of this country consist of calcite, and their radial canals and the smaller interspaces of the skeletal mesh are usually filled up solid with the same mineral. In thin sections seen under the Microscope, the mesh appears as light grey bands by reflected light; whilst in transmitted light the bands or fibres are marked off from the calcitic matrix by numerous minute granules of a darkish tint, which, unless the sections are very thin, render them nearly opaque. This appearance of the mesh is very similar to that in many of the Pharetron Calcisponges from the Inferior Oolite, the Great Oolite, and the Coral Rag, and also in some of the Tertiary Calcisponges from Australia. In no instance have I seen a finely radiate fibrous micro-structure in the mesh, like that which characterises *Millepora* and Madreporarian corals generally.

In many specimens of *Porosphæra* the outer portions are of calcite, whilst in the interior, both the skeletal mesh and the matrix consist to a varying extent of silica. This has given rise to an impression that the fossils were originally of silica which has, in part, been replaced by calcite. That a reverse process has taken place, and that the silica is of secondary origin, is shown by the fact that in the silicified portion of these specimens the mesh is usually very indistinct or altogether obliterated, whilst its characters are retained in the outer or calcitic portion. We find, moreover, that *Porosphæra* is frequently associated in the same beds of Chalk with undoubted siliceous hexactinellid and lithistid sponges, in which the skeletal mesh has been either removed,

leaving an empty mould of silica, or it has been replaced by reddish ferric oxide, thus presenting a marked contrast to the usual state of preservation of *Porosphæra*. Under exceptional conditions, as in the Chalk at Flamborough, the matrix of the interior of many of the specimens of *Porosphæra*, also consists of powdery ferric oxide, but the exterior of these forms shows the calcitic mesh which readily distinguishes them from the siliceous sponges in the same beds.

Porosphæra likewise occurs either partially or entirely imbedded within the flint nodules of the Chalk, and in this condition the skeletal mesh is, in part, siliceous, as well as the matrix. In some of these flint-enclosed specimens the structural details are more distinctly shown than in the usual forms from the Chalk, but in others, and even in parts of the same specimen, they are only faintly visible.

V. Form and Manner of Growth.

A large proportion of the specimens of *P. globularis* are approximately spherical without any indication of a point of attachment. Small individuals of about 1 mm. in diameter show that the rounded form prevailed in the early stages of the growth of the organism, and there is but little variation in the shape of the specimens up to 6 mm. in diameter. In larger specimens the growth is less symmetrical, they become oval, loaf-shaped, cushion-shaped, rounded or subangular at the bases, which are flattened or even slightly concave (pl. I., figs. 1–4, 9, 10). In some instances growth does not take place uniformly over all the surface, but in layers which only extend over parts of the surface and overlap each other (pl. I., fig. 2). Usually the entire outer surface is dotted over closely with the minute apertures of the radial canals bounded by the skeletal mesh, but in a very few rare examples these are covered by small patches of a spicular dermal layer (pl. I., figs. 7, 8).

The specimens of *P. nuciformis* vary in form from nearly round to melon- and pear-shaped; they appear in all cases to have been free. Their surfaces are covered with simple, slightly raised ridges or swellings with correspondingly open, shallow, intermediate furrows, which extend longitudinally from the rounded to the obtusely pointed summit of the specimens (pl. I., figs. 11–17). In a few rare examples there are two or more areas from which the ridges extend (pl. I., fig. 18).

Numerous specimens of *P. globularis*, both of the spherical and of the oval or cushion-shaped forms, and also of *P. nuciformis*, are penetrated by cylindrical tubes, some of which extend quite through, so that the specimen becomes a natural bead, whilst others reach only to the central portion of the fossil or beyond to

near the opposite side, but without passing through it completely (pl. I., fig. 1). The tubes generally pass straight through the centres of the rounded forms, but they are not definitely oriented in the cushion- or pear-shaped fossils, through which they extend either longitudinally, transversely or obliquely. In the collections examined from the zone of *Micraster cor-testudinarium* upwards to the *Bel. mucronata* zone, out of 1799 specimens of *P. globularis* from different localities, there were 321 or about 18 p.c. perforated; of this number 147 were completely perforated or natural beads, whilst 174 were partially perforated. In 184 specimens of *P. nuciformis* from the same beds, there were tubes in 32, or about 17 p.c.; in only 6 instances the tubes extended through; whilst in 26 they only reached to varying depths in the fossils.

EXPLANATION OF PLATE I.

The figures are of natural size except where otherwise indicated.

Fig. 1. *Porosphæra globularis*, Phillips, sp. Large oval specimen, with tubular perforation. Zone of *Micraster cor-anguinum*; South Croydon, Surrey. Collection of G. J. Hinde.

„ 2. Ditto; showing overlapping layers of growth. Zone of *Marsupites*; Margate, Kent. Collection of Dr. A. W. Rowe, F.G.S.

„ 3. Ditto; loaf-shaped. Zone of *Belemnitella mucronata*; Ballard Cliff, Dorset coast. Collection of Dr. Rowe.

„ 4. Ditto; cushion-shaped specimen. Zone of *Bel. mucronata*; Ballard Cliff. Collection of Dr. Rowe.

„ 5. Ditto; of average size. Zone of *Actinocamax quadratus*; Cliff, east of Brighton. Collection of G. J. Hinde.

„ 6. Ditto; median section, showing the arrangement of the radial canals. Upper Chalk. Collection of G. J. Hinde.

„ 7. Ditto; completely enveloped with a spicular dermal layer. Zone of *B. mucronata*; Ballard Cliff. Collection of Dr. Rowe.

„ 8. Ditto; partially covered with an uneven dermal layer. Same zone and locality as the preceding. Collection of Dr. Rowe.

„ 9, 10. Ditto; loaf-shaped specimens, showing faint indications of surface grooves. Zone of *Marsupites* (*Uintacrinus* Band); Thanet coast. Collection of Dr. Rowe.

„ 11. *Porosphæra nuciformis*, v. Hagenow, sp. Viewed from above, showing the convergence of the grooves at the summit. Zone of *Marsupites* (*Uintacrinus* Band); Margate. Collection of Dr. Rowe.

„ 12. Ditto; side view. Zone of *A. quadratus*; near Newhaven. Collection of Dr. Rowe.

„ 13. Ditto; showing closely-arranged grooves. Zone of *A. quadratus*; Winchester. Collection of Dr. Rowe.

„ 14. Ditto; with prominent apex. Zone of *A. quadratus*; Sussex coast. Collection of Dr. Rowe.

„ 15. Ditto; with fragments of the dermal layer. Zone of *A. quadratus*; near Newhaven. Collection of Dr. Rowe.

„ 16, 16*a*. Ditto; viewed from above and in profile. Zone of *Marsupites* (*Uintacrinus* Band); Thanet coast, Kent. Collection of Dr. Rowe.

„ 17. Ditto; viewed from above. Same zone and locality as the preceding. Collection of Dr. Rowe.

„ 18. Ditto; with surface grooves and ridges radiating from several centres. × 2 diam. From same zone as the preceding; Sussex coast. Collection of Dr. Rowe.

These tubes are generally considered to have been occupied originally by some organic body, such as the stem of a sea-weed, not capable of preservation as fossil, round which the *Porosphæra* lived and grew. They are now found solidly infilled with the soft chalky matrix which can readily be extracted.

A further interest is attached to these naturally perforated examples of *Porosphæra* from the fact that similar forms have been found in association with the remains of the "River-Drift" folk, and it has been surmised * with much probability that they may have been used by them for personal adornment, such as necklaces, etc.

P. Woodwardi, Carter, is generally of a rounded form with one or more slightly projecting peaks; the base is small, concave, and

* Rigollot, Mém. sur des Instruments en Silex, etc., Amiens, 1854, p. 16; Parker and Jones, Ann. and Mag. Nat. Hist., ser. 3, vi. (1860) p. 30; James Wyatt, Geologist, v. (1862) p. 233; T. Rupert Jones, tom. cit., p. 236; Sir C. Lyell, Antiquity of Man, 1863, p. 119, fig. 15; 4th ed., 1873, p. 165; Worthington Smith, The Primitive Savage, 1894, p. 272; Sir John Evans, Ancient Stone Implements of Great Britain, 2nd ed. 1897, p. 657.

EXPLANATION OF PLATE I.—*continued.*

Fig. 19. *Porosphæra Woodwardi*, Carter, sp. Showing the branching surface canals. × 2 diam. Zone of *Holaster subglobosus*; Dover. Collection of Dr. Rowe.

,, 20, 20*a*. *Porosphæra pileolus*. Thimble-shaped specimen, with a fragment of dermal layer on the exterior; the base (20*a*) showing concentric bands of growth. Zone of *A. quadratus*; near Newhaven. Collection of Dr. Rowe.

,, 21, 21*a*. Ditto. Zone of *Marsupites* (*Uintacrinus* Band); Thanet coast. Collection of Dr. Rowe.

,, 22, 22*a*. *Porosphæra patelliformis*, sp. n. Viewed in profile (22); the deeply concave base (22*a*) showing concentric lines of growth and faint radial lines. Zone of *A. quadratus*; Sussex coast. Collection of Dr. Rowe.

,, 23, 23*a*. Ditto; a conical specimen, viewed in profile (23); the base with faint concentric lines of growth (23*a*). Zone of *Marsupites* (*Uintacrinus* Band); Thanet coast. Collection of Dr. Rowe.

,, 24, 24*a*. Ditto; a depressed specimen, viewed in profile (24); the base with concentric and radial lines (24*a*). Same zone and locality as the preceding. Collection of Dr. Rowe.

,, 25. Ditto; viewed from above, showing some fragments of the spicular dermal crust. Same zone and locality as the preceding. Collection of Dr. Rowe.

,, 26, 26*a*. Ditto; a small specimen, viewed in profile, natural size (26); and the concave base, with rod-like spicules radiating from the centre to the margins, enlarged 4 diam. (26*a*). Zone of *Terebratulina gracilis*; East Cliff, Dover. Collection of Dr. Rowe.

,, 27, 27*a*. *Porosphæra arrecta*, sp. n. Viewed in profile (27), and showing the base (27*a*), enlarged 3 diam. Zone of *Rhynchonella Cuvieri*; Branscombe Cliff, South Devon coast. Collection of Dr. Rowe.

,, 28, 28*a*. Ditto; showing the exterior and the basal aspect, enlarged 3 diam. Zone of *Marsupites* (*Uintacrinus* Band); Thanet coast. Collection of Dr. Rowe.

wrinkled (pl. I., fig. 19.). The specimens are now free, but the wrinkled character of their bases seems to indicate that they may have been attached to some foreign body during life. From the surface elevations deeply impressed branching canals radiate down their sides.

Typical examples of *Porosphæra pileolus* are thimble- or inverted cup-shaped, with thick walls and deeply concave bases; the basal hollow is lined with a spicular dermal layer and shows successive growth-rings or bands. The upper surface of this species resembles that of *P. globularis* (pl. I., figs. 20, 21). In *P. patelliformis*, the outer form resembles that of a limpet, the basal cavity is wide, the walls are comparatively thin, and it is furnished with a distinct basal dermal layer (pl. I., figs. 22–26*a*) In yet another form which I have named *arrecta*, the sponge is like a small, upright tapering pillar with a concave base (pl. I., figs. 27–28*a*). In some specimens the base may probably have been attached originally to some other body.

VI. Skeletal Mesh.

The skeleton of *Porosphæra* is of a stony character; in thin sections under the Microscope it appears to be made up of a finely porous mesh-work of continuous anastomosing fibres, in which, however, little structure can now be distinguished. The nature of the mesh-fibres is better shown on the surface of specimens obtained directly from the Chalk. These, when carefully cleaned from the matrix, exhibit under a strong lens or a Microscope a multitude of minute, projecting spines or rays, which also can be recognised by a rasping sensation when the finger is rubbed over the surface. On close examination, each of these projecting rays can be seen to spring from the central junction of three other short, generally recurved rays, and they are, in fact, the apical rays of four-rayed spicules similar to those in *Plectroninia* and *Petrostroma*. The three sub-equal, short facial rays of these spicules have truncate ends, which are fused or welded to the surfaces of the adjoining spicules, in such a manner as to form the mesh-fibres which delimit the radial canals (pl. II., figs. 6, 9).

The nature of the skeleton of *Porosphæra* in the early stages of growth is admirably shown in a small specimen of *P. globularis*, about 1·25 mm. in diameter, which has been preserved in a flint from the Upper Chalk of Kent (pl. II., fig. 1). The specimen was discovered by Mr. H. Muller, of Eltham, to whom I am indebted for the opportunity of studying it. The apical rays are very prominent, and the facial rays are already firmly fused to those of adjacent spicules. By further surface growth these prominent apical rays would be partially surrounded by and welded to the facial rays of the succeeding layer of spicules above them, and would thus be

incorporated with the mesh-fibres, so that they would be hardly, if at all, recognisable in microscopic sections of the interior of the organism. In older specimens of *Porosphæra* the mesh-spicules are frequently considerably larger and thicker than in the young individual just referred to (pl. II., fig. 9).

In sections of specimens of *P. globularis* and of *P. pileolus* from South Croydon, the free apical spicular rays near the surface are seen to be furnished with stout lateral prickles, closely resembling those in *Plectroninia Halli* (pl. II., figs. 5, 6).

VII. Basal Layer.

The hollow inverted cup- or thimble-shaped bases of *P. pileolus,* and the more open saucer-like bases of *P. patelliformis,* show concentric lines or bands, which mark intervals of growth (pl. I., figs. 20*a*–24*a*); and these are lined by very slender thread-like and occasionally wavy spicules, disposed generally parallel with each other, in the direction of the margin of the cup. These spicules are so fine and closely set that it is difficult to determine whether they are simple rods or rays of three-rayed spicules; but in some few specimens there is a thin exterior layer of straight, slender spicular rods, extending downwards and outwards like thatch on a roof (pl. I., fig. 26*a*).

In *P. Woodwardi* the base is small, concave and rugose, and its spicular characters are obscured.

VIII. Spicular Dermal Layer.

With a few rare exceptions, the outer surface of *Porosphæra,* even of well-preserved specimens which have had the chalky matrix carefully removed, only shows the skeletal fibres and the projecting apical rays of the spicules described above. But in the exceptional examples, the usual skeletal mesh is covered in places with a layer or crust of so different a character and appearance that at first sight it might have been taken for an encrusting sponge which had settled and grown on the outside of the *Porosphæra.* This dermal layer appears as a whitish crust, in some instances thin and smooth, in others of measurable thickness, uneven, and with occasional small projections (pl. I., figs. 7, 8). Examined directly under the Microscope, it is seen to consist, in the majority of cases, of an agglomeration of minute three- and four-rayed spicules, with an admixture of simple rods so intimately and irregularly mingled together that it is difficult to distinguish the individual forms. These spicules seem to have been originally quite free and not connected together organically in any way (pl. II., fig. 7). In one or two specimens the outer surface of the dermal

layer consists of very slender rod-like spicules, regularly disposed side by side or arranged concentrically round a small opening (? pore). (Pl. II., fig. 10.)

Out of a total number of about 3000 specimens of *Porosphæra* examined, I have only met with a dermal layer in eighteen individuals. In but two of these does it extend over the whole surface; in the others only small patches of the skeletal mesh are now covered by it. Where thin, the apical spicular rays can be seen to penetrate through it. It occurs in specimens of *P. globularis, P. nuciformis, P. pileolus* and *P. patelliformis,* from different localities and horizons, from the zone of *Micraster cor-testudinarium* upwards, with the exception of the zone of *M. cor-anguinum.* Proportionately, a larger number of specimens with the dermal layer partially preserved are found in the zone of *Bel. mucronata* than in the lower horizons of the English Chalk.

In its structure and general characters, the dermal layer of *Porosphæra* is very similar to that of the Tertiary *Plectroninia* and the recent *Petrostroma* from the Japanese Sea. In both of these

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EXPLANATION OF PLATE II.

Fig. 1. *Porosphæra globularis*, Phill., sp. A small specimen, preserved in flint, showing the spicular structure of the exterior. × 50 diam. Upper Chalk; near Sidcup, Kent. Collection of Mr. H. Muller.

,, 2. Ditto; portion of the outer surface, showing the arrangement of the skeletal spicules bounding the apertures of the radial canals. × 40 diam. Zone of *Belemnitella mucronata*; Ballard Cliff, Dorset coast. Collection of Dr. Rowe.

,, 3. Ditto; three-rayed spicules of the dermal layer. × 100 diam. Zone of *Actinocamax quadratus*; Scratchell's Bay, Isle of Wight. Collection of G. J. Hinde.

,, 4. *Porosphæra nuciformis*, v. Hag., sp. Portion of the surface, showing the skeletal spicules and the radial canal apertures. × 40 diam. Zone of *A. quadratus*; Cliff, east of Brighton.

,, 5. *Porosphæra pileolus.* A four-rayed mesh spicule, the apical ray armed with lateral prickles. From a microscopic section near the margin of the specimen. × 200 diam. Zone of *Micraster cor-anguinum*; South Croydon. Collection of G. J. Hinde.

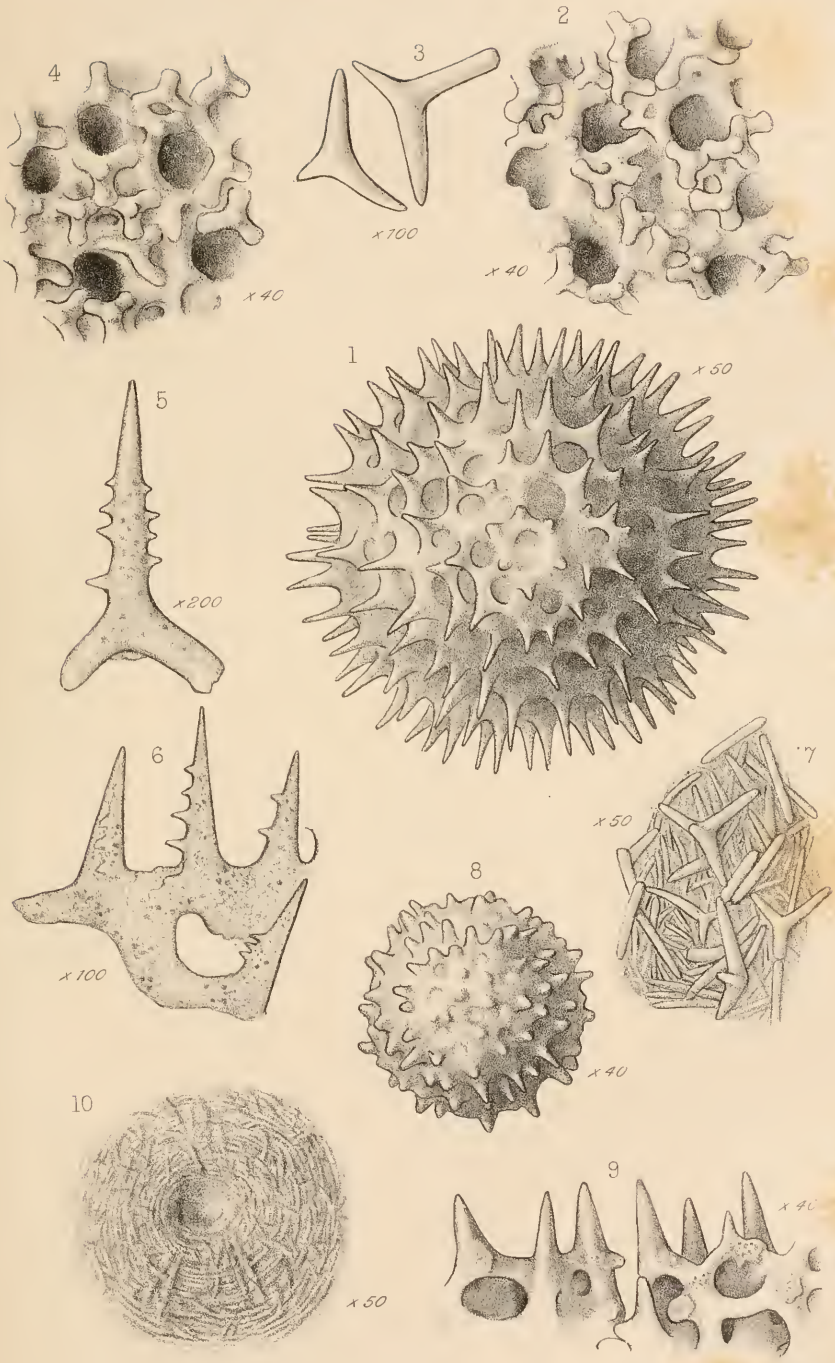
,, 6. *P. globularis.* A portion of the skeletal mesh, showing its structure of four-rayed spicules, the basal rays of which are now fused together. × 100 diam. Zone of *M. cor-anguinum*; South Croydon. Collection of G. J. Hinde.

,, 7. Ditto; a fragment of the dermal layer, showing three- and four-rayed spicules irregularly intermingled. × 50 diam. Zone of *B. mucronata*; Ballard Cliff, Dorset coast. Collection of Dr. Rowe.

,, 8. Ditto; a small specimen preserved in chalk, showing blunted apical rays of spicules projecting from the surface. × 40 diam. Upper Chalk, Gravesend, Kent. Collection of Mr. T. H. Powell.

,, 9. Ditto; the skeletal mesh near the margin of a specimen preserved in flint, showing the curved facial and the projecting apical rays of four-rayed spicules. × 40 diam. Upper Chalk; Chatham. Jermyn Street Museum.

,, 10. Ditto; portion of the outer surface of the dermal layer, showing rod-like spicules arranged concentrically round a central pore (?). × 50 diam. Zone of *Belemnitella mucronata*; Ballard Cliff, Dorset coast. Collection of Dr. Rowe.



G. M. Woodward del. et lith.

West, Newman imp.

POROSPHÆRA FROM THE ENGLISH CHALK.

genera the dermal layer is very fragile and easily removable from the connected skeletal mesh of the body of the sponge, and Dr. Döderlein* states that in the specimens of the latter genus, which had evidently been dead some time before they were hooked up from the bottom of the sea, every trace of the dermal layer had disappeared.

It seems to me, therefore, highly probable that in the various forms of *Porosphæra* from the Chalk a spicular dermal layer covered the surface originally, and its subsequent complete disappearance from the very large majority of these specimens may be attributed to the loose intermingling and the absence of organic connection of its constituent spicules, whereby the crust became liable to disintegration and removal soon after the death of the organism. It is only owing to exceptionally favourable conditions of preservation that some small fragments of the dermal layer still remain on a few of these sponges.

IX. Canal System.

All the forms of *Porosphæra* possess a series of simple, straight canals which, in *P. globularis* and *P. nuciformis,* radiate in all directions from a central point or area to the surface of the sponge (pl. I., fig. 6), whilst in *P. pileolus, P. patelliformis,* also in *P. Woodwardi,* they radiate upwards and outwards from the centre of the concave base. The canals are closely arranged, uniformly small, and of the same dimensions throughout their length; as the sponge increases in size fresh canals are intercalated. The canals are bounded by the spicular mesh-fibres and free intercommunication can take place in the small spaces between the fibres.

In *P. nuciformis,* in addition to the radial canals of the interior, there are simple, shallow, surface grooves, with intermediate, slightly elevated, rounded ridges, which are directed meridionally towards the summit of the sponge, where, however, there is no special aperture. Generally there is but one pole towards which the grooves converge (pl. I., figs. 11–17), but in some rare specimens there are two or more elevations which serve as centres (pl. I. fig. 18). These grooves are but surface features, and they are frequently so faintly marked as to be scarcely noticeable, but it seems probable that they played some part in the circulation of the sponge.

In *P. Woodwardi* there are distinct, strongly marked, branching canals, which extend from one or more slightly raised peaks down the sides of the sponge (pl. I., fig. 19). As in *P. nuciformis,* there is no special aperture at the slightly projecting points where

* Zool. Jahrb., x. (1898) p. 17.

the canals converge. Though now open surface canals, it is likely that they were covered by a dermal layer during the life of the sponge.

X. Affinities of the Genus.

The structure of *Porosphæra*, described above, shows clearly that it is a Calcisponge, belonging to the group of the Lithonina, and its nearest ally is *Plectroninia*, Hinde,* from Tertiary strata, near Geelong, Australia. In common with the other members of this group, it has a very firm resistant skeletal mesh of fibres composed of four-rayed spicules, each with a partially free apical ray and three facial rays, which are intimately fused with the rays of adjoining spicules. It also possessed a dermal layer of loosely interwoven spicules of a readily destructible character. It is distinguished from *Plectroninia* by the well-marked simple radiate canals of the interior, by the absence of distinct floors or layers of growth consisting of smaller spicules, not definitely fused together, and further, by the apparent absence of minute "tuning-fork" spicules. From *Petrostroma*, Döderlein,† *Porosphæra* is also distinguished by its radial canals, and its skeletal fibres are not fused into radial balks, with smaller connecting spicules, as in the former genus. Whether the fibres of *Porosphæra* were invested with a common calcareous pellicle like those of *Plectroninia* is uncertain, for their state of preservation does not allow of determination.

XI. Description of Species.

Porosphæra globularis, Phill. sp. (pl. I., figs. 1–10; pl. II., figs. 1–3, 6–10).

1829. *Millepora globularis*, Phill., Geol. Yorks., pt. 1, p. 186, pl. i., fig. 12.
1833. „ „ S. Woodward, Geol. Norfolk, p. 46, pl. iv., figs. 10–12.
1844. *Ceriopora pisum*, Reuss, Geognostische Skizzen aus Böhmen, vol. ii, p. 140.
1845. *Tragos globularis*, Reuss, Versteinerungen böhm. Kreideformation, Abth. ii. p. 78, pl. xx., fig. 5.
1850. *Coscinopora globularis*, A. d'Orbigny, Prodr. de Paléont., vol. ii., p. 284.
1854. „ „ Morris, Cat. Brit. Foss., 2nd ed. p. 27.
1860. *Orbitolina globularis*, Parker and Jones, Ann. and Mag. Nat. Hist., ser. 3, vol. vi., p. 34.
1864. *Achilleum globosum*, F. A. Roemer, Palæontographica, vol. xiii., p. 56.
1875. *Coscinopora globularis*, Etheridge, Geol. Yorks, 3rd ed. p. 322, pl. i., fig. 12.
1878. *Porosphæra globularis*, Steinmann, pars. Palæontog., vol. xxv., p. 120.
1879. *Ceriopora nuciformis*, Quenstedt, pars. Petrefactenk. Deutschl., vol. vi., p. 262; Atlas, pl. 153, figs. 1–7, 9.

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* Quart. Journ. Geol. Soc., lvi. (1900) pp. 50–66, pls. iii. and iv.
† Zool. Jahrb., x. (1898) pp. 15–32, pls. ii.–vi.

1879. *Porosphæra globularis*, v. Zittel, Handb. der Pal., vol. i., p. 288.
1888. „ „ H. A. Nicholson, Ann. and Mag. Nat. Hist, ser. 6, vol. i., p. 11.
1889. „ „ Nicholson, Man. Pal., 3rd ed. vol. i., p. 200.
1889. *Amorphospongia globosa*, A. Fritsch, Stud. Gebiete d. böhm. Kreidef., vol. iv., p. 108, fig. 52.
1900. *Porosphæra globularis*, Rowe, Proc. Geol. Assoc., vol. xvi., pt. 6, pp. 299, 344, 361; vol. xvii., pt. 1 (1901) pp. 67, 71; vol. xviii., pt. 3 (1903) pp. 37, 49.
1903. „ „ Steinmann, Einführung in die Paläontologie, p. 95, fig. 125.

Sponges simple, generally rounded, like peas or marbles, but sometimes oval, loaf- or cushion-shaped, without any distinctive base; for the most part free and unattached, but in many cases they grew round foreign bodies which have been incapable of fossilisation, and these sponges now exhibit cylindrical hollow tubes which extend partly or entirely through them (pl. I., fig. 1). Generally increase of growth is uniform over the surface, but in some instances fresh layers are formed so as to cover but portions of the surface at once (pl. I., fig. 2). Small specimens are found of about 1 mm. in diameter; the larger forms range to 34 mm. in diameter.

The outer surface is completely covered with the minute apertures of straight, simple canals, which radiate outwards from a central point or small area, with intercalations as the sponge increases in size. The apertures of the canals are rounded or somewhat polygonal, from 0·16 to 0·25 mm. in diameter, and they are separated from each other by the delicate mesh fibres; the interspaces being sometimes less than, and sometimes exceeding, the width of the canal apertures. Rarely, shallow open grooves are faintly shown on parts of the surface of some of the larger loaf-shaped forms (pl. I., figs. 9, 10).

The four-rayed spicules which form the skeletal fibres vary somewhat in size in different specimens. The pointed apical ray is directed outwards; those near the exterior project as minute spines beyond the general surface of the sponge; sometimes this ray is smooth, sometimes armed with horizontal prickles. The apical ray ranges from 0·14 to 0·35 mm. in length, and from 0·04 to 0·1 mm. in thickness at the base. The three facial rays of the spicules are shorter than the apical ray; they curve downwards, tripodal fashion, and are truncate at the ends where fused to proximate spicules. They are from 0·1 to 0·2 mm. in length, and from 0·04 to 0·075 mm. in thickness. The mesh fibres formed by the fusing together of the individual spicules are about 0·11 mm. in thickness.

The dermal layer, which is very rarely preserved, is a whitish crust, uneven, and with small protuberances in places; it consists of three- and four-rayed spicules and apparently simple rod-like

forms confusedly intermingled (pl. II., figs. 3, 7). The rays of the former are from 0·14 to 0·22 mm. in length, and about 0·03 mm. in thickness. The exterior surface of the dermal layer appears to be composed of very delicate linear spicules, regularly arranged; in one instance they are disposed concentrically round a small pore-like aperture (pl. II., fig. 10).

Distribution.—*P. globularis* is by far the most numerous species of the genus; out of a total of 2902 specimens from the English Chalk which I have examined, 2357, or slightly over 81 p.c., belong to it. Its earliest appearance is at the base of the Middle or Turonian Chalk in the zone of *Rhynchonella Cuvieri* at Dover and the South Devon coast. It is distributed generally in all the higher zones of the Chalk, and becomes more numerous and larger in size till reaching its maximum in the zones of *Micraster coranguinum* and *Marsupites.* The loaf- and cushion-shaped forms occur chiefly in the *Marsupites* zone at Margate and the Thanet coast, and in the *Bel. mucronata* zone at Ballard Cliff and Studland Bay, on the Dorset coast. It is common in the Chalk of Flamborough Head and Sewerby, on the Yorkshire coast, where the specimens are small generally. It is also abundant at and near Newhaven and Brighton, and in the Isle of Wight. Inland, it is found plentiful at and near Croydon, Surrey, and sparsely in Hampshire and Wiltshire.

According to Steinmann, *P. globularis* is generally present in the Chalk of Middle and Northern Europe. Reuss and Fritsch record it from the Teplitzer beds (Lower Senonian ?) at Kutschlin and near Bilin, in Bohemia, and von Hagenow from the island of Rügen. Lately Ravn * has recognised it in the Bryozokalk (Older Danian) of Jutland.

Porosphæra nuciformis, von Hagenow, sp. (pl. I., figs. 11–18; pl. II., fig. 4).

1822. *Zoophyte of a pyriform shape, the nature of which is unknown,* Mantell, Geology of Sussex, p. 162, pl. xvi., figs. 17, 18.
1839. *Ceriopora nuciformis,* von Hagenow, Neues Jahrb. für Min., p. 286, pl. v., fig. 9.
1872–5. „ „ Geinitz, Palæontographica, vol. xxii., p. 4.
1879. „ „ Quenstedt, pars. Petrefact. Deutschl., p. 62.
1900. *Porosphæra Woodwardi,* Rowe (non Carter), Proc. Geol. Assoc., vol. xvi., pt. 6, pp. 304, 344, 361; vol. xvii., pt. 1 (1901) pp. 67, 72.

Sponges free, simple, typically pear-shaped, but occasionally melon- or loaf-shaped, with longitudinal low swellings or ridges, and intermediate shallow grooves which converge to the obtuse pole of the sponge. The number of the ridges variable; in some specimens they are set closer and more strongly marked than in

* Kgl. Danske Vidensk. Selsk. Skrifter, 6 Række, xi. 6 (1903) p. 423.

others, sometimes also there are two or more slight elevations to which the grooves converge (pl. I., fig. 18). There are no special apertures at the point of convergence beyond the openings of the minute radial canals, which are present all over the surface, alike on the ridges and the grooves.

As in *P. globularis,* a number of these sponges are penetrated by cylindrical tubes which extend either longitudinally or transversely through them; of those which I have examined about 17 p.c. are traversed by tubes. The sponges range from 4 to 20 mm. in diameter.

The spicular structure of the skeletal fibres appears similar to that of *P. globularis,* and the same may be said of the dermal layer, fragments of which, however, were only observed on the surface of two specimens.

From *P. globularis,* this species is distinguished by its form and the ridges and grooves of its surface; and from *P. Woodwardi,* Carter, by the absence of a concave base of attachment and by the great difference between its shallow simple grooves and the branching canals of *P. Woodwardi.* Specimens of *P. nuciformis* have been generally referred to Carter's species, but this latter is rare, and it seems to me a quite distinct form, and, moreover, it is restricted to a lower zone than that in which *P. nuciformis* occurs.

Von Hagenow considered that the pear-shaped specimens of *nuciformis* which he figured were only more perfect examples of the spherical forms, that is of *P. globularis,* Phillips, of which he makes no mention, and he evidently intended to include both in the species *nuciformis.* If this were the case, Phillips' name would have the priority, but it seems to me that the pear-shaped, grooved forms differ specifically from *P. globularis,* and I propose to retain for them Hagenow's name *nuciformis.*

Distribution.—*P. nuciformis* makes its first appearance in the zone of *Micraster cor-anguinum* at Croydon, coast of Thanet and Dorset, and at Flamborough; it is relatively more numerous in the zone of *Marsupites* at Margate and the Thanet coast, and reaches its maximum in numbers and size in the zone of *Act. quadratus* at and near Newhaven, near Brighton, and the Isle of Wight; it is also numerous in the zone of *Bel. mucronata* at Ballard Cliff and Studland Bay, Dorset, and likewise occurs at Trimingham, Norfolk coast. Abroad it is found in the Chalk of Rügen.

Porosphæra Woodwardi, Carter sp. (pl. I., fig. 19).

1877. (?) *Bradya tergestina,* Carter (non Stache), Ann. and Mag. Nat. Hist., ser. 4, vol. xix., p. 64.
1878. *Millepora Woodwardi,* Carter, op. cit., ser. 5, vol. i, p. 306, pl. xvii., figs. 6–8.

1878. *Porosphæra globularis*, Steinmann, pars. Palæontographica, vol. xxv., p. 120, pl. xiii., figs. 8–10.
1900. *non Porosphæra Woodwardi*, Rowe, Proc. Geol. Assoc., vol. xvi., pt. 6, pp. 304, 344, 361; vol. xvii., pt. 1 (1901) pp. 67, 72.

Small oval or rounded sponges, from 12 to 18 mm. in diameter, with deeply impressed branching canals which extend from the basal portion to the summit, and also to one or more lateral centres. There is no special aperture either at the summit or at the sides where these canals meet. The base of the sponge is concave, elongate and rugose, and it appears to have been fixed; no spicular structure can be recognised in it.

The surface of the sponge is covered with the apertures of radial canals, which are about 0·16 mm. wide and from one to two diameters apart. The skeletal fibres are about 0·05 mm. in thickness; the spicules in them are now rarely visible, but here and there in thin sections the pointed apical rays can be distinguished; these are about 0·11 mm. in length by 0·04 mm. in width at the base.

This species, which has been fully described by the late Mr. Carter, is distinguished from any of the other Chalk species of *Porosphæra* by the strongly-marked branching canals of the surface, which are very distinct from the simple, shallow grooves in *P. nuciformis*. From this latter it differs also in the possession of a concave base of attachment.

Professor Steinmann considered that the branching canals in *P. Woodwardi*, Carter, were of no real signification, and he included the species in *P. globularis*, in which, however, these features are not present.

P. Woodwardi is rare, and in this country has only been met with in the Grey Chalk of the zone of *Holaster subglobosus* at Dover, and at Durdle Cove, Dorset. The specimens from the higher zones of the Chalk, which have been referred by Dr. Rowe and others to this species, really belong to *P. nuciformis*. Steinmann also states that this species occurs in the Upper Chalk (Senonian) of Vordorf and Ahlten, North Germany, but it is probable that the forms mentioned should be included in *P. nuciformis*.

Porosphæra pileolus (pl. I., figs. 20–21*a*; pl. II., fig. 5).

1829. *Lunulites urceolata*, Phill. (non Lamarck), Geol. Yorks., pt. 1, p. 186, pl. i., fig. 11.
1854. *Coscinopora* (?) *pileolus*, Morris, Cat. Brit. Foss., 2nd ed. p. 28.
1860. *Orbitolina concava*, Parker and Jones (non Lam. sp.) Ann. and Mag. Nat. Hist., ser. 3, vol. vi., pp. 35, 39.
1875. *Coscinopora pileolus*, Etheridge (Phill.) Geol. Yorks. 3rd ed. p. 322, pl. i., fig. 11.
1900. *Porosphæra pileolus*, Rowe, pars. Proc. Geol. Assoc., vol. xvi., pt. 6, pp. 304, 344, 361; vol. xvii., pt. 1 (1901) pp. 67, 72.

Sponges simple, free, thimble- or inverted cup-shaped, sometimes hemispherical, with a deeply concave, cup-shaped base. Walls thick. The outer surface is even, without grooves or ridges, and covered with the apertures of the minute radial canals. The concave base shows concentric rings or bands of growth, and a small umbo or boss at the bottom. The specimens range from 2 to 18 mm. in diameter.

The skeletal fibres resemble those of *P. globularis*. The canals radiate upwards from the basal layer. The concave base has a layer of minute spicular rays, regularly arranged like thatch on a roof, and outside of this there appear to have been elongate, slender, rod-like spicules.

In one specimen there is a small fragment remaining of a spicular dermal crust of a similar character to that in *P. globularis*.

This species is characterised by its form, thick wall, and deeply concave base.

The various specific names by which this species has been known, are taken from Lamarck's *Animaux sans Vertèbres*, tom. ii. (1816) pp. 190–197. They were applied originally to Foraminifera or Polyzoa, and therefore have no proper connection with this sponge. It seems to me desirable, however, that quite independently of Lamarck's use of the term "*pileolus*," it may be suitably retained for this species of *Porosphæra*.

Distribution.—*P. pileolus* is first known from the *Holaster planus* zone at Dover, and from this upwards it occurs in the higher beds of the Chalk to the top of the *Actinocamax quadratus* zone at Croydon, Margate, Thanet coast, near Newhaven, near Brighton, Isle of Wight, Dorset coast, as well as at Flamborough and Sewerby, Yorkshire.

Porosphæra patelliformis, sp. n. (pl. I., figs. 22–26*a*).

1822. *Lunulites* (?) Mantell, Geology of Sussex, p. 180, pl. xvi., figs. 22-24.
1835. *Orbitolites lenticulata*, Mantell (non Lam.), Trans. Geol. Soc., ser. 2, vol. iii,. p. 204.

Sponges limpet-shaped, with peaked or rounded summits, base rounded or oval in outline, usually deeply concave, but occasionally flattened, and in some young specimens even slightly convex. Wall relatively thin. The specimens range from 2 to 23 mm. in diameter.

The skeletal fibres are of a somewhat coarse character, and the radial canals are short; their apertures range to 0·3 mm. in width. The concave base shows concentric bands of growth, and its spicular structure is similar to that of *P. pileolus*. Usually there is no boss at the bottom of the base. A spicular dermal crust covers in part the surface of one specimen (pl. I., fig. 25).

This species is distinguished from *P. pileolus* by its limpet-like

form, thin walls, slight development of the radial canals, and somewhat coarser skeletal fibres.

Distribution.—It occurs, rarely, in the zones of *Terebratulina gracilis* and *Holaster planus* at Dover, and in each succeeding higher zone of the Chalk. It is most abundant in the *M. cortestudinarium* zone near Newhaven, in the *Uintacrinus* band of the Thanet coast, and at Flamborough.

Porosphæra arrecta, sp. n. (pl. I., figs. 27–28*a*).

Sponges small, simple, conical pillar-shaped, the base concave with thin margins; in some specimens it retains traces of spicules, whilst in others it is rugose, as if it had been attached to an uneven surface originally. The sponges are about 8 mm. in height, and the diameter of the base from 3 to 7 mm.

The walls are thin and the canals are scarcely noticeable; whilst the skeletal fibres are of the usual character.

This form is rare; it first appears in the zone of *R. Cuvieri* at Branscombe and Barry Cliff on the South Devon coast; it occurs also in the zone of *M. cor-anguinum* at Flamborough, in the *Marsupites* zone at Margate, and in the *A. quadratus* zone near Newhaven.

Porosphæra. Irregular forms.

There are a few specimens in the collections examined which differ from any of the species described above, but do not present any features sufficiently well marked to justify placing them as distinct forms. Some are merely thin crusts either overlapping one another, or attached to other bodies, others are spindle-shaped and free, whilst yet others appear to be distorted or monstrous growths of *P. globularis* and *P. patelliformis.*

XII. Summary.

The descriptions of the structure of *Porosphæra* given in this paper are based chiefly on extensive collections from the various zones of the English Chalk made by Dr. A. W. Rowe and by the author. The fossils have long been well known, but owing to their state of preservation, it has been difficult to ascertain their minute structure, and hence very divergent opinions have been held respecting their nature and systematic position; latterly, however, the view that they were Hydrozoa, structurally allied to *Millepora* and *Parkeria*, has been generally accepted. It is now definitely shown that the calcareous anastomosing fibres of their

skeleton consist of four-rayed spicules, in which one ray is tapering and the other three blunted and organically fused to adjoining spicules. They also possessed originally a crust or dermal layer of smaller spicules than those of the skeletal mesh, which are not fused together, and also in some forms a distinct spicular base is present. In the form of the skeletal spicules and in their arrangement *Porosphæra* closely resembles the Calcisponge genus *Plectroninia,* Hinde, from the Eocene (?) Tertiary of Australia, and the recent *Petrostroma,* Döderlein, from the Japanese sea, and with these genera it finds a place in the Lithonina group of Calcisponges. Descriptions are given of the following species: *P. globularis,* Phill., *P. nuciformis,* von Hag., *P. Woodwardi,* Carter, *P. pileolus, P. patelliformis,* sp. n., and *P. arrecta,* sp. n.

II.—*Microscopic Resolution: Note on a Point in Lord Rayleigh's Paper of* 1896.*

By Professor J. D. Everett, F.R.S.

(*Read November* 18*th*, 1903.)

In Lord Rayleigh's paper of 1896, which contains the fullest investigation ever published of the theory of microscopic resolution, there is one paragraph of special difficulty,—that in which the transition is made from direct to oblique illumination of a grating under the Microscope, the aperture being supposed rectangular.

With direct illumination, the phase of vibration is the same all over the grating, and it is shown that the amplitude of vibration at any point in the plane of the image is expressed by the series

$$\frac{\sin u}{u} + \frac{\sin (u + v)}{u + v} + \frac{\sin (u - v)}{u - v} + \frac{\sin (u + 2v)}{u + 2v} + \ldots \quad (28)$$

v denoting the increment of u from line to line of the grating, or of its geometrical image.

The change to oblique illumination introduces a uniform phase-difference from line to line; and it is assumed (for reasons not stated) that this has the effect of changing the expression for the amplitude to

$$\frac{\sin u}{u} + \frac{\sin (u + v)}{u + v} e^{-imv} + \frac{\sin (u - v)}{u - v} e^{imv}$$
$$+ \frac{\sin (u + 2v)}{u + 2v} e^{-2imv} + \ldots \quad . \quad . \quad (32)$$

i denoting $\sqrt{-1}$, and m a multiplier to be determined.

It is not easy to see how this series can be equal to a quantity which is entirely real; and apart from this difficulty the process of deducing a practical result is rather laborious. I wish to indicate a simpler process leading to the same result.

The grating-interval being denoted by ϵ, and the obliquity of illumination by γ, the difference of optical path from line to line

* See this Journal, August, 1903, pp. 447–73.

is $\epsilon \sin \gamma$, giving a phase-difference $\frac{2\pi}{\lambda} \epsilon \sin \gamma$. This is to be added (with its proper sign) to the phase-difference v in (28), which is found, on examination, to have the value $\frac{2\pi}{\lambda} \sin \alpha$ (α denoting the numerical aperture). It is, therefore, simply necessary to assign to v in (28) the value $\frac{2\pi}{\lambda} (\sin \alpha + \sin \gamma)$, and (28) will be the general expression for the amplitude for any obliquity of illumination (γ being zero when the illumination is direct). This conclusion is in accordance with (45), which is the final result deduced from (32).

The value above assigned to v for direct illumination is obtained in the following way. Let σ denote the distance from line to line in the geometric image of the grating. The magnification σ / ϵ is, by the sine-law, equal to $\sin \alpha / \sin \theta$, the small angle θ being equal (in the notation of the paper) to $\frac{1}{2} \alpha$ divided by f. As u stands for the abscissa of a line in the geometric image multiplied by $\frac{\pi \alpha}{\lambda f}$, its increment v is

$$\frac{\pi \alpha}{\lambda f} \sigma = \frac{\pi \alpha}{\lambda f} \epsilon \frac{2 f}{\alpha} \sin \alpha = \frac{2\pi}{\lambda} \epsilon \sin \alpha.$$

We assume (as usual) that the plane waves of illumination intersect the plane of the grating in lines parallel to the grating lines. The resolution will be most complete when $\sin \alpha + \sin \gamma$ is greatest, that is, when the difference of optical path from line to line is greatest. To this end, the grating (a small microscopic object) should be on one side of the axis of the Microscope, and the light should come from the other side; $\sin \alpha$ and $\sin \gamma$ will then have the same sign.

III.—*The Mouth-parts of the Nemocera and their Relation to the other Families in Diptera.*

By W. Wesché, F.R.M.S.

(*Read November 18th*, 1903.)

Plates III.–VIII.

The work which I have done on the trophi of Diptera has been mostly concerned with the Muscidæ. I have endeavoured to prove: (1) that the palpi, always regarded as maxillary, are in fact labial; (2) that the whole proboscis homologises with the typical insect mouth; (3) that the palpi in the Empidæ and Syrphidæ are homologous, but not homologous with those of the Muscidæ, the two former being maxillary, and the latter labial; (4) I have also formulated a rule which enables the observer to discriminate between the palpi of the two parts. "The maxillary palpi when present in Diptera are always in contact with the stipites and cardines of the maxillæ." The application of this rule, and the comparison of a large number of parts, have enabled me to divide nearly all the families of the order into eight groups.

Several difficulties have been pointed out to me by Mr. A. R. Hammond, F.L.S. (who is well acquainted with the anatomy of the Nemocera), in the Bibionidæ, the Tipulidæ, and the Chironomidæ; these I propose to deal with in my remarks on each group.

In my classification of the families into the different groups, a certain amount of generalisation must be allowed for; the remarkable diversity of the trophi in the order making this necessary. As it is, genera of the same family, and even the sexes of a species have been placed in different divisions, and I have little doubt but that exceptions, other than those I have noted, will be found, especially among the less known families and rarer species.

The first group consists of those flies which possess the nearly complete mouth-parts, and are without exception either blood-sucking or raptorial; mandibles are present, maxillæ lacking the galæ, labium without the palpi, labrum and hypopharynx. As to the epipharynx, it is generally indistinguishable in Diptera, and therefore best omitted; but I suspect a curious wrinkled membrane, lying under the hypopharynx in *Simulium reptans* L., of being this part.

Group 1.—All parts distinguishable, except the labial palpi, which are aborted.

Simulidæ. (Type *S. reptans* L.)
Culicidæ, the females only.
Tabanidæ, „ „ „
Asilidæ.

Group 2.—The mandibles are fused into the labium, and the labial palpi are aborted.

(*a*) *Raptorial, or blood-sucking.*
Empidæ, with exceptions.
Leptidæ. (Type *L. scolopacea* L.)
The genus Ceratopogon of the Chironomidæ.

(*b*) *Suctorial.*
Mycetophilidæ.
Psychodidæ.
Culicidæ, the males only and the genus Corethra.
Rhyphidæ. (Type *R. fenestralis* Scop.)
Bombylidæ.
Syrphidæ.

Group 3.—The mandibles are fused into the labium, the laciniæ and galæ of the maxillæ and the labial palpi are aborted.

Cecidomyidæ.
Chironomidæ, except the genus Ceratopogon. (Type *Ch. plumosus* L.)
Tipulidæ.
Stratiomidæ.
Conopodæ.

Group 4.—The mandibles are fused into the labium; all parts of the maxillæ except the stipites and cardines are aborted; the palpi present are labial, the tracheæ of the paraglossæ (labella) are only moderately developed.

Bibionidæ. (Type *B. hortulanus* L.)
Dolichopidæ.
Phoridæ.

Group 5.—The mandibles and other parts as in Group 4, but having the tracheæ well developed.

(*a*) *With remnants of maxillary palpi.*
Some Tachinidæ.
Some Muscidæ. (Type *M. domestica* L.)
Some Anthomyidæ.

(*b*) *With no remains of maxillary palpi.*

Lonchopteridæ.
Pipunculidæ.
Some Tachinidæ } Particularly highly modified
Some Muscidæ } genera, as Siphona or Stomoxys.
Some Anthomyidæ. (Type *C. erythrocephala* Mg.)
Cordyluridæ.
Ortalidæ.
Trypetidæ.
Loncheidæ.
Chloropodæ.
Hippoboscidæ.

Group 6.—The mandibles are fused into the labium; the cardines, stipites and laciniæ of the maxillæ are present, the latter leaf-shaped and pubescent; the paraglossæ are without teeth; the palpi are labial.

Phycodromidæ. (Type *C. frigida* Mg.)
Helomyzidæ.
Sciomyzidæ.
Sapromyzidæ.

Group 7.—The mandibles are fused into the labium; the maxillæ are embedded, the palpi being the only part exposed, labial palpi also present; the tracheæ of the paraglossæ are more or less well developed.

Opomyzidæ.
Sepsidæ.
Ephydridæ.
Drosophilidæ.
Borboridæ. (Type *B. equinus* Fln.)

Group 8.—All parts atrophied.

Œstridæ. (Type *G. equi* F.)

I propose making remarks on the trophi of these various families, each in its group, which will facilitate reference for those who wish to consult the paper on some particular family; but before doing so it will be of service to explain a diagram of a hypothetical mouth. This has mandibles, complete maxillæ, which only differ from those found in *Hydrellia griseola* by the presence of four joints in the palpi; a labium, also with four-jointed palpi, and which has incorporated into its paraglossæ the transverse levers which I homologise with the ligulæ; a well-marked labrum covering the hypopharynx, which is ciliated, with levers at the base which represent the submentum. This part is also known as the "fulcrum." The mentum is not prominent as

it is on the ventral side of the labium, but it is an important part of the trophi. All these parts are found in the various families of Diptera (pl. III. fig. 1).

I do not include the Pulicidæ in this classification, as good authorities place them in an order by themselves, Siphonaptera. But there are so many points of general affinity that I give a figure of the mouth-parts, which are however on a first view very far removed from the type in Diptera. The absence of any labium or paraglossæ at once differentiates them. These insects are provided with two sets of palpi, both four-jointed, the maxillary on the maxilla and the labial, higher up on the head, and having some analogy to the situation of the labial palpi in the Muscidæ. The labrum is absent or very minute, but the hypopharynx is well marked; the maxillæ have undergone a curious transformation, and the mandibles are scales on either side of the head (pl. I. fig. 2).

Group 1.—The Simulidæ have four-jointed maxillary palpi, and differ from the females of the genus Culex which have apparently only two joints, though the males have four. The hypopharynx in the Simulidæ is ciliated at the extremity, and under it is a curious wrinkled membrane which may possibly be the epipharynx; but this part is so minute that it is impossible to be certain, and I only note it as a possibility. The mandibles are provided with very beautiful serrated edges, and the maxillæ are even more complicated, as they are provided with a double row of sharp teeth. These insects are keen blood-suckers (pl. IV. fig. 7).

In the Culicidæ are curious differences:—(1) The genus Corethra though possessing the wing of a biting gnat, has a much less modified mouth-part; it is without mandibles, and the maxillæ are broad, minutely pubescent and unfitted for piercing purposes. (2) The mouth-parts of the sexes are different in the other genera (pl. II. fig. 5).

Since the mosquito has been found to be the host of the malaria parasite, this family has been much studied, and a number of new species has resulted in several fresh genera. Mr. F. V. Theobald has kindly placed many specimens at my disposal, and I have examined the following species with a view of finding specific or generic characters in the mouth-parts.

Culex pipiens L.
C. fatigans Wied.
C. annulatus Schrk.
C. concolor Des.
Stegomyia fasciata F.
Mizorhynchus barbirostris Walk.
Theobaldia spathipalpus Rond.

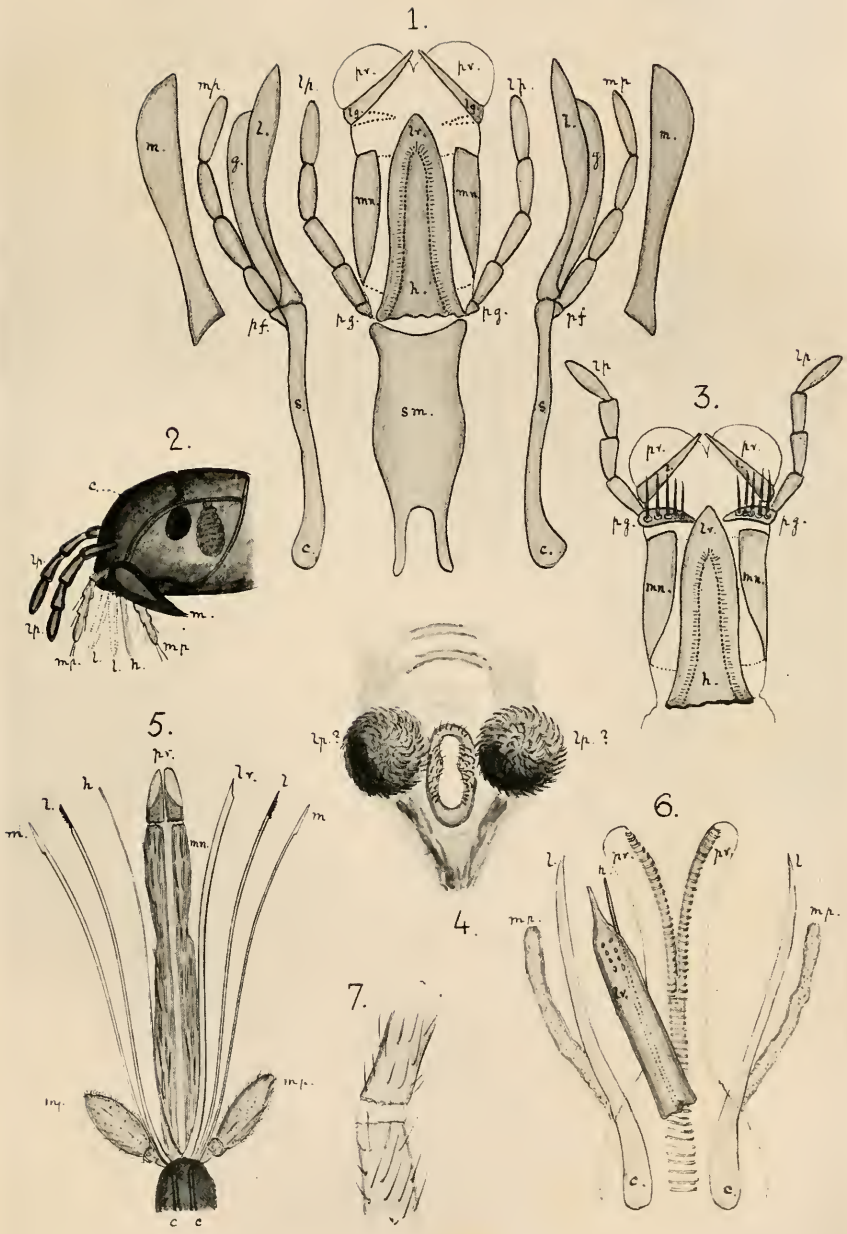
Grabhamia dorsalis Mg.
Myzomia rossii Theo.
Mansonia uniformis Theo.
M. annulipes Mg.
Tæniorhynchus conopus Frau.
Nyssorhynchus jamesii Theo.
Sabethes remipes Wied.
Desvoidia ventralis Walk.
Mucidus alternans Westw.
Dinocerites cancer Theo.
Anopheles cinereus Theo.
A. maculipennis Mg.
Ædomyia squamipennis Arrib.
Acartomyia longirostris Theo.
Verrallia butleri Theo.
Melanconion atratus Theo.
Uranotænia pygmæa Theo.
Eretmapodites sp., undetermined.

EXPLANATION OF PLATE III.

1. Diagram of a hypothetical complete mouth in Diptera. This is seen from the dorsal side; the maxillæ have been separated, and the mandibles removedf rom their positions on the dorsal sides of the maxillæ. The cardines and the submentum are supposed to have been dissected out of the enclosing membrane.
2. Mouth-parts of *Pulex irritans* L. Viewed laterally.
3. Diagram of a hypothetical labium of a common ancestor of the Tabanidæ and the Muscidæ. The labial palpi here are in the position they occupy in Dilophus, and the palpigers are representative of those found in *Chrysops cæcutiens* L.; they are to be found in most of the Muscidæ in a more posterior position, reverting to the position of the part in Blatta. Seen as in fig. 1.
4. Mouth parts of *Gastrophilus equi* F. In this family the trophi are quite rudimentary; in the figure the parts have been cut from the head of a female, and are seen from the ventral side. The upper part is the more anterior portion.
5. Diagram of the mouth-parts of the female *Culex pipiens* L. The parts are seen from the dorsal side. On the labium is marked a depression where the "false joint" is occasionally found. This rarely occurs in the females.
6. Diagram of the usual type of mouth armature in the Empidæ; the trophi in the Syrphidæ only differ by having a much greater development of the tracheæ on the paraglossæ; the characters of the mouth parts in the Empidæ are variable, constant in the Syrphidæ. The diagram is seen from the dorsal side.
7. The "false joint" in the labium of *Dinocerites cancer* Theo. Ventral view.

Note.—The following letters are used throughout the plates:—

m	Mandible.	
l	Lacinia.	Maxilla.
g	Galea.	Maxilla.
mp	Maxillary palpus.	Maxilla.
pf	Palpifer.	Maxilla.
s	Stipes.	Maxilla.
c	Cardo.	Maxilla.
pr	Paraglossa.	Labium.
lg	Ligula.	Labium.
lp	Labial palpus.	Labium.
pg	Palpiger.	Labium.
mn	Mentum.	Labium.
sm	Submentum.	Labium.
lr	Labrum.	
h	Hypopharynx.	
cl	Clypeus.	



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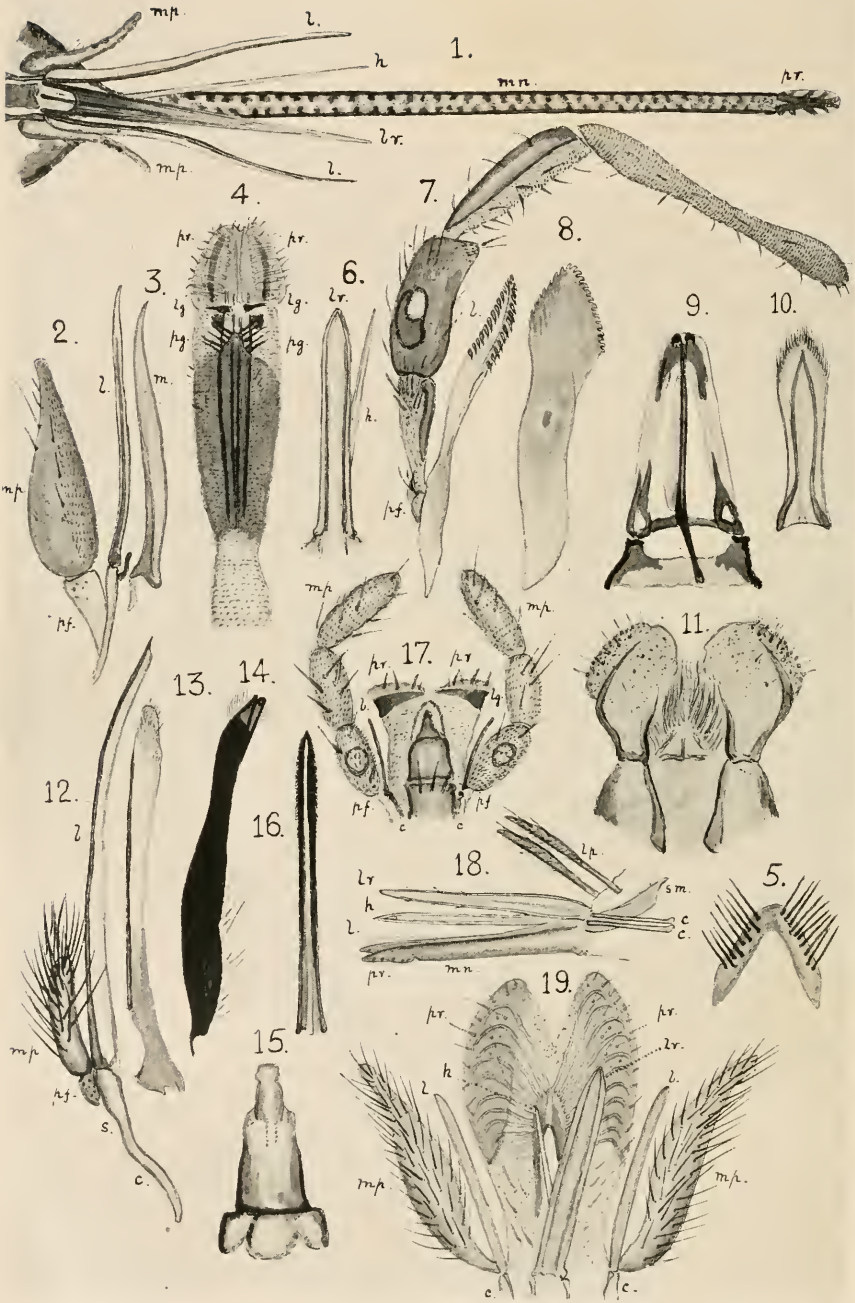
MOUTH-PARTS OF DIPTERA.



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MOUTH-PARTS OF DIPTERA.

I find some characters exist, but they are of so minute a nature, and depend so much for their visibility on the way in which they have been mounted, that they are of little or no value in differentiating species. Yet there is one character that sharply separates Anopheles from the other genera: the mandibles are serrated at the tip. This part in the other species seems in an atrophying state, and is often exceedingly difficult to make out. The rare presence of the mandibles in the males, I shall discuss in Group 2, to which section they belong.

For an excellent description and plate of the mouth-parts of *Anopheles maculipennis*, I refer the reader to Dr. G. H. F. Nuttall's and Mr. A. E. Shipley's paper on the "Structure and Biology of Anopheles." *

In the Culicidæ, omitting Corethra, the parts are specialised for blood-sucking, and especially the blood of man. An examination of the trophi of another pest, *Cimex lectularia*, shows an interesting correspondence in the fine serration and delicate structure of the maxillæ, enabling the insects to puncture the skin without inflicting pain, or attracting the attention of the victim.

In the female *C. pipiens*, the maxillary palpi are apparently two-jointed, but I can trace the remains of two more on the lower joint, making them conform to the Nemocera type of four joints.

In the Brachycera, are the Tabanidæ; they have been so much studied that little need be said about their very beautiful trophi. I have figured *Chrysops cæcutiens* L. (pl. IV. fig. 2), as there are on the dorsal side of the labium two short rows of hairs,

* Journal of Hygiene, i. No. 4, 1901, p. 461, pl. ix.

EXPLANATION OF PLATE IV.

1. Trophi of *Pangonia longirostris* ♂. Seen from the dorsal side.
2. Maxilla and palpus of *Chrysops cæcutiens* L.
3. Mandible of *C. cæcutiens*.
4. Labium of *C. cæcutiens*. Dorsal view, showing the palpigers.
5. Palpigers of *C. cæcutiens*, enlarged.
6. Labrum and hypopharynx of *C. cæcutiens*.
7. Maxilla and palpus of *Simulium reptans* L.
8. Mandible of *S. reptans*.
9. Labrum, with two minute teeth, of *S. reptans*.
10. Hypopharynx of *S. reptans*.
11. Labium of *S reptans*. In the centre is seen the wrinkled membrane, which is possibly the epipharynx. Dorsal view.
12. Maxilla and palpus of *Asilus crabroniformis* L.
13. Mandible of *A. crabroniformis*.
14. Labium of *A. crabroniformis*. Lateral view.
15. Labrum of *A. crabroniformis*. Dorsal view.
16. Ciliated hypopharynx of *A. crabroniformis*.
17. Trophi of *Sciara thomæ* L. Dorsal view.
18. „ of *Hybos femoratus* Müll. Lateral view. Only one of the maxillæ shows.
19. „ of *Leptis scolopacea* L. Dorsal view.

forming a triangle; these remind me of Savigny's often quoted vestiges of labial palpi on *Tabanus italicus*, though they are differently placed. I regard them as the palpigers, as their situation corresponds with the position of the labial palpi in Dilophus (pl. IV. fig. 5; pl. VI. fig. 6). They then explain the constant appearance in the Muscidæ, calyptrate and acalyptrate, of rows of hairs at the base of the labial palpi, though the position is much more posterior. I also find on the labium of *T. sudeticus* Zlr., a cluster of fine hairs in the same place as the palpigers are on in Chrysops (pl. VII. figs. 6, 8; pl. VIII. figs. 6, 11; pl. III. fig. 3).

In Pangonia is found an extraordinary development in the length of the labium without the geniculation that usually accompanies this character. This enables these insects to pierce through clothing to the skin. The figure gives the mouth-parts of the male, and it will be noted that like the normal male Culex, it is without mandibles. The female has a full armature, and certainly belongs to Group 1 (pl. IV. fig. 1).

The Asilidæ, which prey on other insects, have the labium hardened and horny, the hypopharynx ciliated, (showing, as will be seen later, its relationship to the Nemocera,) and the maxillæ very broad and strong; the maxillary palpi have but one joint (pl. IV. fig. 12).

Group 2.—The large family of the Empidæ are raptorial, consequently the maxillæ are well developed; they carry a single-jointed palpus, which is often annulated at the base. In this family the paraglossæ have but few tracheæ, but both the labrum and hypopharynx are almost invariably large and strong (pl. III. fig. 6).

In *Hybos femoratus* Müll. I find a remarkable difference in the palpi, which are labial, and placed as in the Muscidæ. The maxillæ seem atrophying, and are slightly ciliated at the tip; the hypopharynx is very strong and channelled with a large tube leading down to the pharynx; this seems the offensive weapon, as in Scotophaga. In *Ocydromia glabricula* Fln. the palpi are also labial, and the whole labium somewhat of the Musca type (pl. IV. fig. 18).

In *Leptis scolopacea* L. the maxillæ are broad and strong, but the labrum, and particularly the fine, acute hypopharynx, seem better adapted for skin-piercing purposes; the labium is large, and though the tracheæ are relatively small, they are fairly numerous. This insect has been reported to attack man, but nothing exact has been recorded. In June 1903 Mr. F. V. Theobald gave me a female, which had bitten him at Wye, in Kent, and from that insect the figure in the plate is drawn (pl. IV. fig. 19).

In the suctorial group, the Mycetophilidæ have minute maxillæ at the base of the three-jointed palpi; the hypopharynx is ciliated

at the extremity, and the paraglossæ of the labium resemble those found in the Chironomydæ (pl. IV. fig 17).

The paraglossæ, in some species of Psychoda, are hardened, and furnished with three minute teeth on the extremities; these are not to be confounded with the teeth in the Muscidæ, having no homology, being modified hairs. *P. phalænoides* L. and *P. sex-punctata* Curt. are of this type. In Ulomyia and others the paraglossæ are as in Chironomus, Bibio, Sciara, and may be considered as characteristic of the Nemocera. The maxillæ are brush-like in appearance, carry four-jointed palpi, which are joined on to the stipites as in Culex. The hypopharynx is ciliated all down the sides (pl. V. fig. 1).

In this family, when the mouth is used for blood-sucking, the offensive weapon seems to be the labium, and the other ciliated organs seem adapted to carrying up the fluids by capillary attraction. In Britain these insects are not known to bite, and indeed it is very doubtful if they feed at all, as in a number of specimens examined, no food has been found in the abdomen, and it seems difficult to recognise any alimentary canal.

The males in Culex are peculiar, as their mouth-parts differ from those of the females; the mandibles are mostly aborted, and the maxillæ appear to be in an atrophying condition. Occasionally a male is found with developed mouth-parts, but these are decidedly less perfect than the weapons of the female; I have lately examined a number of males of the species enumerated on a previous page, besides many *C. pipiens*. I only found one *Anopheles maculipennis* with complete mouth-parts, and of these the mandibles and maxillæ are in an atrophied state. I have also a record of a male *C. pipiens* in September 1902 with complete trophi (pl. V. figs. 2–5). In the males of all the species, is a surprising reversion; the hypopharynx, unlike that of the female, is *ciliated* at the tip; the palpi also are four-jointed, and hinge on to the maxillary stipites and cardines. In *Dinocerites cancer* the larvæ are parasitic on the crabs in the Barbadoes; the palpi in the males are very short, but the remains of the four joints can still be made out. In some species the males are thought to sting; in *Stegomyia fasciata*, the host of the yellow-fever germ, he is reported to act in this manner. I have dissected the trophi of several males, and I found very short atrophying maxillæ, no mandibles, a ciliated hypopharynx, and the labrum and labium well developed. In August, 1903, I had a number of males of *C. pipiens*, *C. annulatus*, and *A. maculipennis*, and, with the exception mentioned, the trophi were in the same state as in *Stegomyia*. Not one of these males had his abdomen distended with food, though many had been in my sleeping chamber all night; and I have little hesitation in saying that normally the males do not suck blood, and I even doubt that they feed at all. Occasionally an aberrant male appears with fully developed mouth-

parts, and he probably bites, and his individual misconduct is laid to his brethren in general.

Besides the ciliated hypopharynx, another reversion appears occasionally in the males, rarely in the females. On the labium is sometimes found a false joint, or a swelling which has the appearance of a false joint. This is relatively on the same place as the labial palpi are found in Dilophus, or the palpigers in Chrysops. It is difficult of explanation, but it seems probable that it bears some relation to the aborted labial palpi (pl. III. fig. 7). I have preparations of the heads of *C. pipiens*, male and female, *C. concolor* ♂, *C. fatigans* ♂, and *Dinocerites cancer* ♂, with this joint well marked; and in the cabinet at the British Museum (Natural History) is a species, the males all having a hairy bulb at the same spot (*Limatus durhamii* Theo., South America).

Corethra emphasises the relationship between the "plumed" and "biting" gnats, as it has a longer labium than most Chironomydæ, with structures on the base of the paraglossæ similar to those found in the same place in the Culicidæ, a ciliated hypopharynx, four jointed palpi, and broad stout maxillæ (pl. V. fig. 6). *Ceratopogon pulicaris* L., one of the minute biting midges, has a labium very much the same shape as *Corethra plumicornis* F., long fine maxillæ, a strong labrum, and a ciliated hypopharynx. The structure of the mandibles is evident on the dorsal side of the labium (pl. V. fig. 7).

Rhyphus fenestralis Scop. and *R. punctatus* F. have typical mouth-parts of this group, in character practically the same as Psychoda; the maxillæ are hairy, the palpi are four-jointed, the hypopharynx is ciliated, and the tracheæ of the paraglossæ fairly well developed. The Rhyphidæ are said to feed on the juices of plants (pl. V. fig. 9).

In this group, besides the Empidæ, are two more families of the

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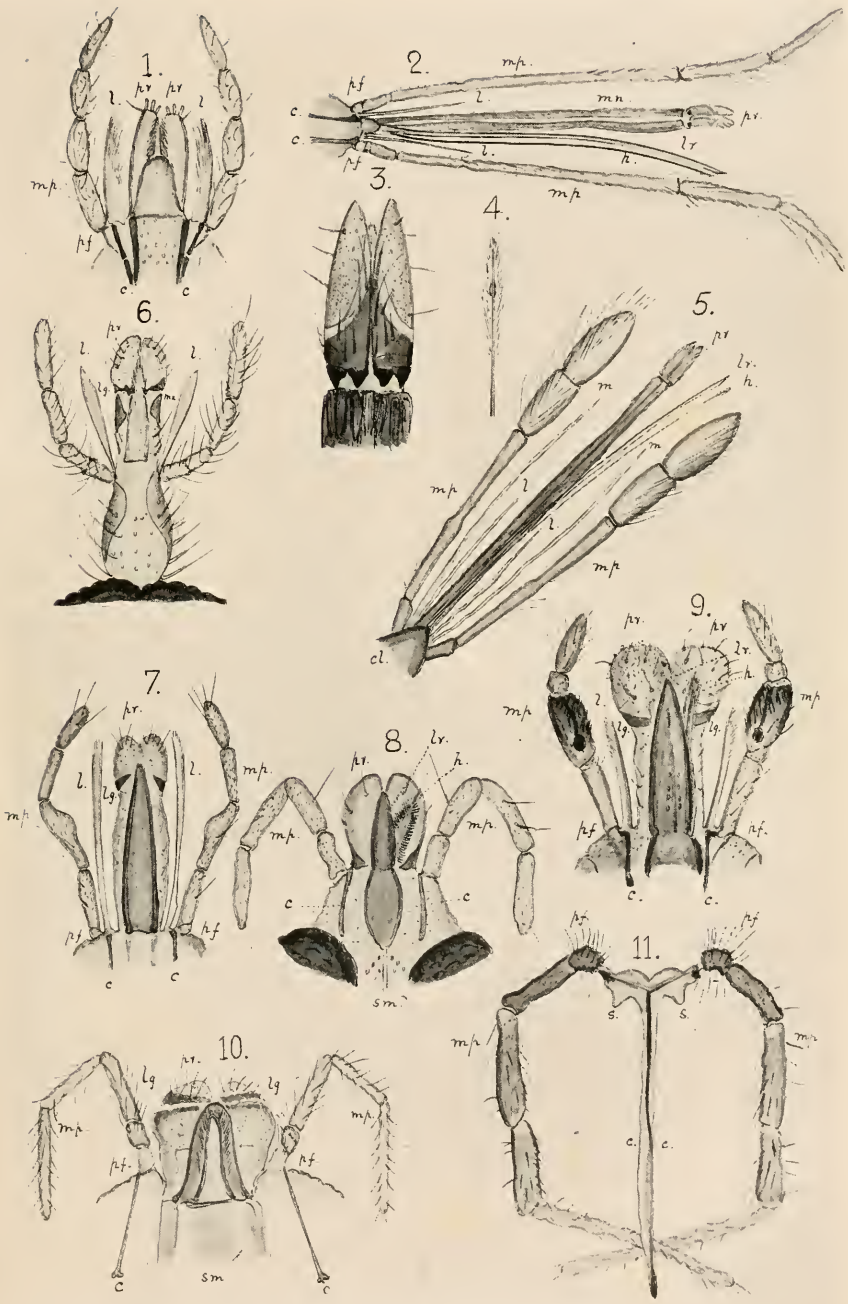
EXPLANATION OF PLATE V.

1. Trophi of *Psychoda phalænoides* L. Dorsal view.
2. Trophi of male *Culex pipiens* L. The mandibles are aborted, and the maxillæ are in an atrophying state. Dorsal view,
3. Paraglossæ of *C. pipiens*. Ventral view, showing chitinous processes at base, also found in *Corethra plumicornis* F.
4. Hypopharynx of *C. pipiens* ♂, showing the ciliated tip.
5. Trophi of *Anopheles maculipennis* Mg. Exceptional male, with complete mouth-parts; the mandibles and maxillæ are in an atrophying condition.
6. Trophi of *Corethra plumicornis* F. Dorsal view.
7. „ of *Ceratopogon pulicaris* L. Dorsal view.
8. „ of an undetermined Cecid. Dorsal view.
9. „ of *Rhyphus fenestralis* Scop.
10. „ of *Chironomus plumosus* L. Dorsal view.
11. Dissection of the dorsal apodeme of *Tipula oleracea* L. Showing the palpi attached, and the median suture of the fused stipites and cardines.



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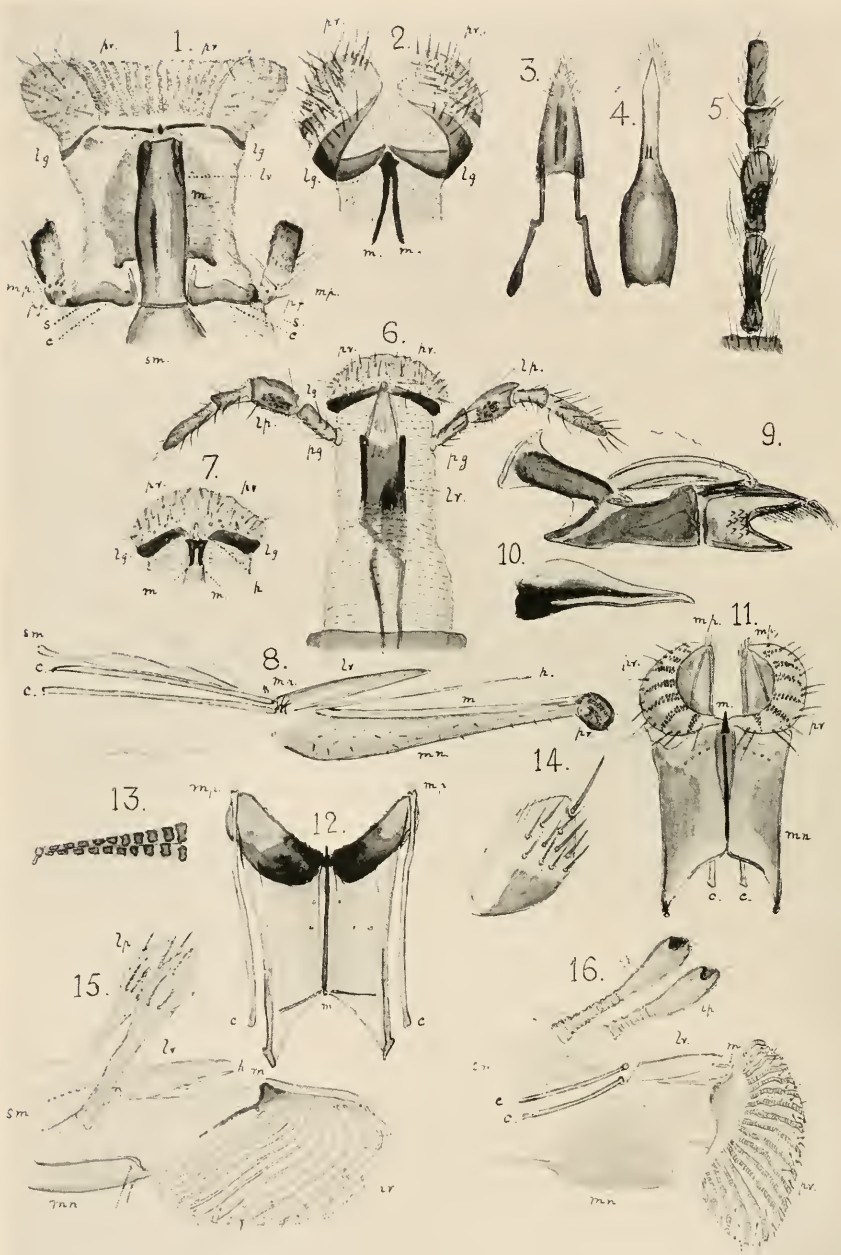
MOUTH-PARTS OF DIPTERA.



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MOUTH-PARTS OF DIPTERA.

Brachycera, the Bombylidæ and the Syrphidæ. In the latter family is less variation in the mouth-parts than in any other large family in Diptera; *Rhingia campestris* Mg. has, however, a very long labium, geniculated in a curious manner.

Group 3.—The minute Cecidomyidæ appear to be without tracheæ on the labium, the hypopharynx is ciliated, the labrum well marked, and the palpi are four-jointed (pl. V. fig. 8).

The large family of the Chironomidæ has fairly constant characters, though Ceratopogon appears to be specialised. The tracheæ of the paraglossæ are but slightly developed, the palpi are attached to the stipites, and the cardines are long, though all the other parts of the maxillæ are wanting; the hypopharynx is ciliated for some distance down its sides; the labrum is less modified than in most families, being little more than a fold of skin. The palpi are four-jointed, though they appear to have only three joints—a careful examination shows the lowest joint to be very short, and underneath is the palpifer, which adheres to the stipes (pl. V. fig. 10). These insects are said not to take food in the imaginal stage.

Owing to the imperfection of some of my preparations, I was inclined to consider the palpi in this family as labial, regarding them as homologous with those found in the Bibionidæ. Mr. A. H. Hammond, F.L.S., pointed out to me that in his, and Prof. L. C. Miall's paper,* they had traced the palpi of *C. dorsalis* Mg.,

* 'The Development of the Head of the Imago of Chironomus,' Trans. Linn. Soc. London, Zool., ser. 2, v., 271–2.

EXPLANATION OF PLATE VI.

1. Trophi of *Stratiomys chamæleon* L. Dorsal view.
2. Paraglossæ of *Bibio hortulanus* L. Dorsal view, but part of the membrane has been removed to show the fused mandibles on the ventral side.
3. Labrum of *B. hortulanus*.
4. Hypopharynx of *B. hortulanus*.
5. Labial palpus of *B. hortulanus*.
6. Trophi of *Dilophus febrilis* L. Dorsal view, showing the position of the labial palpi.
7. Paraglossæ of *D. febrilis*, ventral view, showing the small remains of the mandibles on the ventral side of the labium, corresponding with those on the labium of *B. hortulanus*.
8. Trophi of *Conops quadrifasciata* Deg. Lateral view, showing the very rudimentary state of the maxillary palpi, while the labial are aborted.
9. Labrum of *Dolichopus griseipennis* Stan. Lateral view.
10. Hypopharynx of *D. griseipennis*. Lateral view.
11. Labium and paraglossæ of *D. griseipennis*. Ventral view, showing the fused mandibles and the cardines of the maxillæ on the dorsal side.
12. Labium and paraglossæ of *D. griseipennis*. Dorsal view.
13. One of the tracheæ of *D. griseipennis*, further enlarged.
14. Labial palpus of *D. griseipennis*.
15. Trophi of *Lonchoptera flavicauda* Mg. Lateral view.
16. „ of *Pipunculus zonatus* Ztt. Lateral view.

through larval and pupal stages, from the maxillæ. On making some fresh dissections of the head of *C. plumosus* L., mounted without pressure, I was able to make out very clearly the cardines of the maxillæ, and to see the connection with the palpi, thus proving Mr. Hammond's point and the reliability of my rule. I have also heads of *C. dorsalis*, *C. viridis* Meq., and *C. riparius* Mg., which agree with *C. plumosus*.

In many of the Tipulidæ a special difficulty is encountered. The cardines of the maxillæ, which in the very large majority of species are so useful a guide, are replaced by two median apodemes, one on the dorsal, and one on the ventral side. That on the dorsal side thickens anteriorly and bifurcates, sending out symmetrical arms to the sides, to which the four-jointed palpi are attached. On examining this apodeme with high powers, a suture can easily be made out, running down the centre, and obviously this part is a fusion of the maxillary cardines. The ventral apodeme is without lateral processes, but a suture is evident, and I homologise this part with the mandibles. *Tipula oleracea* L. has a very imperfect labrum and hypopharynx, and the whole mouth-parts seem to have undergone great changes (pl. V. fig. 11). The Ptychopteridæ are also of this type, but the cardines are separate. *Erioptera tæniionota* Mg. has a well-marked labrum of the usual type in Diptera, while an insect which Mr. J. H. Verrall places in the same family (Limnobidæ), the common *Trichocera hiemalis* Deg. has maxillæ, a ciliated hypopharynx and well-developed labrum, and would be placed in Group 2.

In the Brachycera, the Stratiomidæ have the tracheæ well developed and numerous, but not occupying the whole space of the paraglossæ, as in the Muscidæ; the palpi have two joints, and in *S. chameleon* L. the palpifers can be differentiated; the maxillæ are very minute in this species, almost obliterated; they are more visible in *Microschrysa polita* L., but have quite disappeared in *Chloromyia formosa* Scop. The labrum is rather formless, and I have not seen a ciliated hypopharynx in any species (pl. VI. fig. 1).

The Conopodæ have a specialised type of mouth-part, resembling the Syrphidæ, but having no maxillæ. In some species the labrum is short, and the hypopharynx long; the latter organ seems to find its protection in the fold of the labium. In *Conops quadrifasciata* Deg. it is remarkable that only the rudiments of the maxillary palpi are present, while the labial are wholly aborted. I know of no exactly parallel case, but in *Sepsis cynipsea* L. the palpi are exceedingly minute, but are labial, and remnants of the maxillæ are present, two or three hairs marking the place of their palpi (pl. VI. fig. 8).

Group 4.—To determine the homologies of the mouth-parts in Bibio requires a dissection of the parts, and a comparison with the

other genera, Scatopse and Dilophus. From dissection it is seen that the palpi do not adhere to the cardines of the maxillæ, and are quite away from them. This is exceedingly difficult to understand, because these four-jointed palpi are so much like the palpi in Simulium, Psychoda, Chironomus and Rhyphus, which are undoubtedly maxillary. However, similar palpi are found in Dilophus, agreeing in all particulars, having the sense-organ in the second joint, and these are undoubtedly labial. Scatopse has single-jointed labial palpi. The mandibles are found adhering to the bases of the paraglossæ on the ventral side, and enclosed in the membrane of the labium; the tracheæ have a very modest development, but the labrum is strong, is hinged on to the cardines of the maxillæ, and the hypopharynx is large, seems to have fused at its base with some portion of the submentum or fulcrum, and is much ciliated. The labium is exceedingly long in Dilophus, short in Bibio, and still shorter in Scatopse. The mouth-parts of these three genera are at first sight unlike, yet they will be found to have characters in common; in Dilophus they seem specialised for flower-sucking; and, as in Bibio, though smaller, the vestiges of the mandibles can be seen on the ventral side. Scatopse is so small that it can readily penetrate with its whole body into the nectaries of most flowers; I have often seen it feeding on the juices of the ivy blossom. Bibio also has a suctorial mouth-part, but the armature on the fore legs, found in both sexes, inclines me to suspect it of occasionally seizing prey (pl. VI. figs. 2–7).

The mouth-parts of Dolichopus possess one feature which separates them from all other families in Diptera: the tracheæ on the paraglossæ are of the most curious description. Under high powers, each one of them appears to be made up of a number of sub-rectangular, semi-transparent cells, which decrease in size as the tracheæ approaches the edge of the labellum; at its extremity is a very short blunt hair inserted in a minute cylinder. In *Medeterus truncorum* Mg. it has another appearance, rather granular and less differentiated. In most genera of this family the cardines of the maxillæ are very anteriorly placed—the points on which the palpi are usually situated, (close to the base of the labrum,) are quite at the extremity of the paraglossæ, and have feathered processes at the extremities, which are probably the remains of the maxillary palpi. The mentum has a central rod, which ends in a point between the paraglossæ; this rod has a median suture, and is homologous with the paired rods found in Bibio and the ventral apodeme in Tipula, and represents the mandibles. This character is found in several families, and marks them off from the Muscidæ, where the mandibles are on the dorsal side of the labium. The labrum is elaborately toothed and haired, and covers a powerful hypopharynx, with a deep channel, connected with a suctorial trachea, the true pharynx. The palpi are single-jointed, with a few

long hairs, but with no central sense-organs, such as are seen in the second joint of Bibio and of most Nemocera (pl. VI. figs. 9–14).

One interesting specialisation is found in *Orthochile nigroceerula* Ltr., which has an elongated labium, a totally different arrangement of the cardines, and a general similarity to the mouth-parts in the Muscidæ. This lengthening of the labium probably enables the insect to reach the nectaries of flowers; most of the other species are raptorial, haunt marshy spots, and feed on minute insects and Gastropods (pl. VII. fig. 1).

The mouth in the Phoridæ has the cardines in the usual place, and working the labrum and hypopharynx; the latter part has in some species a curious double point, which reaches well up to the tip. Some species have a toothed labrum, which is a character of the Dolichopidæ, and accentuates the affinity which these two families have to each other. Though the tracheæ on the paraglossæ are of a different type from each other, it is remarkable that they have also the short blunt hair in the cylinder at the extremity; this is a striking affinity, as I am not aware of this structure being found in any other families in this situation.

I have often seen these insects on plants and on window-panes, but I have never seen them attack prey. Their appearance is against them, but I have no evidence that they are of raptorial habits (pl. VII. fig. 2).

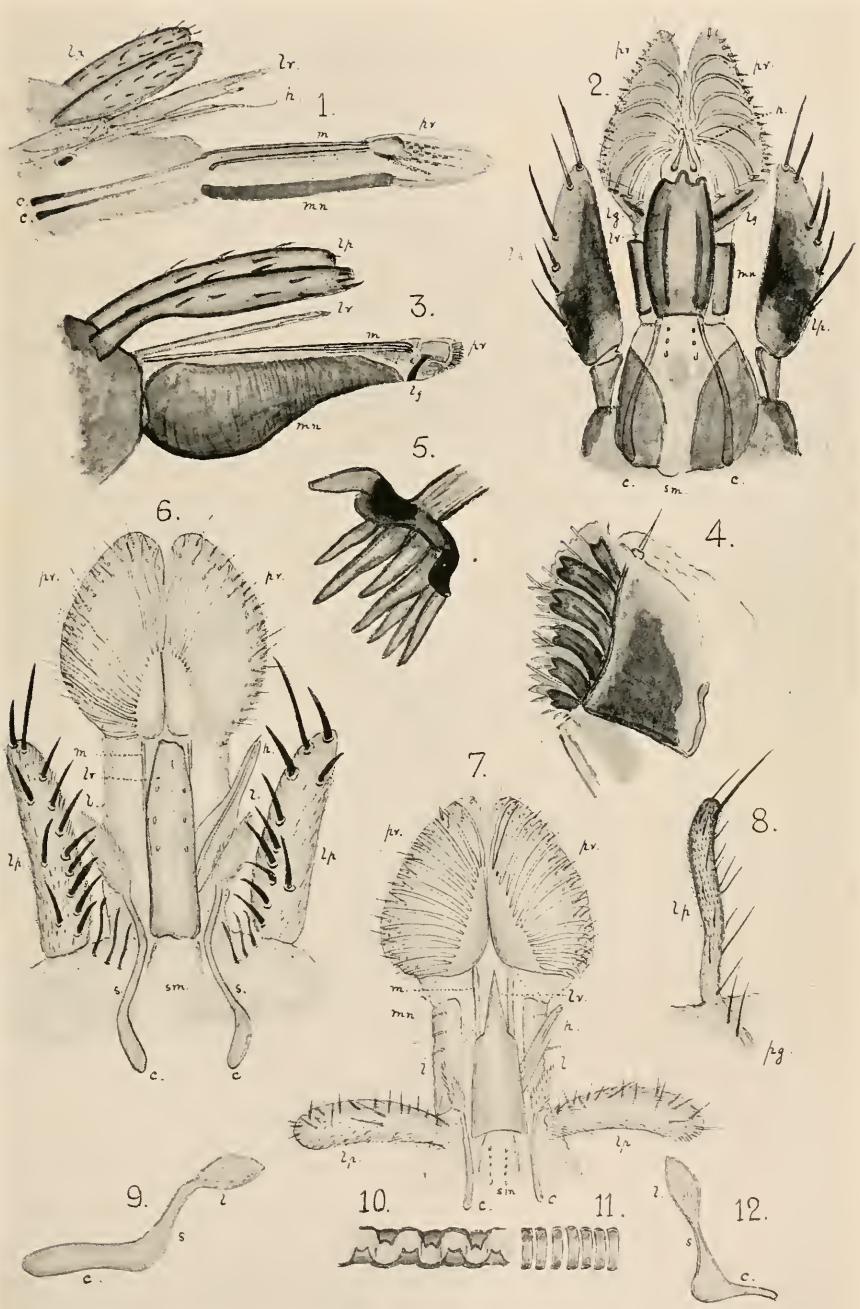
Group 5.—As I have dealt with the first section of this group in previous papers,* I shall confine myself to giving a list of species in which I have found the characteristic rudimentary palpus:—

Myiocera carinifrons Fln.
Graphomyia maculata Scop.
Mesembrina meridiana L.
Musca domestica L.
M. corvina F.
Cyrtoneura stabulans Fln.

* 'Undescribed Palpi in Diptera,' Jour. Roy. Micr. Soc. 1902; 'The Labial and Maxillary Palpi in Diptera,' Trans. Linn. Soc. London, Zool., ser. 2, vol. ix.

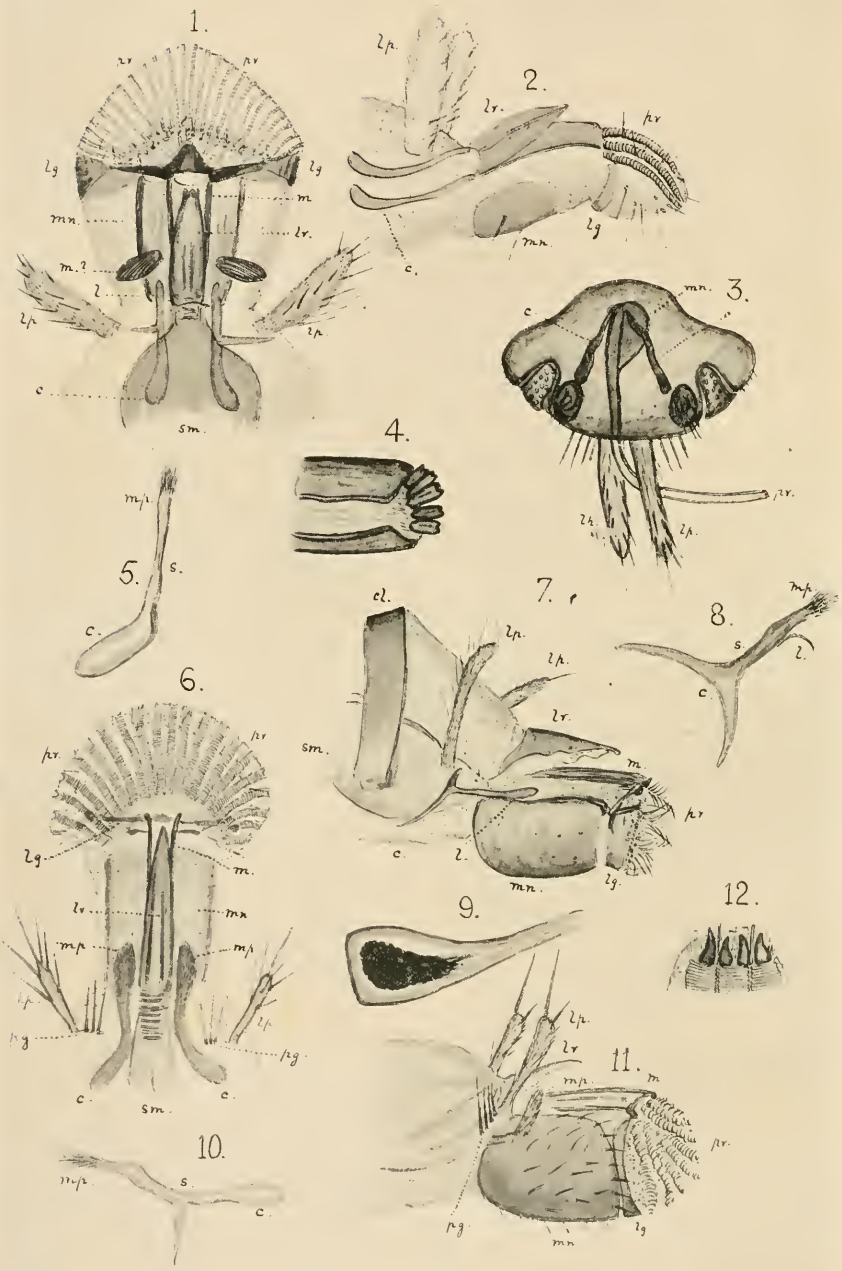
EXPLANATION OF PLATE VII.

1. Trophi of *Orthochile nigroceerula* Ltr. Lateral view.
2. „ of undetermined species of *Phora*. Dorsal view.
3. „ of *Hæmatobia irritans* L.
4. Teeth on the labium of *H. irritans*.
5. „ of *Norellia striolata* Mg. (Cordyluridæ).
6. Trophi of *Cœlopa frigida* Mg. (Phycodromidæ). Dorsal view
7. „ of *Helomyza rufa* Fln. Dorsal view.
8. Labial palpus of *Sciomyza cinerella* Fln.
9. Maxilla of *S. cinerella*.
10. Tracheæ of *Sapromyza præusta* Fln. Dorsal view.
11. „ of *S. præusta*. Viewed ventrally.
12. Maxilla of *S. præusta*.



W. Wesché, del. London Etching Co., eng.

MOUTH-PARTS OF DIPTERA.



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MOUTH-PARTS OF DIPTERA.

Morellia hortorum Fln.
Polietes lardaria F.
Hyetodesia lucorum Fln.
H. obscura Mg.
H. læta Fln.
H. perdita Mg.
H. basalis Ztt.
H. sudetica Schnbl.
Mydea impuncta Fln.
Spilogaster communis Dsv.
S. flagripes Rnd.
S. uliginosa Fln.
Hydrotea occulta Mg.
H. dentipes F.
H. meteorica L.
Ophyra leucostoma W.
Hylemyia strigosa F.
H. cardui Mg.
H. pullula Ztt.
Lasiops stenoscema Kov.
Anthomyia pluvialis L.
A. radicum L.
A. sulciventris Ztt.
Pegomyia bicolor W.
Homalomyia canicularis L.
H. hamata Meq.
Azelia macquartii Stœg.

All these insects are suctorial.

EXPLANATION OF PLATE VIII.

1. Trophi of *Seoptera vibrans* L. Showing the supposed rudiments of mandibles. Dorsal view.
2. Trophi of an undetermined species of *Chlorops*.
3. Diagram of the head of *Melophagus ovinus* L. This is drawn as a transparent object, and shows the bulb of the labium and the cardines of the maxillæ showing through the chitin of the head.
4. The teeth on the end of the labium of *M. ovinus*.
5. Maxilla of *Balioptera combinata* L.
6. Trophi of *Saltella scutellaris* Fln. Showing the four palpi and the palpigers. Dorsal view.
7. Trophi of *Ephydra coarctata* Fln. Lateral view, showing the curious tracheæ.
8. Maxilla of *Mosillus subsultans* F. Showing the palpus, the atrophying lacinia, and the alteration in the cardo and stipes.
9. Organ in the submentum of *Drosophila funebris* F. Gizzard (?).
10. Maxilla of *D. funebris*.
11. Trophi of *Borborus equinus* Fln. Lateral view, showing the labial palpi, a palpiger, and a maxillary palpus.
12. Tip of the labium of *Glossina morsitans* Westw. Showing the teeth and the affinity to *M. ovinus* and *H. irritans*.

In the second section of this group the mouth-parts are very much the same as in the Muscidæ; the tracheæ in the Lonchopteridæ are numerous, but are without teeth at the base, the palpi are quite the same in appearance as in the Muscidæ; the hypopharynx is a relatively strong, sharp, hairless lancet. The paraglossæ in the flower-haunting Pipunculidæ are practically the same as in the Lonchopteridæ; the palpi resemble those found in the Empidæ, but are labial and have a well-marked sense-organ (pl. VI. figs. 15, 16).

The specialised forms in the Tachinidæ are adaptations, enabling the insects to explore the deeper cavities of flowers; in the Muscidæ, to pierce skin and suck blood. *Siphona geniculata* Deg., *S. cristata* F., and *Prosena sybarita* F., are flower-suckers. *Siphona* has an elongated labium, somewhat resembling that of *Rhingia campestris* Mg., of the Syrphidæ. *Prosena* is of a type which has gained an evil notoriety in *Glossina* and *Stomoxys*; but this insect, with different habits, has different modifications. The tip of the labium, which is hardened, laminated and toothed in *Glossina*, has remains of tracheæ, but no vestiges of teeth (pl. VIII. fig. 12).

Glossina has several interesting developments of palpi in different species, mostly in the direction of length, resembling in this particular our English *Hæmatobia irritans* L. (pl. VII. figs. 3, 4).

Glossina, *Hæmatobia*, and *Stomoxys* have lost the tracheæ, though the paraglossæ are still evident, and they retain, and indeed have developed the teeth, as found in the Muscidæ. The palpi, notwithstanding their extreme length and important function, are based on the membrane of the labium; they are therefore labial and not maxillary, as a recent writer with some pretensions to experience has named them.* The cardines are connected with the labrum.

The genera Cœnosia and Caricea in the Anthomyidæ are characterised by a very decided increase in the size of the teeth, resembling in this respect the Cordyluridæ, where they are very marked, and probably reach their largest modification (pl. VII. fig. 5). On account of the teeth, and of the general character of the mouth-parts, I think Mr. Verrall at fault when he transferred the little fly *Schœnomyza littorella* Fln., to the Agromyzidæ. It is a decided Anthomyid. The mouth-parts have all the characters found in the Anthomyidæ, and it shows its relationship to the Cœnosia group, by the large teeth on the paraglossæ, a character quite absent in the smaller acalyptrate Muscidæ.

Though the Cordyluridæ are raptorial, the trophi, with the exception of the teeth, are but little modified; the hypopharynx is a trifle stouter and longer than in the house flies.

* Dr. H. J. Hansen, 'Monograph of the Tsetse-flies,' p. 114. E. E. Austen, London, 1903. Dr. Hansen has also committed himself, in the statement that there are no remnants of maxillæ in the head of Glossina.

Scatophaga is a haunter of the ivy blossom, and feeds there as well as on fresh cow-dung, besides picking up "unconsidered trifles" in the way of flies.

The Ortalidæ, the Trypetidæ, and the Lonchæidæ, have no teeth on the paraglossæ, and have numerous minute tracheæ somewhat like those found in the Pipunculidæ.

Scoptera vibrans L. has curious paired processes on each side of the labium, which may be vestiges of the mandibles; while the cardines of the maxillæ take a form which is also met with in the Ephydridæ and the Borboridæ; it sends out a limb in the centre, at right angles to the rest of the organ. *Ulidia demandata* F. has the cardines straight, as in the Anthomyidæ, as has also the Trypetid *Acidia heraclei* L. The Lonchæidæ have mostly the cardines of the same type as *Scoptera* (pl. VIII. fig. 1).

The obscure and difficult family of the Chloropodæ has a difference in the structure of the tracheæ, which would enable an observer to separate these insects; the tracheæ are stouter, fewer, and more markedly chitinous (pl. VIII. fig. 2).

In the parasitic Hipposboscidæ, there is a venation well removed from that of other families, a modification of shape, and a type of mouth-part, that makes the parentage of this family not at all obvious. But in the mouth-parts are two points that suggest a strong probability of a descent from one of the blood-sucking Muscidæ. This is strengthened by a fact in the life-history of *Glossina*, that insect being viviparous. This would be a step to the curious condition existing in the Pupipara, in which sub-order the young are brought forth as pupæ, having passed the egg and larval state in the oviduct.

The most striking feature of the mouth-parts is a pair of large palpi, which act as a sheath for a chitinous tube, which is the piercing and blood-sucking apparatus of the insect. This tube has some exceedingly minute serration at its extremity; and a very high magnification shows these to be teeth, similar, in character and relationship to their support, to those on the labium of *Glossina*, *Stomoxys* and *Hæmatobia*. Further, the tube swells out at its base into a bulb (pl. VIII. figs. 3, 4, 12; pl. VII. figs. 3, 4).

Taking these facts into consideration, I consider the proboscis in Hippobosca as clearly homologous with the same organ in *Glossina*, *Stomoxys*, *Hæmatobia*, or *Prosena*, and it is therefore a modification of the labium, and the palpi are labial palpi.

It may be suggested that a Tabanid ancestry was not improbable, and that a similar serration can be seen on the labrum of the Tabanidæ. This objection may be disposed of by showing the labrum as present in some species of the Hippoboscidæ as a separate part. The cardines which I have shown to be so constant in Diptera are present, but have changed positions, seeming to work the labium at an angle to the plane of the head.

Group 6.—The Phycodromidæ have paraglossæ much of the same type as the Ortalidæ, and, like them, totally devoid of teeth. The labial palpi are stiffly haired, and have a long hair on the tip. The maxillæ end in a leaf-shaped scale, covered with a fine pubescence. I have mostly taken these insects on sea-weed, and they probably feed on the juices of those plants (pl. VII. fig. 6).

The mouth-parts of the Heliomyzidæ have but little to distinguish them from those of the Phycodromidæ; the likeness in the paraglossæ is very marked, the ends of the maxillæ are sometimes identical in shape, but have a finer pubescence. The labial palpi in those examples I have examined have no long hair on the tip. I have usually found these insects on damp herbage, and there they probably find their food (pl. VII. fig. 7).

The Sciomyzidæ have a great affinity with the Heliomyzidæ, and we may perhaps consider the ciliated costal vein which distinguishes the latter family as almost a generic character, though it is undoubtedly a useful one. The tracheæ are as numerous as in the two preceding families; the maxillæ are of the same shape, with perhaps a trifle less pubescence; and the palpi are haired, and with a long hair on the tip as in the Phycodromidæ (pl. VII. figs. 8, 9).

The Sapromyzidæ have the same type of maxillæ. There are no teeth on the paraglossæ, but the rings of the tracheæ are strong and thick, and the part is very different from that found in the three preceding families (pl. VII. figs. 10–12).

Group 7 is wholly confined to the acalyptrate Muscidæ. The character which distinguishes it from the previous group is the presence of four palpi. Sometimes the laciniæ may be thought to be present, but even then it is so thickly haired as to make certainty as to its real nature impossible.

The Opomyzidæ have tracheæ like the Phycodromidæ. The maxillæ in Balioptera are characteristic, the cardines rather rounded, and tapering to the part that is ordinarily the lacinia, but here is thickly haired and distinctly like a palpus. *O. germinationes* L. differs, in having the maxillæ of the same type as the Phycodromidæ. These insects can be taken anywhere and everywhere in long grass (pl. VIII. fig. 5).

I have already referred to the peculiar mouth-parts of *Sepsis cynipsea* L., in my remarks on Group 3. *Nemopoda cylindrica* F. explains the homologies, as it possesses well-developed labial palpi, and distinct maxillary palpi in the usual position on the cardines. The tracheæ are less marked than in Sapromyza. *Saltella scutellaris* Fln. is very much the same type as Nemopoda (pl. VIII. fig. 6).

In the Ephydridæ the mouth is relatively much developed. There is great variability in the character of the tracheæ, such sur-

prising modifications as the toothed tracheæ of *Hydrellia griseola* Fln. being found. In *Ephydra coarctata*, or *Parhydra coarctata* Fln., of Mr. Verrall's list, are remarkable tracheæ, which may reasonably be supposed to be primitive forms. They consist of a number of hairs, arranged in double lines, which arch over and form passages, capable of drawing up fluid by capillary attraction. This insect I have taken in great numbers on marshy spots, and it may be that it is a special modification, enabling the insect to feed on infusoria; but as it is in this family that I have found complete maxillæ in one species (*Hydrellia griseola*),* and remains in several others, I am inclined to think them of very archaic type. The labrum is a rather shapeless fold of skin, pierced with the sockets of hairs, and the hypopharynx is very rudimentary. The larger palpi are labial and thin. The cardines of the maxillæ bear palpi, which in several species are quite relatively large (pl. VIII. fig. 7).

In *Mosillus subsultans* F. are nearly complete maxillæ; the laciniæ are atrophying, and appear exactly in the same state as in *H. griseola*; but the palpi are very hairy, though the galæ have gone; the stipites and cardines are much altered (pl. VIII. fig. 8).

Drosophila funebris F. has tracheæ somewhat similar to *Sapromyza preusta* Fln.; the maxillary palpi are of the type seen in the Opomyzidæ; the fulcrum is curious, and has an organ in the interior which seems to be some sort of gizzard, or crushing apparatus. The palpi are relatively not so large as in the Opomyzidæ (pl. VIII. figs. 9, 10).

The Borboridæ have characteristic trophi with curious large tracheæ, and the paraglossæ are united and without a median division. The maxillary palpi are very marked in some species, but almost all the other parts of the maxillæ have disappeared; the cardines, with their characteristic joint or hinge, cannot be made out, and only the stipites remain. The large development of the mentum, and the character of the maxillary palpi, bring this family very close to the Ephydridæ. The setæ at the base of the labial palpi, which represent the palpigers, are very constant in this family (pl. VIII. fig. 11).

Group 8 contains but one family, the Œstridæ; these extraordinary flies are quite devoid of any developed mouth-part, two tubercles representing the elaborate structures of the ordinary insect mouth. A small buccal orifice is visible, surrounded by a chitinous ring, which is in some places shortly but thickly haired; more anteriorly placed are two chitinous arches, which appear to cover another cavity. What these parts homologise with, it is difficult to say, (1) but the tubercles have structures on their

* 'The Labial and Maxillary Palpi in Diptera,' Trans. Linn. Soc. London, Zool., ser. 2, vol. ix., pp. 223–229, figs. 21, 22.

surface, (2) are paired organs, and (3) occupy positions, which several facts suggest that they represent the labial palpi (pl. III. fig. 4).

Summary.

(1) On reviewing these eight groups, it is apparent that they are artificial, so that families that are closely related to each other are occasionally in different sections, though it oftener happens that they are in neighbouring, or even in the same group.

(2) It will also be seen that the Nemocera have characters in the trophi, as well as in the antennæ. Examples of species with four-jointed palpi and a ciliated hypopharynx will be found in every family, and these parts may, when in that condition, be considered as distinguishing characters—establishing a relationship with the Asilidæ and the Empidæ, in the sub-order Brachycera. The palpi are maxillary in every case, with the exception of the Bibionidæ, and it is difficult to understand why this family has deviated.

(3) It seems that Dilophus gives the clue to the original situation of the labial palpi, (4) while Chrysops shows the palpigers; these have altered their position in the Muscidæ, but are very constant, and generally to be found at the base of the labial palpi.

(5) That as a rule the males of the Culicidæ are harmless, but their trophi are variable, and may in some instances be fully developed.

(6) The mandibles of *Anopheles* differ from those of other Culicidæ.

(7) In some males of the genus Culex, and related genera, is found a false joint on the labium. This possibly marks the spot where the labial palpi were articulated. In some genera this is constant, in others variable.

(8) The median apodemes in Tipula are a fusion of the mandibles on the ventral, and of the cardines of the maxillæ on the dorsal side.

(9) Species exist in Diptera (apart from Œstridæ) in which both palpi are aborted.

(10) Homologisation of the trophi of the Dolichopidæ, and their aberration both from the Nemocera and Musca types.

(11) Affinities exist in the trophi of Dolichopus and Phora.

(12) The palpi in *Glossina* are labial.

(13) The Hippoboscidæ are descended from blood-sucking Muscidæ. Homology of their trophi.

(14) Archaic types of trachæ and maxillæ in the Ephydridæ.

(15) Gizzard in the submentum (fulcrum) of *Drosophila*.

(16) The trophi in the different species of a family are sometimes variable, especially in the Brachycera. The Dolichopidæ and Empidæ present the greatest divergences in this respect, and it is

only in the Cyclorrhapha that types of mouth-parts seem firmly established, and the specialisations easily homologised.

In the whole order, the mandibles are only present in a few families, and even in those families they are often absent in the males. The palpi are very variable, and when the maxillary are present the labial are absent, though occasionally rudiments of the absent part are found, more often of the maxillary than of the labial. The paraglossæ, which are considered typical of the order, only occasionally disappear, as in the specialised Muscidæ and the Hippoboscidæ. The most constant parts are the stipites and cardines of the maxillæ, which are only absent in the Œstridæ; and it is very possible that a more comprehensive study of that family than I have hitherto had the opportunity of making, may show them to be present in some species.

It follows from this constant variability, that the trophi cannot be regarded as unfailing guides in classification, but I think that this variability will be of assistance in considering the relations of families; on the other hand, the persistence of types in the Cyclorrhapha makes the mouth-parts of great use in studying the phylogeny of that sub-order.

OBITUARY.

Charles Thomas Hudson, M.A. LL.D. F.R.S. Hon. F.R.M.S. 1828–1903.

Charles T. Hudson was the son of John Corrie Hudson, of Guildford, and was born at Brompton on March 11, 1828. He was educated at the Grange, Sunderland, and at St. John's College, Cambridge. In 1852 he took his degree, being bracketed fifteenth Wrangler in the Mathematical Tripos.

From 1855 to 1860 he was head master of Bristol Grammar School, and from 1861 to 1881 of Manilla Hall, Clifton. Dr. Hudson became a Fellow of the Society in 1872, served on the Council for some years, and was President from 1888 to 1890. In 1889 he was elected a Fellow of the Royal Society, and in 1901 Honorary Fellow of the Royal Microscopical Society.

Dr. Hudson was always devoted to microscopical studies, and his researches on the Rotifera are of world-wide knowledge and repute; in this branch of science he was the chief authority of his time. In 1886 he published, in collaboration with Mr. P. H. Gosse, F.R.S., *The Rotifera, or Wheel Animalcules.*

He was the discoverer of several new genera and species of Rotifera, among which may be mentioned *Pedalion mirum.* The results of his researches and observations were communicated to various scientific journals, our own being specially favoured. His addresses were charming in style, and his lectures on his favourite topics were exceedingly interesting both to hear and see, for they were elegantly illustrated by a method which he had made peculiarly his own. The outlines of the objects were indicated by means of dots and lines, cut out of a large brown paper screen, the perforations when necessary being covered in with coloured transparencies. When illuminated from behind, a dark-ground effect was produced, which was most effective and elegant.

Mr. Hudson was twice married, first to a daughter of Mr. W. B. Tibbits, of Braunston, Northamptonshire, and in 1858 to a daughter of Mr. Freelove Hammond.

He died on October 24, 1903, at Hillside, Shanklin, where he had resided for some time.

List of papers by Dr. C. T. Hudson in the *Journal of the Royal Microscopical Society*:—

1879. On *Œcistes umbella* and other Rotifers. Note on M. Deby's paper (on *Pedalion*).

1881. On *Œcistes janus* and *Floscularia trifolium*, two New Species of Rotifers.

1883. Five New Floscules, with a Note on Prof. Leidy's Genera of Acyclus and Dictyophora.
On *Asplanchna Ebbesbornii* nov. sp.
1885. On Four New Species of the Genus Floscularia, and Five other New Species of Rotifera.
1889. President's Address: On the Distribution of Rotifera.
1890. President's Address: On some Needless Difficulties in the Study of Natural History.
1891. President's Address: On some Doubtful Points in the Natural History of the Rotifera.

Other Papers by Dr. Hudson.

On *Rhinops vitrea*, a new Rotifer. Ann. Mag. Nat. Hist. iii., 1869.
On *Triarthra longiseta.* Monthly Microsc. Journ. i., 1869.
Notes on *Hydatina senta.* Monthly Microsc. Journ. ii., 1869.
On *Synchæta mordax.* Monthly Microsc. Journ. iv., 1870.
On *Pterodina valvata* sp. n. Monthly Microsc. Journ. v., 1871.
On a new Rotifer. Monthly Microsc. Journ. v., 1871.
Note on *Pedalion mirum.* Monthly Microsc. Journ. vi., 1871.
On *Euchlanis triquetra* and *E. dilatata.* Monthly Microsc. Journ. viii., 1872.
Is Pedalion a Rotifer? Monthly Microsc. Journ. viii., 1872.
On *Pedalion mirum.* Quarterly Journ. Microsc. Sci. xii., 1872.
Remarks on Mr. Henry Davis's paper 'On the Desiccation of Rotifers.' Monthly Microsc. Journ. ix., 1873.
On some Male Rotifers (1874). Monthly Microsc. Journ. xiii., 1875.
On the classification and affinities of the Rotifera. Brit. Assoc. Rep., 1875.
On *Cephalosiphon* (*limnias*) and a new Infusorian (*Archimeda remex*). Monthly Microsc. Journ. xiv., 1875.
On a new *Melicerta* (*M. tyro*). Monthly Micros. Journ. xiv., 1875.

SUMMARY OF CURRENT RESEARCHES

RELATING TO

ZOOLOGY AND BOTANY

(PRINCIPALLY INVERTEBRATA AND CRYPTOGAMIA),

MICROSCOPY, ETC.*

ZOOLOGY.

VERTEBRATA.

a. Embryology.†

Mendel's Law of Heredity.‡—W. E. Castle gives a lucid account of the discovery which Gregor Mendel made in 1866—the discovery of a law of heredity. The law was re-discovered independently in 1900 by De Vries, Correns, and Tschermak, who were engaged in the study of plant hybrids. It remained, however, for Bateson, two years later, to point out the full importance and the wide applicability of the law. To make the matter clear in a summary, we follow the headings of the analysis which Castle has given.

(1) *The Law of Dominance.*—When mating occurs between two animals or plants differing in some character, it often happens that all the offspring exhibit the character of one parent only, and that is called the "*dominant*" character; while the character that is not seen in the immediate offspring (though still part of the heritage) is called "*recessive.*" When white mice are crossed with grey mice, all the offspring are grey; the grey colour is *dominant*, the white colour *recessive*. Parents with distinctive characters A and B, yield hybrid offspring with the character A (B) or B (A), the parentheses being used to indicate a recessive character not visible in the individual. This is the law of dominance.

(2) *Peculiar Hybrid Forms.*—The law of dominance is not of universal applicability. (1) The cross-bred offspring, e.g. of peas differing in height, may be intermediate between the parents $\left(A \times B = \frac{AB}{2}\right)$. (2) The cross-bred offspring, e.g. of brown-seeded and white-seeded beans, may exhibit what seems to be an intensification of the character

* 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, etc., 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, Reproduction, and allied subjects.

‡ Proc. Amer. Acad., xxxviii. (1903) pp. 535–48.

of one parent ($A \times B = A^2$). (3) The cross-bred offspring, e.g. of spotted, black-and-white mice and albino mice, may have a character entirely different from either parent, "a character of its own" ($A \times B = C$). (4) The cross-bred offspring, e.g. of white and buff pigeons, may resemble an ancestral form, may exhibit "reversion" ($A \times B = R$). (5) But, finally, as with grey and white mice, the offspring may show patently the character of one parent only ($A \times B =$ A (B) or B (A), according to the law of dominance.

(3) *Purity of the Germ-cells.*—The great discovery of Mendel is this: The hybrid, whatever its own character, produces ripe germ-cells which bear only the pure character of one parent or the other. The hybrid A (B) or B (A) will have germ-cells, bearing *either the character A or the character B, but not both; and A's and B's will be produced in equal numbers.* This is the law of "*segregation*" or the law of the "purity of the germ-cells." "It bids fair," Mr. Castle says, "to prove as fundamental to a right understanding of the facts of heredity as is the law of definite proportions in chemistry. From it follow many important consequences."

A first consequence is polymorphism of the second and later hybrid generations, as may be represented in the following scheme:—

A × B = *A* (B) or *B* (A).
A (B) × *A* (B) = (1) A set of pure A's, which if inbred will breed true to that character ever afterwards.
(2) A set of similar pure B's approximately equal in number to the pure A's.
(3) A third set of A B's like those of the first hybrid generation.

If this be expressed in terms of the germ-cells, it seems to mean this:—*A* (B) produces germ-cells bearing either the character A or the character B. If a male germ-cell A meet a female germ-cell A, the result is an offspring pure A; if a male germ-cell B meet a female germ-cell B, the result is an offspring pure B. As these pure A's and pure B's occur in approximately equal numbers, the inference is probably correct that the original hybrid *A* (B) produces two equal sets of gametes, dominantly A's and B's. There is one chance each for the combinations A A and B B, and two chances for the combination A B. And the whole progeny tends to occur in the proportions 1 A + 2 A B + 1 B. As a mattter of fact this does occur.

In his experiments with the Chinese primrose (*Primula sinensis*) Bateson produced an unfixable hybrid, "Giant Lavender," by crossing a magenta-red with a white flowering variety tinged with pink. This hybrid constantly produces plants bearing magenta-red and white flowers respectively, as well as other plants bearing lavender flowers in the proportion of 1 : 2 : 1, the exact numbers being 12 : 23 : 11 and 9 : 20 : 9.

In cases of complete dominance, only two categories of offspring will be recognisable, and these will be in the ratio of 3 : 1, but the larger group on further breeding breaks up into two classes: first,

dominants; secondly, hybrids; i.e. into groups A and A (B) in ratio of 1 : 2.

Mendel found his results to come very close to the theoretical presupposition, when he crossed yellow with green peas. He found the numbers to be 3 : 1, and the recessive or green seed produced only green seed; while of the yellow or dominant, one in three produced only dominants, but two out of three produced hybrids, and this gave him A, 2 A (B), B, the theoretical proportions. Mr. G. M. Allen has found the same proportions to be true in the case of crossing white mice with grey mice.

The correctness of Mendel's hypothesis of the purity of the germ-cells and of their production in equal numbers, is shown by back-crossing of a hybrid with one of the parental forms. For example, in a case of simple dominance the first generation will all be D (R). Any one of them back-crossed with the recessive parent will produce 50 p.c. pure recessives and 50 p.c. hybrids.

For hybrid produces germ-cells . .	D + R
For recessive parent produces germ-cells	R + R
The possible combinations are	2 D (R) + 2 R

And this has been proved for peas and for mice.

In dealing with cross-breeding between parents differing in more than one character, we find in the second and later hybrid generations, individuals possessing *new combinations* of the characters found in the parents, indeed, *all possible combinations* of these characters will be found, and in the proportion demanded by chance.

Take parents differing in two characters A, B (the recessive phases *a*, *b*). The immediate offspring resulting from the cross will be all alike, A B (*a b*). The second and later generations of hybrids will contain the stable classes A B, A *b*, *a* B, *a b*, also the unstable forms A B (*a b*), A (*a*) *b*, and *a* B (*b*). One, therefore, of each of the stable combinations occurs in every sixteen "second-generation" offspring; and only the individual which possesses *both recessive characters* can at once be set aside as pure. Moreover, nine out of every sixteen "second generation" hybrids will possess the *two dominant characters*, but *only one* will be *pure* with regard to those characters, for four will be hybrid in one character, and four will be hybrid in *both characters*.

Mendel generalised these statements as follows: In cases of complete dominance (parents differing in *n* ways), the number of different classes in the second generation will be 3^n, of which 2^n will be stable; the remainder will be hybrid, though indistinguishable from pure individuals, and the smallest number of individuals which, in the second hybrid generation, will allow of *one pure individual* to each visibly different class will be 4^n. This gave rise to a new conception of "purity": An animal or plant is pure if it produces gametes of only one sort, even though its grandparents may among themselves have possessed *opposite* characters.

Several exceptions to Mendel's law have been observed, for example:

(1) Mosaic inheritance, in which a pair of characters usually related as dominant and recessive occur in a balanced relationship side by side

in the hybrid, and frequently in its germ-cells also. This balanced condition, once obtained, is stable under close breeding, for the germ-cells are not D or R, but ½ D R, and this breeds true to itself; but this is very easily disturbed by cross-breeding, e.g. if the gamete unites with a pure R or a pure D, the result is D (R); in some cases it may be ½ D (R) · R, and this latter hypothesis accounts for the reappearance of, say, spotted mice after their disappearance for a generation in consequence of crossing.

(2) Stable hybrid forms may occur, and this occurrence may be explained either by the gametes bearing the balanced relationship ½ D R, or by one of the gametes which unite, bearing the character D and the other the character R.

(3) Coupling (or complete correlation) may exist between two or more characters, so that they form a compound unit not separable in heredity, e.g. the blue flower and purple-coloured stems of Datura, and in animals, white hair and pink eyes.

(4) Disintegration of characters apparently simple may take place in consequence of cross-breeding. Thus the grey coat-colour of the house-mouse is always transmitted as a dominant unit in primary crosses with its white variety, but in the second generation a number of *black* appear. These black mice belong to the category of dominant individuals, but they have *only the black constituent* of the grey coat; the remaining constituent, a rufous tint, has become separated, and it may have become latent (recessive).

(5) Departures from the ratios of dominants to recessives may be explained in some cases as due to inferior vigour, and so greater mortality, on the part of dominants or recessives respectively.

(6) Cases of apparent reversal of dominance may arise from "false hybridisation" or induced parthenogenesis, where the one gamete has served merely to *stimulate the other to development* without uniting with it. It is possible, however, that one of a pair of characters may be sometimes dominant, sometimes recessive. Sex may be a case of this sort.

Mendel's principles strengthen the view that species arise by discontinuous variation. They explain also why new types are especially variable, how one variation causes others, and why certain variations are so persistent in their occurrence.

Regeneration of Hind Limbs and Tail in Amphibia.*—P. Wintrebert finds that in the larvæ of Anura regeneration of the tail is rapid and regular, and independent of the nervous system. In *Siredon*, after spinal extirpation, it proceeds regularly. His conclusion is that regeneration and ontogeny proceed in the same fashion; the various parts are formed in the same order in both cases, and apparently independently of nervous control in the ordinary sense.

Interstitial Cells of the Mammalian Testicle.†—P. Bouin and P. Ancel have investigated the morphological and functional relations of the testis and its interstitial cells, and make out an independent function for the latter. They find that interstitial cells exist in the Mammals

* Comptes Rendus, cxxxvii. (1903) pp. 761–3.
† Arch. Zool. Exp., 1903, pp. 437–523 (3 pls.).

which have been examined; their abundance varies with the species. In the first place it is noted that they present all the cytological characters of *glandular* elements,—the structure of the nucleus, the presence in the cytoplasm of numerous secretion products (granules and vesicles, fat, pigment, and crystalloids), and the existence of a cycle of secretion. These cells possess a relative independence—ontogenetic, structural and functional—manifesting itself (1) in young testicles, where they are well developed, while the seminal organ has embryonic characters; (2) in adults, where numerous interstitial cells occur far from the seminiferous tubules, in the albuginea, bodies of Highmore, trabeculæ, where their situation is distinctly perivascular; (3) in old testicles, where they are entire while the sexual elements are degenerate, or have disappeared; (4) in various pathological conditions of the testis, in which the interstitial tissue persists and presents the usual cytological manifestations.

The independence of the two tissues, which the foregoing illustrates, suggests the function of an internal secretion. The investigators consider the interstitial gland an organ which probably elaborates nutritive material for the testis proper, and by its internal secretion controls genital ardour and the determination of the secondary sexual characters. This is an important paper with a bearing on the general question of ductless glands, as well as on the various functions of the testis.

Ova and Larvæ of Fishes.*—F. B. Browne gives a very interesting report on the eggs and larvæ of Teleostean fishes observed at Plymouth. His paper contains a large number of interesting data with regard to *Callionymus*, *Zeugopterus*, *Phrynorhombus*, *Gadus*, and *Motella*.

b. Histology.

Histology of Hyaline Cartilage.†—Richard Fibich has examined the cartilage of a five-month human embryo, and finds that the cells have prolongations at both poles. These prolongations, which sometimes branch and connect with those of other cells, are protoplasmic continuations of the cell, and are most numerous at a distance from the vessels. Near the vessels the cells are isolated in a hyaline substance. He considers that this latter arrangement is possibly related to the transference of the nutritive fluid from the vessels to the tissue, since just before ossification the stream is stronger. In the neighbourhood of the vessels the passage is through the matrical substance, and presumably rapid; further off it is only from cell to cell.

Xerothermic Localities.‡—Von Schulthess-Schindler discusses the occurrence of these "dry-warm" areas, with remains of a steppe-like flora, which persist here and there as sunny islands, with a relict fauna not found in the adjacent areas. The area studied was the Domleschg—a valley between the Stätzerhorn range and the Heinzerberg. The insect fauna is discussed in detail.

Human Locomotion.§—Otto Fischer discusses the kinematics of the swinging movements of the legs in walking. This is the fifth memoir

* Journ. Marine Biol. Assoc., vi. (1903) pp. 598–616.
† Anat. Anzeig., xxiv. (1903) pp. 209–14.
‡ MT. Schweiz. Entomol. Ges., xi. (1903) pp. 26–40.
§ Abh. K. Sächs. Ges. Wiss., No. 5 (1903) pp. 321–418 (4 tabular pls.).

that he has published on human locomotion—of physical rather than biological interest.

Transitory Fissures of Human Brain.*—G. Elliot-Smith points out that Bischoff, Cunningham, Ecker, and Retzius are in error in ascribing to human fœtuses of the fifth and sixth months a "fissura perpendicularis externa." The structure so described he finds is invariably causally related to a "ridge formed by the inward-folding of the membrane joining the occipital and parietal bones in the lambdoid sutural line." It is, in fact, a mechanically produced post-mortem furrow. Another type of "transitory fissure," found in fœtuses of third and fourth months, is accounted for by the "puckering of the partially-collapsed and decomposed neopallial bladder."

Adaptations to Aquatic Life in Mammals.†—Raymond C. Osburn contributes an able paper on aquatic adaptations in Mammals. He starts from the reasonable supposition that all Mammals were originally terrestrial, and for convenience classifies their adaptations to aquatic life under three headings: those connected with the general form, including the head, trunk and tail regions; next, those of the limbs; and lastly, those affecting the integument. He gives a detailed account of the various adaptations under each heading. With regard to hyperphalangism he agrees with Kükenthal in saying that it is a result of retarded ossification and the formation of double epiphyses. Under the third heading he calls attention to the loss of hair and of dermal armature. He also discusses the light and spongy nature of the bones in truly aquatic forms.

Oxidation of Glucose in Mammalian Blood.‡—L. Jolly finds that in the blood of the ox, there arises as a decomposition product of glucose a very small amount of alcohol, a certain part of which by oxidation is transformed into acetic acid.

The Phylogeny of Elephants.§—W. Salensky points out that the phenomena of transformation in the feet of the mammoth follow the same law, which, generally speaking, determines the transformation in the number of toes in Mammals and especially in the change of pentadactyl feet to the tetra-, tri-, bi-, and monodactyl type in Ungulata. From this it appears that the mammoth, which represented the latest development of the numerous order of prehistoric Elephantidæ, was undergoing a process of transformation when it became extinct. It is not easy to understand how pentadactyl proboscidean types such as elephants could have arisen from a type which was undergoing retrogressive development. The two species of elephants have probably originated from some order of fossil Elephantidæ. They have no phylogenetic affinity with the mammoth.

Migrations of Right Whales.‖—Gustav Guldberg is of opinion that the migrations of particular species of whale are regulated by the distribution, the drifting hither and thither, and the season of appearance

* Anat. Anzeig., xxiv. (1903) pp. 216-20 (2 figs.).
† Amer. Nat., xxxvii. (1903) pp. 651-65.
‡ Comptes Rendus, cxxxvii. (1903) pp. 771-2.
§ Biol. Centralbl., xxiii. (1903) pp. 793-803. ‖ Tom. cit., pp. 803-16.

of the organisms upon which they feed. On this account the ocean currents, too, have a secondary influence on the migration and appearance of the whale in certain regions near the coast. On the other hand, the reproductive instinct has a determining influence. Gravid females seek calm and shallow waters; and mating also has been observed most frequently during fine quiet weather. The subject is to be continued in a second paper.

Canadian Birds.*—John Macoun has completed Part II. of his catalogue of Canadian Birds. It deals with the birds of prey, woodpeckers, fly-catchers, crows, jays, and blackbirds. The catalogue includes many breeding notes, and will be found of interest to British as well as Canadian ornithologists.

West Asian Reptiles and Batrachians.†—Dr. F. Werner describes a list, with in some cases brief descriptions, of Reptiles from Asia Minor, chiefly from the Island of Kos, and from N. Persia, collected by Prof. Vosseler and J. Bornmüller.

Sumatra Fishes.‡—Dr. W. Volz, during a stay of two and a half years in S.E. Sumatra, collected much zoological material. He describes in this paper the fishes, amongst which there is one new genus *Trypanochenopsis*, nine hitherto undescribed species, and nineteen new to the fauna of Sumatra.

Sumatra Lizards.§—Dr. W. Volz enumerates with brief notes, sixteen species of lizards from Palembang, a place seldom visited by zoologists.

c. General.

Digestive Ferments in Cephalopods, Echinoderms, and Tunicates.‖ V. Henri finds that hepatic juice from *Octopus* and *Sepia* is rich in amylase and proteolytic ferment. It digests albumin of cooked egg, fibrin, and gelatin. The product of the salivary glands is not specially digestive, but its injection in small quantities into crayfish and crabs causes paralysis. There is a little amylase in the blood and much in the kidney.

The cæcum upon the intestine of *Spatangus* has glandular walls and contains a yellowish-brown feebly acid liquid, which has a notable quantity of amylase and exhibits the same digestive action as the hepatic fluid of Cephalopods. The perivascular liquid contains a little amylase, but has no proteolytic ferment.

Macerations of the pyloric gland of *Salpa* yielded a liquid rich in amylase, but it did not digest the substances mentioned above, though it had a feeble effect on glycerin. The gland contains many digestive ferments. Maceration-fluids from other parts gave no result.

Lake Survey.¶—D. J. Scourfield writes a short paper advocating the scientific investigation of lakes, not only because it is desirable to have

* Geol. Survey of Canada, Ottawa, 1903, pp. 219–413.
† Zool. Jahrb., xix. (1903) pp. 329–46.
‡ Tom. cit., pp. 347–420 (2 pls.).
§ Tom. cit., pp. 421–30.
‖ Comptes Rendus, cxxxvii. (1903) pp. 763–5.
¶ Proc. South London Entom. and Nat. Hist. Soc., 1902 (published 1903), pp. 61–6.

them investigated, but also on account of the fact that their investigation will furnish many important details with regard to such problems as the origin of lake-basins, the influence of environment and the laws of variation. In addition they will furnish many interesting facts with regard to the physical conditions of these faunal areas. It has already been shown how important the presence of the "*Sprungschicht*" is to the organisms in the lake.

Tunicata.

Development of Diplosomidæ.* — A. Pizon has worked out the development of Diplosomidæ during the three weeks after hatching. The facts described are remarkable. From the individual which is hatched, there arises by budding a "bithoracic" individual which in turn gives origin to an ascidiozooid "*bithoracique et biventrique*," which is described as a "new physiological individual, much more complex than the preceding, with two independent branchiæ, two œsophagi superimposed, two stomachs communicating with the œsophagi, two hearts, whose contractions are rarely synchronous, and two recti superimposed." In the main, there are three remarkable phenomena: (1) the regular regression of the old thorax in the bithoracic specimens; (2) the persistence of the abdomen from the one ascidiozooid to the other; (3) the building up of the "*bithoracique et biventrique*" ascidiozooids, and their final division into two simple ascidiozooids with transformation of the visceral masses.

Ova of Crustaceans and Gastropods.†—F. Henschen communicates some notes on the structure of the immature eggs of *Astacus fluviatilis*, *Homarus vulgaris*, *Helix pomatia*, *Limnæa stagnalis*, etc. In all these forms he finds in some of the cells, chiefly those of medium size, "pseudo-chromosomes" such as have already been described in various ova by other observers. Their commonest position in *Astacus* is around the nucleus forming part of a sphere, and enclosing a zone which is sometimes distinguished by a greater granularity and sometimes by small alveoli. With hæmatoxylin and eosin, they stain an intense blue. They are straight or slightly bent and of a varying thickness; the coarsest consist of two threads lying closely together. He has no suggestion as to their significance.

Fauna of the Gulf of Trieste.‡—Dr. Ed. Graeffe gives a list of the Molluscoidea (Bryozoa and Brachiopoda) and Tunicata, with notes on the time of appearance and spawning of certain species. No new forms are enumerated.

INVERTEBRATA.

Mollusca.

γ. Gastropoda.

Olfactory Sense in Helix Pomatia.§—Emile Yung states that there are in the snail no groups of tactile, gustatory, or other differentiated

* Comptes Rendus, cxxxvii. (1903) pp. 759–61.
† Anat. Anzeig., xxiv. (1904) pp. 15–29.
‡ Arbeit. Zool. Inst. Univ. Wien, xv. (1903) pp. 1–16.
§ Comptes Rendus, cxxxvii. (1903) pp. 720–1.

sense-corpuscles, and that there is no part which can be described as a group of specialised olfactory cells. In reality, the sensory cells are "mixed" and respond to shock, heat, or odour. The whole exposed surface of the body is sensory, the long tentacles most so, and next the smaller pair, and next the dorsal surface. Snails deprived of both pairs of tentacles were able to find food placed in their vicinity; in one case a piece of ripe melon was "tracked" at a distance of 40 centimetres.

Structure of Cryptoplax larvæformis.*—Ernst Wettstein describes the structure of this representative of the Cryptoplacidæ, an interesting family of Placophora, which seems likely to throw some light on the affinities between Placophora and Solenogastres.

The form is elongated, almost worm-like; the strongly developed mantle makes the foot inconspicuous; the mantle cavity is deepest in the region of the gills; localised muscle strands are lost in the general body-musculature, which like the form, means adaptation to boring; the stomach and intestine are spirally coiled; the pericardium is reduced in its most anterior portion to a narrow vesicle; the aorta is connected by looping vessels with the vena pallialis (peculiar to Cryptoplacidæ), and the latter with the sinus lateralis.

The most notable fact in regard to the nervous system is the shunting of the origin of the buccal connective to the posterior portion of the cerebral semicircle. A peculiarity, which only occurs elsewhere in Aplacophora, is the existence of two connections of the pleurovisceral strands over the hind-gut.

The left and right kidney are directly connected by a vesicle. This species agrees with *C. oculatus* in the dorsal position of the main canal and of the reno-pericardial duct, and in the nature of the reproductive organs.

δ. Lamellibranchiata.

Anatomy of Anomia ephippium.†—Moriz Sassi, in a detailed research on the heart and kidneys of *Anomia ephippium*, sets himself to discover whether a portion of the cœlome exists with which the kidneys communicate by a ciliated funnel, and if so, whether it also functions as a pericardium. He finds that each kidney has the remains of such a funnel communicating with a small sac-shaped remnant of the cœlome, which from its position might have been originally situated round the heart.

Arthropoda.

α. Insecta.

Habits and Instincts of Insects.‡—J. H. Fabre has published the eighth series of his delightful "Souvenirs Entomologiques." It deals with rose-beetles, bean-beetles, Pentatomas and masked bugs, aphides, wild bees, carrion-flies, etc. Special attention has been given to eggs,

* Jenaische Zeitschr. Naturwiss., xxxviii. (1903) pp. 473–504 (3 pls.).

† Arbeit. Zool. Inst. Univ. Wien, xv. (1903) p. 1–16 (1 pl.).

‡ 'Souvenirs Entomologiques (Huitième Série): Études sur l'Instinct et les Mœurs des Insectes.' 8vo, Paris, 1903) p. 379. See Ann. Nat. Hist., xii. (1903) pp. 637–8.

cocoons, and nests. Some observations of former writers are questioned. Thus he has been "unable to confirm the statement that *Pentatoma griseum* watches over her young like a hen over her chickens or that the favourite prey of *Reduvius personatus* is the bed-bug"; nor does he regard the superficial resemblance between *Volucella* and a wasp as having anything to do with mimicry. "The relation of *Volucella* to the wasp seems to be that of a simple scavenger."

In regard to limitation of instinct, it is noted that when the nest of the common wasp is covered with a bell glass, "the enclosed wasps never dig a passage out, but remain cooped up till they die; and though stragglers left outside will dig their way in, they are equally unable to show their companions the way out or even to make their own escape."

Viviparous Insects.* — N. Holmgren has examined a very large number of species in which viviparity occurs, and finds that in relation to this condition the structure of the female organs is variously affected in different cases. In those cases where parthenogenesis occurs the development of the egg may take place within the ovary, as in the Aphides and Coccidæ, or in the body cavity as in *Miastor* larvæ. In amphigenetic types the place of storing of the eggs depends upon the region in which fertilisation is effected. In the Diptera they are retained in the vagina or its differentiations, in Strepsiptera in the body cavity or brood canal, and in *Orina* and *Chrysomela* in the canals of the ovary. In Diptera there is sometimes differentiated on the vagina a diverticulum which acts as a brood-sac, in others the vagina is lengthened and functions as a brood-sac, while in others only the wider and more anterior portion so functions.

In Diptera the larvæ may remain only till partially developed; in pupiparous forms the young are born in a highly advanced state.

In most viviparous insects there is no special maternal provision for the brood. Only in pupipara are there specific organs of nutrition, the accessory glands being transformed into nutritive glands, a fact which is related to the long life of the brood in the vagina.

Variations in Lycænidæ.†—L. G. Courvoisier describes variations from the normal type of wing-marking in various Lycænids, especially *Lycæna* and *Chrysophanus*. They are not irregular, but follow certain lines, some with too much ("luxuriant" forms), others with too little (impoverished forms) of certain normal characters. The author's observations were made before he became aquainted with Oberthür's great work, 'La Variation chez les Lépidoptères' (1896).

Red and Yellow Pigment of Vanessa.‡ — Dr. M. Gräfin von Linden has investigated the chemical nature, function and origin of these pigments. The various colours of the butterfly are the result of various stages of oxidation of a pigment that is itself attributable to the plant-cells forming the food of the caterpillar.

* Zool. Jahrb., xix. (1903) Heft. iv. pp. 431–68.
† MT. Schweiz. Entomol. Ges., xi. (1903) pp. 18–25 (1 pl.).
‡ Biol. Centralbl., xxiii. (1903) pp. 821–8.

Hymenoptera of West Indian Islands.*—W. A. Schulz describes a number of Aculeate Hymenoptera from the West Indies. About 1300 Hymenoptera are now known from the Antilles, and it seems probable that this is only a small fraction of the existing species. The paper gives a good example of the need of caution in making species; *Pepsis rubra* and *P. stellata* are the dimorphic sexes of *P. rubra*.

Ergatogynic Ants.† —Margaret Holliday has made a thorough examination of numerous species with a view of determining the relative sexual conditions of the queens and workers. She finds that the ovaries of the workers of most of the species investigated show a reduction in the number of tubules, but they are not rudimentary. Morphologically and histologically they are capable of producing and do produce eggs. The presence of the receptaculum seminis is not peculiar to the queen ant and cannot be used as a distinguishing feature. There is no physiological reason why those workers possessing the receptaculum should not have the power of performing the function of the sexual female, and it is believed that they do so. The author does not think that intermediate conditions of fertility are induced by direct changes in social conditions, as has been held, but thinks a phylogenetic explanation the better one.

Males of Andrena.‡ —E. Frey. Gessner describes the males of *Andrena æneiventris* Mor., *A. incisa* Evers., *A. parviceps* Krchb., and *A. rogenhoferi*, which were not known when Schmiedeknecht published his monograph on the Bees of Europe. The author has found the males of the four species noted, and Morawitz has also described the male of *A. incisa*.

Habits of the Drone-Fly.§—W. H. Harris gives an account of the emission of musical notes and of the hovering habit of *Eristalis tenax*. He shows that the musical notes are not due to the rapid vibrations of wings or poisers, nor to the rapid motion of the legs, but to the expulsion of air from the tracheæ through the spiracles. In each spiracle there are two chitinous crescent-shaped rods joined together by a ligament and thus forming a bow with elongated free arms. The rods support very delicate and pliant membranes which are folded or plicated in a very complicated manner. When the air is expelled and the free edges of the plicated membranes are brought together by the thoracic muscles the musical notes are produced. He finds that the power of hovering is due to specialised or auxiliary organs. In *Eristalis tenax* it is due to the four alulets and to a newly discovered organ which he calls the "plume." These organs are attached near the bases of the wings, and consist of a basal part of chitin and a membranous hollow expansion with long hairs attached.

Habits of Chironomus.‖—T. H. Taylor contributes some notes on *Chironomus sordidellus*. He describes the way in which it converts its

* SB. K. Akad. Wiss. München (1903) Heft. iii. pp. 451–88 (7 figs.).
† Zool. Jahrb., xix. (1903) pp. 293–328 (16 figs.)
‡ MT. Schweiz. Entom. Ges. xi. (1903) pp. 40–5.
§ Journ. Quekett Micr. Club, viii. (1903) pp. 513–20.
‖ Trans. Ent. Soc. Lond., 1903, part iv. pp. 521–3.

larval tube into a pupal case, and how it makes a new exit for itself at the lower end of the dilated portion. This exit is seldom single ; generally two, three, or even four holes are made. When it is ready to emerge, the pupa creeps out by using hooks on its body. The larva of a water mite is often attached to the pupa, and it succeeds in attaching itself to the fly, to which it apparently does no harm.

Marine Chironomid New to Britain.*—A. D. Imms found *Clunio bicolor* Kieff skimming on the surface of rock pools near Port Erin. It is a new addition to the British fauna. The males appear to be only on the wing in fine weather ; even a slight wind is detrimental to their fragile constitution. They are only seen at low water, and probably do not survive until a second ebb-tide. A single female—not previously known—was discovered resting on the surface film. She is likewise very short-lived, and is apterous and vermiform.

Follicular Cells of Cricket.†—Edwin G. Conklin describes the process of amitosis in the follicle cells of the ovum of the cricket. He shows the stage at which amitosis occurs, and finds that the type found here exactly corresponds to the type described by Remak. He finds that the amitotic division is, in this case, one of the last functions of the cells, and that it is an accompaniment of cellular senescence and decay.

Pelecinidæ.‡—W. A. Schulz makes a contribution to our knowledge of this small family of Ichneumon-flies, which is represented by two genera, *Pelecinus* and *Monomachus*. A third genus, *Ophionellus* = *Pharsalia*, previously referred to the Pelecinidæ, belongs to the Ophionidæ (Nototrachinæ). The Pelecinidæ occur in equatorial regions in the New World, and one species is Australian. They are remarkable in form and show well-marked sexual dimorphism.

Collembola of the Beach.§—C. B. Davenport deals with *Anurida maritima* Guérin, *Xenylla humicola*, Tullberg and *Isotoma bessellii* Packard—the common Collembola of the beach, as at Cold Spring on the north shore of Long Island. He discusses their distribution and movements on the beach, their reactions to gravity, contact, moisture, air-currents, light, etc., the Collembola as ancestral insects, and the evolution of insect intelligence. He also gives, after Macgillivray, a useful key to the determination of the genera of boreal Collembola.

The Podurids of the beach live between tide-marks, go into the sand at high tide and rise to the surface to take the air when the tide is out. They run up surfaces in face of the wind, and leap when they reach the top, being blown back to the starting point. They are exceedingly sensitive to gravity, to contact, to moisture, to currents of air, and to light, and these elementary reactions are so combined as to bring about their normal movements. They are provided with these instincts before they reached the beach, else they could never have survived there. The

* Proc. and Trans. Liverpool Biol. Ass., xvii. (1902–3) pp. 81–5 (3 figs.).
† Amer. Nat., xxxvii. (1903) pp. 667–75 (8 figs.).
‡ SB. K.B. Akad. Wiss. München, 1903, Heft. iii. pp. 435–50 (1 pl.).
§ Cold Spring Harbor Monographs, Brooklyn Inst. of Arts and Sciences, No. ii. (1903) p. 32 (1 pl.).

instincts have selected the habitat. The behaviour of insects is determined by their elementary reactions to the chemical and physical conditions of the environment.

Protective Coloration.*—A. H. Thayer contributes a memoir on protective coloration in its relation to mimicry, warning colours and sexual selection. He begins his paper by a statement of the artist's claims to be the only judge of all matters of colour, pattern, visibility, and their effect on the mind. He says that the pattern and coloration of butterflies are all evolved for the sake of rendering them invisible, as a pattern is less conspicuous than a monochrome; he also holds that the mimicking is not of each other, but of some flower or of some organic form, for if they were mimicking each other there would be no necessity for the great detail, but if they were mimicking flowers then they would derive the greatest benefit from the minutest details. He holds that the syncryptic resemblance to flowers gives a full explanation of all the patterns and colours. His paper contains many very important suggestions, e.g., the concealing effect of iridescence, the overflow of individuals from a concealing region to one less favourable, and the resemblance of butterfly patterns in general to flower-masses and the shadow-depths between them.

E. B. Poulton † criticises Thayer's paper on Protective Coloration. He holds that the syncryptic resemblance is a highly improbable interpretation and that, in spite of Thayer's repeated statement to the contrary, zoologists have not entirely misunderstood the principles underlying the cryptic pattern. He also holds that the effacive shading of the body and the brilliant pattern of the wing help in preserving the life of the butterfly, as they misdirect the attack of the enemy. He believes that Thayer's suggested interpretation of mimetic resemblance is untenable, but he admits having had ideas similar to Thayer's in regard to warning colours. He concludes his paper by saying that naturalists owe Thayer a large debt for many new points of view and illuminating suggestions.

δ. Arachnida.

Stridulation in Scorpions.‡—R. I. Pocock describes a new stridulating organ in scorpions discovered by W. J. Burchell. This organ consists of the modified pectines and granular areas on the overlying sternal plate. These modifications were a puzzle until a reference and explanation was found in Burchell's MSS. The author has now given a full description and careful drawings of this organ, and he adds that it is purely of aposematic significance.

New Chelifer.§—R. T. Lewis describes a new species of *Chelifer*. His attention was first drawn to it in 1890 by a specimen sent from Natal. This, when compared with a number of specimens in the British Museum, was found to be new. The Chelifer is bright red in colour, with an ovate body much narrowed in front and semicircular behind. On account of the beautifully sculptured segments it is proposed to name the species *Chelifer sculpturatus*.

* Trans. Ent. Soc. Lond., 1903, pp. 553–69. † Tom. cit., pp. 570–5.
‡ Ann. Nat. Hist., xiii. (1904) pp. 56–62 (1 pl.).
§ Journ. Quekett. Micr. Club, viii. (1903) pp. 497–8 (1 pl.).

ε. Crustacea.

Larval Forms of Crangonidæ.*—Robert Gurney gives an account of the larvæ of two species of Crangonidæ—*Cheraphilus trispinosus* and *Ægeon fasciatus*. He describes the characteristic features of the larvæ, and gives at the end of his paper a diagnostic table for the distinction of all Crangonid larvæ at present known. In many cases he has been able to confirm the descriptions that Sars has given of the larval forms.

Cladoceran new to Britain.†—R. Gurney has found *Scapholeberis aurita* S. Fischer in three localities in Norfolk. He compares its swimming habits and some points in its structure with Scourfield's description‡ of *Sc. mucronata* O. F. Müller. The two species swim on their backs suspended by the surface film, but the mechanism is different in the two.

New Copepod Genus.§—Adolf Steuer describes a Copepod which he finds in great abundance in the intestine of *Mytilus galloprovincialis*. It requires a new genus, and he names it *Mytilicola intestinalis* n.g. et sp., within the family Dichelestiina. From its size, relative transparency, frequency of occurrence, and the ease with which it may be kept free living in an aquarium, he has found it well suited for thorough observation. In his present communication he gives a full account of the vascular system, shell glands, reproductive organs, and other parts.

Copepoda of Basel.‖—A. Graeter, in a very full paper, gives an account of the Copepods of this region, and discusses, with the help of analytical tables, the horizontal and vertical distribution of the species in the different areas. The chief interest of the memoir is as regards distribution.

British Freshwater Entomostraca.¶—D. J. Scourfield continues his synopsis of the known species of British freshwater Entomostraca. He gives a list of the free-swimming and of the parasitic Copepoda, to which is added a table of distribution in England and in Scotland. Among the free-swimming forms, he notes the occurrence of *Belisarius viguieri* in Regent's Park, London, and Kew Gardens. This form is peculiar in its habitat—the cups formed by the leaves of Bromeliaceous plants; it is remarkable in being blind, in having no ovisac, and in having a special vibrating organ in the region of the shell-gland.

Variation in Cyclops.**—Harriet Lehmann undertook the investigation of the variations in form and size of *Cyclops brevispinosus* and *Cyclops americanus*, with special reference to the question of specific distinction between these forms in the furca and the armature of the fourth swimming foot. She found that the range of variation was very great, so much so that the specific differences between the two forms are not trustworthy. She advocates a careful study, and thinks the result would be a re-classification of the species and varieties.

* Journ. Mar. Biol. Ass., vi. No. 4 (1903) pp. 595–7.
† Ann. Nat. Hist., xii. (1903) pp. 630–3 (2 figs.).
‡ Journ. Linn. Soc. (Zool.) xxv. (1894) pp. 1–19.
§ Arbeit. Zool. Inst. Univ. Wien, xv. (1903) pp. 1–46 (5 pls.).
‖ Revue Suisse Zool., ii. fasc. 3 (1903) pp. 419–541.
¶ Journ. Quekett Micr. Club, viii. (1903) pp. 531–44.
** Trans. Wisconsin Acad. Sci., xiv. (1903) pp. 279–98 (4 pls.).

Annulata.

New Polygordius.* — Akira Izuka describes *Polygordius Ijimai*, a new species from Misaki, Japan. The discovery is noteworthy, since all the species hitherto known are from the coasts of Europe. The members of this species, both male and female, are of a light pink colour. On each side of the head, at about the level of the mouth, an oval-shaped vibratile pit is found. The musculature of the body wall is peculiar in not having circular muscle fibres, while in the intestinal wall neither longitudinal nor circular muscles are to be found. The vascular system is peculiar in having the dorsal and the ventral vessel connected by a pair of lateral loops in each segment. A point worthy of notice is that the species is nearly sexually mature as early in the season as the end of March.

Development of Phascolosoma.†—J. H. Gerould, in a preliminary note, summarises the results of his studies on the development of *Phascolosoma*. They throw light on the hitherto apparently anomalous development of *Sipunculus*. *Phascolosoma* is in most respects less highly modified, and is more like the Annelids. Numerous features, e.g. a transitory metamerism of the mesoblastic bands, and of the nerve-cord in the trochophore, indicate close relationship between the Sipunculids and Annelids. Sipunculids are to be regarded as forms that have recently sprung from the ancestral trochozoon. The adult Sipunculid retains the retractor muscles and nephridia of the trochophore. The loss of the prototroch, the development of the cœlome, and the enormous elongation of the trunk, are the only fundamental changes which the trochophore undergoes in passing into the adult condition.

Histology of Ctenodrilus Clap.‡—Egon Galvagni has made a detailed comparative study of the two species of *Ctenodrilus*, dealing principally with details of the vascular system, nephridia, and pharynx previously incorrectly described, and with other features, e.g. circular muscles, pigment, and mucous cells, etc. He concludes that the characters of the nervous system, etc., and in particular the nature of the bristles, suggest relationship to the Cirratulids, and decides in favour of classing the genus under this family.

Musculature of Branchiobdell aparasitica.§—F. Schmidt finds the musculature of this parasite, in relation to its extremely sluggish and leisurely movements, feebly developed. The muscle cells are of the primitive nematoid type, i.e. the myoblast is surrounded by a contractile tegument, which is interspersed with either widely-gaping or narrow slit-like fissures, into which the protoplasm of the myoblast is continued. The myoblast consists of plasma and a nucleus. The contractile tegument contains radiating layers of fibrils, which consist of colourable and uncolourable longitudinally-placed columns. There are notably two types of muscular cells, a cylindrical and double cylindrical type.

Anatomy and Histology of Myzostoma.‖—R. Ritter v. Stummer-Traunfels, in view of the fact that descriptions of species of this genus contain a series of errors, due to the neglect of internal characters in

* Annot. Zool. Japon, iv. (1903) pp. 137–9.
† Arch. Zool. Exp., ii. (1904); Notes et Revue, No. 2, pp. xvii–xxix.
‡ Arbeit. Zool. Inst. Univ. Wien, xv. (1903) pp. 1–34 (2 pls.).
§ Zeitsch. f. Wiss. Zool., lxxv. (1903) pp. 596–705 (1 pl., 13 figs.).
‖ Tom. cit., pp. 495–595 (5 pls.).

species diagnosis, seeks to place the classification upon a firmer basis. He gives a revised diagnosis of *Myzostoma asteriæ* Marens, a form which, on account of its strictly endoparasitic mode of life within the arms of certain star-fishes, is of special interest. This is followed by a detailed account of its anatomy and minute structure.

Platyhelminthes.

New Species of Phagocata Ledy.*—G. Chichakoff has found near Mount Vitocha, in company with *Planaria alpina*, a Turbellarian which appears to differ from this species in one character only, viz. in possessing a multiple pharynx. This character classes it in the genus *Phagocata*, of which there has hitherto been known a single species, *P. gracilis*. The new species, however, differs from *P. gracilis*, not only in the general form of the body, but also in certain internal characters. Reasons are adduced for believing that the genus has had a teratological origin from *Planaria alpina*. The new species he terms *Phagocata cornuta*.

Incertæ Sedis.

Gonads of Phoronis.†—Iwaji Ikeda gives a concise account of the development of the sexual organs and of their products in Phoronis. In young individuals, he says, sexual organs are not found, but in their stead there exist cæcal capillaries which, by the modification of the peritoneal layer, give rise to the gonads. As sexual maturity approaches, the peritoneum becomes thickened and forms a pyramidal layer. This layer is called the nutritive layer, because it contains reserve nutriment in the form of spheres. Immediately below this layer a few scattered peritoneal cells lie which give rise, by proliferation, to the germinal cells.

In the ovary the oogonia soon differentiate into oocytes and follicular cells. These cells absorb the nutritive layer in their growth, and then the follicular layer becames a mere membrane when the egg approaches maturity. In the testis the same development takes place, but the characteristic feature is the pushing out of fibrous bundles, by the connective tissue layer, round which the spermatogonia arrange themselves.

Rotifera.

New Species of Philodina.‡—David Bryce figures and describes two new species, *Philodina nemoralis* and *Ph. rugosa*, with two varieties of the latter, found on mosses growing in damp ground, or on sphagnum in mossy pools, and also gives some general details about the structure of the foot and toes of the animals belonging to this genus.

New Male Rotifers.§—To the long list of male Rotifers now known, K. I. Marks and W. Wesché add those of *Brachionus quadratus*, *Anuræa brevispina*, and *Pterodina patina*, figures and description of which are given.

Variation Cycle of Anuræa cochlearis.‖—Three years ago Robert Lauterborn published ¶ the first part of his study of the cycle of

* Arch. Zool. Exp., 1903, pp. 401–9 (1 pl.).
† Annot. Zool. Japon, iv. (1903) pp. 141–53 (1 pl.).
‡ Journ. Quekett Micr. Club, viii. (1903) pp. 523–30 (1 pl.).
§ Tom. cit., pp. 505–12 (1 pl.).
‖ Verh. Naturhist.-Med. Ver. Heidelberg., Bd. vii. 4 (1903) pp. 529–621.
¶ Cf. this Journal, 1901, p. 159.

variation of this Rotifer, in which he showed how the variations could be traced in three or four definite directions from the type species, so as to embrace all the known varieties of this very variable form. The second part, now published, is an elaborate account of the conditions which appear to produce these variations. These conditions the author finds principally in the constitution of the water of the various ponds and lakes, and in the changes of temperature due to the seasons. By collecting regularly once a month throughout the year in seven different localities, examining and measuring twenty-five to fifty specimens each time, and tabulating the results, the author has ascertained that *Anuræa cochlearis* goes through a regular cycle of variation, which is repeated every year. During the cold season—December, January, and February—this species is represented in the old bed of the Rhine, near Neuhofen, by the typical form and by the variety *macracantha*, with long posterior spine. In the spring these forms are very gradually replaced by members of the *irregularis* and *hispida* series, with short spines, including *tecta*, with no spine; so that by the month of May the long-spined varieties have entirely disappeared, to reappear again in the month of October or November. The author has observed the same regular cycle of variation in the same locality for a period of twelve years. In order to account for these regular variations, the author is inclined to adopt W. Oswald's suggestion that the reason is to be found mainly in the "internal friction" of the water, which varies very considerably with the temperature, and which must have an influence on the floating capacity of the various organisms living in the water. He thus sets aside as insufficient the theory advanced by Wesenberg-Lund, who thinks that similar seasonal changes in the size of animals and appendages in Cladocera, Rotifera and Infusoria, are due to a tendency to accommodate the organisms to changes in the specific gravity of fresh water, which decreases, but only slightly, with increasing temperature.

New Rotifers.*—E. von Daday gives an account of the Plankton organisms collected by Franz Werner in some fresh-water lakes in the northern parts of Asia Minor, and thereby figures and describes one new species and one new variety of Rotifers, *Mastigocerca heterostyla* (which really is *Rattulus bicornis* of Western) and *Brachionus rubens* var. *Werneri*. The author also gives some new figures of several species already known, namely *Brachionus budapestinensis* and *forficula* and *Notops macrourus*.

Echinoderma.

Non-regeneration of Sphæridia in Sea-Urchins.†—Yves Delage in an interesting note points out that removal of the epidermis, spines, pedicellariæ, sphæridia,—everything in fact—from the surface of *Paracentrotus* (*Stryonglocentrotus*) *lividus*, was followed by regeneration of all the structures, except the sphæridia. It does not appear to be the case that these bodies are necessary to equilibrium as has been suggested, since the urchins can turn over, although these have been removed.

Osmotic Action of the Internal Fluids of Echinoderms.‡—V. Henri and S. Lalou find that the membranes connecting the internal cavity of

* SB. K. Acad. Wiss. Wien, Bd. cxii. pp. 139–67 (1 pl.).
† Comptes Rendus, cxxxvii. (1903) pp. 681–2.
‡ Tom. cit., pp. 721–3.

sea-urchins and Holothurians with the external medium are semi-permeable, as are also the walls of the water-vascular system, the polian vesicles, and the digestive tubes of Holothurians.

Cœlentera.

Development of Corymorpha.*—Albert J. May undertook the study of *Corymorpha pendula* with special reference to the development of the medusoid, and to the origin of the sex cells. His results may be summarised thus :—*Corymorpha* is a solitary form, developed from a bud of the peduncle wall, in which the attaching filaments and papillæ are modifications of the same structure. The central axis of the stem is filled with parenchyma-like cells in which extensions of the hydranth cavity are found as longitudinal canals. Owing to the development of gland cells in the hydranth cavity, digestion and circulation have become localised. The sex cells are derived from an apical plug of ectodermal cells, and in the case of the ova, the development is by absorption of the germinal tissue, thus giving rise to a syncytium in which the nuclei of the primitive germ cells persist for a time.

Depastrum.†—E. S. Russell contributes a few notes on the rare Lucernarid *Depastrum cyathiforme* (Gosse). Its peculiarly local distribution is difficult to account for, but he has found that it never occurs in muddy localities, nor in spots where there is much decaying sea-weed. He shows that instead of there being many rows of tentacles, as Haeckel says, there are only two. He found two types, one with a long narrow umbrella and the other with the umbrella as broad as long. His paper is of interest as a record of the fairly abundant occurrence of a Lucernarid around the Cumbraes, etc., which is but little known to the majority of British zoologists.

Porifera.

Haddonella.‡—Igerna B. J. Sollas gives an account of the new genus *Haddonella*, a ceratose sponge belonging to the Dendroceratina, paying special attention to the structure and development of the pithed fibres of *Haddonella topsenti*. She finds that *Haddonella* and *Ianthella* are closely allied in having cells in the cortex of their pithed fibres. The growing points consist of naked pith secreted by a many-layered cap of spongoblasts. Layer after layer of spongoblasts deposit spongin until finally the pith is enclosed in many successive sheaths of spongin, between which lie the spongoblasts, which have diminished and lost their granular contents. These results justify Polejaeff's assertion that the presence of cells in the spongin of sponge-fibres is a character of sub-family or family value.

Protozoa.

Nuclear Apparatus in Paramœcium.§—P. Mitrophanow has studied the functions and accompanying changes of structure in the nuclei of *Paramœcium*. The micronucleus plays the principal part in the phenomena of multiplication and conjugation ; it exhibits the principal

* Amer. Nat., 1903, pp. 579-99 (12 figs.).
† Ann. Nat. Hist. xiii. pp. 62-5 (1 pl.).
‡ Op. cit., xii. (1903) pp. 557-63 (2 pls.).
§ Arch. Zool. Exp., 1903, pp. 411-35.

features of the changes in the nuclei of metazoan cells in division. The macronucleus dominates above all the functions of nutrition, assimilation, and movement; it is very susceptible to changes in the conditions of life, and assumes sometimes, among other transformations, characters which recall the appearance of chromosomes. On the whole, the structure of the nuclei is complicated, and the changes in the macronucleus varied in relation to the numerous functions of the organism.

Action of Induction Shocks on Ciliata.* — P. Statkewitsch gives a very full account of the behaviour of seventeen different species of Ciliata to stimuli of this type. There are two different groups of results from single induction shocks, which he relates to both physiological reaction and to structure, viz. certain movements of the cilia (which occur in all), and alteration of the form of the individual in consequence of the contraction of the outer layers. These results are detailed for each of the species examined. His results contradict Pflüger's law of polar excitation.

Micro-fauna of Boulder Clay.†—Joseph Wright found Foraminifera in three-fourths of 134 samples of boulder clay from widely separate localities. With one or two exceptions all the species found in the clay occurred recently off our coast. More than half the specimens are referable to *Nonionina depressula*, and *Cassidulina crassa*, though somewhat rare, as a recent British species is often plentiful. Porcellanous forms are usually very rare, and the only arenaceous form is *Haplophragmium canariense*.

North American Gregarines.‡—Howard Crawley has prepared a list of the Polycystid Gregarines of the United States. He has made a careful examination of the species, and has established twelve new ones, which he carefully describes and figures, giving in each case the locality and the host.

In a subsequent paper,§ Crawley continues his list of North American Polycystid Gregarines, and gives a description of two new genera and several new species. He also adds a note on the time required for a Gregarine cyst to mature, and gives a short account of the cysts of *Acutispora macrocephala*.

Tick Fever.‖—J. F. Anderson confirms the observations of Wilson and Chowning, who discovered the presence of an intracorpuscular parasite in spotted or tick fever. It is not pigmented; it shows amœboid movements; it is arranged in pairs, or occurs as a single pyriform or ovoid body. It stains with difficulty; and is never found in large numbers. Cultivations were negative.

* Le Physiologiste Russe, iii. (1903) pp. 1–55.
† Rep. and Proc. Belfast Nat. Hist. and Phil. Soc., 1902–3, pp. 47–50.
‡ Proc. Acad. Nat. Sci. Philadelphia, 1903, pp. 41–58 (3 pls.).
§ Tom. cit., pp. 632–44 (1 pl.).
‖ Bull. No. 14, Hygien. Lab. U.S.A., 1903, 50 pp. (3 pls.).

BOTANY.

GENERAL,

Including the Anatomy and Physiology of Seed Plants.

Cytology,

including Cell Contents.

Nucleus of the Yeast-Plant.*—F. A. Janssens gives a review of the various observations made on this subject since the publication of his and Leblanc's paper on the cytology of yeast. The majority of recent observers are agreed that the yeast-cell possesses a definite corpuscle, with the micro-chemical characteristics and the physiological properties of a true nucleus. A few others doubt the existence of a definite nucleus, and consider the cell to have the same structure as that of the bacteria. Others, again, hold an intermediate view, that the nucleus exists in a primitive state as a vacuole, containing granules of nuclein. Wager puts forward the view that the cells contain a nuclear apparatus rather than a true nucleus, consisting of a nucleolus (the nucleus of most authors) which resists peptic digestion and stains feebly; and in young and vigorous cells a vacuole also, which contains granules often united in a network and resisting digestion with pepsin. It is clear, then, that most authors admit the existence of a nucleus in the yeast-cell, but there is considerable disagreement on the existence and significance of the vacuole. Janssens believes that the nucleolus always lies inside the vacuole when the latter is present; its appearance by the side of the vacuole, as observed by Wager, he considers to be due to the process of fixation, which he has followed under the microscope. The author ranges himself on the side of those who believe in the existence of a true nucleus, since there is to be found in the yeast-cell, as in the cells of higher forms, an organised body which contains nuclein, and plays an important part both in ordinary division and in spore-formation. Recent observations also confirm the views put forward earlier by Janssens and Leblanc as to the importance of this body in fertilisation. The rôle of the nucleus in budding, in sporulation and in fertilisation, is discussed with reference to recent work.

Micro-chemistry and Cytology of a Torula.†—Janssens and Mertens have isolated a rose-coloured Torula from a deposit in beer, and investigated its structure and behaviour. Their most important observations are, that the colouring matter is *carotin*, that it is sensitive to light, and that its nucleus sometimes increases by a process of unequal division. When grown in reverse plate cultures, small masses of gelatin are projected on to the cover and form there images of the colonies; this is brought about by a liquefaction of the gelatin and the formation of a certain quantity of gas.

* La Cellule, xx. (1903) pp. 337–49. † Tom. cit., pp. 353–68 (2 pls.).

Abnormal Nuclear Division.* — C. van Wisselingh has made a detailed study of the various methods of abnormal division of the nucleus to be found in *Spirogyra* when subjected to the action of various reagents, chiefly dilute chloral-hydrate solution. His general conclusion is that the various abnormal processes observed are not of a special nature or of the nature of amitosis, but are to be considered as processes of karyokinesis, though modified to a greater or less extent. The evidence for amitosis in plants is reviewed, and its unsatisfactory nature pointed out. Many of the observations are to be explained as modifications of karyokinesis. The author has modified somewhat his views on normal division ; he no longer believes that two of the six or twelve chromosomes are derived from the nucleolus (or nucleoli), but that a small portion only of the substance of these two special chromosomes is derived from the nucleolus.

Spermatogenesis of Hybrid Peas.† — W. A. Cannon, continuing his studies in plant hybrids, has investigated the nuclear development in pollen-formation in hybrid peas, namely, Fillbasket × Debarbieux and Express × Serpette. The hybrids investigated were of those of the second generation, and they showed variation after the Mendelian law. They matured their spores in exactly the same way as the pure ancestral forms; the first mitosis being heterotypic, the second homotypic. The reduced number of chromosomes was seven, both in hybrids and pure forms, the somatic number being fourteen. In the anaphase, however, of the last sporogenous division of both hybrids and of the pure form, Fillbasket, the chromosomes were found associated in pairs ; this condition is considered not to be the result of chance. It is clear that abnormalities and irregularities of nuclear division (which have been observed in some forms, probably in connection with their non-fertile nature) do not form the basis for the variation of these hybrids. The basis of variation is probably the same as that of variations in the pure forms.

Structure and Development.

Vegetative.

Stem of Sicyos angulata.‡—Fr. Tondera gives an account of the morphology and the anatomy of the stem of this member of the order Cucurbitaceæ. The stem is a sympodial structure, and the arrangement and course of the vascular bundles is clearly described and figured. The five-angled stem contains a mass of collenchymatous tissue in each of the angles, the well-developed parenchymatous ground-tissue is bounded by a sclerenchymatous ring, and contains an inner and an outer series of bicollateral bundles, the course of which through the internodes is carefully followed.

Saprophytic Gentianaceæ.§ — N. Svedelius describes some points in the structure of species of *Leiphamos* and *Voyria*, from material

* Bot. Zeit., xxxii. (1903) pp. 201–48 (3 pls.).
† Bull. Torrey Bot. Club, xxx. (1903) pp. 519–43.
‡ SB. K. Akad. Wiss. Wien, Math.-naturwiss. Cl. cxi. (1902) pp. 317–26 (2 pls.).
§ Bihang. K. Svensk. Vet.-Akad. Handl., xxviii. (1902) Afd. iii. No. 4, pp. 1–16 (11 figs. in text).

collected by Dr. Lindman on the Regnell Expedition to South America. His results serve to confirm or supplement those obtained by Karsten, Johow, and others. The two species examined were *Leiphamos azurea* and *Voyria cærulea*. He finds in the former a whorl of disc-like scales at the base of the sepals, similar to that already described in other species. In the anatomy of the roots, *L. azurea* approaches most nearly *L. tenella*, which represents the most reduced type of the genus. In this species, too, as Johow also found in the species which he studied, the fungal hyphæ which form a well-marked mycorhiza in the root, occur also in the tissue of the stem penetrating to directly beneath the flower. In contrast with Johow's statement as to the absence of stomata from all leaf- and stem-organs in West Indian saprophytes, including species of *Leiphamos*, the author describes and figures these organs on the reduced leaves of *L. azurea*, and also of *L. aphylla*.

In the case of *Voyria cærulea* an account is given of the stem-structure. No vascular bundles are present in the much-reduced scale-leaves, but stomata occur sparingly on the inner surface. In the structure and development of the ovules, this species differs from *Leiphamos*, in which Johow found the ovules erect and with no integument. Here also occurs the phenomenon noted by Johow, that many ovules remain sterile, forming hair-structures like paraphyses. The ovules in *V. cærulea* are anatropous and have a single integument, thus agreeing with those of other members of the order.

As *Leiphamos* and *Voyria* show but little agreement in their anatomical structure, and also differences in seed-structure, pollen, etc., it is probable that the two genera are not so closely related as has sometimes been supposed. *Leiphamos* would seem to be a remarkably reduced and isolated type, while *Voyria* shows more agreement with the Gentianaceæ in general.

Structure of the Extrafloral Nectaries of Hevea.* — Aug. Daguillon and H. Coupin describe the form and internal structure of the glands which occur in different species of this genus of Euphorbiaceæ, at the top of the petiole on its upper face, near the origin of the three large leaflets. These glands, although used by systematists in the distinction of species, do not seem to have been studied anatomically. In *Hevea brasiliensis* the glands, which vary from two to five in number, form a little wart, in the centre of which is a more or less circular depression, surrounded by a sort of cushion. The authors describe in detail the internal structure of the central depressed glandular area, the cushion and the rest of the gland, and draw special attention to two points: (1) the presence of a ring of sclerosed parenchymatous cells in the interior of the cushion; and (2) the distribution and termination of the laticiferous cells in the parenchyma adjacent to the glandular surface and right among the cells of the secreting epidermis.

Reproductive.

Germination of Davidia.†—W. B. Hemsley describes the structure of the fruit and the germination of the seeds in this genus, which is a

* Comptes Rendus, cxxxvii. (1903) pp. 767–9.
† Journ. Linn. Soc., xxxv. Bot. (1903) pp. 556–9 (1 pl.).

monotype, and one of the most remarkable of the endemic genera of Chinese trees. It was discovered more than thirty years ago by the Abbé David near Moupin, in the province of Szechuen, but a recent supply of fresh seeds has rendered possible the study of the germination. The fruit is drupe-like; the hard bony endocarp intrudes between the six to ten one-seeded cells to the axis with which it unites. After the decay of the fleshy coat, the fruit opens by the separation of the upper portion (one-half to two-thirds) of the back of each carpel in the form of a valve or shutter. Usually only about half the number of the ovules are fertilised and develop, sometimes only one. The solitary pendulous seeds are not released by the falling away of the dorsal valves, but held fast until the seedling has reached a considerable development. The straight embryo has a pair of flat leafly cotyledons, and is imbedded in endosperm. After the dehiscence of the dorsal valves of the carpels, the radicles of as many seeds as are present in the fruit emerge simultaneously, the cotyledons elongate rapidly, the axis of the plantlet is carried out of the testa, and the cotyledons after absorbing the endosperm free themselves, and form the first green leaves of the plant. An opposite pair of foliage-leaves is developed at right angles to the cotyledons, while the succeeding leaves are alternate. The writer suggests that in a cluster of seedlings, developing thus from one fruit, there is a greater chance of partial escape from phytophagous organisms than there is for solitary individuals. Another point of interest is the presence of buds in the axils of the cotyledons, which may serve to ensure the development of the plant if the plumule is injured or destroyed.

Davidia is usually placed in the Cornaceæ, next to *Nyssa*, a genus of Asiatic and North American trees, which it resembles in some particulars, but from which it differs greatly in appearance and floral structure.

Synanthy in Lonicera.*—E. A. N. Arber gives a detailed account of the cases of synanthy which occur in the *Xylosteum* section of this genus. This, the largest of the three sections into which the genus has been divided, contains more than seventy species, which are mainly erect shrubs. It is widely distributed in the northern hemisphere, but its chief centre is eastern Asia; several species are alpines in the mountains of southern and eastern Europe. Two different types of synanthy are represented. One, which is distinguished as true synanthy, is effected by the partial or complete fusion of the receptacular walls of the inferior ovaries or fruits, and the bracteoles play no part in its formation. *Lonicera xylosteum*, a doubtful British plant, is an example of an incomplete union; *L. alpigena* may serve as the type of the somewhat more numerous cases in which the synanthy is complete, and where the resulting fruit is a false berry, the pericarp being formed from the walls of the two ovaries. In many species the pistils are enveloped by a bracteolar sheath, which as a rule plays no part in the formation of the fruit, but in *Lonicera cærulea* a false synanthy is effected by the union of the two pistils in certain planes with the bracteolar sheath, the pistils themselves remaining quite free from one another. The fruit is a

* Journ. Linn. Soc., xxxvi. Bot. (1903) pp. 463–74 (3 figs. in text).

pseudocarp, forming a false berry in which the bracteoles as well as the ovary-walls contribute to the formation of the pericarp.

The author is unable to make a suggestion as to the special biological significance of the false berries of *L. alpigena* and *L. cærulea*, beyond the possibility that the adaptations have some connection with the alpine conditions under which these species thrive.

New Graft-Hybrid.* — L. Daniel describes a graft-hybrid which originated under the following circumstances from a grafted pear in the garden of the St. Vincent Institution at Rennes. The pears had been badly attacked with chermes, and to prolong their life had been severely pruned and cut down to within about 2 metres from the ground. M. Daniel followed carefully the results of this severe disturbance of the relation between the absorbing and transpiring members of the plant. In every case the grafts put out shoots which were for the most part more or less drooping. The fruit-buds flowered and bore fruit in the same year, yielding monstrous productions, the form and structure of which the author has already described (*La Théorie des capacités fonctionnelles*, Rennes, 1902). Hitherto only one of the stocks has developed shoots (a Coignassier, on which is grafted a William pear), but these are of special interest. Two, which are situated well below the cushion, preserve all the characters of the normal plant, but, at the level of the cushion, on a protuberance entirely covered by the cortex of the stock, are three other shoots, which in their size, direction, indumentum, number of lenticels, and leaf-characters are more or less intermediate between the stock and the graft. They represent a graft-hybrid in the same sense as those obtained by the writer in experimenting with herbaceous plants, or those which have since been recorded in woody plants. M. Daniel again points out that the absence of observations on graft-hybrids in the Rosaceæ, although members of this order have been grafted from time immemorial and in large numbers, is due to the constant suppression of shoots on the stock.

LINDMARK, GUNNAR—**Om Adventiv Lökbildning på Stjälken hos *Lilium candidum*.** (On formation of adventitious bulbils on the stem of *Lilium candidum*.) [The author describes and figures a remarkably copious bulbil formation on the stem of this lily.] *Bihang k. Svensk. Vet.-Akad. Handl.*, xxviii. (1903) Afd. iii., No. 3, pp. 1–9 (1 pl.).

Physiology.

Nutrition and Growth.

Photosynthesis.† — T. Bokorny, experimenting with *Petroselinum sativum*, shows that assimilation of carbon dioxide is checked in solutions containing 1 part of formaldehyde in 20,000, and even by 1 in 50,000. It is therefore impossible for appreciable amounts of formaldehyde to accumulate in plants; but there is nothing improbable in the assumption that this is immediately converted into carbohydrate. As regards reduction of carbon monoxide, the author points out that pro-

* Comptes Rendus, cxxxvii. (1903) pp. 765–7.

† Chem. Zeit., xxvii. (1903) pp. 525–7. See also Journ. Chem. Soc., lxxxiv. (1903) ii. p. 505.

duction of hydrogen has hitherto only been observed in connection with fermentation processes. He concludes that hydrogen carbonate is directly reduced to formaldehyde by the chlorophyll apparatus in presence of an adequate amount of light.

L. Macchiati * claims to have established some new facts in support of his contention that photosynthesis takes place in extracts prepared from the green parts of plants, owing to the presence of a ferment. Having powdered the leaves of five species of plants last autumn, and stored the powder in dried sterilised flasks, he mixed these powders with distilled water last March and succeeded in obtaining an evolution of oxygen gas in varying quantities, when the temperature of the air rose to 15° C. A triangular discussion as to the validity of his contention is carried on between himself, G. Pollacci and A. Fiori in the same periodical.

Synthesis of Proteids.†—E. Laurent and E. Marchal arrive at the following conclusions. Nitrogen in the form of ammonia is assimilated both by normal and by etiolated chlorophyllous plants, the process being more active in the former. Assimilation of nitrogen in the form of nitrates by green plants is, with some exceptions, far more intense in presence of light than in darkness. When nitrogen is assimilated in darkness, the necessary energy is derived from the consumption of carbohydrates. Whilst the lower non-green plants can produce proteids in absence of light, the synthesis in higher chlorophyllous plants can take place only in the light.

Deficiency of Nitrogen, Phosphoric Acid and Potassium in Plant-Growth.‡—H. Wilfarth and G. Wimmer find that when nitrogen or phosphoric acid is deficient, growth is more or less restricted, but the composition of the dry matter is only affected when the deficiency is very great. When the phosphoric acid is present in insufficient quantity, the leaves become a dark green or bluish-green according to the amount of nitrogen present, or in extreme cases the leaves blacken, beginning from the edges. Very small amounts of potassium enable plants to grow normally for weeks or months, but when the potassium is used up photosynthesis ceases. Sugar-beet when grown with insufficient potassium readily decays, and the sugar is often changed, partially or entirely, into invert sugar. As in the case of the sugar-beet, the proportion of leaves in potatoes is much increased when potassium is deficient, but the yield and size of the tubers and the percentage of starch are reduced. The effect of want of potassium on the appearance of the leaves and plants is frequently very difficult to distinguish from that of fungi and insects.

Influence of Mineral Food on Sex in Diœcious Plants.§—E. Laurent has made a series of experiments, extending over seven years, on the effect of the nature of the mineral food of a plant on the sex of

* Bull. Soc. Bot. Ital., 1903, pp. 196–8.

† Bull. Acad. Roy. Belg., 1903, pp. 55–114. See also Journ. Chem. Soc., lxxxiv. (1903) ii. p. 506.

‡ Journ. Landw., li. (1903) pp. 129–38. See also Journ. Chem. Soc., lxxxiv. (1903) ii. pp. 506–7. § Comptes Rendus, cxxxvii. (1903) pp. 689–92.

its flowers; the plants used were spinach, hemp, and *Mercurialis annua*. These have been treated with manures in which one of the following elements predominated: nitrogen, potash, phosphoric acid, chalk, and sodium chloride. In the hemp and *Mercurialis* no obvious influence on the number of male or female plants could be observed; but in the case of spinach, especially the Dutch variety, the effect was a marked one. Two distinct effects were noticeable. In the first place, there was a direct effect on the sex of the plants observed; in the second, the nutritive elements reacted on the sex of the embryos produced by these same plants. As regards direct action, an excess of nitrogenous manure or of chalk gives more male plants, while potash and phosphoric acid cause an increase in the number of the females. As regards the second effect, the seeds of plants cultivated with an excess of nitrogen produced fewer male plants, more female, and among the monœcious individuals a larger number of female flowers. On the contrary, an excess of potash, phosphoric acid, or chalk, predisposes the seeds to yield more male plants among the diœcious individuals, and more male flowers among the monœcious individuals. In two years the descendants of the monœcious plants of the Dutch spinach were tabulated. Seeds were taken from a plant, of which the main axis bore female flowers, while on the branches the male flowers were more numerous. In the first year (1899), 100 large seeds gave 72 plants comprising 46 males, 13 monœcious and 13 females; 100 small seeds of the same origin gave 21 plants, of which 17 were males, 2 monœcious and 2 females. In the second year (1900), 200 seeds of medium size gave 98 male plants, 23 female and 29 monœcious; and among the latter there was only one in which female flowers preponderated. These results, associated with the general preponderance of male over female flowers in Dutch spinach, suggest that the monœcious plants are males, in which a certain number of flowers have become female.

Chemical Changes.

Experiments on Yeast Extract.*—J. Meisenheimer finds that even when yeast extract is considerably diluted (1 in 25) it still has strong fermentative properties. With water alone as the diluent, the activity is largely destroyed; dilution with 10 p.c. glycerol solution, or with 10 p.c. egg-albumin solution, does not destroy the activity. Impure zymase may be precipitated from the extract by the addition of large amounts of acetone (10 to 1), and the product is similar in all respects to that obtained by the use of ether and alcohol. Trommsdorff's statement that the proteids undergo a change during extraction from the yeast is not correct, as the dry residue gives the same reaction with Gram's reagent as the yeast itself. Small amounts of acetic and lactic acids are formed during the fermentation of sugar solutions with the extract freed from yeast cells.

Co-efficient of Respiration of Yeasts.†—E. Wosnessensky and E. Elisseef give the tabulated results of experiments with different

* Zeit. Physiol. Chem., xxxvii. (1903) pp. 518–26. See also Journ. Chem. Soc., lxxxiv. (1903) i. p. 591. † Centralbl. Bakt., x. (1903) pp. 629–36 (1 fig.).

races of yeasts cultivated on nitrogenous media. Their intention was to test whether Pasteur's dictum, that "Fermentation is life without oxygen," would hold good for other forms than *Saccharomyces cerevisiæ*. They experimented with this yeast, and also with *S. Ludwigii* and *S. Pombe*. The authors find that the co-efficient of respiration depends on the kind of yeast under culture, and also on the substratum; they find also that fermentation takes place with full aeration, and they have no doubt that alcoholic fermentation is a zymase fermentation. They got a very small co-efficient from *S. Pombe* cultivated on ammonium phosphate, which indicated the absence of alcoholic fermentation.

Micro-chemical Researches on some Glucosides and some Vegetable Tannins.* — A. Goris gives a *résumé* of previous work, dealing with the question of the localisation in the cells of the active principles found in plants. He then describes the results of his investigations on the æsculin and tannin in the horse-chestnut and in *Pavia rubra*. Æsculin is characterised by the intense blue fluorescence of its watery solution, its solubility in acetic acid and ethyl-acetate, and its intense blood-red coloration after passing successively into concentrated nitric acid and pure ammonia (Sonnenschein's reaction). After discussing the composition, chemical constitution and affinities of æsculin, the author studies its localisation in the plant-tissues by means of Sonnenschein's reaction. He finds that it is especially localised in the epidermis, often also in the sub-epidermal layer, in the endodermis, and in a peripheral layer of the pith; but it also occurs abundantly, though in varying quantity, in isolated cells of the parenchyma of the cortex and pith, in the pericycle and the medullary rays, in the wood and parenchyma, and the old bast parenchyma. It is absent from the meristem and from dead tissues, the young bast tissue, the wood-vessels, the root-hairs and the embryo.

Its formation apparently has no direct relation to the action of light; it appears in seedlings from seeds germinating in the dark as well as in the light, and bears no relation to the chlorophyll-containing cells, but brightly illuminated aerial organs are the richest in the glucoside. It does not seem to be a reserve-substance, since it makes its appearance in germination as an early result of the utilisation of the reserves in the embryo. However, in the autumn it partly disappears from the leaves, and is found in the bast of the branches, as if it were being carried towards the persistent parts of the plant.

The chestnut also contains a tannin (æsculitannic acid) which M. Goris finds in the same organs and in the same cells as æsculin. Moreover, since the latter, although insoluble in alcohol, disappears from twigs when treated with alcohol, and since the alcohol thus obtained yields under proper treatment a quantity of æsculin, the author concludes that the glucoside occurs in the cells, in combination with the tannin, as a tanno-glucoside.

By similar or analogous methods the author has studied the fustin in *Rhus Cotinus*, the fraxin in the Ash, the daphnin in *Daphne alpina*,

* Goris, Alb. Recherches microchémiques sur quelques glucosides et quelques tanins végétaux. Thesis. Joanin, Paris, 1903. See also Bot. Centralbl., xciii. (1903) pp. 261–3.

the salicin in *Salix alba*, and the cafein in *Thea sinensis* and *Cola acuminata*.

All of these glucosides or special compounds seem analogous to æsculin, and, with the exception of daphnin, occur in the cells in composition with a tannic acid ; and M. Goris thinks it probable that many of the compounds, both glucosides and alkaloids, occur in the plant totally or partially combined with a body having the reactions of tannin. It is these tanno-glucosides or tanno-alkaloids, very soluble in water and alcohol, but also very unstable, which in the majority of cases are the chief active principle in certain medicinal plants.

Cyanogenesis in Plants.*—Wyndham R. Dunstan and T. A. Henry have made a further contribution to this aspect of plant physiology, viz. the isolation of Phaseolunatin, the cyanogenetic glucoside of *Phaseolus lunatus*, an annual, widely cultivated in the tropics where the edible bean is used as a vegetable. When a few beans are powdered and moistened with cold water, the odour of hydrocyanic acid is perceptible in a few minutes, but if boiling water is used, and the vessel is immediately closed and allowed to cool, no prussic acid odour is perceptible, and no evidence of its production can be obtained by the usual tests. These observations indicate that the production of the acid is connected with the action of an enzyme. The glucoside was isolated from an alcoholic extract of the powdered beans, as spreading rosettes of colourless needles from ½ in. to 1 in. long, which melt at 141° C. Its formula was determined as $C_{10}H_{17}O_6N$, by combustions of specially purified material dried at 100° C., and the correctness of the formula was confirmed by estimations of the dextrose produced on hydrolysis. The alkaline hydrolysis proves that phaseolunatin is the dextrose ether of acetone cyanhydrin. The hydrolytic enzyme of *Phaseolus lunatus* was isolated as an amorphous white powder, almost completely soluble in water ; it readily hydrolyses amygdalin, salicin, and phaseolunatin. As the latter is also hydrolysed by the emulsin of sweet almonds, it is probable that the enzyme of *Phaseolus lunatin* is emulsin. The occurrence in the plant, apparently throughout its life, of a cyanogenetic glucoside, together with the enzyme appropriate for its hydrolysis, seems to strengthen the view, previously expressed by the authors, that these glucosides must play some definite part in the metabolism of plants.

General.

Australian Fossil Botany.†—R. Etheridge gives a description of more complete specimens than have hitherto been obtained from the Leigh Creek coal measures, South Australia, of *Thinnfeldia odontopteroides*, and points out that the nervation is more complex than in the typical form of the species, and that at least three varieties of nervation have been included in *Thinnfeldia* : suggesting those of the three genera, *Thinnfeldia*, *Odontopteris* and *Lescuropteris*.

J. Shirley ‡ describes several new species, and gives notes on others,

* Proc. Roy. Soc., lxxii. (1903) pp. 285–94.
† Contributions to the Palæontology of South Australia, 1902, No. 12, p. 2 (1 pl.).
‡ Geolog. Survey, Queensland, Bull. No. 18 (1902) pp. 1–16 (11 pls.).

from various Queensland localities. From the Permo-carboniferous of Dawson river he records several species of *Sphenopteris* and *Glossopteris*, and describes a new seed, *Cycadospermum Dawsoni*. It is suggested that *Sphenopteris lolifolia*, *S. alata*, *S. flexuosa* and *S. crebra* represent different parts or growth-stages of the same frond, which a discovery of the fertile leaves places in the genus *Mertensia*. *Taxoxylon Philpii* is a new species from the Ipswich beds, and represents the first taxaceous fossil wood from Queensland.

Plant-Life in the Sihlthal at Einsiedeln.* — Max Düggeli gives an account of the geographical position, the geology, climatology and flora of this high valley, and the plant-associations which it comprises. The district, which has an area of 12 kilometres, is soon to be submerged to form a reservoir in connection with some electric works. Under the heading vegetation, the author gives a list of about 150 cultivated plants, followed by a list of those growing wild. The latter comprise nearly 200 species of fresh-water algæ, 50 fungi, 75 lichens, 130 mosses, 25 vascular cryptogams, and 560 seed-plants. In his description of the œcology of the valley the author distinguishes the following formations:—(*a*) forest; (*b*) bush-vegetation; (*c*) schuttfluren; (*d*) meadow-formation (the most important), and the various types comprising it; (*e*) water-vegetation, both of flowing and stagnant water, including the plankton; and (*f*) culture-formation. The text is accompanied by several sectional diagrams, showing the characteristic plants at the different levels in several of the formations. Another feature of interest is the tabulation which the author gives of the plant-remains found in the peat at various stations in the valley, compiled from a study of numerous sections. There is also a good general map of the district.

Swedish Saxifrages.† — G. Lindmark gives a somewhat detailed account of the vegetative and floral morphology of the Swedish species of *Saxifraga*. A short general account containing an organographic key to the species is followed by a special portion, comprising for each species an account of the germination of the seed, the development of the seedling, and the vegetative and floral characters of the adult plant. The paper is well illustrated by five plates; four of these are double-page.

Chinese Cyperaceæ.‡ — C. B. Clarke has elaborated this order for Messrs. Forbes' and Hemsley's *Enumeration of the Plants of China*. The order is well represented in the Chinese flora. Mr. Clarke's enumeration includes a number of new species, especially in the genus *Carex*, which is by far the largest. There are also various critical notes of some general interest.

Teratology.§—K. Schilberszky describes and figures the following examples of teratology: twin-bulbs in an onion (*Allium Cepa*), the

* Vierteljahrschrift der Naturforschend. Gesellsch. in Zurich, xlviii. (1903) pp. 49–270 (with map and figs. in text).

† Bihang K. Svensk. Vet.-Akad. Handl., xxviii. Afd. iii. No. 2 (1902) pp. 1–84 (5 pls.). ‡ Journ. Linn. Soc. Bot., xxxvi. (1903) pp. 217–36.

§ Növénytai Közlemények, Fachbl. bol. Sekt. kgl. ungar. Naturw. Gesellsch. Budapest, ii. (1903) pp. 76–89 (7 figs.). See also Bot. Centralbl., xciii. (1903) p. 260.

formation of foliage-leaves on the tendrils of the vine, and a forked flower-spike in *Plantago lanceolata* var. *altissima*.

O. V. Wennersten * describes, with illustrative figures, examples of floral and also foliar teratology in specimens of the walnut grown in Gothland.

ARECHAVALETA, J.—**Contribucion al conccimento de la Vegetacion del Uruguay.** (Contribution to our knowledge of the vegetation of Uruguay.)
[Includes mainly grasses, with descriptions of new species of *Stipa* and *Aristida*.] *Anales Mus. Nacion. Montevideo*, iv. (1903) pp. 61–86 (7 pls.).

" " **Nomina Vernacularia.** (A list of vernacular names of the Uruguay flora.)
Anales Mus. Nacion, Montevideo, iv. (1903) pp. 132–52.

GOLDSCHMIDT-GEISA, M.—**Die flora des Rhöngebirges III.** (The flora of the Rhöngebirg.)
[Comprises the grasses, with a few additions to the two previous parts.]
Verhandl. Phys.-Med. Ges. Wurzburg, N.F. xxxv. (1903) pp. 313–35.

JOHANSSON, K.—**Archieracium-Floraninom Dilarnes Silurområde I Siljanstrakten.**
[A long paper on *Hieracia*, with notes on localities, etc., of previously known species, and very full descriptions (in Latin) of many new ones.]
Bihang K. Svensk. Vet.-Akad. Handl., xxviii. (1902) Afd. iii. No. 7 (1902) pp. 1–156 (12 double plates).

KORSHINSKY, S.—**On the origin of the Peach.** (Russian.)
Bull. Acad. Imp. Sci. St. Pétersb., ser. 5, xiv. (1901) pp. 77–83.

" " **On the original form of the Common Almond and allied species.**
Bull. Acad. Imp. Sci. St. Petersb., ser. 5, xiv. (1901) pp. 85–94.

NATHORST, A. G.—**Svenska Växtnamn.** (Swedish plant-names.)
Bihang K. Svensk. Vet.-Akad. Handl., xxviii. (1902) Afd. iii. No. 9 pp. 1–72.

SARGENT, C. S.—**Recently recognised species of Cratægus in Eastern Canada and New England, IV. and V.**
[Several new species are described in the two groups *Coccineæ* and *Tomentosæ*.]
Rhodora, v. (1903) pp. 159–68, 182–7.

CRYPTOGAMS.

Pteridophyta.

Isoetes.† — G. H. Shull shows in a map the exact distribution of *Isoetes saccharata* along the shores of the tributaries of Chesapeake bay, and discusses various problems presented by it. It is confined to Chesapeake bay, and occurs but locally, on tidal beaches, requiring fresh or slightly brackish water, and soil firm enough to resist wave-action. It does not thrive where competition with other plants is great. Its dispersal is effected probably by water-currents, not by winds or birds. A nearly related species, *I. riparia*, is similarly confined to the neighbouring Delaware bay. There are grounds for concluding that the former species is polymorphic, and for supposing that *I. riparia* may prove to be an extreme form of it, some intermediate varieties being untenable. The curious distribution finds an explanation in the geological alteration of the coast-line by upheaval and subsidence.

* Bihang. K. Svensk. Vet.-Akad. Handl., xxviii. (1902) pp. 1–12 (12 figs. in text).
† Bot. Gazette, xxxvi. (1903) pp. 187–202 (with map).

Investigations on Fern-Prothallia.*—A. Jakowatz has studied the development of the prothallium in several members of Polypodiaceæ, and finds remarkable differences in the early stages of development and their conversion into the later flat expanded form. It is, however, impossible to say whether these differences are characteristic of the various species or genera. In some species the developmental course in these stages follows a definite scheme; in others, different types of development are observed apparently without reference to external conditions. There is, however, a common law governing the first stages of development, which in all the forms investigated begins with a thread-like stage; the growth of this becomes closed, while the flat prothallial growth originates from an apical cell appearing laterally on the filiform rudiment. Often the formation of a branch coincides with the formation of this cell, which then comes to stand in the axil of the branch. The further development of the prothallial surface depends on the well-known segmentation of the apical cell. The segments, always the earliest, show a limited growth and often conclude with a papilliform terminal cell.

In the filiform rudiment, the lateral origin of the later flat structure, and the formation of segments with limited growth, the ferns investigated show a remarkable homology with the development of the mosses. We may regard the thread-like rudiment as a protonema stage, and the papilla-like ends of the segments as structures homologous with the leaf-ends of the Muscineæ.

Tropical American Ferns.†—C. A. M. Lindman gives an account of the ferns collected by him during the first Regnell Expedition (1892–4) in Brazil and Paraguay, and of those collected by Regnell, Mosén and others, thirty to fifty years ago. In all he records 209, sixteen of which, with three varieties and nine forms, are new. Having examined Swartz's types at Stockholm, he has revived several old species which had been misunderstood or quite forgotten. This has involved change of nomenclature and synonymy. He has followed the general lines of Hooker's *Synopsis Filicum*. Finding the old descriptions too elastic and indefinite, he pleads that they be made more exact, and hence more helpful to collectors in enabling them to appreciate rare species, which run the risk of being disregarded as mere forms of common species too loosely defined.

Trichomanes (sect. Didymoglossum).‡—C. A. M. Lindman publishes critical notes on the American species of *Didymoglossum* Desv., a section of the genus *Trichomanes*. Having studied Swartz's little-known types in the Stockholm Museum, he is able to correct the erroneous conceptions which Hooker, Greville, and others, formed of the species *T. apodum*, *muscoides*, *reptans*, *quercifolium*, etc., and to amend the confusion that has consequently arisen. He has carefully re-described the original specimens, and, as words are insufficient to give an accurate idea of such difficult plants, he has found it indispensable to add a number of camera-lucida drawings to prevent future misunderstanding.

* SB. K. Akad. Wiss. Wien, Math.-naturwiss. Cl. cx. (1901) pp. 479–505 (7 pls.).
† Arkiv. för Botanik. Stockholm, i. (1903) pp. 187–275 (8 pls.).
‡ Tom. cit., pp. 7–56 (31 figs. in text).

He gives descriptions of thirteen species in all, and three of these are new species collected in South America.

Asplenium Ruta-muraria.*—V. H. Christ has studied the varieties and allies of this well-marked but most variable species, and publishes a systematic account of the various forms grouped in accordance with his views, with descriptions and critical notes and figures. He arranges them in four sections—*rhomboidea*, *ellipsoidea*, *lanceolata*, *cuneata*—according to the ultimate segments of their leaves. Passing on to the consideration of the abnormal forms, exotic forms and allies of *A. Ruta-muraria*, he concludes with a synoptic key to the whole group.

Linnæus's System of Ferns.† — L. M. Underwood criticises Linnæus's treatment of the ferns, especially those of America, in the *Species Plantarum* (1753), and shows that he was not the originator of binominal nomenclature. His conception of the genera was, with a few exceptions, far different from those of the present day. His fern-system was crude even for the time at which it was published, as is evidenced by the unnatural groupings under *Osmunda*, *Acrostichum*, and *Polypodium*. The greater number of his species were compiled from books and plates. His herbarium is of comparatively little value for the determination of his types. A small part only are represented by specimens, often scrappy—mere tips of leaves, often sterile. His types must very largely depend on the plates and descriptions of ea lier writers quoted by him.

BARSALI, E.—**Nota sul Polypodium vulgare L.** (Note on *Polypodium vulgare* L.) [Describes a waxy coating excreted by the exposed rhizome to protect itself from desiccation in hot climates.]
Bull. Soc. Bot. Ital., 1903, pp. 119–21.

LYON, F. M.—**Two megasporangia in Selaginella.**
[Occurrence of two normal megasporangia on one sporophyll in *Selaginella rupestris*.] *Bot. Gazette*, xxxvi. (1903) p. 308 (fig. in text).

Bryophyta.

Fossil British Mosses.‡ — C. Reid gives a list of ten mosses obtained from a glacial fresh-water stratum, reached at a depth of 60 feet, during the sinking of a well at Mundesley in Norfolk. They were identified by H. N. Dixon, who reports that the bulk of the deposit consisted of *Hypnum turgescens*, a boreal moss which was not known to grow in the British Isles, but was discovered on Ben Lawers in July 1902. With it were *H. capillifolium* and *H. Richardsoni*, neither of which are members of the existing British flora. A variety of *H. polygamum* occurred in some quantity.

North American Species of Leskea.§ — G. N. Best publishes a revision of *Leskea*, a genus now much restricted as compared with its earlier dimensions. The name *Leskea* may have to be transferred if the strictest rules of nomenclature are applied to it. Accepting *L. polycarpa* as the type of the genus, he ranges the species under two sub-

* Hedwigia, xlii. (1903) pp. 153–77 (4 pls.).
† Torreya, iii. (1903) pp. 145–50.
‡ Trans. Norfolk and Norwich Nat. Soc., vii. (1902) pp. 290–8.
§ Bull. Torrey Bot. Club, xxx. (1903) pp. 463–82 (2 pls.).

genera, *Euleskea* and *Heteroleskea*, each containing five species, the former with papillose leaves, the latter with smooth. He gives careful descriptions of the species and varieties, with critical notes, synonymy and good figures. The novelties are two species and four varieties.

Bryology of the Tuscan Archipelago.*—A. Béguinot in the winter of 1897–8 studied the Muscineæ of the Tuscan archipelago, and gives lists for the islands as follows: Giannutri, 27 mosses, 9 hepatics; Giglio, 108 mosses, 45 hepatics; Montecristo, 49 mosses, 23 hepatics; Pianosa, 32 mosses, 17 hepatics; Elba, 182 mosses, 54 hepatics; Capraia, 83 mosses, 33 hepatics; Gorgona, 59 mosses, 13 hepatics. The total for the archipelago is 176 species of mosses and 61 species of hepatics. The geographical distribution of the mosses is worked out at considerable length, and the species are divided into four groups: (1) ten species which are cosmopolitan; (2) eighty-three which are not cosmopolitan, but widely distributed in and outside Europe; (3) fifty-four which are widely distributed in southern and middle Europe and in other continents; (4) twenty-eight more or less widely distributed in southern (and western) Europe and outside the continent. The actual distribution is detailed for each species. The comparative floras of various countries and regions, and past and present geological conditions, climate, etc., are fully discussed; also the conditions of growth required by the species themselves. An attempt is made to explain the floras of the Tuscan islands in terms of these factors. The geographical distribution of the hepatics is not discussed owing to lack of satisfactory data for comparison. The paper ends with a tabulated list of the species and varieties that constitute the bryological flora of the archipelago.

European Mosses in the Himalayas.†—E. Levier calls attention to the want of a work of reference giving the geographical distribution and zones of altitude of the mosses of the world; and, as a contribution towards such a work, he has compiled from his carefully labelled herbarium a catalogue of 162 European mosses which occur in the Himalayas, with their exact localities and altitudes in the latter region. These mosses were collected by J. F. Duthie and his assistants, and determined by V. F. Brotherus.

North American Mosses.‡—E. G. Britton publishes some notes on *Splachnum*, especially with reference to the curious umbrella-shaped apophysis of the sporophyte of *S. rubrum* and *S. luteum*. J. M. Holzinger § reports on some well preserved fossil mosses from Iowa, extracted from a deposit five to ten thousand years old—*Hypnum fluitans*, *H. revolvens*, and *H. Richardsoni*. A. J. Grout ‖ gives the results of some exhaustive examinations of the colonies of mosses occurring in selected areas of a few square feet; for example, an old pear tree, an old log in a deep moist wood, a sandy field, a road cutting, an old stone wall. To his surprise, these yielded several species which he had never gathered before. R. S. Williams ¶ publishes a list of 382 mosses gathered by himself in the State of Montana, between 1886 and 1897. Three new

* Nuov. Giorn. Bot. Ital., x. (1903) pp. 285–532, 429–530.
† Bull. Soc. Bot. Ital., 1903, pp. 105–14.
‡ Bryologist, vi. (1903) pp. 91–3 (1 pl.).
§ Tom. cit., pp. 93–4. ‖ Tom. cit., pp. 94–6.
¶ Bull. New York Bot. Garden, ii. (1903) pp. 351–80 (6 pls.).

species are described, and these and three other rare species are figured in detail. Some critical notes are appended to the more difficult species. R. S. Williams* gives a list of 230 mosses collected by him in the Yukon territory during a residence of more than a year (1898–9). A new genus with one new species, *Bryobrittonia pellucida*, closely related to *Tortula* and *Desmatodon*, is established; and ten other new species are described. Numerous critical notes are interspersed. B. M. Britton † records the first discovery of the rare *Buxbaumia indusiata* in New England. It occurred in quantity on a rotten log of poplar at Surry, New Hampshire. It is usually found as a saprophyte on decayed coniferous logs. It is known from four other localities in the United States. J. F. Collins ‡ publishes some critical and distributional notes on *Hypnum Richardsoni*, *Anacamptodon splachnoides*, *Catoscopium nigritum*, and other mosses in connection with the New England flora.

South American Mosses.§ — P. Dusén gives an account of the Sphagnaceæ and Andreæaceæ collected by himself and by O. Nordenskjöld and F. W. Neger in the neighbourhood of the Straits of Magellan, in west Patagonia and south Chili, with descriptions and figures of seven new species and two new varieties, and critical notes as to their affinities. The Sphagnaceæ attain their highest development in the regions of the deciduous and evergreen forests; of the commoner forms two varieties of *S. medium* form bogs, and a variety of *S. fimbriatum* occurs in large loose cushions in open country.

Germination of Liver-worts.‖ — E. Lampa publishes some well illustrated studies on the germination of *Preissia*, *Reboulia*, *Plagiochasma*, *Fegatella*, *Fossombronia* and *Anthoceros* from their spores, and considers that the development of the sexual generation can be divided into several stages. The germ-tube is a protonema usually of limited growth. The rudiment of the stem arises from segmentation of the terminal cell, the apical cell arising from the third segment, the plan of this process resembling that of moss-gemmæ. The embryo is highly sensitive to the direction and intensity of the incident light. Leaves do not appear in *Anthoceros*, and are more or less rudimentary in Marchantiaceæ. In *Fegatella*, though absent in the rudimentary stage, they appear later as under-leaves. Three rows of well-developed leaves are produced in the vertically growing *Haplomitrium*. They are present in other Jungermanniaceæ. *Anthoceros* holds a leading position in virtue of its highly developed asexual generation, though the sexual generation appears very reduced as compared with the Jungermanniaceæ, the Marchantiaceæ occupying an intermediate position. In the rudiment of the stem are signs of reduction which approach the typical development of the moss-stem.

Development of Riella.¶ — M. P. Porsild gives the results of his investigations of this aquatic genus. Starting with a historical and geographical survey of the species, he supplies a comparative table of

* Bull. New York Bot. Garden, ii. (1903) pp. 105–48 (10 pls.).
† Rhodora, v. (1903) pp. 257–8. ‡ Tom. cit., pp. 199–201.
§ Arkiv. för Botanik. Stockholm, i. (1903) pp. 441–65 (11 pls.).
‖ SB. Akad. Wiss. Wien, cxi. (1902) pp. 477–89 (5 pls.).
¶ Flora, xcii. (1903) pp. 431–56 (8 figs. in text).

the spore-measurements, calling attention to the vitality and floating-capacity of the spores, which for germination require good light; in cultivating them he succeeded best by employing their native mud, and he noticed that the fronds arranged themselves parallel to the incident light. He describes the first stages of development, in which he could find no trace of an apical cell. Gemmæ he found in the Central Asiatic *R. Paulsenii*; these rise to the surface, and float until their stores of fat are used up in growth. As the result of germination of spores, gemmæ, etc., a primordial lobe (protonema) is produced, the growth of which ceases at the apex, and a meristematic growing-point is formed near the base at one or both edges, which as it develops pushes aside the primordial lobe and forms on one side the stem and leaves, and on the other the dorsal wing and reproductive organs. In species of vertical habit, the stem and dorsal wing are from the first vertical. The growing point is thus intercalary and meristematic. As a general rule there is no apical cell, even up to a late stage; sometimes, however, in strongly developed plants of the larger species, a wedge-shaped apical cell occurs at the point of junction of stem and wing, and throws off segments upwards to the wing and downwards to the stem, but only the wing-segments can be recognised for any length of time. The normal absence of an apical cell indicates the primitive character of the genus. The oil-bodies situated along the margin of the frond possibly serve to protect the plant from being eaten by animals. No fresh details as to the reproductive organs were observed, but in the sporogonium some of the cells which fail to become spore-mother-cells persist as stores of starch. As to the *R. helicophylla*, the beautiful helicoid growth figured in the *Flore d'Algérie* is no exaggeration, and may be a result of growth in subdued light in deep water (Goebel); and the tufts of rhizoids shown as springing from knots at the base of the stem are germinations from spores in semi-decayed sporangia. *R. Parisii*, a floating species, is peculiar in its habit.

Riella capensis sp. n.*—F. Cavers describes and figures this new species, obtained from dried mud, which had been gathered from a pond at Port Elizabeth for the sake of the Crustacea contained in it, and sent to the Owen's College, Manchester, for cultivation in an aquarium. The plant soon made its appearance, and in three months' time was found to be in a fruiting state. It is allied to *R. helicophylla*, but sufficiently distinct. The author gives full details as to its habit.

Petalophyllum Ralfsii.†—F. Cavers gives a full description of this very rare hepatic, which occurs sparingly in patches of *Pallavicinia* on Coatham Marshes, Yorkshire. It has been gathered only in five British and one Italian locality, and always in damp sandy places near the sea. It may prove to be identical with the Algerian *Fossombronia corbulæformis*. The author describes in detail and figures the structure of the gametophyte, and calls attention to the marked occurrence of mycorhiza in the ventral zone of the thallus, and to the formation of tubers much resembling those described in the Californian *Geothallus tuberosus*.

* Rev. Bryol., xxx. (1903) pp. 81–4 (1 pl.).
† The Naturalist, 1903, pp. 327–34 (figs. in text).

The sexual organs and sporogonium agree closely with those of *Fossombronia.*

Yukon Hepatics.*—M. A. Howe gives a list of 24 hepatics, collected by R. S. Williams in the Yukon territory in 1898–9. It contains one new species, *Scapania imbricata*, one species new to North America, five new to Alaska, and two or three of great rarity.

ARNELL, H. W.—**Martinellia calcicola Arnell et Persson sp. nov.**
[Description of a new Swedish hepatic.]
Rev. Bryol. xxx. (1903) pp. 97–8.

BAGNALL, J. E.—**The Mosses and Hepaticæ of Worcestershire.**
[List of 283 mosses and 65 hepatics, with numerous varieties.]
Journ. of Bot., xli. (1903) pp. 366–71, 388–97.

BARSALI, E.—**Una breve escursione al Monte Argentario.** (A short trip to Monte Argentario.)
[Contains a list of 29 additions to the local moss-flora, six of which have never before been recorded for the Tuscan archipelago.]
Bull. Soc. Bot. Ital., 1903, pp. 149–52.

BLISS, M. C.—**The occurrence of two venters in the archegonium of Polytrichum juniperinum.**
[The egg-cell occupying the upper venter represents the first neck-canal-cell.]
Bot. Gazette, xxxvi. (1903) pp. 141–2 (fig. in text).

BOMANSSON, J. O.—**Brya nova.**
[Descriptions of ten new species of *Bryum* collected in Finland.]
Rev. Bryol. xxx. (1903) pp. 85–89, 98–100.

CULMANN, P.—**Notes bryologiques sur les flores du canton de Zurich et des environs de Paris.** (Bryological notes on the floras of Canton Zurich and of the vicinity of Paris.)
[Annotated list of 27 hepatics and 10 mosses from near Zurich, and five from a suburb of Paris.] *Rev. Bryol.*, xxx. (1903) pp. 89–92.

JENSEN, C.—**Fire for Norge nye Sphagnum-Arter.** (Four species of *Sphagnum* new to Norway.) *Nyt. Magazin for Naturvidensk.*, xl. (1903) pp. 119–21.

LETT, H. W.—**Some Mosses and Hepatics of South Donegal.**
[List of 115 mosses and 73 hepatics gathered in two days on Slieve League, a rich locality.) *Journ. of Bot.*, xli. (1903) pp. 356–9.

LILLIE, D.—**A new British Hepatic.**
[Describes *Jungermannia Kaurini* Limpr., and its first discovery in Britain, at Caithness.] *Journ. of Bot.*, xli. (1903) pp. 363–4.

MACVICAR, SYMERS M.—**Anthoceros dichotomus in Britain.**
[Contains a description of this Mediterranean plant and of its first finding in Britain. The species is remarkable for its tubers.]
Journ. of Bot., xli. (1903) pp 347–8.

PARIS, E. G.—**Muscinées de Madagascar (4e article).**
[Eighteen mosses, three described as new, and two new hepatics undescribed.
Rev. Bryol., xxx. (1903) pp. 93–5.

" " **Muscinées de l'Afrique occidentale française.**
[List of 20 mosses and one hepatic from French West Africa, with descriptions of seven new species.] *Rev. Bryol.*, xxx. (1903) pp. 101–4.

PODPĚRA, J.—**Miscellen zur Kenntnis der Europäischen Arten der Gattung Bryum.** (Additions to our knowledge of the European species of the genus *Bryum.*)
[Contains descriptions of three new Sardinian species and three new varieties, together with notes on a number of critical forms.]
Beih. z. Bot. Centralbl. xv. (1903) pp. 483–92.

ROTH, G.—**Die Europäischen Laubmoose.**
[Gives descriptions and figures of all the mosses of Europe.]
Leipzig, Engelmann, 1903, i. pp. 129–384; tabb. viii.–xxvi., xlix.

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* Bull. New York Bot. Garden, ii. (1901) pp. 101–5 (1 pl.).

SEBILLE, R.—**Nouvelles observations sur Gasterogrimmia poecilostoma (Cardot et Sebille).**
[Description of the male plant, and distribution of this moss-species in Dauphiné.] *Rev. Bryol*, xxx. (1903) pp. 105-6.

THÉRIOT, J.—**Brachythecium populeum (Hedw.) Br. Eur. var Levieri, var. nov.**
[Description of a moss gathered at Bormio.]
Bull. Soc. Bot. Ital., 1903, p. 226.

Thallophyta.

Algæ.

Polymorphism of Algæ.* — A. Hansgirg adds a final note to his work on this subject, pointing out the inevitable necessity for a thorough reform in the systematic classification of algæ, and maintains that the study of "pure cultures" of algæ, advocated by Klebs as a necessary preliminary to such reform, will only lead to error. He gives a list of papers bearing on this subject, which have appeared since the publication of his paper, 'On the Polymorphism of Algæ,' in 1893.

Fossil Algæ.†—P. Fliche records some additions to the genera of fossil algæ, which, from their resemblance to modern genera, he names *Chordites*, *Lomentarites*, and *Cystoseirites* Sternb. (emend.). Each is represented by a single species. *Lomentarites* was found in the Grès Vigarré, at Merviller-Vacqueville, the other in the Muschelk.-supérieure, at Chauffontaine and Sainte-Anne, near Lunéville. They were all very abundantly represented. Four other species from the Muschelkalk have been named *Algacites*, since the author cannot with certainty place them near any existing genus, though he has no doubt as to their algal nature.

B. Renault publishes a note on the algæ which form "Boghead," in which he states that this formation in the northern hemisphere is characterised by the presence of *Pila*; *Reinschia* occurs everywhere in the southern hemisphere; *Thylax britannicus* is the principal constituent of British Boghead, and *Cladiscothallus* that of the Moscow beds. Every important stratum can be recognised by the algæ of which it is formed.

Algæ in Public Water-supplies.‡—G. T. Moore reports on the contamination of reservoirs and cress-beds by fresh-water algæ. *Spirogyra* gives considerable trouble in a mechanical way by smothering the young water-cress plants, and it also forms a thick heavy mat over the surface of the water, thus preventing the growth of even the older plants. The Schizophyceæ are very commonly the cause of pollution in drinking-water, especially the genera *Clathrocystis*, *Anabæna* which produces a polluting oil, and *Oscillatoria*. Diatomaceæ, notably the genus *Asterionella*, play a prominent part in the pollution of water, as also members of the group Syngeneticeæ. The author mentions as methods of prevention of such pollution: the covering over of reservoirs, since light is favourable to algal growth; the keeping of both source of supply and reservoir as free as possible from organic matter; and the aeration of water by pumping, fountains, or some sort of spraying apparatus. The

* Beibl. Bot. Jahrb. xxxii. No. 72 (1903) pp. 1-3.
† Comptes Rendus, cxxxvi. (1903) pp. 827-9, 1340-3 (6 figs.).
‡ Year Book Dept. Agricult. U.S.A. (1902) pp. 175-86.

last method is, however, beneficial rather than harmful to certain forms of polluting algæ, and may, therefore, do more harm than good. A new remedy is being tried, and has so far proved successful; but the author waits for the result of further trials before detailing the process. This pollution by algæ renders water extremely unpleasant, though not actually poisonous.

Thames Plankton.*—F. E. Fritsch continues his investigations on this subject, and compares his results with those of Schröder and Brunnthaler on the Oder and Danube respectively. In the Thames there is a well-marked living plankton all the year round, while in the two continental rivers there is an almost entire absence of plankton in the winter. A table is given showing the periodicity of Thames plankton, which may be summarised thus: mixed plankton—*Melosira*—*Synedra*—mixed plankton. *Asterionella* forms a minor phase during the winter months. The periodic distribution of forms is not by any means the same as that of the Oder or the Danube, but the author considers that the periodicity of the Thames plankton may vary in different portions of the river's course. The plankton of four backwaters was also examined, namely, Molesey, Sunbury, Walton and Shepperton; and the results are given in the form of tables, together with a comparison with the plankton of the main stream. Though there is a considerable difference both in quality and quantity, the backwaters have far more of a river than a pond-plankton.

Scottish Fresh-water Plankton.†—W. West and G. S. West give the result of their examination of the plankton of some lochs in various parts of Scotland. They divide their paper into four sections. The first is an Introduction, which deals with previous literature on British fresh-water plankton, and contains remarks on the present collection and the method of obtaining it. In Section II. the various lochs examined are described geographically, and notes are given on the animal plankton which was collected with the algæ. Two tables follow, one of which enumerates the species from eleven lochs taken in summer and autumn, and the other deals with a few small collections made in the south of Scotland during the spring. Section III. consists of a systematic account of the most interesting species in the preceding plankton collections. This is almost entirely confined to Desmids, of which six new species and some new varieties are described. An interesting record is *Staurastrum verticillatum* Archer, no figure of which has hitherto been published; since the so-called figure of it in Cooke's *British Desmids*, 1886, tab. 61, fig. 3, does not represent this species. The general conclusions of the authors form the contents of Section IV. They find that the Scottish plankton differs considerably from that of the western parts of continental Europe. It is unique in the abundance of its Desmids, of which the most conspicuous are of a type confined almost exclusively to the extreme western and north-western shore districts of Europe and North America. The commonest and most abundant species are invariably those of the genus *Staurastrum*, principally *S. Ophiura*, *S. Arctiscon*, and

* Ann. Bot., xvii. (1903) pp. 631–47.
† Journ. Linn. Soc. Bot., xxxv. (1903) pp. 519–56 (5 pls.).

S. grande. There are very few free-swimming Protococcoideæ. The majority of the species of *Staurastrum* and *Arthrodesmus* are remarkable for their long spines or long processes with spinate apices, and this characteristic holds good throughout the entire plankton. The most striking diatoms are *Asterionella gracillima*, *Tabellaria fenestrata* var. *asterionelloides*, and forms of *Surirella robusta*. The plankton is richer in species in late summer and autumn than in the spring.

Phytoplankton from Brandenburg Lakes.*—E. Lemmermann continues the publication of his investigations into the phytoplankton of the Müggelsee and other neighbouring waters. His results are first presented in the form of tables or lists for each month from May to September 1897, and from June 1898 to May 1899, with details concerning the temperature of air and water, the wind, the presence or absence of sunshine, etc., on the specified days. Then follow deductions from the tables as to the development of the plankton flora during these two periods of investigation, tracing the maximum of various groups and species. Finally, lists are given, arranged systematically, of all the species hitherto recorded from the Müggelsee, and eleven other lakes and waters.

Plankton of Hallstätter See.†—K. von Keissler, in a paper on this subject, records five species of Chlorophyceæ and three of Bacillariaceæ, with indications of the seasonal distribution of each species.

Norwegian Phytoplankton.‡—C. H. Ostenfeld publishes a list of 43 plankton algæ found by him in two lakes in the Rendalen district, Lomnaessjön and Harsjön. He finds that the algæ of the former lake are much the same as those recorded from the forest lakes of Lappmark, and include *Dinobryon* (which is predominant), *Tabellaria fenestrata*, *T. flocculosa* and *Asterionella formosa*. Myxophyceæ and Peridiniaceæ are entirely absent, and the Chlorophyceæ are rare. The phytoplankton of Lake Harsjön is rather rich, and differs entirely from that of Lomnaessjön, but resembles strikingly that of Swiss lakes. The author adds critical notes to twelve of the species recorded.

Russian Fresh-water Algæ.§—L. Iwanoff gives an account of the vegetation growing in and around certain lakes, especially Lake Bologoje. The first chapter of his work contains a physical and geographical description of that lake, with a list of the diatoms which help to compose the thick mud at the bottom. The second chapter deals with the distribution of the vegetation in Lake Bologoje, and the subject is treated in some detail. The third chapter contains a list of 438 algæ from nine other Russian lakes. In the fourth are given diagnoses of new species, and remarks on species already existing which present points of special interest. Among these may be mentioned the division of the monad of *Uroglena volvox* Ehrenb., which is here described for the first time. The fifth chapter is devoted to a study of 'Algæ-formations,'

* Zeitsch. f. Fischerei, xi. (1903) pp. 73–123 (figs. in text).

† Verhandl. k. k. Zool. Bot. Gesell. Wien, liii. (1903) pp. 338–48.

‡ Bot. Tidssk., xxv. (1903) pp. 235–41.

§ V. d. biol. Station Bologoje d. Kais. St. Pet. Naturfv., ii. (1902) 152 pp. See also Bot. Centralbl., xciii. (1903) pp. 379–87.

the Aerophilæ, Geophilæ, Reophilæ, or those that inhabit running water, Magmaphilæ, or tuft-forming algæ, Paludophilæ, Phytoplankton, and finally, those that live at the bottom of lakes, etc. Tables are given showing the Desmids and other algæ which live in bogs, composed of *Sphagnum* or *Hypnum* respectively. The paper is written in Russian.

"Flowering" of North American Lakes.* — Marshall A. Howe describes an alga which appears in great quantities at Honnedaga Lake, Herkimer County, New York, and appears to be *Gloiotrichia echinulata* P. Richt. The same plant occurs freely at Chilson Lake, Essex County, where it forms small colonies, which are usually spherical. No spores were found, but the resemblance between these plants and those from the Plön Station, in Germany (No. 587, *Phykotheka universalis* of Hauck and Richter), is so great, that there is little doubt as to their identity. The Lake Chilson specimens show a greater development of terminal hairs than those figured in Hauck and Richter (l. c.), but the hairs vary with the age of the colony, and in some stages they may be entirely wanting. The colonies multiply by means of hormogonia. The author makes remarks on the "flowering" of other American lakes and on the synonomy of *Gloiotrichia echinulata*.

New England Desmids.† — J. A. Cushman records 30 species of Desmids found by him in Steep Brook, Massachusetts, about three miles north of Fall river railway station. *Staurastrum* was well represented in the collection. Notes on the measurements and other points of special interest follow each species' name, and a bibliography of New England Desmids completes the first of a series of papers on this subject.

The second paper gives two lists of Desmids from New England, one locality being in Massachusetts, the other in Maine. The first contains 20 species, the second 25 species, both lists including records formerly doubtful.

Fresh-water Algæ from Brazil and Paraguay.‡ — O. Borge has worked out the collection of Desmidiaceæ brought home by the Regnell Expedition, and publishes the results, including descriptions of 28 new species and some new varieties. A list of 55 localities is given, of which 44 are in Brazil, and the remainder in Paraguay.

The same author records eleven species of Zygnemaceæ and Mesocarpaceæ from the same collection, including two new species, *Spirogyra paraguayensis* and *Gonatonema sphærospora*.

Diatoms New to the Hull District.§ — R. H. Philip adds some new records to the diatoms already known from this part. The rock pools at Filey, and the flats east of Cleethorpes on the Lincolnshire coast, have yielded good material. The most interesting find was *Surirella medulica* Per., from a ditch in the low-lying country between the wolds and the Market Weighton canal, called Hotham Carrs. Some of the frustules show an indentation on one side of the valve, and a specimen of this form is figured, together with a typical specimen. Many other species are figured in a plate.

* Torreya, iii. (1903) pp. 150–4. † Rhodora, v. (1903) pp. 221–5, 252–5.
‡ Arkiv. Bot. Stockholm, i. (1903) pp. 71–138, 277–86 (pls. 1–5, 15).
§ Trans. Hull Sci. & Field Nat. Club, iii. (1903) pp. 110–14 (pl. xi., fig. in text).

Diatoms and Plankton from the Faeröes.*—E. Oestrup enumerates 182 species from these islands. The material at his disposal consisted of the collections of Börgesen and Helgi Jonsson, and included 136 gatherings from different localities. The following genera are the most characteristic of the whole: *Amphipleura*, *Cocconeis*, *Fragilaria*, *Gomphonema*, *Grammatophora*, *Licmophora*, *Navicula*, and *Synedra*. A list is given of the species most frequently found in localities exposed to the open sea, and it is pointed out that there exists no slight resemblance between the genera characteristic of the Faeröes and of Greenland.

C. H. Ostenfeld gives a list, accompanied by critical notes, of 54 diatoms found in the marine plankton round the Faeröes. Tables are also drawn up giving for each species the locality, date, temperature C°, and salinity *pro mille*. Notes are given on the geographical distribution of the species. An account of the Peridiniaceæ is included.

Foslie, M.—**New Species or Forms of Melobesieæ.**
[The author describes four new species of these coralline algæ, and four new forms of already existing species. They all occur on the western coast of North America.] *K. Norske Vidensk. Sels. Skrift.*, 1902, No. 2, 11 pp.

Karsten, G.—**Zur Frage der Auxosporentypen.** (On the types of auxospores.)
[A criticism on Mereschkowsky's views concerning auxospore formation. Among other points, the author denies that auxospores are entirely a condition of growth, and maintains that the periods of the first auxospore formation and those of its growth are quite distinct.]
Bot. Zeit., ii. (1903) pp. 306–11.

Pampaloni, L.—**Sopra un singolare modo di comportarsi di un' alga, allorchè venga coltivata in determinate sostanze nutritizie. Nota preliminare.** (Preliminary note on the curious behaviour of an alga when cultivated on certain nutritious substances.)
[Cultivation of *Protococcus caldariorum*.]
Nuov. Giorn. Bot. Ital., x. (1903) pp. 602–5 (with figs. in text).

Peragallo, H.—**Diatomées marines de France.** (Marine diatoms of France.)
[A continuation of a former paper, and describes fifteen species and three varieties of *Campylodiscus*.]
Le Micrographe Préparateur, xi. (190?) pp. 186–9.

Tilden, J. E.—**Algæ collecting in the Hawaiian Islands.**
[An account of the author's experiences.]
Postelsia, 1902, pp. 135–75.

De Toni, G. B., & Achille Forti—**Pugillo di Diatomee bentoniche del Lago Ngebel (Giava).** (Small collection of Benthon-Diatoms from Lake Ngebel, in Java.)
[List of 24 diatoms, with notes and bibliography.]
Bull. Soc. Bot. Ital., 1903, pp. 133–41.

Fungi.

New Chytridineæ,†—F. E. Fritsch has found parasitic on a fresh-water alga two species of *Resticularia*, one of them already recorded by Dangeard, the other new to science, which he names *R. Boodlei*. The fungus occupies the cells of the host from which hyphæ pass out into the open, branching and forming spores. No zoospores were seen.

* Bot. of the Faeröes, pt. ii. (1903) pp. 533–611.
† Ann. Bot., xvii. (1903) pp. 649–64 (1 pl.).

Basidiobolus Lacertæ.*—W. Loewenthal found the spores of this fungus in the intestine of the lizard. Germination was easily induced either in distilled or tap water. The spores grew out into a short septate filament, or a slight pseudotissue was formed. The vegetative cells were all nucleate. Zygospores are formed by the fusion of the nuclei of two neighbouring cells. The process is somewhat similar to that observed in *B. Ranarum*. The writer considers that the fungus reproduces itself in the lizard, as he found other types of spores smaller in size.

Research on the Genus Streptothrix.†—L. Petri found a form of *Streptothrix* growing on the roots of *Fragaria*. He isolated it and made cultures and reinfected other healthy plants. The *Streptothrix* grew very sparingly, and did not impair the healthiness of the host-plant. Petri therefore concluded that it was only a saprophyte. The cells in which it was found were empty of contents and dark in colour. The writer takes occasion to review the affinities of *Streptothrix*. He gives a list of known species and records the results of his cultures. He calls special attention to the formation of vesicles laterally on the filaments. They are not conidial in their nature, and development of the filament ceases when they are formed. He compares them with the clavate formation of *Actinomyces*. They are formed of a mucilaginous substance the nature of which is not determined, and are presumably to be regarded as a degenerative process of the filament.

Note on Phycomycetes.‡—M. Henning Eiler Petersen records the fungal flora he found on the chrysalis of caddis-worms. There were a number of oomycetes, their presence doubtless being due to the nutritive quality of the substratum. The absence of hairs seems to allow the development of the sporangia of various Chytridineæ. Besides forms already known he records three new genera of that order: *Rhizoclosmetium* with branching hair-like mycelium and globose sporangium; *Asterophlyctis*, with a somewhat hemispherical sporangium studded with protuberances, but akin to the previous genus; and *Siphonaria*, near to the genus *Obelidium* and distinguished by the thick-walled empty-looking rhizoids.

Contribution to our Knowledge of Peronosporeæ.§—A disease of cucumbers occurring in the Twer Government was indentified by S. J. Rostowzen as similar to that caused by the fungus *Plasmopara cubensis*, and hitherto found only in America. He gives an account of the damage done by the disease, and devotes attention to the fungus itself. The conidia, which are borne on branched conidiophores, like those of *Peronospora*, are violet-grey in colour, and have at the tip a colourless papilla which is characteristic of species of *Plasmopara*, and on germination they form zoospores, also a feature of *Plasmopara*. This peculiarity had already been noted by Humphrey, who considered the fungus in question a transition form between the two genera.

* Archiv. f. Protistenkunde, ii. (1903) pp. 364–420. See also Bot. Zeit., lxi. (1903) pp. 326–7. † Nuovo. Giorn. Bot. Ital., x. (1903) pp. 585–601 (2 figs.).
‡ Journ. de Bot., xvii. (1903) pp. 214–22 (17 figs.).
§ Flora, xcii. (1903) pp. 405–25 (3 pls.).

Rostowzen found that in the plant he was examining, the conidia formed zoospores or they germinated by a tube. He places it under a new genus, *Pseudoperonospora*, and, as it differs slightly from the species *cubensis* first described by Berkeley and Curtis, he designates it as var. *tweriensis*.

Studies on the Fertilisation of Albugo Lepigoni and some Peronosporeæ.*—W. Ruhland records the results of his research on several forms of Oomycetes. *Albugo Lepigoni* grew on *Spergula marina*; the oogonia developed rather plentifully towards the end of the vegetative period. In the young oogonium there are some 60 to 90 nuclei present. These increase in size and the first mitosis takes place, simultaneously in the oogonium and the antheridium. The chromosomes, about four or five in number, were extremely small and evidently round in form. At a further stage the nuclei wander towards the periphery of the oogonium; other divisions must take place though they were not followed in detail, but the number of nuclei increased to 300 or 450. The latter stages of division show a much smaller spindle. Meanwhile the cœnocentrum had appeared towards the centre of the oogonium. It absorbs the surrounding plasma and increases to a relatively large size. The female nucleus attaches itself to the cœnocentrum, and after division and degeneration of the resulting daughter nucleus it is joined by the male nucleus from the antheridium, and both enter the cœnocentrum, which gradually disappears as the nuclei increase in size. They show a very fine spirem stage, then fusion takes place and subsequent division, the dividing nucleus resembling the first karyokinesis in the oogonium, with the same number of chromosomes. By repeated division, some seventy to eighty nuclei are formed, and the oogonium becomes surrounded by a thick exospore formed from the periplasm.

In *Peronospora Alsinearum* the nuclei of the oogonium divided only once, and the "period of zonation," when all the nuclei had travelled to the periphery, lasted a considerable time. A cœnocentrum appeared here also. Fusion of the two nuclei was delayed for a considerable time till after the exospore was formed.

Sclerospora graminicola provided an immense number of oogonia. These contained few nuclei. The spindle formed in mitosis was very large, and the chromosomes had a U shape. No cœnocentrum was present, and probably owing to this the male nucleus remains for some time at a distance from the female nucleus. The different stages are described in detail.

In *Plasmopara densa* the development largely resembles that of *Sclerospora*. There is no cœnocentrum, and in both forms the periplasm is drawn into the oospore, and the exospore is consequently of a slighter structure.

The writer concludes by reviewing the work done on all the forms of *Albugo*. He finds a regular gradation of forms from *Albugo Bliti*, in which a large number of female nuclei fused with male nuclei, to *A. Lepigoni*, where only one is present. The receptive papilla is also

* Jahrb. Wiss. Bot., xxxix. (1903) pp. 135–66 (2 pls.).

less developed, while the cœnocentrum is larger. He compares, finally, the development of the Albuginaceæ with the Peronsporaceæ.

Peronospora on Rheum undulatum.* — A. Osterwalder found that the fungus causes small reddish spots on the leaves. The conidiophores emerged from the leaf on the under side through the stomata. Oospores were not seen, but the writer considers the species to be the same as *Peronospora polygoni*. The conidiophores and conidia are of a slightly violet colour.

Biology of Cystopus candidus.†—Albert Eberhardt describes the changes brought about in the host-plant by the presence of the parasite. There was universal hypertrophy and distortion, alteration of form in the floral organs, physiological changes in the cell-contents and in the cell-forms, etc. He tested by culture experiments the specialisation of the parasite, and found that within a limited range of host species the conidia from *Cystopus* would infect easily. With conidia taken from *Tragopogon pratensis* it was impossible to infect any of the Cruciferæ.

Notes on Syncephalis.‡ — Paul Vuillemin records a new species, *Syncephalis adunca*, and makes an examination of the section *Curvatæ*. He insists on the autonomy of *S. curvatæ*, which has been included under *S. cornu*, and gives his reasons for doing so. The new species is yellow in colour, and the spores occur in chains of four, the enclosing membrane (mérisporocyste) remains visible up to maturity. Vuillemin places it between *S. nigricans* and *S. curvata*.

Zygospore of Mucorini.§—Paul Vuillemin has studied the process of zygospore formation, especially in *Sporodinia*, with a view to watching the fusion of the wall of the gametes. After the two copulatory branches have joined, the end of each remains for a time distinct, forming a median wall, and a new layer is then laid down on each side of it and on the external walls of the cells. Vuillemin notes that these two layers fuse separately, the primitive central wall disappearing first. The later-formed layers coalesce into one, to be in turn absorbed in the protoplasm of the zygospore.

New Genus of Phacidieæ.‖—R. Maire and P. A. Saccardo found a minute Discomycete parasitic on the leaves of *Juniperus Oxycedrus*, half covered by the torn epidermis. The fungus had no excipulum, the asci were tetrasporous, and the spores two-celled, brown ; characters which are found in no existing genus. The writers have named it *Didymascella Oxycedri*, one of the Phacidieæ, and near to *Didymascus* in form and structure.

Fertilisation in Ascodesmis.¶—P. A. Dangeard finds at the origin of the perithecium, branches of the hyphæ which fuse in pairs, as they do in *Gymnoascus*. The number varies from six to ten for each fruit. The two branches, which wind round each other in a spiral, are at first

* Centralbl. Bakt., x. (1903) pp. 775–7 (3 figs.).
† Tom. cit,, pp. 655–6.
‡ Ann. Mycol., i. (1903) pp. 420–7 (1 pl.).
§ Comptes Rendus, cxxxvii. pp. 869–71.
‖ Ann. Mycol., i. (1903) pp. 417–19 (4 figs.).
¶ Comptes Rendus, cxxxvii. (1903) pp 528–9

identical, but one, the ascogonium, gradually becomes richer in contents. Both branches are multinucleate, seven or eight nuclei in the ascogonium, three or four in the antheridium. A cell is cut off at the tip of the ascogonium analogous to the trichogyne of *Monascus*; after the separation of the trichogyne only four or five nuclei are to be seen in the ascogonium, but they are larger, and they furnish, after division, the copulatory nuclei of the asci. Dangeard explains the theory of this retarded copulation by comparison with the Siphomycetes. He considers it to be sexual fertilisation.

Cytology of Galactinia succosa.*—R. Maire, with a view to elucidate the affinity between nuclear evolution in the Ascomycetes and the Basidiomycetes, has studied one of the higher Pezizas, *Galactinia succosa*. This species is of interest in having laticiferous elements which are still but little known in the Ascomycetes. The author finds that it shows a real relationship with the Basidiomycetes from the point of view of its nuclear evolution; the presence of a group of synkaryons before the formation of the ascus, places it above the other Ascomycetes: we find here the first suggestion of that phase in the life-history, the *synkaryophyte*, which plays so important a part in the development in the Basidiomycetes.

Infection Experiments with Nectria ditissima.†—Rud. Aderhold refuses to accept Brzezinski's theories as to the origin of canker in fruit trees. The latter had failed to induce canker by infection with *Nectria* spores, but in all cases had done so by injecting *Bacterium Mali* into the trees. By repeated experiments Aderhold has proved that *Nectria* causes the wounds known as canker, not only in apple and pear trees, where it is well known, but in cherry trees and plum trees, where its parasitism was unsuspected. The writer has found canker wounds on cherry trees not due to artificial infection, in all points resembling those induced by the introduction of *Nectria*, but he was unable to find the fruiting form of the fungus. He calls for further proof by Brzenzinski of his theory before it can be received.

Morphological and Biological Researches on Stysanus.‡ — F. Guéguen has come to the conclusion that *Stysanus Mandlii* is only a form of *St. Stemonites*. From both he developed a similar perithecial form, *Melanospora stysanophora*. The ascus spores were cultivated in turn, and produced a form of *Acladium*, brown chlamydo-spores and new perithecia, but Guéguen failed to reproduce the *Stysanus* form. He cultivated also *Echinobotryum atrum*, so frequently found on *Stysanus*. He considers it a sessile form of *St. fimetarius*. He has classified some other forms with *St. Stemonites*, and thinks that, though usually saprophytic, it may grow as a true parasite.

Rhizoctonia violacea.§—Jakob Eriksson completes his account of experiments with this fungus-disease of roots. He had already recorded that the parasite can transfer itself to other roots, and that in succeeding

* Comptes Rendus, cxxxvii. (1903) pp. 769–71.
† Centralbl. Bakt., x. (1903) pp. 763–6.
‡ Bull. Soc. Mycol. France, xix. (1903) pp. 217–44 (3 pls.).
§ Centralbl. Bakt., x. (1903) pp. 766–75 (1 pl. and 1 fig.).

generations this power of adaptation grows stronger. He has proved that, in the second generation, such an adapted fungus increased greatly in vitality and destructive power. The new fungus race is, however, less hardy, and succumbs easily to unfavourable weather conditions. Lime has proved useless as a fungicide, but Eriksson thinks that carbolic lime and petroleum water may prove effective remedies for the disease.

Experiments with Heterœcius Rusts.*—M. Tranzschel records the successful injection of *Æcidium leucospermum*, from *Anemone nemorosa*, on *Sorbus Aucuparia*, the uredospores of *Ochrospora sorbi* developed. He further proved the connection of *Puccinia* on *Polygonum amphibii*, with *Æ. sanguinolentum* on *Geranium*; of a *Puccinia*, on *Carex limosa*, with *Æ. Trientalis*, and of *Æ. coruscans*, on *Picea*, with a species of *Chrysomyxa* on *Ledum palustre*.

Vegetative Form of Yellow Rust.†—Jakob Eriksson has revised his work on Mycoplasma, and finds that the bodies which he termed "*corpuscles spéciaux*" are not the first visible form of the fungus, as they belong to a later stage in its development. He finds, first of all, in the cells of the leaf a granular vacuolated substance, which takes a darker violet colour when fixed and stained with Flemming, and is the mycoplasma.

When the first spots of rust begin to appear, a plasmic mass is formed occupying the tissue between the different sori. It spreads as mycelial filaments between the cells, or it occupies the intercellular spaces; this stage he terms *protomycelium*. In the third stage the protomycelium becomes septate, and forms a pseudoparenchyma, and this is followed by the formation of the sporiferous hymenium.

Heterœcious Rusts.‡—H. Klebahn has collected from many sources all that is known about these rusts. He gives a list of the species of which the life-cycle has been traced—150 in all—and discusses the different questions touching on their growth. The occurrence of the different forms, the conditions that influence their growth, spore dissemination, infection, methods of culture, theories as to the spread of the rust disease, and theories as to their sexuality, occupy the first part. The second half of the book takes up each species in full detail. There are complete indices and graphic tables of illustration; the whole forming a valuable summary and book of reference.

Infection Experiments with Rusts.§—Ernst Jordi extends still further our knowledge as to the specialisation of rust forms. Under *Uromyces Fabæ* he finds there are four specialised forms on the different hosts, species of *Vicia*, *Lathyrus* and *Pisum*. *Uromyces Ervi* grew only on *Vicia hirsuta*. *U. Anthyllidis* infected only *Anthyllis Vulneraria*. Experiments were also made with *U. Hedysari obscuri* and *U. Astragali*. The latter species grows on a number of host-plants.

* Centralbl. Bakt., xi. (1903) p. 106.

† Comptes Rendus, cxxxvii. (1903) pp. 578–80.

‡ Die Wirtswechselnden Rostpilze. Gebr. Borntträger, Berlin, 1903, pp. xxxvii. and 447.

§ Centralbl. Bakt., x. (1903) pp. 777–9.

BAINIER, M. G.—**Sur quelques espèces de Mucorinées nouvelles ou peu connues.** (Some new or little-known species of Mucorini.)

[The new genera are *Parasitella*, *Glomerula* and *Pseudo-absidia*, each with one species. There are ten new species of *Mucor*, and one new *Circinella*. The writer describes the zygospores in the latter genus: they had not been hitherto known.]

Bull. Soc. Mycol. France, xix. (1903) pp. 153–72 (2 pls.).

BARBIER, MAURICE—**Liste annotée d'Hymenomycetes des environs de Dijon. 3me partie.**

[This part includes the Polyporeæ, Hydneæ, Thelephoreæ, Cyphelleæ, Corticieæ, Clavarieæ, Caloceræ and Tremellaceæ, with critical notes on many of the species.]

Bull. Soc. Mycol. France, xix. (1903) pp. 273–90.

BOUDIER, E.—**Note sur quelques Ascomycetes nouveaux du Jura.**

[The author describes and figures six new species.]

Bull. Soc. Mycol. France, xix. (1903) pp. 193–9 (1 pl.).

CAVARA, F.—**Novita Micologiche Siciliane.** (New Sicilian fungi.)

[*Peziza Ammophila*, found on the leaves of *Arundo Mauritanica* and *Awerswaldia Chæmerops*, parasitic on *Chæmerops humilis*, in the botanical garden of Catalania.] *Bull. Soc. Bot. Ital*, No. 4 (1903) pp. 114–55.

COSTANTIN ET LUCET—**Sur un Rhizopus pathogène.**

[A new pathogenic form, *Rhizopus equinus*, is described by the authors.]

Bull. Soc. Mycol. France, xix. (1903) pp. 200–16 (2 pls.).

DIETEL, P.—**Ueber die Teleutosporenform von Uredo læviuscula D. & H. und über Melampsora Fagi D. el Neg.**

[The author finds that the first of these plants is *Thekopsora læviuscula* D. and H., and that the second is not a *Melampsora*, but *Mikronegeria Fagi*.] *Ann. Mycol.*, i. (1903) pp. 415–17.

EARLE, F. S.—**Mycological Studies.**

[A synopsis of the North American species of the genus *Periconia*, and a list of other new fungi. The new genera are *Hypodermopsis*, an Ascomycete somewhat similar to *Hypoderma*, and *Ohleriella*, near akin to *Ohleria*.]

Bull. New York Bot. Garden, ii. (1902) pp. 331–50.

HENRY, E.—**La lutte contre le champignon des maisons. Expériences récentes.** (Methods of destroying dry-rot.)

[A description of the various antiseptic solutions used to impregnate wood and render it sterile.] *Bull. Mensuel. Soc. Sci. Nancy*, 1902, 11 pp. See also *Centralbl. Bakt.*, x. (1903) pp. 809–10.

HÖHNEL, FRANZ V.— **Mycologische Fragmente.**

[A large series of new forms and critical notes on species already described. The new genera are *Heimerlia*, a myxomycete, one of the Echinosteliaceæ, and *Siropatella* and *Agyriellopsis*, belonging to Excipulaceæ.]

Ann. Mycol. i. (1903) pp. 391–414.

HOLLOS, LASZLO—**Descriptions of Fungi.**

[The writer describes a new genus, *Glasteropsis*, from South Africa, and two species of *Lycoperdon* from South Carolina.]

Bot. Sekt. K. Ungar-Natorius, Ges., ii. (1903) pp. 72–6.

KASERER, HERMANN—**Versuche zur bekämpfung von Peronospora und Oidium im Jahre 1902.** (Methods of destroying *Peronospora* and *Oidium* during the year 1902.)

[Solutions containing copper were found more effectual than the employment of sulphur.] *Zeits hr. Landwirtsch. Versuchswesen in Oesterreich*, 1903, 205 pp. See also *Centralbl. Bakt.*, x. (1903) p. 809.

KELLERMAN, W. A.—**Ohio Fungi. Fascicle VIII.**

[The fascicle includes 20 fungi, all of them parasitic on various hosts. Diagnoses of some of the species are given.]

Journ. of Mycol., ix. (1903) pp. 171–6.

KELLERMAN, W. A.—**Index to North American Mycology.**
[Alphabetical list of articles, authors, subjects, new species and hosts, new names and synonyms.] *Journ. of Mycol.*, ix. (1903) pp. 177–199.

KONING, C. J.—**Bijdrage tot de kennis van het leven der humicole fungi en van de scheikundige processen welke bij de humificatie plaats hebben.**
[Deals with the microfungi that live on decaying vegetation, and discusses their disintegrating action on humus.]
Verhand. K. Akad. Wetensch. Amsterdam, ix. (1903) No. 7, 69 pp.

LINDAU, GUSTAV—**Hilfsbuch für das Sammeln der Ascomyceten mit Berucksichtigung der Nährpflanzen Deutschlands, Osterreich-Ungarns, Belgiens, der Schweiz und der Niederlande.**
[Aid to the collection of Ascomycetes, with regard to their host-plants and the substances on which they grow]
Gebr. Bornträger, Berlin, 1903.
See *Bot. Zeit.*, lxi. (1903) pp. 321–2.

LINDNER, P.—**Zum nachweis von untergäriger Bierhefe in Preszhefe.**
Zeitschr. Spiritusindustrie, Bd. xxvi. No. 22, p. 229.
See also *Centralbl. Bakt.*, x. (1903) pp. 663–4.

MACALPINE, D.—**Australian Fungi. New or unrecorded. Decades III.–IV.**
[Forty species of microfungi, most of them parasitic on leaves, etc. Fifteen are new species.]
Proc. Linn. Soc. N. S. Wales, xxviii. (1903) pp. 94–103.

MAUBLANC, A.—**Sur quelques espèces nouvelles de champignons inférieurs.**
[The writer describes 18 new species of microfungi. There is one new genus, *Nomuræa*, a member of the Hyphomycetes.]
Bull. Soc. Mycol. France, xix. (1903) pp. 291–6 (2 pls.).

MOLLIARD MARIN—**Observations sur le Cyphella ampla Lév., obtenu en culture pure.** (Observations on *Cyphella ampla* grown in a pure culture.)
[The fungus was developed from the basidiospores.]
Bull. Soc. Mycol. France, xix. (1903) pp. 146–9.

" " **Sur une condition qui favorise la production des perithèces chez les Ascobolus.** (On a condition which favours the production of the fruit of *Ascobolus*.)
[The writer finds the association of a bacterium necessary for the formation of the fruits of *Ascobolus furfuraceus*.]
Bull. Soc. Mycol. France, xix. (1903) pp. 150–2.

MAGNIN, M. L.—**Un cas d'empoisonnement par l'Amanita muscaria.** (A case of poisoning due to *Amanita muscaria*.)
[Some pathological notes on the effects of the poison.]
Bull. Soc. Mycol. France, xix. (1903) pp. 173–5.

MURRILL, W. A.—**The Polyporaceæ of North America. (V.) The genera Cryptoporus, Piptoporus, Scutiger and Porodiscus.**
[The writer is dealing chiefly with the somewhat fleshy terrestrial forms, which are exceedingly rare and beautiful in North America. The genus *Porodiscus* is new, and has been created to contain the species known as *Cyphella pendula*.]
Bull. Torrey Bot. Club, xxx. (1903) pp. 423–34.

PATOUILLARD, N.—**Addition au Catalogue des champignons de la Tunisie (suite).**
[A list of fungi, with habitat and locality; with critical notes on some of the species, several of which are new to science.]
Bull. Soc. Mycol. France, xix. (1903) pp. 245–61.

PENNINGTON, STUART—**Uredineæ from South America.**
[The writer records 30 species.]
Anal. Soc. Cientif. Arg. lx. (1903) pp. 31–40.
See also *Bot. Centralbl.* xciii. p. 273.

SACCARDO, P. A.—**Floræ mycologicæ Lusitanicæ.**
[The list enumerates 129 species. A number of the species of Microfungi on the leaves and stems of plants are new to science]
Bol. da Soc. Bot., 1903, pp. 1–16.
See also *Ann. Mycol.*, xix. (1903) pp. 458–9.

SACCARDO, P. A., & TRAVERSO, G. B.—**Contribuzione alla flora micologica della Sardegna.**
[The writers take up the work begun by the late A. N. Berlese. They enumerate 167 species of Microfungi, ten of them new to science.]
Ann. Mycol., i. (1903) pp. 427–44 (1 pl.).

SYDOW, H. & P.—**Neue und kritische Uredineæ.** (New and critical Uredineæ.)
[Many of the species from various parts of the world are described for the first time.] *Ann. Mycol.*, i. (1903) pp. 324–34.

TRAVERSO, G. B.—**Primo elenco di Micromiceti di Valtellina.** (First catalogue of Micromycetes from Valtellina.)
[The writer records 157 species; several of them are new to science.]
Ann. Mycol., i. (1903) pp. 297–323 (5 figs.).

ZAHLBRÜCKNER, A. —**Ueber die systematische Gruppierung der pyrenokarpen Flechten.**
[The author has grouped them in six families, according to the formation of thallus and fruit.] *Verhandl. Zool.-botan. Ges. Wien*, 1903, pp. 81–2.
See also *Ann. Mycol.*, i. (1903) p. 474.

" " **Die "Parmelia ryssolea" der pennonischen Flora.**
[A description and diagnosis of this plant.]
Magyar botan. Lapok., ii. (1903) pp. 169–175 (1 pl.).
See also *Ann. Mycol.*, i. (1903) p. 474.

Lichens.

Lecanora subfusca.*—A. Hue has looked through a large amount of material, and finds that this very wide-spread Lichen has three distinct varieties and a number of forms. They are distinguished by the form of the apothecium.

Lichens from Socotra.†—J. Steiner worked through a small collections of Lichens made by O. Simony, and found three new genera and eleven new species. The new genera are *Simonyella* and *Roccellographa*, both belonging to the Roccellaceæ. The latter has a distinct Graphidean fruit, and this confirms Darbishire's view of the position of Roccella among the Graphideæ. The remaining new genus, *Phlœopeccania*, belongs to the family of Glœolichenen.

Mycetozoa.

Development of Myxomycetes.‡—M. Pinoy had already found that various species of endosporous myxomycetes would not grow in pure cultures until some bacterium was added to the medium. He has carried out further researches on *Dictyostelium mucoroides*. He considers that the bacterium associated with the species of Acrasiæ exercises a considerable influence in determining the colour and the form of the organism, and that species described as distinct from each other are merely the same species associated with different chromogenic bacteria.

FRIES, ROB. E.—**Myxomyceten von Argentinien und Bolivia.**
[Myxomycetes of Argentina and Bolivia collected and determined by the author, forty-seven species in all. He notes the comparatively large occurrence of species with lime in the sporangia.]
Arkiv. för Botanik. K. Svens. Vetenskaps-Akad., i. (1903) pp. 57–70.

* Bull. Soc. Bot. France, 1903, pp. 22–86. See also Ann. Mycol., i. (1903) p. 472.
† Deutschr. Kaiserl. Akad. Wiss. Wien, lxxi. (1902) 1903, pp. 93–102. See also Ann. Mycol., i. (1903) pp. 475.
‡ Comptes Rendus, cxxxvii. (1903) pp. 580–1.

Schizophyta.

Schizomycetes.

Uric Acid Bacterium.* — C. Ulpiani gives the results of his work on a micro-organism capable of causing the following change in uric acid:

$$C_5H_4N_4O_3 + H_2O + 3O = 2CO\left\langle\begin{matrix}NH_2\\NH_2\end{matrix}\right. + 3CO_2.$$

It was isolated from the fresh excrement of the fowl, by means of inoculations first in tubes containing a solution of uric acid, then by agar plates. Pure cultures are capable of completely fermenting a solution of uric acid in three to four days, at 37° C. It is a motile coccus furnished with a capsule. Involution forms are common. It is positive to Gram and stains well with fuchsin.

Cultivated on plates of agar with uric acid, it develops in three days round superficial yellowish white colonies 1–1·5 mm. in diameter. In both it causes turbidity and the formation of a surface pellicle. In a solution of uric acid and traces of salts it produces opalescence. It grows well between 29° C. and 42° C., and best at 39° C. An hour at 50° C. stops further development.

Bacterial Origin of the Forms of the Arabin Group.†—R. Greig Smith, working at this subject, first investigated the acids produced during the growth of *Bact. acaciæ* and *Bact. metarabinum* in saccharose media. He used saccharose with asparagin as a nitrogenous nutrient, and found that the action of the two organisms is identical and consists in the formation of lævolactic, succinic, lauric, and oxalic acids (non-volatile), and of acetic, formic, and carbonic acids (volatile). The author found that the gum-flux of the vine is caused by *Bact. acaciæ* and *Bact. metarabinum*; that the gum-flux of the plum is due in part at least to the action of *Bact. acaciæ*; that the gum-flux of the cedar is caused by *Bact. acaciæ* and *Bact. persicæ*; and that the gum-flux of the peach is produced chiefly by *Bact. acaciæ*, as is also the gum-flux of the almond. He also shows that the gum-flux of a Japanese date-palm is dependent on *Bact. levaniformans* and *Bact. acaciæ*.

Streptothrix in a Dog.‡—Trolldenier found, in a dog dead after a short illness, caseous and suppurative bronchial lymphadenitis and other lesions. In the suppurating bronchial glands were detected a great number of longer or shorter threads with distinct bifurcation, staining intensely red by the Ziehl-Cabbot method. Glycerin plates inoculated with the same material showed after 24 hours numerous white grains, which were found microscopically to be formed of a *Streptothrix* species The author concludes that the infection occurred by the inhalation of the fungi into the lung alvioli, so to the bronchial glands, and thence through the lymph channels into the vascular system. He established the virulence of the organism in mice, guinea-pigs,

* Atti R. Accad. Lincei, xii. (1903) pp. 236–40.

† Proc. Linn. Soc. N.S.W., xxviii. (1903) pp. 114–31.

‡ Zeitschr. f. Tissand, vii. p. 81. See also Centralbl. Bakt. 1te Abt. (Ref.) xxxiv. (1903) pp. 124–5.

rabbits, dogs and cats. Liquefaction of gelatin did not occur, and growth was strictly aerobic. On horse serum there was no growth, and the author was unable to infect the horse. The organism was not identical with *Streptothrix Eppinger*.

Jaundice of the Beet: a Bacterial Disease.* — G. Delacroix has investigated this disease of the beet, a disease characterised by irregular spots on the leaves. In these spots, as well as in the roots, petioles and seed-vessels, he found numerous motile bacilli; and his experiments indicate that these bacilli are the cause of the disease, which is probably propagated by means of the seed-vessels. The micro-organism can be cultivated on various media, but not on gelatin, and the author proposes to call it *Bact. calificans*. It stains with ordinary dyes, but not with Gram. It does not produce spores. Cultivated to the twelfth generation it loses its virulence. In the way of treatment, the author recommends rotation of crop at least triennially, the avoidance of carrying to waste heaps the diseased leaves, and the burying of them directly; the sowing only of four-years-old seeds, and the absolute exclusion of seed-vessels from the neighbourhood of fields where beet is cultivated.

Spirillosis of Fowls.†—E. Marchoux and A. Salimbeni have investigated a disease of fowls common in Rio de Janeiro. The symptoms are diarrhœa, pyrexia, malaise, and death usually in a few days. In the blood they found a spirillum, and this blood produced the disease in other fowls. The authors conclude that the disease is caused by this spirillum, and is transmissible by inoculation of infective blood, and also by way of the digestive tract when blood charged with spirilla or the dejecta of infected fowls is ingested. Outside the organism the spirilla lose all virulence in about 48 hours. Protection can be obtained by the injection of blood or virulent serum, which has been kept 48 to 96 hours, or heated to 55° C. for five to ten minutes, and also by serum freshly obtained from an infected fowl and passed through a Berkefeld filter. Serum of animals which have recovered has preventive properties. *In vitro* the same serum has marked agglutinating power.

* Comptes Rendus, cxxxvii. (1903) pp. 871–2.
† Ann. Inst. Pasteur, xvii. (1903) pp. 567–80.

MICROSCOPY.

A. Instruments, Accessories, &c.*

(1) Stands.

Swift's Simple Dissecting Microscope.†—This is shown in fig. 1, and consists of a metal base and sliding pillar for focussing, with 3-in. and 2-in. lenses.

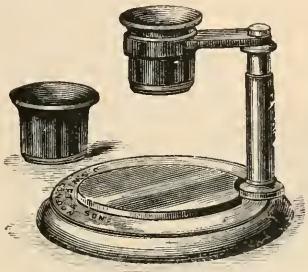

Fig. 1.

Swift's Newly Designed Microscope for Bacteriological Research.‡ This stand (fig. 2) was constructed from suggestions given by Delepine of Manchester. It is fitted with Swift's spiral rack-and-pinion for coarse adjustment. The fitting carrying the optical tube has the same wear-and-tear-preventing device as in the last instrument. The fine adjustment is also the same as in the last instrument. The draw-tube is divided to millimetres ; when fully extended it is 220 mm., when closed 160 mm. The triple nose-piece is perfectly dust-tight. The stage is covered with vulcanite, and is specially large to allow of the free use of the largest size Petri dish ; its right-hand side is divided into squares which answer the purpose of a finder. A full-size improved Abbe condenser, fitted with iris diaphragm and special focussing adjustment for raising or lowering it, is screwed to the under surface of the stage. Flat and concave mirrors are supplied, and a simple ingenious device enables the manipulator to determine when they are in the vertical axis. Three object-glasses are supplied with the instrument, one of them being Swift's $\frac{1}{12}$-in. oil immersion N.A. 1·30. The makers specially guarantee this particular lens to be of the highest possible optical excellence. Another of the objectives is the $\frac{1}{6}$-in., as supplied with the last.

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

† J. Swift & Son's Catalogue, London, 1901, p. 26.

‡ J. Swift & Son's special Catalogue, London.

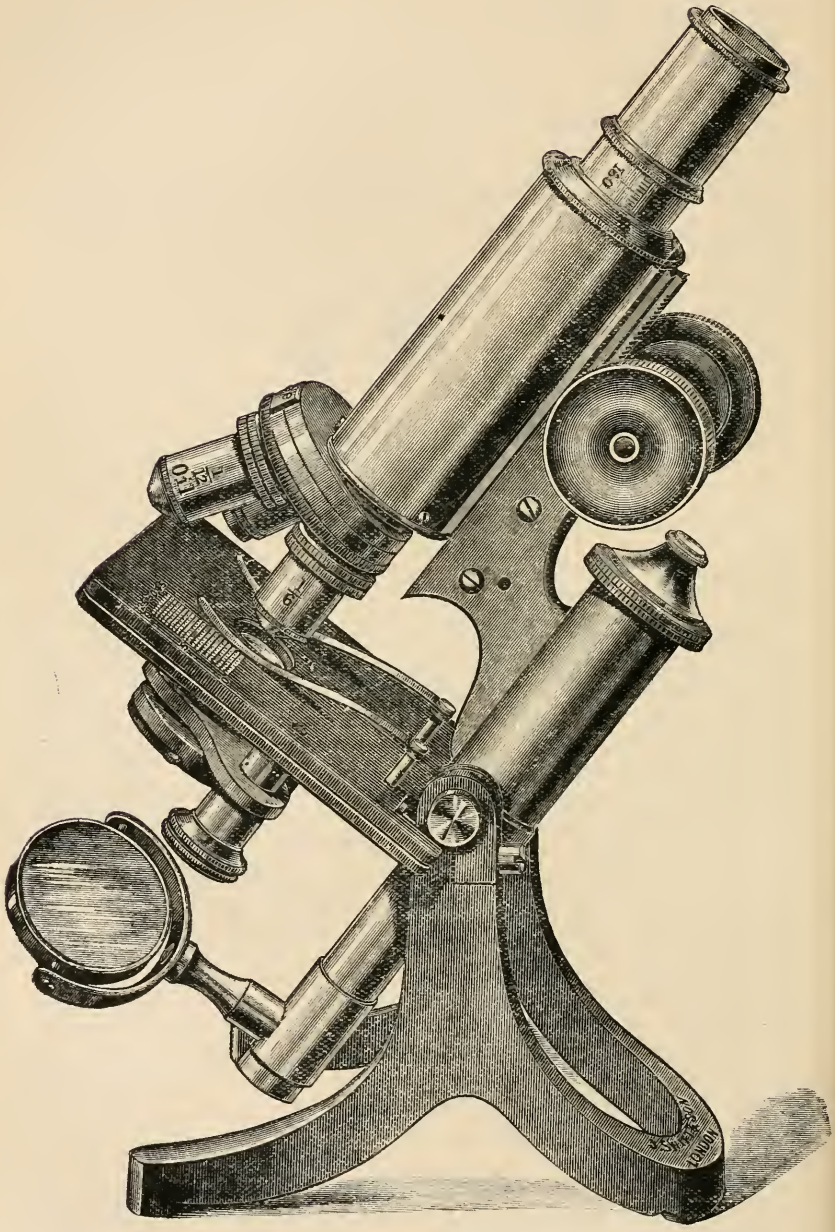

Fig. 2.

Swift's Newly Designed Histological and Physiological Microscope.* — This stand (fig. 3) is fitted with Swift's newly patented

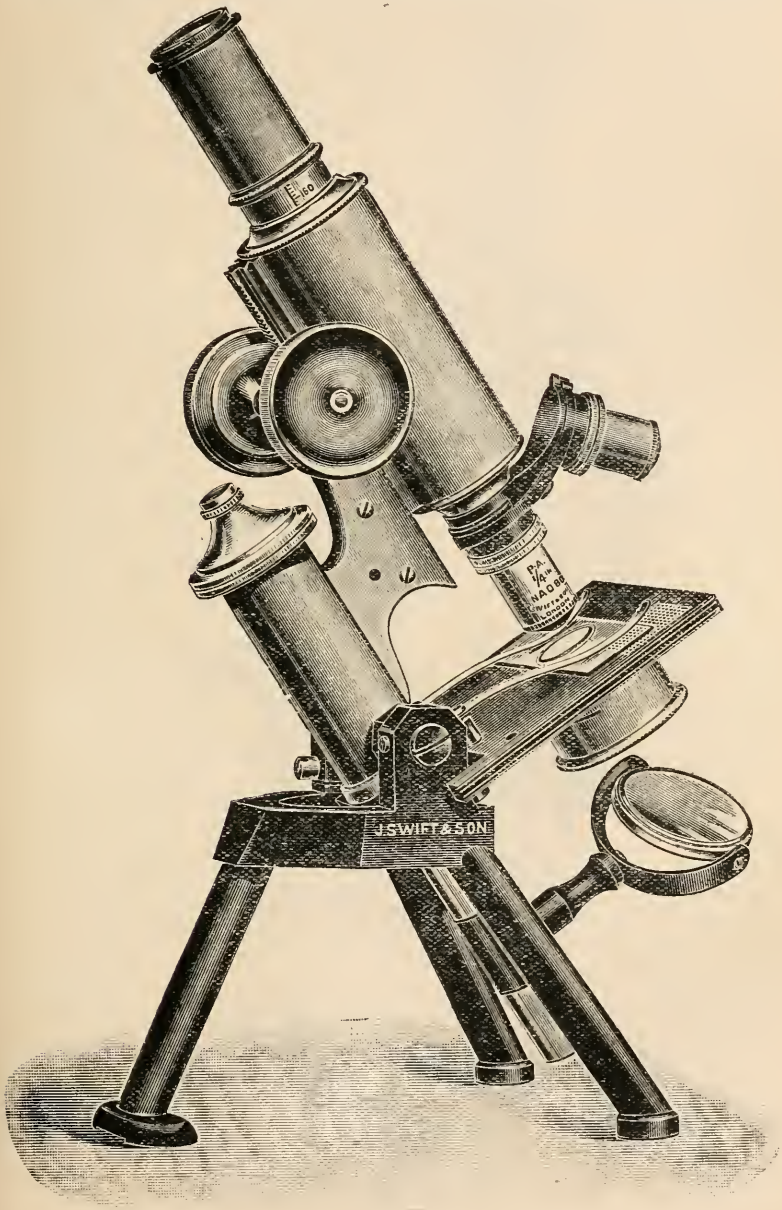

Fig. 3.

* J. Swift & Son's special pamphlet, London.

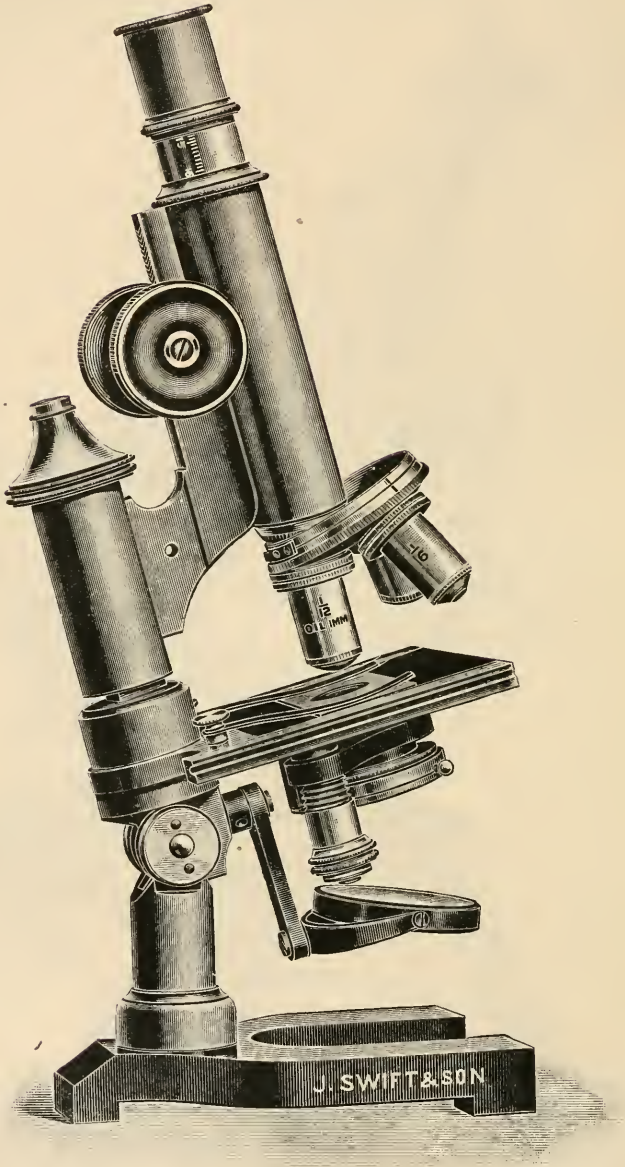

Fig 4.

isolated micrometer screw, whereby side movement is entirely eliminated. The fitting carrying the body or optical tube is new and of a novel construction, such that the wear and tear indispensable to all fittings can be compensated for by means of a simple adjustment effected by three screws fitted to the limb. The coarse adjustment is by means of Swift's patented diagonal rack-and-pinion. The stage is larger than that usually supplied to students' stands, and allows of the free use of a Petri dish. The whole of the instrument, with exception of the tripod and stage, is polished bright, and is of the highest possible mechanical excellence. The $\frac{1}{6}$-in. objective supplied has an exceptionally long working distance for blood examination with the Thoma-Zeiss hæmacytometer.

Swift's Continental Stand.* — The makers have introduced this stand (fig. 4) for the convenience of those who prefer this style. A special plant of machinery has been put down for the manufacture, and the instrument is an absolute réplique of a stand manufactured by one of the most reputed German makers, and is listed at the Continental price. A variation is, however, introduced in the size of the stand, which is much larger than in the original, and allows of the free use of the largest Petri dishes.

Watson and Sons' "Works" Metallurgical Microscope.† — The form and construction of this instrument are shown in fig. 5, and resemble the "Van Heurck" model made by the same firm. The foot is of the tripod pattern, and its front is so shaped that access is freely obtained to the milled heads, which control the movements of the stage and substage. The spread is $9\frac{5}{8}$ in. The instrument can be inclined on the foot in any position from the horizontal to the vertical; a clamping screw being provided for fixing it firmly in position. The stage is mounted on a very substantial bracket which, at the back, is fitted by dove-tailed grooves into a frame in which, by rack-and-pinion, it can be raised or lowered to or from the body of the Microscope. Special attention has been given to affording a sufficient interval between the nose-piece of the Microscope and the surface of the stage, for the use of very low-power objectives. The coarse adjustment afforded by the rack-and-pinion has, in many instances, been supplemented by a fine adjustment, so that the whole focussing of the specimen can be done from the stage instead of with the Microscope body. The stage usually supplied is similar to that of Watson's "Circuit Stage Van Heurck" Microscope with mechanical screws, having a range of motion of one inch in each direction. Complete rotation is provided, so that specimens may be examined under every aspect of illumination. In the illustration it will be seen that a sliding bar is fitted to a recess in the stage; this bar may be instantly removed, and a levelling stage or metal holder may interchange with it. The body is of extra large diameter, and is fitted with two draw-tubes; one having a rackwork, and the other sliding, so that a wide range of body-length may be obtained. There is sufficient range of adjustment for the focussing of the lowest-power lenses. The instrument is recommended by the makers

* J. Swift & Son's special Catalogue, London.

† W. Watson & Sons' Catalogue of Micro-outfits for Metallurgy, pp. 1, 3, 4.

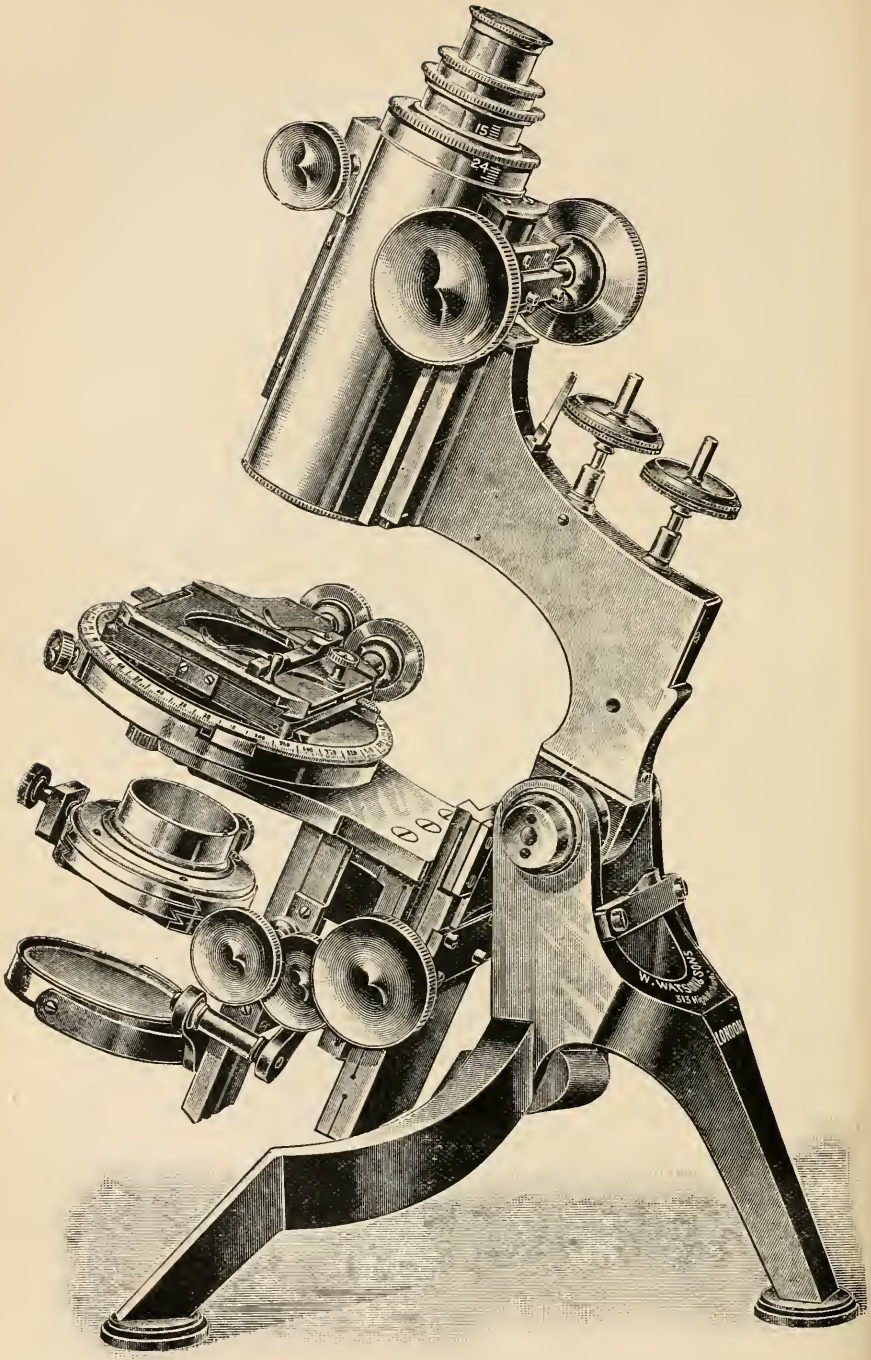

Fig. 5.

as embodying the latest ideas, and maximum of convenience for metallurgical work.

Leach's Oxy-hydrogen Lantern Microscope.*—This instrument (fig. 6), which has been for some time before the public, and has been described in earlier numbers of this Journal,† has received some improvements from its manufacturers, Messrs. Woolley of Manchester, who equip

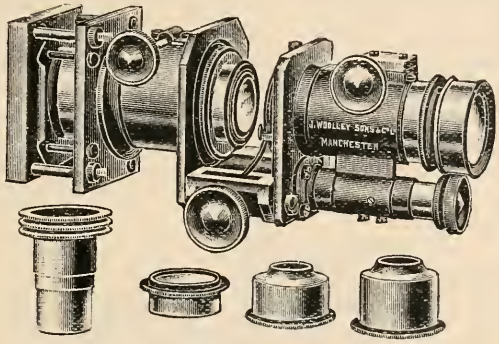

Fig. 6.

it with the highest quality lenses and workmanship. It is fitted to any oxy-hydrogen lantern by screwing it into the flange, which carries the usual lantern objective. In working with this Microscope, all the different parts are mechanically connected. There are no loose parts to get out of position, or to keep in their place after the instrument is set up. Fig. 6 shows the Microscope in its present form.

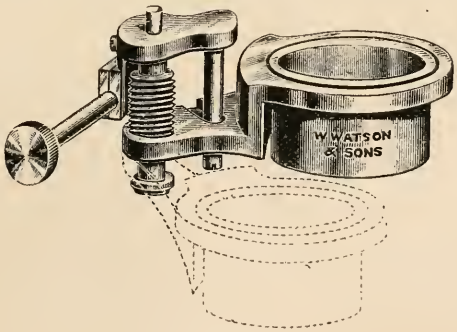

Fig. 7.

Watson's New "Argus" Substage.‡—This substage (fig. 7) can be fitted to almost any Microscope. It is intended to replace the spiral focussing screw so frequently applied to under-fittings of students' Microscopes, and which Messrs. Watson have found so unsatisfactory

* Woolley, Manchester, Special Circular.
† 1887, p. 1019; 1890, p. 803; 1892, p. 105.
‡ W. Watson & Sons' Special Catalogue, p. 7.

that they have determined to discontinue it. The rackwork in the above auxiliary consists of a number of grooves cut on a cylinder, against which a pinion engages, as in the ordinary coarse adjustment of Microscopes. This can be mounted strongly, and to work accurately on almost any Microscope. It is provided with a loose ring, by which it is centred precisely to the Microscope, with which it is to be used, before leaving Messrs. Watson's works, and the ring is then held by screws in position.

Watson's Compound Substage.*—This substage (fig. 8) has spiral rackwork, pinion, coarse adjustment, and centring screws, to enable the apparatus that may be contained on it to be set exactly coincident with the optical axis of the objective.

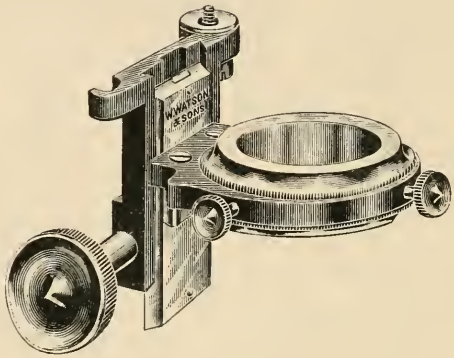

Fig. 8.

Metallurgical Stage.† — W. B. Stokes has devised an appliance, intended to effect a temporary conversion of any Microscope possessing a focussing substage into a stand suited to the needs of metallurgists. When using the "vertical illuminator," a change of object often involves a considerable change in the illumination, but by giving the stage a focussing movement the lighting arrangements remain undisturbed. The aim of the present accessory is to supply this movement to an ordinary Microscope. Taking advantage of the substage movement, it is evident that there is required only a stage-plate fixed to a stem, which fits into a substage adapter in such a way that the stem passes through the ordinary stage aperture.

Pocket-Magnifier.‡ — G. C. Karop describes a new pocket-lens (fig. 9) made by Swift and Son. It is a modified Herschelian doublet, made up of a lower inequi-convex 6 : 1 lens, and an upper plano-convex of smaller size, just sufficiently spaced to admit a thin polished

* W. Watson & Sons' Supplemental List, October 1903, p. 7.
† Journ. Quekett Micr. Club, viii. (1903) pp. 549–50 (1 fig.).
‡ Tom. cit. pp. 499–504 (8 figs.).

metal reflector-diaphragm between them. The sizes and focal lengths of the lenses are approximately as follows: Inequi-convex, diameter 1·3; focus 2·1. Plano-convex, diameter ·65; focus 1·75. Focus of combination, diameter 1·95. Of course, all these can be varied in

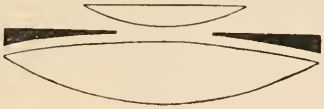

Fig. 9.

relative proportion if required. The three elements are mounted separately, so that, although it is calculated to act as a "system," either lens may be used by itself with or without the speculum.

(2) Eye-pieces and Objectives.

Nelson's Formula Oculars.*—A. A. C. E. Merlin calls attention to the very fine visual results obtained by the employment of E. M. Nelson's new formula Huyghenian eye-pieces when fitted to the telescope. One of these yields a measured power of 160 diameters on a 3·3-in. clear aperture refractor, the object-glass of which was made by Wray. The formula of this description of eye-piece was computed by Mr. Nelson some years ago, and is published in the last edition of Carpenter, but its high qualities when used on an astronomical telescope do not appear to be generally known.

The author is satisfied of the superiority of these oculars for critical microscopical work, over the compensated or ordinary Huyghenian eye-pieces, when working with apochromatic, semi-apochromatic or achromatic objectives.

Lens Calculation.†—"H." in a letter to the *English Mechanic*, compiles the following bibliography of works useful for above purpose.

1. The Perthensis Encyclopædia, vols. xvi. and xxii.
2. Encyclopædia Britannica, third edition.
3. The Telescope, by Herschel.
4. Optical Instruments, by Herschel, in vol. ii. of the Library of Useful Knowledge.
5. Rees' Cyclopædia—very full and complete—vol. xxxv. being the most useful one.
6. Coddington's Optics.
7. Potter's Optics, part ii.
8. Hansen's Dioptrische Untersuchungen.
9. W. Scheibner's Dioptrische Untersuchungen.
10. Steinheil's Handbuch der Angewandten Optik, containing numerous worked out examples and figures.

* English Mechanic, lxxviii. (1903) p. 425.
† Tom. cit., (Nov. 13, 1903) p. 316.

(3) Illuminating and other Apparatus.

Dunning's New Portable Oil-tight Lamp.*—This (figs. 10 and 11) has been constructed to meet the requirements of microscopists exhibiting at societies' meetings and conversazioni. The lamp packs in an oval tin case, $2\frac{3}{4}$ in. by $1\frac{3}{4}$ in. by 8 in., and can be easily carried in the coat-pocket without any risk of leakage. When full it will burn for four hours, and give sufficient light for a large binocular Microscope.

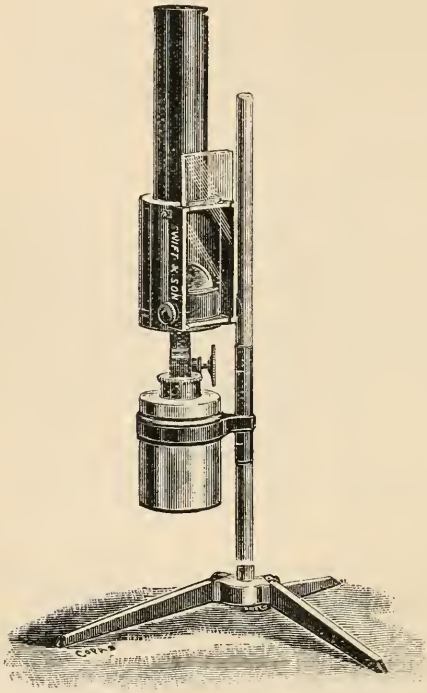

Fig. 10.

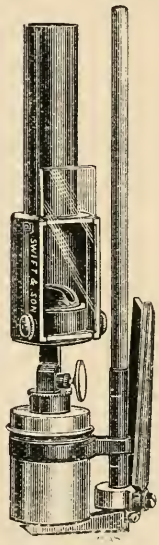

Fig. 11.

Either the flat or edge of the flame may be used by turning the metal chimney, which takes an ordinary 3-in. by 1-in. slip. The flame can be lowered sufficiently for direct illumination. Fig. 10 shows the lamp set up for use. Fig. 11, folded for packing in case.

Swift's Light Modifiers.†—These are light filters, and consist of a metal frame made to carry one or more squares of tinted glass, with adjustments admitting of any position in front of and close to the source of illumination. The modifiers are made in two forms: one

* J. Swift & Son's Catalogue, London, 1901, p. 45.
† Tom. cit., p. 47.

(fig. 12) carries two pieces of cobalt glass of different tints in a telescopic horizontal arm, sliding upon a vertical pillar attached to a heavy base ; the other (fig. 13), has a hinged arm and bull's-eye.

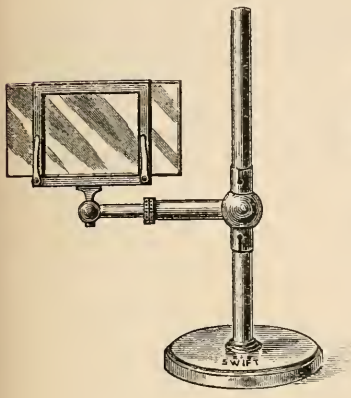

Fig. 12.

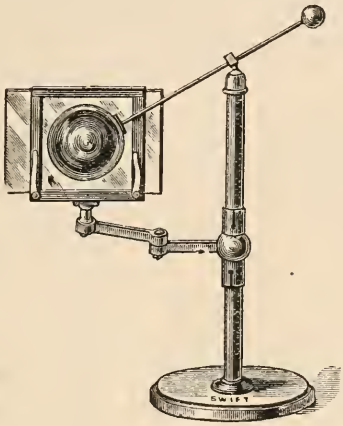

Fig. 13.

Swift's Double-Image Prism for Petrological Microscopes.*—This accessory is shown in fig. 14, and will be found extremely useful for viewing small dichroic crystals. The two images are seen side by side in the field, and one rotates round the other when the prism is turned round the eye lens of the ocular. The images differ according

Fig. 14.

to the nature of the crystal mineral and the direction in which the light passes through it. A thin plate of brass, with a number of small apertures, is inserted in the eye-piece for the purpose of reducing the field to a size smaller than the crystal under observation.

(4) Photomicrography.

Rose, L. K.—**Photomicrography of Metals.**
[An historical and practical paper.]
Photographic Journ., xliii. (July 1903) pp. 195–9.

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* J. Swift & Son's Catalogue, London, 1901, p. 40.

(5) Microscopical Optics and Manipulation.

LYMAN, T.—**The Prolongation of Spectral Lines.**
[Explains the cause of the streamers observed in the use of a concave grating.]
Proc. Amer. Acad. of Arts and Sciences, xxxix. No. 2 (July 1903) pp. 33–5 (1 pl.).

" " **Explanation of False Spectra from Diffraction Gratings.**
[Shows that they seem due to a so-called periodic error in the grating ruling.]
Proc. Amer. Acad. of Arts and Sciences, xxxix. No. 3 (July 1903) pp. 39–47 (1 pl.).

(6) Miscellaneous.

General Principle of some Novel Forms of Geodetical Instruments.*—Sir H. Grubb describes an important simplification in geo-

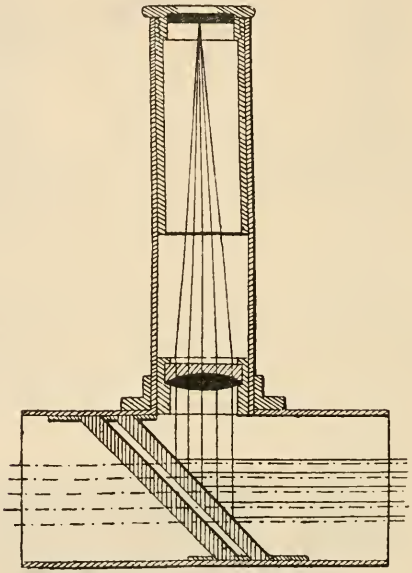

FIG. 15.

detical instruments, which may also be found useful in some departments of microscopy. The half-silvered, half-plain piece of glass generally used in such instruments is replaced by a piece of glass having a thin film of lead sulphide deposited on its surface. This film both reflects and transmits the incident light, and by varying its thickness the proportion of transmitted to reflected light may be varied. The effect is that the images of two objects may be got actually superposed, instead of (as in the prismatic compass) vertically above and below one another. The arrangement will be understood from fig. 15, where the distant object is seen by direct vision through the film, and the near object (after collimation) by reflection. One great advantage is that all the

* Brit. Opt. Journ., iii. (Oct. 1903) pp. 29–31 (4 figs.). Eng. Mech., lxxviii. (Oct. 30, 1903) pp. 263–4.

rays on the observer's eye are parallel, and there is therefore no error due to parallax.

The Collected Treatises of Abbe.*—Dr. S. Czapski has undertaken the welcome task of collecting and publishing in a compact form the various treatises of Prof. Abbe. This, the first volume, is to be followed, in due course, by two or three others, all on mathematical and optical subjects; and a later volume will contain his writings on social and economical topics.

The order adopted is chronological, and treatises originally written in other languages have been translated into German. The task of editing has been performed by Prof. Ambronn.

The following is a translation of the titles of the various papers, and the reference is given when the original was in English. The year of composition is also given.

1. On a spectrum apparatus for the Microscope (1870).
2. On the determination of the light-intensity of optical instruments, with especial reference to the Microscope, and apparatus for light concentration (1871).
3. Contributions to the Theory of the Microscope and of microscopical veracity (1873).
4. On a new illuminating apparatus for the Microscope (1873).
5. Description of the apertometer (1877).†
6. The optical auxiliaries of the Microscope (1878).
7. On micrometric measurement by means of optical images (1878).
8. On the computation of blood corpuscles (1878).
9. On Stephenson's system of homogeneous immersion for Microscope objectives (1879).
10. On new methods for improving spherical correction applied to the construction of wide-angled object-glasses (1879).‡
11. On the conditions of aplanatism of lens-systems (1879).
12. Some remarks on the apertometer (1880).§
13. Description of a new stereoscopic ocular, with general remarks on the conditions of micro-stereoscopic observation (1880).
14. On the limits of geometrical optics, with observations on Altmann's treatise 'On the Theory of Image-formation' (1880).
15. On the conditions of orthoscopic and pseudoscopic effects in the binocular Microscope (1881).‖
16. On the estimation of aperture in the Microscope (1881).¶
17. The relation of aperture and power in the Microscope (1882).**
18. On the mode of vision with objectives of wide aperture (1882).††
19. Note on the proper definition of the amplifying power of a lens or a lens-system (1884).‡‡

* Gesammelte Abhandlungen, von Ernst Abbe, Erster Band, 186 pp., 2 p's., 29 figs. Portrait of author. Published by Fischer, Jena, 1904.

† Journal R.M.S., i. (1878) pp. 19–22.

‡ Op. cit., ii. (1879) pp. 812–24.

§ Op. cit., iii. (1883) pp. 20–31.

‖ Op. cit., i. (1881) pp. 203–11.

¶ Op. cit., i. (1881) pp. 388–423.

** Op. cit., ii. (1882) pp. 300–9, 469–73; iii. (1883) pp. 790–812.

†† Op. cit. iv. (1884) pp. 20–26

‡‡ Op. cit., iv. (1884) pp. 348–51.

20. On improvements of the Microscope by means of new kinds of optical glass (1886).
21. On the effect of illumination by means of wide-angled cones of light (1889).*
22. On the adaptability of fluorite for optical purposes (1890).

Focussing Safeguard.†—In showing microscopic objects to those unacquainted with the use of a Microscope, there is always the risk of accidental injury to either the slides or objectives when the latter are of short focal length. To obviate risk of injury S. E. Dowdy has devised the following contrivance (fig. 16). A B is a metal collar, velvet lined, with a screw at A for clamping on to the objective. D is a fine screw rotating with arm B C, and having a felt-covered circular base, E. In use, the objective should first be accurately

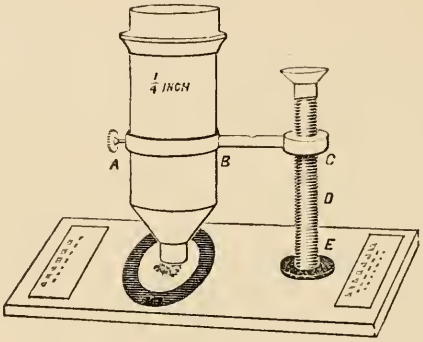

Fig. 16.

focussed, and then by means of the fine adjustment brought within its focal length, with its front lens as near as possible to the cover-glass without touching it.

The screw D is then rotated until the base touches the slide, when it will be obvious that it would be impossible to bring the objective into contact with the cover, though focussing in a safe direction may be effected to any extent.

Ultra-Microscopic Investigation of Colour-matters and their Physiological Significance.‡—A. Birch-Hirschfeld describes how Raehlmann used a new Microscope, introduced by Siedentopf and Zsigmondy, of Jena, which, by means of a brilliant focal, lateral illumination, renders visible the smallest particles (5μ to 10μ) in their natural colour. With this instrument he examined solutions of colouring matter, such as Prussian-blue, carmine, ultramarine, naphthol-yellow, and so forth. The resolution of each of the colouring matters into its component colours

* Journ. R.M.S., ix. (1889) pp. 721–4.
† English Mechanic, lxxviii. (1903) p. 291 (1 fig.).
‡ Ophth. Klinik, Aug. 20 and Oct. 5, 1903. See Ophthalmoscope, i. (1903) p. 218.

yields an unsuspected insight into the physical and physiological nature of colour, and is of importance as regards our conception of the mixing of colour. The smallest particles of a pure colouring matter are not only characterised by their colour, but probably also by distinctive form and movements. It therefore follows that colouring matters may be analysed by this method. The composite colours examined showed their smallest component particles either lying alongside each other (physiological mixture of colours), or were seen to consist of particles differing in shape, movement, and colour from those of the components. This condition has been proved by more recent researches—for example, on a mixture of Prussian-blue and naphthol-yellow—to rise from the fact that the particles of one component cluster around those of another, forming, as it were, a kind of sheath. This covering, according to Raehlmann, is formed by electro-magnetic action, minute negatively charged particles collecting around those positively charged, or *vice versâ*. These composite particles may be again separated by the action of electro-magnetism.

DOWDY, S. E.—**Amateur Microscopy.**

[A series of four excellent articles upon this subject, describing a student's Microscope, its apparatus, and the way to use it. The articles are well worth the attention of those intending to purchase a student's Microscope, as well as of those taking up the subject for the first time.]

English Mechanic and World of Science, lxxviii., Nos. 2008-11 (Sept. and Oct. 1903).

B. Technique.*

(1) Collecting Objects, including Culture Processes.

Wright's Collecting Bottle.† — This (fig. 17) contains an improvement by the introduction of an extremely rapid siphon, which is covered with a cylinder of very fine silk, thus preventing the escape of the smallest rotifer during the drawing off of the superfluous water. At the same time the fabric permits the water to be drawn off almost as quickly as it is poured into the bottle. This apparatus will be found invaluable to those collecting pond life, as gallons of water can be rapidly drawn off by means of the siphon without sacrificing a single insect. A cork bung with boxwood top is supplied to the bottle, to save the loss of material collected.

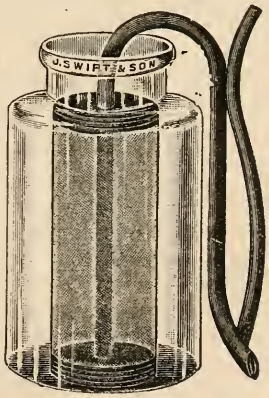

FIG. 17.

* 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.

† J. Swift & Son's Catalogue, London, 1901, p. 42.

Bacteriological Methods in Sanitary Water Analysis.*— C. E. A. Winslow and C. P. Nibecker in an extensive series of water examinations employed the following bacteriological methods: (1) The gelatine plate at 20° C., the count being made after 48 hours. This count was found to roughly correspond to the free ammonia and "oxygen consumed" of chemical analysis, and indicates the amount of organic decomposition in process. A low count is, of course, highly reassuring, but a high one may only mean an exceptional multiplication of certain water forms. (2) The fermentation test, as determined by the gas formula obtained in dextrose-broth tubes after 24 hours, at 37° C. This was found to be especially useful as an indicator of *B. coli*. (3) The litmus-lactose-agar plate after 24 hours, at 37° C. This, by means of the total count and the count of the red colonies, gave a measure of the organisms which thrive at the body temperature, and of those which form acids, which latter are coming to be recognised as intestinal forms.

Technique of the Bacteriology of the Blood.†— R. C. Rosenberger quotes the following procedure adopted by Coplin, who has elaborated and extended Sittmann's method. The middle half of the arm is washed with hot soap and water, and then with sterile water and 60 p.c. alcohol. The arm is then covered with 1 to 1000 sublimate gauze. In 24 hours it is cleaned with alcohol and ether, followed by hot 1 to 1000 perchloride, and lastly with sterile water or normal salt solution. All the solutions should be used hot. The blood is withdrawn from the median vein with a syringe or an aspirating needle. 20 c.cm. of blood should be obtained. From this, plates may be made by passing blood into liquefied agar kept at 45° C., in the proportion of 2 to 3 c.cm. of blood to 6 c.cm. of medium. After thorough mixing, plates are made and incubated at 37° C. Bouillon in flasks should be inoculated; 8 to 10 c.cm. of blood should be divided among flasks each containing 150 c.cm., so that the dilution is from 1 to 75 to 1 to 150. The flasks are well shaken and incubated at 37·5. If the bouillon become cloudy it is plated upon agar. Agar and serum slopes should be inoculated with 1 to 2 c.cm. of blood. Spreads on slides should be made, and animals inoculated with at least 5 c.cm. of blood. A sample of the blood may be incubated as a control or enrichment. Special solid media should be used for certain kinds, as urine agar or blood-serum agar for gonococcus, blood-smeared agar for *Bacillus influenzæ*. The spreads and films should be stained with anilin pigments. The hæmoglobin may be removed by immersion in 5 p.c. acetic acid for ten seconds. The acetic acid is removed by rapid aeration and by exposure to ammonia vapour. The film may then be stained for bacteria, the removal of the hæmoglobin facilitating the search for micro-organisms.

Cultivating Trypanosomes.‡—W. J. McNeal and F. G. Novy have cultivated *Trypanosoma lewisi* in a mixture of defibrinated rabbit's blood and agar. Agar, prepared in the usual way, is sterilised and cooled

* Technology Quarterly, xvi. No. 3 (1903) pp. 227–39.
† Amer. Journ. Med. Sci., cxxvi. (1905) pp. 234–57.
‡ Bull. Inst. Pasteur, i. (1903) p. 602.

down to 50° C. To this, one-third of its bulk of defibrinated rabbit's blood, obtained aseptically, is added, and agar slants made. Loopfuls of trypanosomatous rat's blood were sown in the condensation water, and the tubes incubated at from 34° to 37° C.

(2) Preparing Objects.

New Method of Preparing Superficial Fungi.* — H. H. Whetzel has found the following method very useful for demonstrating the presence of mycelium and pycnidia of fungi: (1) Peel or slice off a piece of the epidermis on which the fungus is growing. (2) Immerse the slice in a 2 to 4 p.c. solution of KHO, and boil in an evaporating dish over a low flame for 20 to 30 minutes. Cook long enough to remove all colour from the tissue of the host. (3) Pour off the potassium hydrate, and wash by letting the material stand for 10 to 20 minutes in each of two or three changes of water. If all the colour be not removed from the host tissue, cook again. Pick away any pieces of sub-epidermal tissue that may cling to the epidermis. (4) Dehydrate in 95 p.c. alcohol. (5) Clear in a mixture of two parts carbolic acid and three parts turpentine. (6) Mount in balsam.

The gist of the process lies in the fact that the pigment of the host-plant is bleached by caustic potash, while that of the parasite is not affected.

Demonstrating the Statocysts of Cephalopods.† — R. Hamlyn-Harris fixed and decalcified the material by immersion in sublimate-acetic acid, though bichromate of potassium and acetic acid answered perfectly well. Heidenham's staining method gave the best results, though other stains were satisfactory. If the Statoliths were not sufficiently decalcified the Statocysts were imbedded in celloidin, and then decalcified with 1 to 2 p.c. hydrochloric acid. The celloidin was afterwards dissolved out, and the preparations imbedded in paraffin.

Detection of Tubercle Bacilli in Organised Sediment by means of Centrifugalising or Simple Sedimentation.‡ — C. Dilg gives the results of a research chiefly on the specific gravity of the sputum in relation to the position of tubercle bacilli in the tube of sputum after centrifugalising, i.e. as to whether these bacteria are present in the upper, middle, or deeper layers, as determined by the use of a capillary pipette. In estimating the specific gravity of the sputum, it was first rendered as air-free as possible by means of the air-pump, and then a modification of the blood method of Hammerschlag employed, an acetone-chloroform mixture being used. The specific gravity of the tubercle bacilli, if in pure culture, was estimated in the same way. If in sputum, it was held that if the bacilli were found copiously in the middle layers of the tube of sputum after centrifugalising, then they and the sputum were of the same specific gravity. By these means the author found that the specific gravity of the sputum varied between

* Journ. Mycol., ix. (1903) pp. 218–9.
† Zool. Jahrb., Abt. f. Morph., xviii. (1903) pp. 327–58 (5 pls.).
‡ Zeitschr. f. angew. Mikr., ix. (1903) pp. 141–55.

0·9290 and 1·2242, while that of tubercle bacilli varied between 1·0110 and 1·0760. The sputum is, therefore, sometimes lighter and sometimes heavier than the bacilli. The author accordingly proposes to ensure its always being heavier by the addition of an equal volume of a 25 p.c. salt solution, a drop of ammonia having previously been added. By this means the bacilli are always found in the surface layers, after centrifugalising, a drop being removed thence by means of a capillary pipette, placed on a slide, dried, and stained in the usual way. The added salt does not cause any difficulty in staining. The author has also devised an instrument which he names a "Sputumdensimeter," for the ready determining of the specific gravity of sputum.

(4) Staining and Injecting.

Modification of Teichmann's Injection Syringe.*—Sieber describes some improvements which he has effected in this syringe (fig. 20). The

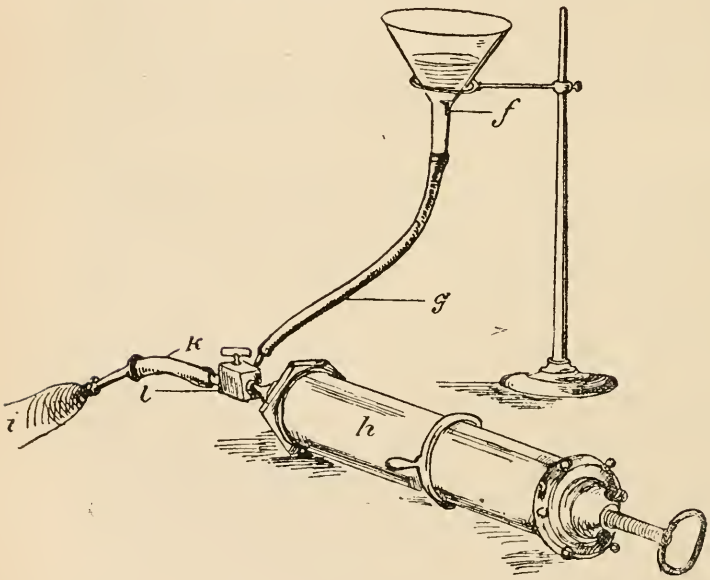

Fig. 18.

end of the piston-rod is grooved, so that, though fixed to the plunger, rotary movement is permitted. The end-cap of the syringe snaps on by means of a bayonet-joint, and this is quite independent of the piston-rod screw. Handles attached to the syringe afford a firm grip of the instrument. A two-way cock (fig. 19) attached to the nozzle allows the syringe to be refilled without disturbing the apparatus or unfasten-

* Anat. Anzeig., xxv. (1903) pp. 7–10 (7 figs.).

ng the parts. A piece of tubing is slipped over the joins of the cannula and nozzle. This pressure-sheath is capable of resisting the pressure of

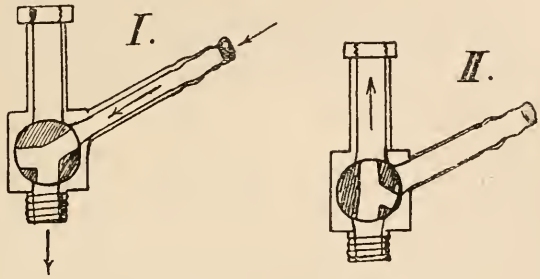

Fig. 19.

two atmospheres, and prevents the cannula from becoming detached from the syringe during manipulation. The illustrations show the syringe (fig. 20), the two-way cock (fig. 19), and the working arrangement (fig. 18).

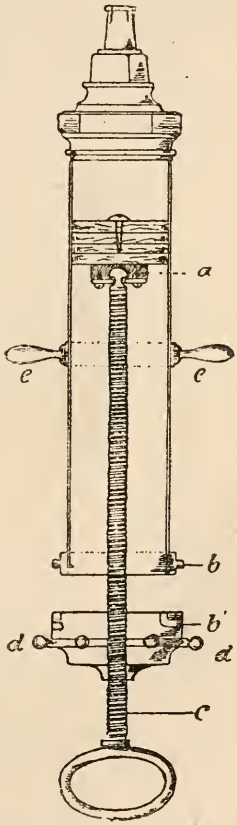

Fig. 20.

Vital and Supravital Granule Staining.* J. Arnold has studied the granules in epithelial, endothelial and connective-tissue cells, mast-zellen, leucocytes, etc. Employing the vital method, he either sprinkles the tissue to be examined, e.g. the mesentery, with neutral-red solution, or dusts it with the same substance in powder. If the supravital method is followed, the tissues taken fresh from the animal are placed at once in normal saline solution, containing either ·01 to ·1 p.c. neutral-red or ·0005 p.c. methylen-blue, as the case may be. The granules appear in 10 to 20 minutes. In the epithelium of the frog's bladder he finds a perinuclear arrangement of granules, which he thinks might easily be mistaken for karyokinetic figures. He has compared the effects of vital with those of supravital staining in the case of the tongue of the frog, and finds them identical. The author is of opinion that cell-granules are concerned in the elaboration of fat, iron and bile pigment.

Naphthol-Blue as a Reagent for Bacterial Fat.† — A. Meyer, in order to demonstrate this staining reaction, uses organisms known by accurate research to be rich in fat and destitute of volutin, e.g. *B. megatherium*. He mixes a

* Anat. Anzeig., xxiv. (1903) pp. 1–6.
† Centralbl. Bakt. 1te Abt. Orig., xxxiv. (1903) pp. 578–9.

a drop of a filtered 1 p.c. solution of dimethyl-paramethylendiamin (base) on a slide with a trace of a colony of the organism, and then adds to it a single loopful of a solution of α naphthol in 1 p.c. NaOH. If the preparation is examined after a minute the fat granules or drops are found to be stained dark blue. They are decolorised, however, with 1 p.c. H_2SO_4. To show that this reaction is not due to volutin, he uses *B. alvei*, an organism rich in this substance and fat-free. In this, the reaction did not take place.

Gonococci Staining.* — A. Pappenheim advocates the use of a methyl-green and pyronin mixture for the staining of gonococci and for their differentiation from the cell nucleus. The action of this staining mixture depends on the aversion of methyl-green to bacteria, and on its affinity for the cell nucleus, whilst pyronin being a weak stain only affects the nucleus if added in excess. The result is a blue-green nucleus and red cocci. If it is desired to stain also the protoplasm of the cell, an acid stain, such as eosin, may be added to the mixture.

Modification of Gram's Method.† — Nicolle has employed instead of the ordinary Gram's solution, one containing bromine 1 grm., potassium bromide 3 grm., water 100 grm. Over the former it has no advantage, but the results in each case appear to be identical.

Method of Staining the Protozoal Parasites of the Blood.‡—Laveran suggests the following modification of Giemsa's staining method § for the malaria parasite. Cover-glass preparations are stained for ten minutes with eosin (1 : 1000) 2 c.cm., distilled water 8 c.cm., azur (1 : 100) 1 c.cm. A drop of a 5 p.c. solution of tannin is then placed on the film and allowed to act for 2 to 3 minutes. The film is then washed and dried. The author finds this method useful when dealing with material which is not fresh.

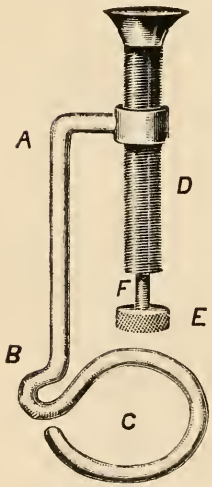

Fig. 21.

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

Improved Mounting Clip.‖—S. E. Dowdy has devised the following form of clip or press by which central pressure, which is completely under control, may be readily obtained (fig. 21).

A B C is a stout piece of wire bent into a circle at right angles to the upright A B at C. D is a screw, having at its end a flat circular metal button at E, which rotates, *independently* of the scre on the pin F. In use, a freshly prepared Canada balsam slide is placed on the circle C, and the screw D rotated until the button or

* Monatshefte f. prakt. Dermat., April, 1903. See also Centralbl. Bakt. 1te Abt. Ref., xxxiv. (1903) pp. 20–1.

† C. R. Soc. Biol., No. 10, 1903. See also Centralbl. Bakt., xxxiv. (1903) pp. 78–9.

‡ Op. cit., No. 9. 1903. See also Centralbl. Bakt. Ref., xxxiv. (1903) p. 78.

§ Centralbl. Bakt., xxxii. p. 307.

‖ English Mechanic, lxxviii. (1903) p. 337 (1 fig.).

pad E presses on the cover-glass. Direct downward pressure without displacement of the cover is then attained by further rotation of the screw.

GRIBBON, W.—**Mounting Clip.**

English Mechanic, lxxviii. (1904) p. 491 (1 fig.).

VILLAGIO.—**Modern Mounting Methods.**

Tom. cit., p. 490.

(6) Miscellaneous.

Waterproof Cement for Glass.*—The following preparations, which are unaffected by water, will be found suitable for cementing glass, repairing troughs, etc. :—

(1) Dissolve 5 to 10 parts gelatin in 100 parts of water; add 10 p.c. of saturated bichromate of potassium solution; mix thoroughly and keep in a dark place. After using the cement the articles are exposed to sunlight, by the action of which the medium is rendered unaffected by water. (2) Quicklime, 4 parts: litharge, 6 parts; linseed-oil varnish, 1 part.

Mounting Medium Bottle.†—S. E. Dowdy gives the following directions for fitting up a bottle for holding balsam. Obtain a 1 oz. or 1½ oz. wide-mouthed metal screw-stoppered bottle, and bore a circular hole through the lid large enough for a thin glass rod to pass through with plenty of room to spare. Thread the rod on a medium sized cork several diameters larger than the hole in the metal lid, and the thing is finished. Pour the balsam into the bottle, after removing the lid. The length of the rod can be easily altered to suit the depth of the medium.

Gelatin Plates as Substitute for Glass Light-filters.‡—K. Diederichs describes a procedure for making light-filters for microscopical and photomicrographical purposes. A solution of the best gelatin, such as is used for making dry plates, is made in the usual way, the proportion to the water being as 1 to 200. To the filtered solution 3 c.cm. of 1 to 50 aqueous solution of alum are added.

The films are made by pouring the gelatin on a glass plate placed on a levelling stand. When quite dry the gelatin is overlaid with a film of collodion stained with some anilin dye.

Red plates may be made as follows:—Dissolve (1) 2 grm. aurantia in 40 c.cm. absolute alcohol, (2) 5 grm. rose Bengal in 20 c.cm. methyl alcohol. Then mix 20 c.cm. of (1) with 10 c.cm. of (2), and add 90 c.cm. of 4 p.c. collodion. Yellow plates can be made by adding 20 c.cm. of a saturated alcoholic solution of aurantia to 80 c.cm. 4 p.c. collodion. The gelatin plates may be doubled so as to strengthen the film, or one may be placed on either side of the coloured layer.

Method of taking Internal Casts of Foraminifera.§—H. J. Quilter obtains perfect specimens by the following method. The shells having been cleaned by boiling in caustic potash, in order to remove all traces

* Scientific American. See Knowledge, xxvi. (1903) p. 285.
† English Mechanic, lxxviii. (1903) p. 401 (1 fig.).
‡ Zeitsch. angew. Mikr., ix. (1903) pp. 197–8.
§ Journ. Quekett Micr. Club, viii. (1903) pp. 551-2.

of sarcode, are soaked in benzole to extract most of the air and prepare the surface of the shell for the wax. They are then transferred to melted paraffin wax, the wax being cooled and heated several times in order to expel the air. After the air-bubbles have disappeared a little melted wax is put on the centre of a slide placed on a warm stage. To the melted wax the shells are transferred, and arranged so that there is a clear space around each. The slide is then allowed to cool. When the wax has become hard the wax above and around the shells is removed by means of a brush dipped in benzole. After this the preparations are brushed with soap and water, and then immersed in a beaker filled with water. To this hydrochloric acid is added until effervescence takes place. When effervescence ceases the slide is washed, dried and mounted.

Silicate of Soda (Water Glass) as an Injection Medium for Macroscopic Preparations.* — S. Jachtchinsky recommends a saturated solution of silicate of soda, to which is added a little powdered chalk stained with cinnabar or ultramarine, for injecting the vascular system of animals. The advantages claimed are that it is used cold, does not set too quickly, does not block the syringe, has no disagreeable odour, and when once dry the preparations keep excellently.

New Small Shaking Apparatus.†—H. Zikes has devised the following shaking apparatus for use in fermentation work (fig. 22). A

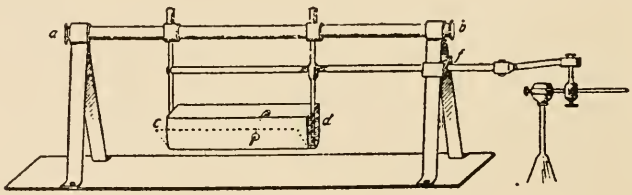

Fig. 22.

steel bar *a b* is supported at each end by a rigid metal stand. From this bar hangs the shaking trough *c d* by two short brass rods. These rods can glide on the steel bar and are firmly joined to a pushing rod, which by means of a projecting end *f* is able to move the trough to and fro in one direction. This projecting end articulates with a connecting rod, through which the movement is given by means of a turbine or electro-motor. The shaking trough is a half cylinder, closed at the ends, open at the top, and having a flap along one of its sides. The fixing of the vessel to be shaken is accomplished by means of a steel peg attached to the flap on one side, and fitting into one of a series of holes on the other, according to the size of the vessel.

Bacteriological Tests for Show Butters.‡ — D. Houston, in a bacteriological examination of butters exhibited at the winter show of the Royal Dublin Society, employed the following method: ·1 grm. of

* Anat. Anzeig., xxiv. (1903) pp. 204-5.
† Centralbl. Bakt., 2te Abt., xi. (1903) pp. 107-8 (1 fig.).
‡ Proc. Roy. Dublin Soc., i. (1902) pp. 179-88.

the butter sample was placed in 10 c.cm. sterile water and kept at 25° C. This was then thoroughly mixed and allowed to cool. The fat having separated, ·1 c.cm. was taken and mixed with nutrient gelatin, usually 2 p.c. lactose gelatin, and plated out in the usual way. The colonies were then counted, and subcultures made in different media. For the more ready estimation of gas-forming organisms, the solidified inoculated gelatin in the Petri dish was covered with a thin layer of sterile gelatin. The little gas-bubbles were then easily seen. The author found that undesirable flavours and aromas were in most cases due to the action of micro-organisms, working either in the ripening cream or in the made-up butter. Such organisms may be either bacteria, yeasts or moulds. A good-flavoured butter containing undesirable contaminations will soon become objectionable. The bacteriological tests were not found to agree with the judge's awards.

Metallography, etc.

Dichroiscope.*—This instrument (fig. 23), made by Swift & Son, is for the accurate comparison of the different colours of dichroic minerals. It is extremely useful for distinguishing coloured gems from glass imitations.

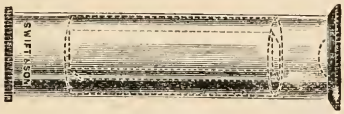

Fig. 23.

Petrological Examination of Paving Sets.† — J. Joly gives the following method for determining the proportions of hard and soft constituents in rock. The thin rock-section is placed in the Microscope, and using a low power and low eye-piece the image of the field is projected into a ground-glass screen above the eye-piece, any of the usual photographic apparatus being used. The ground glass is turned rough side up. Upon this is placed a transparent divided scale prepared as follows. A piece of logarithmic paper (divided to square millimetres, or square tenths of inches) is placed in contact with a sensitive plate in a photographic printing frame, and printed off by contact in the usual manner. The result is a negative, having the divisions appearing as clear lines on a dark background. This negative may be used, or a positive printed from it. The transparent divided scale is placed *face downwards* upon the ground-glass. We now have an image of the field traversed by the lines upon the scale. On the back of this scale, the outline of any particular constituent is traced by an ordinary writing pen and ink. This done, the divided plate is lifted off, and holding it up to the light the number of square millimetres, or square centimetres, are estimated as contained within the ink outlines. The whole circular

* Swift's Catalogue, 1901, p. 40.
† Proc. Roy. Dublin Soc., x. (1903) pp. 62-92 (4 pls.).

area of the field in square centimetres is $\frac{\pi D^2}{4}$; hence the area occupied by the mineral can be estimated as a percentage of the area of the field. This is done for several fields, and an average taken. In most cases this method is quite accurate, but in exceptional instances, e.g. where mica plates appear edge-on in the field, certain allowances must be made, otherwise the quantity of the constituent would be underestimated.

Microscopic Study of the Prehistoric Bronzes of the Charente.* M. G. Chesneau has microscopically examined the metal of two prehistoric bronze axe-heads. One head was provided with a socket; the other merely heeled. It is admitted that the former is the more recent type of weapon. Micrographic analysis reveals that, at any rate in the Charente district, axes were used rough from the mould at the beginning of the Bronze Age, but that later on the methods of manufacture were improved, and the axe, after casting, was submitted to numerous reheatings and hammerings at high temperatures to increase the hardness of the material.

Surface Structure of Solids.†—G. T. Beilby seems to succeed in proving the following important propositions by means of his series of photomicrographs of metallic films:

(1) The operations of cutting, filing, grinding or polishing, produce on the surface of solids a thin film, which is in many respects essentially different to the general body underneath it.

(2) This surface film results from a certain mobility, which is conferred on a thin layer of molecules by the tool or polishing agent moving over the surface.

(3) While it is in the mobile condition, the film of solid molecules behaves like a liquid, and is subject to the action of surface tension.

(4) If these propositions are established it will follow that a truly polished surface is one in which, for a certain minute depth, the substance has been liquefied and then smoothed by the action of surface tension.

(5) Heat and solvents can confer on the molecules of solids sufficient mobility to enable their films or other minute portions of the solid to behave like a liquid.

(6) In the aggregation of solids from their molecules there is a certain size of the aggregate up to which its form is controlled by surface tension, and only after this point is passed can crystallic force come into play.

(7) The metals are the most opaque bodies we know, but their substance is nevertheless intrinsically transparent.

(8) The "spicular" appearance frequently to be seen by the Microscope on the surface of metals, and other solids under obliquely-reflected light is due to a granular texture in the thin translucent film with which the surface is covered.

(9) This granular texture results wholly or in part from the action of surface tension on the surface layer of molecules, while it is in the mobile condition.

* Comptes Rendus, cxxxvii. (1903) pp. 930–2 (2 figs.).

† Third Hunter Memorial Lecture, Glasgow; 1903, 55 pp., 42 photomicros.

Contributions to the Study of Alloys of Aluminium and Silicon.* Vigouroux and Arrivault find that the lack of durability often met with in vessels made of commercial aluminium is due to the presence of minute crystals of silicon, or of the eutectic silicon alloy. The two elements act as the poles of a battery, and set up rapid corrosion.

Primary and Secondary Devitrification in Glassy Igneous Rocks.† T. G. Bonney and J. Parkinson point out analogies between these phenomena and those observed in the micro-chemistry of alloys. Just as important changes take place after solidification in copper-tin alloys, so that the structures and compounds produced at earlier stages of consolidation disappear, to be replaced by later products; so not improbably similar changes would be found to have taken place in many rocks.

Metallography of Nickel Steels.‡—L. Guillet has made a very complete set of observations on steels containing nickel varying in amount from zero to 90 p.c. The observations included :—

(1) Microstructure of cast steels. (2) Microstructure of quenched steels. (3) Microstructure of reheated steels. (4) Microstructure of cold-worked steels. (5) Microstructure of steels cooled below atmospheric temperature. (6) Cementation and decarbonisation of nickel steels. (7) Research on the regeneration of quenched steels. (8) Conclusions.

His conclusions are that the constituents of nickel steel are :—

(1) Ferrite, pearlite, and, of course, troostite and sorbite. (2) Martensite. (3) Acicular crystals, which appear after etching, sometimes white, sometimes black, although the reason for this phenomena is not known. (4) Polyhedric grains, undoubtedly corresponding to Mr. Osmond's iron.

The acicular crystals are probably hardenite, another form of martensite.

ASHE, A.—**Photography of Cavities in Minerals and the Determination of the Condensation Points of the Enclosed Gases.**
Journ. Quekett Micro. Club, viii. (1903) pp. 545–8 (1 pl.).

BECK, W. T.—**Preparation of Samples for Microscopic Analysis, as followed by the Westinghouse Ele tric and Manufacturing Company.**
Proc. of Engineers' Soc. of Western Pennsylvania, Dec. 1902.
Metallographist, vi. (Oct. 1903) pp. 320–2.

LAU, F. C.—**Tests on Finishing and Annealing Heats.**
Sparks from the Anvil, Oct. 1902.
Metallographist, vi. (Oct. 1903) pp. 322–7 (6 figs.).

WOODWORTH, J. V.—**Hardening, Tempering, Annealing, and Forging of Steel.**
[Favourably reviewed by J. O. Arnold in *Nature*, lxix. No. 1780 (Dec. 10, 1903) p. 124.] Constable & Co., 288 pp.

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* Procès-Verbaux des Séances de la Soc. des Sciences de Bordeaux, 1901–2, pp. 20–3, 3 plates f 6 photomicros.

† Quart. Journ. Geol. Soc., lix. (Nov. 1903) pp. 428–44, 1 plate of 6 photomicros.

‡ Bull. de la Soc. d'Encouragement, May 31, 1903; Metallographist, vi. (Oct. 1903) pp. 274–302 (40 figs.).

PROCEEDINGS OF THE SOCIETY.

MEETING

HELD ON THE 16TH OF DECEMBER, 1903, AT 20 HANOVER SQUARE, W.
DR. HENRY WOODWARD, F.R.S., PRESIDENT, IN THE CHAIR.

The Minutes of the Meeting of the 18th of November, 1903, were read and confirmed, and were signed by the President.

Mr. Vezey said that having been one of those Fellows of the Society who attended at the Natural History Museum by invitation of the President, he should like to take the opportunity of thanking Dr. Woodward, on behalf of himself and of the other members of the party, for the very interesting explanations which were given to them of the Fossil Mammalia on Saturday November 28, and of the Fossil Reptiles on the Saturday following. The descriptions of the specimens in each case were given in a particularly clear and interesting manner, and he thought they ought to express their thanks for the trouble taken by Dr. Woodward on these occasions.

Mr. Wesché said he should like to join Mr. Vezey in thanking the President for his kindness and courtesy. He had greatly enjoyed Dr. Woodward's demonstration, and could only say that their President had given them, in the short time at his disposal, as much information as it would take them a week of hard reading to acquire; and even then, speaking personally, Mr. Wesché doubted if he would have understood it as well.

The President said he was glad to know that these visits had given pleasure to those who responded to his invitation, and only regretted that more persons had not been able to attend. Unfortunately, on the second occasion a pitchy darkness prevailed, so that he feared it was for the most part necessary to accept his descriptions of objects which they were scarcely able to see. He hoped, however, that as the new year advanced, they should be able to arrange for some further meetings—under more favourable atmospheric conditions.

The List of Donations to the Society, exclusive of exchanges and reprints, received since the last Meeting, was read, and the thanks of the Society were voted to the Donors.

Abbe, Gesammelte Abhandlungen. Band I., Abhandlungen über die Theorie des Mikroskops. (8vo, Jena, 1904)	*The Publisher.*
Herdman, W. A., Report on the Pearl Oyster Fisheries of the Gulf of Manaar. (4to, London, 1903)	*The Royal Society.*

Mr. F. W. Watson Baker said that he had brought for exhibition a series of sixteen specimens illustrating the development of an Ascidian. A card describing the specific object shown was placed beside each Microscope, so that no detailed description would be further necessary; but he might mention briefly that the series originated as follows. Two simple Ascidians of the same species were under observation in a small dish; one was observed to eject a number of ova, and in about one minute the second Ascidian discharged some spermatozoa, and fertilised them: then the process of development proceeded, as illustrated in the specimens exhibited. The specimens had been seen by well-known experts in such matters, and as they had considered them to be an exceedingly complete and valuable series, it had been thought worth while to bring them for exhibition before the Fellows of the Society.

The President expressed his sense of the indebtedness of the Society to Mr. Watson Baker for his extremely interesting exhibition, and also proposed that their thanks should be voted to Messrs. Watson and Sons for their kindness in lending the Microscopes under which the objects were shown.

The thanks of the Meeting were unanimously voted to Mr. Watson Baker and to Messrs. Watson and Sons.

Dr. G. J. Hinde, F.R.S., then read his paper 'On the Structure and Affinities of the Genus *Porosphæra*,' which he illustrated by diagrams, and by the exhibition of numerous specimens, a large number of which he had found in his garden at Croydon, where they had no doubt been weathered out of the Chalk, and were now commingled in the thin layer of surface soil overlying the Chalk.

The President said it would be unnecessary to ask the Fellows present to return their thanks to Dr. Hinde—as they had done so already—for his very interesting communication, which was in itself an object lesson on the way in which a subject of that kind should be approached. He had worked out the structure of Porosphæra from materials which, though very abundant, did not appear to have been carefully studied by anyone who had hitherto taken it up; they all seemed to have been satisfied with noticing the mere external appearance. Long before Mr. Worthington Smith took up the subject of Coscinopora in the Bedford Gravels, Mr. Read brought to Prof. Owen a mass of these beads which he had picked out of the gravel in close proximity to a number of flint implements; and Mr. Wyatt also found a large number of these specimens, which were still preserved in the geological collection. The President also thought that his own father, Mr. Samuel Woodward, was one of the earliest to notice Coscinopora, as he had figured them in his *Geology of Norfolk*, as far back as 1833, and might possibly even have antedated Phillips.

Mr. D. J. Scourfield asked whether it was known what was the special function of the radial canals, and how was the water supposed to circulate in these curious organisms?

Dr. Hinde in reply, said that Phillips named these forms in 1829; and that Mr. S. Woodward in 1833 adopted Phillips' names for the same fossils. He believed the radial canals were excurrent in function;

there were a number of small apertures occurring between the spicules of the fibres through which the water may possibly have entered, and then found its way out through the radial canals. He desired to express his thanks to the Fellows of the Society for the attention which they had given to what he feared must have been a very dry subject.

The thanks of the Society were cordially voted to Dr. Hinde for his communication.

The Secretary reminded the Fellows that their next Meeting, on January 20th, would be the Anniversary Meeting of the Society, at which the Officers and Council for the ensuing year would have to be elected. He therefore read the following list of nominations by the Council, to be submitted for election by the Fellows at the Annual Meeting.

President—Dr. D. H. Scott.

Vice-Presidents—Messrs. A. D. Michael, E. M. Nelson, H. G. Plimmer, and Dr. Hy. Woodward.

Treasurer—Mr. Vezey.

Secretaries—Rev. Dr. Dallinger and Dr. Hebb.

Council—Messrs. J. M. Allen, Wynne E. Baxter, C. Beck, Rev. E. Carr, Mr. A. N. Disney, Dr. J. W. H. Eyre, Messrs. J. W. Gordon, G. C. Karop, Rt. Hon. Sir Ford North, Messrs. T. H. Powell, P. E. Radley, and C. F. Rousselet.

Librarian—Mr. Radley.

Curator—Mr. Rousselet.

The Secretary also announced that Mr. W. E. Baxter had been appointed Auditor on behalf of the Council, and invited the Fellows present to elect an Auditor to act on behalf of themselves.

Mr. J. M. Offord thereupon proposed Mr. Chas. L. Curties as Auditor, and this having been seconded by Mr. Ersser, was put to the Meeting and unanimously carried.

It was further announced that the Rooms of the Society would be closed from December 24th to January 2nd inclusive.

The President said that he hoped to take as the subject of his Address at the next Meeting, "The Vertebrate Forms of Life,"—in continuation of his subject of the previous year.

The following Instruments, Objects, etc., were exhibited:—

Mr. F. W. Watson Baker:—Sixteen slides illustrating the development of an Ascidian: (1) The fertilised ovum; (2) after 30 minutes, segmentation; (3) 1 hour; (4) 1 hour 35 mins.; (5) 2 hours; (6) 2 hours 25 mins.; (7) 3 hours; (8) 3 hours 40 mins.; (9) 5 hours 55 mins.; (10) 10 hours 25 mins.; (11) 14 hours 15 mins.; (12) 20 hours; (13) 25 hours 15 mins.; (14) 49 hours; (15) 73 hours; (16) 10 days, fixing stage.

Dr. George J. Hinde:—Specimens of Fossil Calcisponges belonging to the genus Porosphæra, from the English Chalk: *Porosphæra globularis* Phill. sp., Upper Chalk, Gravesend, young specimens; *P. globu-*

laris, Upper Chalk, South Croydon, section showing skeleton spicules; *P. globularis* Phill. sp., Upper Chalk, Sidcup, Kent, young specimen preserved in Flint; *P. pileolus*, Upper Chalk, zone of *Micraster coranguinum*, South Croydon, vertical section showing skeleton spicule; section of Tertiary Calcisponge, *Plectroninia Halli* H., Eocene Tertiary, Moorabool, Victoria, Australia: for comparison with Porosphæra and section of recent Calcisponge, *Petrostroma Schulzei*, Döderlein, Sagamai Bay, Japan, also for comparison with Porosphæra.

New Fellows.—The following were elected *Ordinary* Fellows:—Messrs. A. R. W. Heupt, and W. A. Riley.

ANNIVERSARY MEETING.

HELD ON THE 20TH OF JANUARY, 1904, AT 20 HANOVER SQUARE, W. DR. HENRY WOODWARD, F.R.S., ETC., PRESIDENT, IN THE CHAIR.

The Minutes of the Ordinary Meeting of the 16th of December, 1903, were read and confirmed, and were signed by the President.

The President having appointed Mr. Rheinberg and Mr. Taverner to act as Scrutineers, the ballot for Officers and Council for the ensuing year was proceeded with.

The List of Donations received since the last Meeting (exclusive of exchanges and reprints), was read, and the thanks of the Society were voted to the donors.

	From
Michelsen, A. A., Light Waves and their Uses. (8vo, London, 1903)	*The University of Chicago Press.*
Abbe, Ernst, Gesammelte Abhandlungen. Erster Bd. Abhandlungen über die Theorie des Mikroskops. (8vo, Jena, 1904)	*Messrs. Carl Zeiss.*

Mr. C. F. Rousselet exhibited an old form of Microscope by Plössl of Vienna, which had been sent to the Society on approval, and read a full description of the instrument.

The thanks of the Meeting were unanimously voted to Mr. Rousselet for his communication.

The Scrutineers having handed in the result of the ballot, the President declared the following gentlemen to have been elected as the Officers and Council of the Society for the ensuing year.

President—Dukinfield Henry Scott, M.A. Ph.D. F.R.S. F.L.S.

Vice-Presidents—A. D. Michael, F.L.S.; E. M. Nelson; Henry Geo. Plimmer, F.L.S.; Henry Woodward, LL.D. F.R.S. F.G.S. F.Z.S.

Treasurer—J. J. Vezey.

Secretaries—Rev. W. H. Dallinger, LL.D. D.Sc. D.C.L. F.R.S. F.L.S. F.Z.S; R. G. Hebb, M.A. M.D. F.R.C.P.

Other Members of Council—Jas. Mason Allen; Wynne E. Baxter, J.P. F.G.S. F.R.G.S.; Conrad Beck; Rev. Edmund Carr, M.A. F.R.Met.S.; A. N. Disney, M.A. B.Sc.; J. W. H. Eyre, M.D. F.R.S. (Edin.); George C. Karop, M.R.C.S.; The Rt. Hon. Sir Ford North, P.C. F.R.S.; Thomas H. Powell; Percy E. Radley; Charles F. Rousselet.

Librarian—Percy E. Radley.

Curator—Charles F. Rousselet.

The Secretary called attention to the fact that although at the last Meeting twelve Fellows had been nominated to serve on the Council, the names of eleven only appeared on the ballot papers. This was owing to one gentleman having found, since the last Meeting, that it would be inconvenient for him to attend, and having consequently withdrawn his name. They were, however, perfectly within their legal rights in electing only eleven on that occasion.

The Report of the Council for the year 1903 was then read by the Secretary, as follows.

REPORT OF THE COUNCIL FOR 1903.

FELLOWS.

Ordinary.—During the year 1903, 19 new Fellows have been elected, 15 have resigned, 9 have died, and 9 have been removed from the list. Among those who have died are found the distinguished names of James Glaisher, President from 1865 to 1868; of Charles Thomas Hudson, President from 1888 to 1890; and of Rudolf Virchow; the two last being Honorary Fellows.

The list of Fellows now contains the names of 422 Ordinary, 1 Corresponding, 44 Honorary, and 82 Ex-Officio Fellows, being a total of 549.

THE JOURNAL.

The papers communicated to the Society during the past year have fully maintained their previous high standard; some indeed, notably those of Mr. J. W. Gordon, Dr. H. Siedentopf and Lord Rayleigh, being of unusual merit and importance.

The Summary of Current Researches continues to be of the same merit as heretofore.

FINANCE.

There is not much calling for special notice in reference to Finance during the past year. It is satisfactory to note an improvement in the amount received for admission fees, and a material increase under the head of Annual Subscriptions. This is partly owing to the more prompt payment of the Annual dues, and the Treasurer hopes Fellows will see the desirability of maintaining this improvement, as it greatly facilitates the financial arrangements of the Society.

The sale of the *Journal* has somewhat fallen off in the past year, but the Council trusts it is only a temporary decline. The *Journal* for 1903 compares most favourably with any of the preceding years, and as the editorial and abstracting staff receive very small remuneration for their services, the expenses of publication are reduced to the lowest possible figure. In spite of this, however, Fellows will observe that the cost of the *Journal* swallows up nearly the whole of the Annual Subscriptions. It is therefore imperative that the sale of the *Journal* outside the Society should be well kept up, otherwise its maintenance at its present high standard cannot be continued.

Though some of the issues of the *Journal* during the past year have been of exceptional size, the cost of printing and illustrating has been kept within the ordinary limits.

During the year a further investment in India 3 per cents. was made, consisting of the admission and compounding fees received in the previous year.

The Treasurer has been enabled to keep a somewhat larger sum than usual on deposit during the year, which is a matter of great importance, as it is only by the strictest economy that the finances of the Society can be kept in a satisfactory condition.

Instruments, Apparatus, Etc.

The Instruments and Apparatus in the Society's Collection continue to be in good condition.

With the consent of the Council two of our old Microscopes, Nos. 20A and 31 in the Catalogue, being duplicates, have been exchanged with Messrs. Carl Zeiss of Jena, for two old German Micro scopes, types not yet represented in our Collection.

During the past year, the following additions have been made :—

Feb. 18, 1903.—An old Microscope, with Apparatus. Presented by Mr. Frank Orfeur.

April 15.—An Old Microscope by Dollond. Presented by Mr. Wynne E. Baxter.

May 20.—An Early Compound Microscope, and an Old Microscope by Cary. Both presented by Mr. E. M. Nelson.

June 17.—An Old Non-Achromatic Simple Microscope. Presented by Mr. E. M. Nelson.

Oct. 24.—A Microscope by Negretti and Zambra, and Accessories, elonging to the late James Glaisher, F.R.S., a former President of the ociety. Presented by Dr. Glaisher.

Two Stage-Micrometers, supposed to have been ruled by Hugh Powell. Presented by Mr. E. M. Nelson.

Some slides belonging to the late Mr. James Glaisher, F.R.S. Presented by his son, Dr. Glaisher.

LIBRARY.

The Library is in good order, and every item catalogued up to the end of the year 1903. The attention of Fellows is called to the rules in regard to the length of time books may be kept, as great inconvenience is sometimes caused by their non-observance.

VISITS TO THE BRITISH MUSEUM.

On the initiative and by the invitation of the President, five visits have been paid to the Natural History Museum. In three of these a party of Fellows was conducted by the President through the Geological galleries, where Dr. Woodward described numerous specimens, and discoursed on the geological aspects of the Invertebrata, Mammalia, and Reptilia. On the other occasions the parties visited the Botanical department under the guidance of Mr. Carruthers, and the Mineralogical under that of Mr. Fletcher.

These visits were highly instructive, and much appreciated by those present, and should sufficient interest be evinced it may be anticipated that, by the kindness of Dr. Woodward and other gentlemen, further visits may be arranged for.

The Treasurer read the Annual Statement of Account and Balance Sheet for 1903, which had been audited and found correct.

Mr. Marshall then moved, "That the Report and Balance Sheet now read be received and adopted, and that they be printed and circulated in the usual way."

The motion, having been seconded by Mr. Gardner, was put to the Meeting by the President, and carried unanimously.

Dr. E. J. Spitta said he should like to ask the Council if they would consider whether it would be possible to issue post-cards, to such Fellows who desired to have them, intimating the subjects to be brought before the Meetings of the Society a few days before the date of the Meeting. He thought, in common with some others, that they lost a great deal in consequence of the absence of such information, for everyone had his own tastes, and if they knew beforehand what was going to be discussed, Fellows interested in that special subject would attend the Meeting, and add to their general knowledge. He hoped, therefore, that the Council would kindly take the suggestion into consideration, and that they might be able to see the advisability of introducing the practice. It had been tried at the Royal Astronomical Society, and he believed at other learned societies, and found to be of great advantage. The only objection to it was the expense, but he thought this would not be a very serious matter,

CASH STATEMENT FOR THE YEAR ENDING 31st DEC. 1903.

Dr.

1903.				£	s.	d.
To Balance from 1902				61	14	0
„ Admission Fees				45	0	0
„ Compounding Fee				31	10	0
„ Annual Subscriptions—						
1895	0	10	0			
1900	1	11	6			
1901	3	5	9			
1902	45	12	9			
1903	606	11	4			
1904	24	3	0			
1905	1	11	6			
1906	1	11	6			
1907	1	11	6			
				686	8	10
„ Interest on Investments and Deposit Account				52	19	6
„ Sale of Journal				316	1	6
„ Receipts for Advertisements				60	0	0
„ „ „ Sale of Surplus Books				2	10	0
„ „ „ Reprints and List of Fellows				11	11	5
„ „ „ Screw tools				3	2	2
„ Withdrawn from Deposit				50	0	0
„ Income Tax returned				5	17	2
„ Sundries				2	12	6
				£1329	7	1

Cr.

1903.				£	s.	d.
By Rent, Coals, etc.				133	16	0
„ Salaries and Reporting				164	4	0
„ Books purchased				99	11	0
„ Bookbinding				11	9	6
„ Expenses of Journal—						
Printing and Postage	£410	4	3			
Illustrations	63	14	6			
Editing and Abstracting	150	18	9			
				624	17	6
„ Purchase of India Three per Cents., 62*l.* 6*s.* 6*d.*				62	16	10
„ Placed on Deposit				100	0	0
„ Refreshments at Meetings				13	10	0
„ Stationery				12	6	1
„ Fire Insurance				3	8	6
„ Sorting and Storing Journals				4	6	3
„ Postage and Petty Expenses				37	15	11
„ Instrument purchased				0	6	6
„ Balance in hand				60	19	0
				£1329	7	1

Investments.

	£	s.	d.
Nottingham Corporation Stock Three per Cents.	400	0	0
New South Wales Three and Half per Cents.	315	11	1
India Three per Cents.	537	5	11
On Deposit at Union of London and Smiths Bank	200	0	0
North British Railway	400	0	0
	£1852	17	0

J. J. Vezey, *Treasurer.*

We have examined the foregoing Account, and compared the same with the Vouchers in the possession of the Society; we have also verified its Securities as above mentioned, and find the same to be correct.

January 9th, 1904.

Wynne E. Baxter } *Auditors.*
C. Lees Curties }

as only a comparatively few persons outside London, who do not see the advertisements in the newspapers or the notices in the opticians' shop-windows, would need to be advised in this way.

The Secretary reminded the speaker that the subjects of the papers and demonstrations to come before the next Meeting were duly notified in several journals, e.g. *Nature*, *The Athenæum*, *The Standard*, and others.

A Fellow thought that any gentlemen who sent stamped and addressed post-cards to the Society for the purpose might have these filled in and posted to them, if they so desired.

The President said that if this motion was offered as a suggestion to the Council, they would no doubt be very glad to take it into their consideration. He was of opinion that it would greatly conduce to the interest of the Meetings of the Society if the Fellows knew beforehand the nature of the papers to be brought before the Meeting. To send a notice to each individual member might, however, be beyond the capacity of the clerical staff; the question of expense would also have to be considered. But in any case, he felt sure that the Council would carefully consider it.

Sir Ford North did not think that they could dispose of the question at once, as no formal resolution could be put at this Meeting, but the motion might be treated as a request to the Council to take the matter into consideration. The expense could not be very much, and he thought the suggestion a desirable and useful one.

The President then gave his Annual Address, taking as his subject 'The Evolution of Vertebrate Animals in Time,' but intimated that instead of giving it *in extenso* he intended merely to read the first few pages, and then to exhibit the slides which he had brought in illustration, offering a brief description of each.

The slides, to the number of about eighty, were then shown upon the screen, the special points of interest being pointed out.

Mr. A. D. Michael said it was almost unnecessary for him—after the applause which had just subsided—to do so, but yet he rose with very great pleasure to propose a vote of thanks to the President for his admirable and most interesting Address, in which he had been carrying them through the Vertebrata in the same way as he took them through the Invertebrata at the Annual Meeting of the previous year. They had also to thank the President for his services to the Society during his whole term of office, and for the unfailing interest which he had taken in its affairs. He should like, therefore, to propose that their heartiest thanks be given to Dr. Woodward for his conduct in the Chair during the term for which he had occupied it, and for the great service he had rendered to the Society, and the extreme interest he had taken in it during his period of office. He was sure there was not a Fellow present who would not feel that they were losing a President who had filled that position admirably during a period which they would all remember with the greatest pleasure.

Sir Ford North, on behalf of Dr. Braithwaite (who had been obliged to leave the Meeting earlier) had great pleasure in seconding the motion.

Mr. A. D. Michael said that as the President would be unable to put this motion to the Meeting, he had much pleasure in submitting that the best thanks of the Society be given to the President for his interesting and instructive Address, and for the great interest he had shown in the Society during his period of office.

Carried unanimously.

Mr. T. C. White said that a pleasant duty had been delegated to him, that of proposing that their best thanks be given to the Officers of the Society for their services during the past year. Having himself in former years gone all through the drudgery of office, he knew something of what time and care were required to make things go smoothly. He need not particularise individuals, for they knew that all had worked well—indeed, they knew this so well, that it seemed hardly necessary to propose this vote of thanks to them.

Mr. Webster having seconded the motion, it was put to the Meeting by the President, and unanimously carried.

Mr. W. Wesché then moved that the cordial thanks of the Society be given to the Auditors and Scrutineers.

Mr. J. J. Vezey had great pleasure in seconding this proposition, for certainly, as far as the auditors were concerned, he knew how much trouble had been taken and how carefully their work had been done.

This also was put to the Meeting by the President, and carried unanimously.

The President said that as they had been so kind as to accord him a vote of thanks, he must on his part be allowed to thank them for the kindness shown to him during the past two years. It had been a great pleasure to him to preside over such an amiable and kindly Society. He must further thank them for the honour they had done him in electing him as one of their Vice-Presidents. He hoped still to be able to render them some service in the future; and if they should desire again to visit the Natural History Museum, he should be only too happy to conduct them round, and point out to them the excellent work which was being carried on by the present staff, and he hoped they would be able to avail themselves of the offer at no distant date.

Mr. J. J. Vezey said Dr. Hebb had asked him to respond on behalf of the Officers, and to thank the Fellows for the kind way in which they had acknowledged their services. It would, of course, be idle to say that the work done did not entail any trouble, but he could say that it was work which they had done with a great deal of pleasure.

The President then said it now only remained for him to ask Dr. Dukinfield H. Scott, F.R.S., to take the Chair, and to assure the Fellows that they had in their new President one who would be certain to do his best in the interests of the Society.

Dr. D. H. Scott having taken the Chair, said it would be a poor return for their kindness if at that late hour of the evening he were to detain them with any remarks of his own; but he could not take his seat without thanking them for the very great compliment paid to him, one which he especially appreciated, because this Society was the first scientific body he had ever joined; and though he had not been able

very often to come to their meetings, he had been a constant reader of their *Journal*. He could promise them that he would do his best to further the interests of the Society, and he felt it a special honour to follow such a President as his friend Dr. Woodward.

The following Objects, Instruments, etc., were exhibited :—

The President, in illustration of his Address :—Table of strata giving, on an approximate scale, the relative thickness of the sedimentary deposits from the Archæan upwards, with the appearance in time of all the great groups of Vertebrata, Invertebrata, and Plants.

Illustrations (more than eighty in number) were shown by means of the Epidiascope upon the screen. Commencing with *Amphioxus*, the CYCLOSTOMI, and the minute denticles known as Conodonts, from the Cambrian and Silurian ; then illustrations of OSTRACODERMI, *Pteraspis*, *Cephalaspis*, etc. ; followed by the true fishes : commencing with the primitive shark *Cladoselache*, from the Upper Devonian of Ohio ; the TELEOSTOMI, and other groups of early fishes with bony plates, enamelled scales, and generally a notochordal skeleton ; giving examples of the Crossopterygii and Actinopterygii.

The AMPHIBIA were represented in the Coal Measures by the LABYRINTHODONTIA and other forms, whose remarkable skulls, teeth and skeletons were shown ; also the CAUDATA, illustrated by *Cryptobranchus*, and the ECAUDATA by the tail-less *modern* Batrachians.

Passing on to REPTILIA, *Pariasaurus* and other Anomodonts were shown, also the Plesiosaurs, Chelonia, and Ichthyosauria ; the flying Pterodactyls and terrestrial Dinosauria were likewise illustrated.

The early Birds (ARCHÆORNITHES) *Archæopteryx*, *Hesperornis*, *Ichthyornis*, and the more modern Ratite or Struthious birds, and also the *degenerate* (carinate) Dodo, etc.

Examples of the leading Mammalian types were next illustrated, as the Monotremes, Marsupials, CETACEA, Sirenia and EDENTATA ; and the leading examples of Ungulate quadrupeds, the AMBLYPODA, PROBOSCIDEA, TOXODONTIA, PERISSODACTYLA, ARTIODACTYLA, etc.

Among special illustrations may be mentioned a carnivorous Theriodont Reptile from the Permian of Russia ; restorations of *Arsinoitherium Zitteli*, a new Amblypod from Egypt ; and three ancestral forms of Elephant, viz. *Meritherium*, *Palæomastodon* and *Tetrabelodon* ; lastly, a beautiful slide, and an unpublished plate of *Okapia Johnsoni* were exhibited.

Mr. C. F. Rousselet :—An Old Microscope by Plössl of Vienna.

New Fellow.—Mr. Thomas John Davis was balloted for and duly elected a Fellow of the Society.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

APRIL 1904.

TRANSACTIONS OF THE SOCIETY.

IV.—*The President's Address: The Evolution of Vertebrate Animals in Time.*

By Dr. Henry Woodward, F.R.S.

(*Delivered January 20th*, 1904.)

In my Anniversary Address to you last year, I directed attention to what is known of the History of the great groups of the Invertebrata in past geological times, and I pointed out to you, that although we could not trace back the phylogeny of these to a common stem, yet we were able to show that every individual group whose appearance is recorded in the various sedimentary deposits, and can be traced upwards through successive ages, marks also the evolution of its progeny; some, like the giant Oak and Plane-tree, putting forth many wide-spreading branches; others, like the Bamboo of the tropics, attaining great length with years, but no lateral expansion; some families, like the Trilobites, the Graptolites and the Eurypterida, reaching perfection in Palæozoic times, and then disappearing; whilst others, having put forth great vigour in the past, have left, like some ancient tree, but one living branch to tell of its past greatness.

Before proceeding with my address to the Fellows of the Royal Microscopical Society, I must apologise to them in that I have for a second time diverted their thoughts from the field of the Microscope to the field of Nature; but every apologist has his excuses also.

Last year I spoke of many minute organisms (which I illustrated on the screen), whose whole body would not fill the aperture of a Microscope.

This year I propose to speak of Vertebrate animals, many of which are of such large size that one of them would easily fill

this entire room to overflowing; nevertheless their *separate structures*, whether of bones, teeth, hairs, horns, feathers, or scales, as well as their blood-corpuscles and various tissues, have doubtless often attracted the investigation of our Fellows. I venture to think that an introduction to these animals and their ancestors in past times may not be so inappropriate as might at first sight appear, and that some slight account of them, *as a whole*, may even enhance the interest we may hereafter take in their minute structures when brought to our notice under the Microscope.

From the earliest Archæan rocks up to the Carboniferous, through a series of deposits more than fifteen miles in thickness, comprising Cambrian, Ordovician, Silurian and Devonian formations, all are *marine* deposits, and in consequence yield scarcely any trace of other than marine organic remains.

The first appearance, then, of Vertebrate life upon our earth must necessarily have been marine, or at least *aquatic*—in fact, in the form of fishes only.

The first fishes were, however, without hardened skeletons, having a *persistent notochord*, a condition of the spinal column characteristic of the embryo of most vertebrate animals, but only found to be persistent through life in the adult of a few groups of Fishes and Amphibia.

THE FIRST VERTEBRATES.—The lowliest of these (forming the LEPTOCARDII or PHARYNGOBRANCHII) is the "Lancelet" or *Amphioxus*—a minute animal, flattened in body and pointed at both ends, which has no hard parts whatever, only a membrano-cartilaginous skeleton without vertebræ, ribs, or jaws.

The mouth in *Amphioxus* is furnished with cirri; respiration is performed by gills enclosed in a branchial chamber; and pulsating vascular trunks serve instead of a heart.

Having no hard parts to be preserved in a fossil state, we of course cannot claim for it great antiquity by reason of its remains having been met with in Palæozoic strata; nevertheless, its wide geographical distribution on the sandy coasts of the North Sea, of the Mediterranean, of South America, of the Indian Ocean, and other widely separated localities, justify us in considering it to be a very ancient and primitive,* as it undoubtedly is a most simple, form of vertebrate.

In the next group (the CYCLOSTOMI or MARSIPOBRANCHII) are placed certain cylindrical vermiform fishes, without pectoral or pelvic fins, with a simple cartilaginous skeleton and persistent notochord. Respiration is performed by means of a series of six

* On similar grounds Prof. E. B. Poulton claims for the curious Arthropod *Peripatus* (which has *not been found fossil*, but has at present a most extensive *terrestrial* geographical range) a geological antiquity greater than any other form of life we are acquainted with, "at least twice as remote as the earliest known Cambrian fossil." Presidential Address (Zoology), British Association, Liverpool, 1896.

or seven pairs of pouch-like gills; the mouth is circular, or semi-circular and suctorial, but there are no jaws, and the teeth are arranged around the buccal cavity. To this order belong the "Lamprey" and the "Hag-fish."

The "Lamprey" (*Petromyzon*) is marine, but ascends rivers to spawn.

The "Hag-fish" (*Myxine*) has similar habits. Its teeth are numerous, minute and serrated; it lives attached, parasitic, on other fishes, and even in some instances enters their body-cavity.

The species have a very wide geographical distribution in the North Atlantic, the shores of Japan, Straits of Magellan, the North Sea, Norwegian fiords, the British shores, and many of our rivers, as the Thames, Severn, etc.

The point of geological interest which they present to us is that, although the rest of the animal-structure is soft, or merely cartilaginous and incapable of conservation, their minute microscopic teeth of glistening chitinous consistence may readily have been preserved.

Now certain minute bodies, like conical and serrated teeth, but of considerable variety of form, were discovered by Pander in the Silurian and Devonian rocks of Russia, as long ago as 1856, and in 1875 by Prof. Newberry in North America; in 1879, they were obtained by Dr. G. J. Hinde, F.R.S., in the Cambrian and Silurian rocks of Britain, North America, and of Sweden; and later, both Prof. Newberry in America, and Prof. Pander in Russia, have expressed the opinion that these microscopic structures belong to Cyclostomatous fishes, like our modern Lamprey and Hag-fish, and were not referable to either Annelida or Mollusca. This opinion was also shared by the late Prof. Huxley, who examined a series submitted to him by Dr. G. J. Hinde.

In 1894, Dr. R. H. Traquair described a remarkable fossil from the Old Red Sandstone of Scotland, being the nearly complete skeleton of a small creature, about an inch in length, having a calcified skeleton, the general aspect of the skull resembling that of a recent Lamprey, with no evidence of jaws or separate ossifications, but with well-calcified ring-vertebræ, and neural and hæmal spines.

A single species, named *Palæospondylus Gunni*, has been found in the Caithness Flagstones near Thurso.

Another primitive group, the OSTRACODERMI, appears in the Upper Silurian and Lower Devonian, and exhibits no trace of jaws or of a segmented axial skeleton or arches for the support of paired limbs, but median fins are present; with *no hard internal skeleton*, and with the notochord persistent.

The head and trunk are invested with a dermal armour, and in addition to the shield covering the head there is usually one covering the abdomen, and a ventral plate meeting the dorsal on

each side. The tail seems to have remained flexible. The plates consist of three layers, an inner "nacreous" layer of lamellæ, a thick middle one of polygonal cancellæ, and an outer hard layer of vasodentine.

The OSTRACODERMI comprise the *Cyathaspis, Pteraspis, Cephalaspis, Pterichthys, Bothriolepis,* and some others. The bodies of *Pteraspis, Cephalaspis* and *Pterichthys,* were covered with dermal enamelled scales or plates.

They mimic in a singular manner the contemporary giant Crustaceans, the EURYPTERIDA.

Quite lately, a number of new forms have been discovered in the Upper Silurian of Lanarkshire, and described by Dr. R. H. Traquair. They are considered to be primitive HETEROSTRACI, or *Pteraspidian* fishes, covered with a dermal armour of shagreen-like granules (*Lanarkia spinosa*), or an outline of plates with a central shield and a series of polygonal plates (*Drepanaspis*).*

The OSTRACODERMI, as a group of early vertebrates, are quite extinct; and their range in past time seems to have been very limited, namely, from the Upper Silurian to the Upper Devonian.

If the MARSIPOBRANCHII of to-day (the "Lampreys" and the "Hag-fishes") were really represented by the Cambrian Conodonts and the Old Red Sandstone *Palæospondylus,* then these lowly vertebrates may claim as great a range in time as any of the Invertebrata; but this point is not as yet definitely established.

PISCES.—We have spoken of the preceding groups as Fishes, but they lack the important character of possessing a lower jaw, they also have only a notochordal skeleton, and they do not always possess paired appendages.

TRUE FISHES begin with the class ELASMOBRANCHII, the most ancient of which are the sharks, which extend as far back in time as the Lower Devonian, the entire skeleton is cartilaginous, only the teeth and the periphery of the vertebræ being calcified; but in many species the primitive notochord is persistent; the gills are not covered by an operculum, but are pouch-like, having distinct clefts on each side; they have both median and paired fins, and the tail is heterocercal.

Examples of Early Sharks have been discovered in a remarkable state of preservation in the Upper Devonian of Ohio, showing the complete outline of the fish with its fins and tail preserved. Although the jaws are cartilaginous the teeth in all are coated thickly with enamel and are well preserved. They also possess bony and enamelled dorsal spines, and microscopic shagreen dermal ossicles in the skin. This type is very persistent, and its remains are met with in almost every formation from the Devonian to the seas of the present day.

* Geol. Mag, 1902, pp. 289–291.

Another interesting order are the DIPNOI, or double-breathers, in which both the gills and the air-bladder, which serves the purpose of a lung, are present, and take part in respiration.

The modern *Lepidosiren* of South America, the *Protopterus* of South African rivers, and the *Ceratodus* (or "Mud-fish") of the Australian rivers, are living examples of this type.

Teeth, like those of the living *Ceratodus*, occur in the older Secondary formations in both hemispheres, and similar teeth, known as *Ctenodus*, occur in the Carboniferous and Permian rocks.

The true fishes, with well-developed paired fins and jaws, the CROSSOPTERYGII and the ACTINOPTERYGII, are characterised by the presence of external ganoine-coated bony plates, with a more or less notochordal skeleton, or only a thin bony tube to the vertebræ and a gelatinous centre.

Others, like *Platysomus*, *Dapedius* and *Lepidotus*, had a compact dermal covering of thickly enamelled bony scales.

Similarly-armoured fishes like *Aspidorhynchus*, from the Solenhofen lithographic limestone, still exist, such as the bony pike of the American rivers.

The great majority of the Fishes in Secondary and, Tertiary times, like our modern bony-framed fishes, were TELEOSTOMI.

Fishes with a complete bony skeleton, and in which the gills are but feebly separated, and open into an external cavity covered by a bony operculum, are, with few exceptions, homocercal tailed.

With the exception of the Dipnoi, all the Fishes are purely aquatic in their habits, and breathe simply by gills, and cannot sustain life for any long period out of the water.

AMPHIBIA.—The earliest vertebrates which show by the arrangement of the nares that they breathe by means of lungs (at least in the adult state) belong to the AMPHIBIA. This group of animals are distinguished from true reptiles by the fact that the young undergo certain metamorphoses after leaving the egg. At this early stage of their existence they breathe by means of external gills, which are occasionally retained along with internal lungs in the adult animal, and one or more pairs of limbs may be wanting. When present, they have the same bones as in the limbs of higher animals; they are never converted into fins; the skull has two occipital condyles; the mandible articulates directly with the skull; teeth are commonly present on the premaxilla, the maxilla, the vomer, and the dentary bone of the mandible; they are usually achylosed to the bone, and are simple in structure, but more complex in *Labyrinthodon*; only two vertebræ are coalesced to form the sacrum; sometimes the backbone is unossified, forming a mere ring of bone, the interior being gelatinous, a form of backbone called notochordal.

The earliest of these Amphibians are found in the Coal Measures, such as *Anthracosaurus*, represented by *Loxomma*, and *Archegosaurus*.

These forms are represented by *Cryptobranchus*, in the Miocene of Switzerland, and by the gigantic salamander of China and Japan, now living.

The tail-less BATRACHIA, Frogs and Toads, do not make their appearance until Tertiary times.

All these forms appear to have undergone regular metamorphoses in the young state after leaving the egg. Some of those in the Coal Period, and especially in the Permian, attained to a very large size, and had thick bony plates covering the head. The head varies in form from a broadly semicircular shape in *Branchiosaurus*, to a more elongated form in *Loxomma* and *Archegosaurus*; the skull in *Mastodonsaurus giganteus*, from the Keuper of Würtemberg, measured a yard in length and was broad in proportion.

Like their modern representatives at the present day, the Amphibia were all of aquatic habits, although air-breathing in the adult; but they were also capable of progression upon the land—they represent, therefore, the first terrestrial vertebrates.

Representatives of both the tailed and tail-less forms, the Newts and Salamanders, and the Frogs and Toads, still survive, although greatly reduced in size.

The skeleton in the Amphibia presents a combination of characters intermediate between the lowest Mammals and certain of the Anomodont reptiles.

REPTILIA.—Of the extinct forms of Reptiles, the *Anomodontia* are certainly the most remarkable, as they are among the most recent discoveries of geological science. They derive their name from the varied modification of their dentition, so unusual a character among Reptiles, in which the teeth are, most generally, all of one pattern and size. They were all land animals, with limbs adapted to habitually support the body; some were of very massive build, others were of much more light and agile form.

One of the most striking of the former of these is the *Pariasaurus Bainii*, from the Trias formation of Cape Colony: the teeth are close set, and fused with the bone; they resemble those of the *Iguanodon* in being worn down on their summits, as if applied to the mastication of vegetable food; fifteen or sixteen are closely set on each side of both the upper and lower jaws; they are very uniform in character, there being no means by which to separate the incisors or canines from the premolars or molars; the palate also bears several rows of small teeth; the entire animal measures fully nine feet in length, and its skull and jaws closely resemble those of the short-headed Labyrinthodont Batrachia; while the surface of the skull was completely covered by a bony roof sculptured on the surface, like the cranial plates in many Labyrinthodonts and Crocodilia.

One of the most strange Rhynchocephalian reptiles is the *Dimetrodon incisivus* from the Permian of Texas, remarkable for

the extraordinary dorsal fin supported upon bony prolongations from the dorsal spines of the backbone; the body is Crocodilian in aspect; the legs were short, the jaws armed with exceedingly sharply pointed teeth, and may have served for the purpose of preying upon fish and other aquatic animals.

Passing over a number of forms, Dicynodontia, etc., with variously modified teeth and skulls, we come to the division THERIODONTIA, remarkable for the resemblance of the skull to that of a carnivorous mammal (*Galesaurus, Ælurosaurus*), and the differentiation of the marginal teeth (so far as shape is concerned) into incisors, canines and molars. Only one occipital condyle, however, articulates the skull to the vertebral column. So far as we are able to judge by a knowledge of recent reptiles, they exhibit an advance upon the AMPHIBIA, not only in being provided with a fœtal envelope, known as the amnion, but also by breathing by lungs throughout life, and never possessing branchia at any stage. The remarkable form *Tritylodon*, originally considered by Owen to be a mammal, has now been referred to the *Theriodontia*. In nearly all these forms the pineal foramen can be distinctly seen; they have also anterior nares.

The SAUROPTERYGIA (*Plesiosauria*) form another primitive group of reptiles, in which the bones of the skull in the temporal region contract into a single broad zygomatic arch. Commencing with small amphibious animals in the Trias, they are represented by larger, truly aquatic forms through the whole of the Secondary period. Although these larger forms (the Plesiosauria) lived wholly in the open sea, they retained their two pairs of pentadactyle limbs, and their long-neck and lizard-like form, in contradistinction to the ICHTHYOPTERYGIA, which have an extremely shortened neck, and are quite fish-like in external shape. They have a pineal foramen, and exhibit two large supra-temporal vacuities on the skull; the conical teeth form a single series on the margin of the jaws, and they have distinct sockets.

In the small Triassic form *Lariosaurus*, which preceded them, and was probably ancestrally connected, the limbs are elongated and slender, with five digits, and the normal number of phalanges. In the later genera they are modified as paddles, with shortened fore- and hind-limb, but still with only five digits present; but these are lengthened by the addition of supernumerary phalanges, and are destitute of claws. They have a system of well-developed ventral ribs, and the skin appears to have been destitute of armour.

The CHELONIA may possibly have been developed from a highly modified form of Plesiosaurian. The earliest known Chelonian is met with in the Trias, and differs in no very important degree from the later forms. They have a very wide geological and geographical range. The genus *Testudo*, which is represented by many large living species, is found fossil in the Siwalik Hills of India and in

Madagascar, whilst living examples survive in the Mauritius, Bourbon, and many other small islands of the Indian Ocean, and on Galapagos Island.

Gigantic marine turtles with extremely degenerate shells, like the modern leathery turtle, occur fossil in the Eocene of Europe and of America, and living in the West Indies. One living sub-order of CHELONIA, the Pleurodira, is confined to the Southern Hemisphere, although its fossil remains have been discovered in Europe and North America. The genus *Miolania* has been found in the Pleistocene deposits of Queensland, and has also been obtained from Lord Howe Island, 400 miles distant from the Australian coast. Quite recently Dr. Moreno has obtained the same genus (only specifically distinct) in the Tertiary deposits of Argentina, South America.

The ICHTHYOPTERYGIA, or fish-limbed reptiles, make their first appearance in the Trias, range throughout the Mesozoic, with little structural modification, and disappear in the Chalk. In outward form they must have closely resembled the Cetacean mammals of the present day, such as the dolphin, with its large head, long rostrum, numerous and uniform teeth, and no apparent neck. Their hind limbs have never (unlike the Cetacea) quite disappeared, although sometimes extremely reduced in size; and the caudal fin was expanded in a vertical plane, as in fishes, *not* in a horizontal plane, as in the Cetacea. It is possible that the Ichthyopterygia were originally derived from land animals, as the earliest Triassic forms show a slightly elongated character in the radius and ulna, and the teeth are in less uniform series than those from the Jurassic and Cretaceous rocks—but we know nothing of their terrestrial ancestors. The vertical folding of the walls of the conical teeth is only paralleled by that observed in many Labyrinthodonts; their short biconcave vertebral centra may also best be compared with *Mastodonsaurus.*

Another remarkable group of Reptiles having its origin in the Trias, called the RHYNCHOCEPHALIA (beak-headed), in allusion to the typical beak-shaped rostrum of several of the genera, has a single representative at the present day in the small lizard-like *Sphenodon* or *Hatteria*, found on certain small islands off New Zealand. The two best known genera in the Permian are *Palæohatteria*, a long-tailed-lizard-like reptile of small size, and *Protorosaurus*, a large reptile from the Upper Permian; but the British form of *Hyperodapedon Gordoni* from the Trias of Elgin, and a larger species from the Trias of Central India, with *Rhynchosaurus* from the Trias of Shropshire, and another form from Bavaria, make up a most remarkable and all but extinct group.

The SQUAMATA, or Scaled Animals, represented by the Lizards and Snakes, are, comparatively speaking, of recent origin, only going back to the Cretaceous period; one of the earliest of these

is a small aquatic animal of snake-like shape, named *Dolichosaurus*, from the English Chalk. One extinct order must, however, be mentioned—the PYTHONOMORPHA. They were truly aquatic reptiles with remarkable elongated snake-like bodies; the skull resembled certain Lizards, such as *Varanus*; the teeth are large and conical and fixed by tumid bases to the supporting bones; the pterygoid bones also bear teeth like those on the jaw.

We are familiar with the remains of the great *Mosasaurus* from the Upper Chalk of Maestricht, Holland, and the more complete remains of *Platecarpus* from the Chalk of Kansas.

Clidastes is also found in the Chalk of America.

Snakes occur in the Eocene of Sheppey, and of Bracklesham; they have also been obtained of large size by Dr. Andrews, in beds of similar age in Egypt. Large lizards occur in early Tertiary times in Europe and in Queensland, Australia, related to *Varanus*.

The DINOSAURIA form a singular group of very large terrestrial reptiles now entirely extinct. They all possessed limbs suited to progression on the land, and capable of sustaining the body in either a quadrupedal position or erect, supported on the hind-limbs and tail, like the kangaroo. The tail was of large size, and they were probably good swimmers. Some were no doubt amphibious in habit, the caudal appendage being expanded vertically and well adapted to assist in aquatic progression. The hind-quarters in a large number of forms are disproportionately massive as if to support the body in an erect position, whilst the fore-limbs were often exceedingly small. Some of the Dinosaurs had very massive and others very light, strong, and *hollow* bones; the teeth in the latter were adapted to a carnivorous diet, while the worn surfaces of the former show that they were herbivorous in habit; two or more of the sacral vertebræ are fused together to support the pelvis.

The earliest Dinosaurs appear in the Triassic deposits; a small, nearly complete, carnivorous Dinosaur was obtained in 1884 from the Trias of Connecticut River Series—the *Anchisaurus colurus*; these Connecticut Sandstones have long been famous for the remarkable foot-prints preserved upon their slabs formerly ascribed to birds; Marsh has now shown them to have been made by this small Dinosaur *Anchisaurus*. Another little reptile of carnivorous habit, about the size of a rabbit, with greatly elongated hind limbs suggesting the generic name of *Hallopus* or "Leaping-foot," from its probable mode of progression, occurs in the Jurassic strata of Colorado. A third minute carnivorous form (*Compsognathus*) occurs in the Lithographic stone of Solenhofen; these are among the smallest of the class.

One of the largest predaceous forms was *Ceratosaurus* (*C. nasicornis* Marsh), measuring some 18 ft. in length and standing nearly 15 ft. from the ground. It had a horn-core on the nasal

bone; the bones of the pelvis and the metatarsals are all co-ossified, as in existing birds. The premaxillaries each contained three, and the maxillaries had each fifteen, large, powerful, and trenchant teeth, clearly indicating (as in our own Oolitic *Megalosaurus*) the ferocious character of the animal.

Of the other carnivorous Dinosaurs of the American Jurassic, three forms, *Allosaurus, Creosaurus,* and *Labrosaurus,* are specially worthy of notice. They were the natural enemies of the gigantic herbivorous forms that were so abundant in the same period. All had powerful jaws, sharp, cutting teeth, and a flexible neck. The fore-limbs were quite small, and the feet (manus and pes) were armed with strong claws for seizing their living prey. The hind-limbs were large and strong, and the animals probably used these alone either in running or leaping, or for ordinary locomotion.

The herbivorous Dinosaurs comprising the *Sauropoda* are the most primitive and gigantic forms of the group. *Atlantosaurus* is only known from imperfect remains; but the pelvic bones and femur of *A. immanis* give an idea of its gigantic size. The femur is over 6 ft. in length, and this, with the other portions of the skeleton, indicate (says Marsh) an animal about 70 or 80 ft. in length!

Brontosaurus is known from nearly an entire skeleton, which measured more than 60 ft. in length. The head is remarkably small, probably smaller in proportion to the body than in any other known reptile. The neck is long and flexible, the body short, the tail much elongated. There are about thirteen cervical vertebræ, with a very small neural canal and no neural spines. The hatchet-shaped ribs are fused with the anterior cervicals but free on those behind. Its skeleton is distinguished among Dinosaurs by the peculiar lightness of its vertebral column, the cervical, dorsal, and sacral vertebræ, all having very large cavities in their centra; the first three caudals, also, are lightened by excavations in their sides.

An animal fully equal in size to *Brontosaurus,* named *Cetiosaurus,* has been obtained from the Oxford Clay of Peterborough, and, although imperfect, the skeleton shows it to have been as large as the American form.*

The Sauropodous Dinosaurs, of which *Cetiosaurus* and *Diplodocus* are examples, are the largest known four-footed animals. Their weight must have been so great that it is difficult to believe they were active on the land. Their remains are often found in marine deposits, and Prof. E. D. Cope has suggested that, like the extinct sea-cow (*Rhytina*), they may have lived on the sea-shore browsing

* This specimen may be seen exhibited in the Reptilian Gallery of the Geological Department, British Museum of Natural History, Cromwell Road, having been lately set up by the present Keeper, Dr. Arthur Smith Woodward, F.R.S. The specimen was obtained by A. N. Leeds, Esq., F.G.S., Eyebury, near Peterborough.

on the sea-weeds just below low-water mark. This theory would afford an explanation of the long, slender neck. The animal, on account of its great weight, would be able to walk in tolerably deep water and reach the surface to breathe, by means of its neck without the necessity of swimming.

Another remarkable form met with in America is named *Diplodocus.*

The orbits are large and placed far back in the cranium; the facial portion is elongated and broadened in front; the nasal opening is very large and placed near the apex of the skull. The teeth are very weak, slender, and cylindrical in shape, like a row of bluntly rounded pins, and are all crowded to the front of the jaw, twenty-six above and twenty below, forty-six in all. No restoration of this Dinosaur has been attempted, but it is believed to have been from 40 ft. to 50 ft. in length. The teeth indicate a herbivorous diet, the animal feeding largely upon succulent vegetation, and the position of the nares seems to indicate an aquatic mode of life. *Morosaurus* is placed near to *Diplodocus.* The limbs suggest a plantigrade progression, as in *Brontosaurus.* There does not appear to be any representative of *Diplodocus* out of North America.

Some of the Dinosaurs had a remarkable defensive armour: for instance, *Stegosaurus* had a row of enormous vertical plates forming a single series and reaching from the head to the tail, the extremity being armed by one or more pairs of large spines; the head was very small, as in *Brontosaurus.* We have in this country an interesting example of an armoured Dinosaur in *Scelidosaurus Harrisoni* from the Lias of Dorsetshire; the back was protected by plates and spines; there were also lateral rows of smaller tubercles; the head was small and furnished with teeth, like those in the *Iguanodon.*

Triceratops was a large Cretaceous Dinosaur, the head being 6 ft. in length and broad in proportion; it had a huge bony frill margined by tubercles, covering the back of the neck and joined to the skull. A pair of bony horns were placed, one over each eye, covered in life by a horny sheath, and a smaller central one over the nasal bones; the extremity of the beak was provided with a horny bill, both in the lower and upper mandible. The cheek teeth are very singular among reptiles, having two distinct roots placed transversely in the jaw, with a separate cavity for each fang; this structure in the teeth is truly remarkable, being characteristic of the Mammalia.

One of the earliest Dinosaurs known in this country is the *Iguanodon,* originally described by Dr. Mantell and more fully by Prof. Owen, but neither of these anatomists had anything but very imperfect remains and detached bones to guide them in arriving at a correct idea of the form of the entire animal. Mr. Waterhouse Hawkins, in 1857, commenced a series of restorations of

extinct animals for the Crystal Palace Company at Sydenham, then in its palmy days. Among these restorations may still be seen the *Iguanodon*, represented as a pentadactyle four-footed beast, the fore and hind limbs being of equal length. From the remarkable discoveries made of late years in the Wealden deposits at Bernissart in Belgium, we now know the true character of the entire skeleton of the *Iguanodon*, a reproduction of the Brussels Museum skeleton being set up in the Natural History Museum in Cromwell Road.

The proportion between the fore and hind limbs is truly remarkable; the tail was of very great length; the hind feet were provided with three toes, and closely resemble in their digits the foot of ordinary birds; the fore limbs are very much shorter than the hind limbs, and have the full complement of five digits. In an erect position, the animal would measure 15 ft. in height, and about twice that in length; the only defensive armour consisted of a strong spine on the thumb of each hand, covered in life by a horny sheath; the cheek teeth, which are very numerous in the sides of the jaw, were—by the trituration of their food (which was of a vegetable nature)—worn flat on their tops, like the molar teeth in horses. Instead of front teeth, there was a horny covering to the jaws above and below, resembling the beak in the Tortoise or Turtle, by means of which they cropped their food.

Remains of the carnivorous form of Dinosaur, the *Megalosaurus*, are only imperfectly preserved to us, but from its teeth, limbs, and vertebræ we know that it was predaceous in habit, its teeth being adapted for cutting and tearing flesh, not vegetable food; the feet and hands were armed with sharp claws, like those of carnivorous mammals of the present day. In this group of reptiles, which formerly occupied nearly the whole terrestrial field in the Secondary period, we find the same arrangement as among existing mammals, that is to say, many and very numerous forms of Herbivora, mostly slow-moving, heavy beasts, and a few types of very active and formidable Carnivora, whose business it was to keep down the excessive number of the Herbivora.

Pterosauria, the flying Lizards, form a remarkable extinct order of Winged Reptiles only met with in the Secondary rocks. These animals had the centra of the vertebræ hollow in front; they possessed a broad *sternum*, or "breast bone," with a median ridge or keel, similar to that of birds; the jaws were usually armed with teeth fixed in sockets. The fore limbs had a short humerus, a long radius and ulna, and one of the fingers of the hand was enormously elongated to give support to the wing-membrane (*patagium*), which was attached to the sides of the body, the arm, the thumb, and the long finger, and also to the hind limb and tail. The other fingers of the hand were free, and furnished with claws. The wing-membrane appears to have resembled that of the Bat, being desti-

tute of feathers. The caudal series of vertebræ in some genera (as in *Rhamphorhynchus*) was greatly elongated, and stiffened with slender ossified fibres. The bones were pneumatic (i.e. filled with air-cavities), the walls of the bones being very thin, and their substance very hard and compact, thus combining strength with lightness. A great American Pterodactyl, *Pteranodon*, with a head 4 ft. long, had its jaws armed with a horny bill and no teeth; the expanded wings measured about 18 ft. across. The remains of another form, met with in the English Chalk of Kent, had its jaws armed with teeth, and possessed wings of equal expanse. The *Dimorphodon*, from the Lias of Lyme Regis, had a rather large head, armed with lancet-like teeth, and a long rigid tail, which served —like the same organ in *Rhamphorhynchus*, from the lithographic stone of Bavaria—as a rudder to steer by, being provided with an expanded membrane near its extremity, like the blade of a canoe-paddle. Many forms, varying greatly in size, some no bigger than a sparrow, others as large as *Pteranodon*, existed in the Lias, Oolites, Greensand and Chalk, but they have all now disappeared, and left no representatives behind among living beings.

The Crocodilia make their appearance in the Keuper and Lias and are well represented by long and broad-headed forms in the Secondary and Tertiary periods, but they offer but few points of interest, save to the comparative anatomist, by which to separate them specially from living forms. The Crocodiles belong to Professor Owen's group the Procœlia, having the vertebræ concave in front; this includes the long-snouted Garials, as well as the short-headed Alligators and Crocodiles, and various Tertiary forms.

The Secondary genera belong to Owen's Amphicœlia, in which the vertebræ are concave at both ends. *Belodon*, in the Keuper of Stüttgart, and *Stagonolepis*, in the Trias of Elgin, are among the oldest forms.

AVES.—Birds are so similar to reptiles in all the most essential features of their organisation, that they may be said to be merely extremely modified and aberrant forms of the reptilian type; still, the differences which they present are sufficiently great to justify their being placed in a distinct class. Another reason why Birds are placed in an intermediate position between the Reptilia and Mammals is because, whilst their bony skeleton most closely relates them to the Reptilia, yet the fact that the chambers of the heart in Birds are completely separated, as in Mammals, the blood in consequence possesses a high temperature—in spite of all the changes of external variations to which they are subjected—the loss of heat being provided against by the clothing of down and feathers, which preserves them from cold, just as the thick coat of hair and wool does in the Mammalia.

The most ancient type of birds was supposed to be some gigantic forms of struthious birds, such as the *Ostrich, Rhea, Emu,*

Cassowary or *Apteryx*; but the bird-like footprints in the Trias, which gave support to this belief, were not accompanied by any osseous remains. When such remains were met with, they proved that the supposed footprints of great Ratite birds were really made by bird-footed bipedal reptiles. When a feathered fossil was first discovered, its bony skeleton, although accompanied by impressions of feathers, presented so many points of resemblance with the Reptilia, as to lead the German naturalist Wagner to name it *Gryphornis.* This bird, the *Archæopteryx*, was obtained from the lithographic stone of Solenhofen, Bavaria, and exhibited a tail elongated like that of a lizard, comprising some twenty free vertebræ, each bearing a pair of feathers. The pelvis was not constructed of a large number of anchylosed vertebræ, but had only two or three vertebræ coalesced with the iliac bones; the vertebræ were either amphicœlous or with flat ends; the sternum is not well known, but the furculum resembles that of modern carinate birds. The wing was small, with three free digits, each terminated by a claw. It is not certain if the metacarpal bones were fused together or not; the hind limb is essentially Avian, but the tibia does not show the usual cnemian crest. In addition to the characters of the tail and wing-bones, the skull also—which was very imperfectly preserved in the first example—is now known (from a second example preserved in the Berlin Museum), to have been furnished with a series of conical teeth, both in the upper maxillæ and the mandible. The foot is that of a true perching bird.

The next example of a fossil bird met with is from the Upper Chalk of Kansas, in America, and makes us acquainted with a huge fish-eating ratite bird, resembling in general form the loons and grebes. The *Hesperornis*, which was apparently destitute of wings, possessed a long neck, and elongated skull; the margins of both jaws are provided with very numerous teeth arranged in grooves, not in distinct sockets. There are twenty-three pre-sacral vertebræ united with saddle-shaped articulations, like those of modern birds, seventeen being cervical vertebræ; fourteen are fused together in the much-extended sacrum, and there are twelve caudals, eight or nine of which are free.

The femur is remarkably short, thick, and flattened; the tibia-tarsus is the largest bone in the skeleton, and very stout and powerful, its legs and feet being admirably adapted for swimming and diving; there are four digits in the foot, the fourth or outer toe being much the largest. One specimen discovered shows traces of feathers, which were soft and plume-like over the whole body.

The *Hesperornis regalis* attained a height of 3 ft. 6 in. when standing. On account of its ratite breast-bone, and its rudimentary wings, it has been spoken of by Marsh as "the swimming ostrich."

Another Cretaceous bird, *Ichthyornis victor*, also from Kansas, appears to have been possessed of powerful flight, with a strongly formed and deeply carinate breast-bone; the beak being like *Hesperornis* armed with teeth, but implanted in distinct sockets. The vertebræ were bi-concave, as is the case with a few recent and many extinct reptiles.

The *Odontopteryx toliapicus*, from the London Clay of Sheppey, also had a powerful serrated bill well adapted for seizing fishy prey. An imperfect skull of a large bird, from Sheppey, probably allied to the ostrich, is named *Dasornis Londiniensis*.

We have another struthious bird, *Gastornis Klaaseni*, from the lower Eocene of Croydon, as large as an ostrich but more robust.

A similar bird, *Gastornis parisiensis*, was found in the Eocene of Meudon, near Paris.

Fossil bird remains have not unfrequently been met with in the Miocene-Tertiary beds of Allier, La Grive-St. Alban, in France, the Brown Coal of Bonn, and from Oeningen in Switzerland. Another fossil Ostrich comes from the Miocene of the Siwalik Hills in India. But the most wonderful assemblage of fossil bird remains met with anywhere has been found in the islands of New Zealand. Here since first these birds were isolated and left alone unmolested to increase and multiply, undisturbed by man the destroyer, or by any carnivorous mammal; with only two possible enemies, a large vulturine bird *Harpagornis*, and the "Kea" parrot which is carnivorous in its habits;—for untold centuries they remained and flourished until the advent of the Maoris, who commenced their steady destruction, which must have gone on probably for hundreds of years. Mr. Commissioner Mantell discovered at Poverty Bay the native ovens where the Maoris prepared their repasts, and where the bony remains of hundreds of these birds were found associated with the charcoal of the fires in which they had been cooked. They were probably living as lately as down to the first visits paid to New Zealand by white men in 1642;* or even when Capt. Cook, the navigator, sailed around the islands in 1769–70, and took possession of them for the British Government; they however remained uncolonised by the English until the year 1840. The Maoris, being cannibals, created some little trouble, as after exterminating all the wingless birds, they proceeded to Chatham Islands, 500 miles distant from New Zealand, where they devoured all the natives.

Some idea may be formed of the enormous length of time during which these great Ratite birds, *Dinornithidæ*, must have lived undisturbed, from the fact that some twenty species have been described, varying in size from animals 12 ft. or more in

* These Islands were first discovered by Tasman in 1642.

height down to individuals but little bigger than the existing *Kiwi* or *Apteryx*. It is quite possible that these great wingless birds, which must have existed in thousands, judging by their remains, once occupied a land area far larger than the existing islands of New Zealand. Of wingless birds on these islands the *Apteryx* alone survives.

In the adjacent continent of Australia two species, the Emu and the Cassowary are living, and two other forms named *Dromornis* and *Genyornis* are extinct. On the island continent of Madagascar, near the coast of Africa, the *Æpyornis* was once equally abundant, and like the *Dinornis* in New Zealand was represented by several well-marked species, some of which attained a size as great as that of the *Dinornis*; and the eggs which have been very commonly found in the sands of Madagascar, surpass in size those of any bird's egg known, living or extinct. On the neighbouring continent of Africa, the Ostrich still survives. In South America another struthious bird also exists, named the Rhea, and a fossil bird of very great size, the *Phororhachos*, from the Tertiary of Patagonia, which was probably as tall as the *Dinornis* and destitute of the power of flight.

It is not positively known whether the great series of wingless Birds, the *Ratitæ* or Raft-breasted Birds, originally belonged to one family or not; they are now certainly very widely separated on the great Southern land-areas, and if they have sprung from a common ancestor in the past, they afford remarkable evidence of the high antiquity of Birds on the surface of the earth. One wingless bird, the Dodo, found only on the Island of Mauritius, was probably exterminated more than 250 years ago by man. The Dodo was a great wingless ground pigeon, which had lost by disuse the power of flight, and so fell an easy prey to the early Dutch navigators, who devoured them all. The Mascarene Islands were also the ancient home of the Solitaire (*Pezohaps*) which inhabited the island of Rodiguez, the "weka" or wood-hen (*Erythromachus*), a great species of crake, and several other birds now quite extinct.

The Penguins (*Spheniscidæ*) have fossil representatives in New Zealand and Patagonia. They range at the present day from South America to the Falkland Islands, South Africa, Australia, New Zealand, and most of the Antarctic lands, but are not met with north of the Equator.

The Great Auk (*Alea impennis*), though separated from its representatives in the Antarctic, is a corresponding type of fish-eating, diving, wingless birds, in which the wing no longer functions as a wing, but rather as the fore-arm or flipper of an aquatic mammal or reptile: it is, in fact, only used in swimming. Once common on all the Arctic lands, just as the Penguin is at the present day on the Antarctic coasts and islands, it lived around the

shores of Scotland, Iceland, Faröe Islands, Greenland, and the shores of Newfoundland, but since the year 1844 it has been completely exterminated by man.

MAMMALIA.—In the earlier groups of the Vertebrata which we have already considered, the young have, as a rule, been deposited by the parent enclosed in an egg, while in a few instances they have been found to be hatched *before birth*, as in the case of the Viper among Reptiles, the Blenny among Fishes, the Scorpion in the Arachnida, the Flesh-Fly, and the Earthworm. Among Mammalia in general, the fœtus is nourished by the parent before birth by a vascular membrane called the placenta, in which it is enclosed, and when born it has usually attained a certain amount of growth; in fact, the young are born alive, and are suckled by the parent until sufficiently advanced to be able to feed themselves.

Birds, we have seen, are clothed in feathers, but the Mammalia have instead a hairy covering, which is seldom entirely absent even in huge aquatic forms like the whales; whilst a few large, apparently-naked, terrestrial, tropical species possess hairs on certain parts of the body: for instance, the CETACEA have short bristles at least on the lip; animals like the Elephant and the Hippopotamus have some hairs, whilst the extinct Mammoth had a complete hairy and woolly covering. Mammals, then, may be described as warm-blooded, hairy animals, the head being attached to the vertebral column by a double-occipital condyle. They are viviparous (bringing forth their young alive), and the young are suckled by a secretion, known as milk, furnished by the mammary glands.

The earliest mammals known belong to the PROTOTHERIA.

PROTOTHERIA: MULTITUBERCULATA.—Two living examples of the Monotremata (*Ornithorhynchus* and *Echidna*), small, toothless, burrowing animals, probably represent the sole survivors of the first-known mammals of the Trias, the Stonesfield Slate, and the Purbeck Beds.

There is a remarkable resemblance between the early-shed teeth of the immature *Ornithorhynchus* and the multituberculate molars in certain small jaws found in Mesozoic and Eocene strata.

Some of the forms originally placed by Owen among the earliest mammals, as, for instance, *Tritylodon*, from the Trias of South Africa, are now referred to the Anomodont Reptiles, with *Cynognathus*, etc. Those still considered to represent early mammals are placed in the Multituberculata, on account of the number of tubercles borne on the molar teeth; the most interesting of these are *Amphilestes*, *Phascolotherium*, and *Stereognathus*, from the Great Oolite Stonesfield, and *Plagiaulax*, *Microlestes*, *Bolodon*, *Allodon*, *Ctenacodon*, from the Purbeck Beds—all these represent extremely small animals, not bigger than a rat or a mouse. *Polymastodon* is represented by somewhat larger animals, one being equal in size to a kangaroo; the teeth are on the rodent pattern, with cutting

incisors, the molars and premolars being tubercular. Numerous remains of these small mammals have been met with in this country, in America, and in France, the earliest being the *Dromatherium sylvestre*, from the Trias of North Carolina.

MONOTREMATA.—The lowest type of living mammals (the *Monotremata*) are oviparous, the egg being apparently placed by the female in the marsupium or pouch of the mother, the young remaining attached to the parent until able to feed themselves.

METATHERIA: MARSUPIALIA.—In the Marsupialia, which comprise the kangaroos and wombats, the young is not enclosed in an egg at birth, but is produced as a very minute and immature fœtus, and placed by the parent in the marsupial pouch, where it becomes attached to the mammary gland, and is carried in this receptacle until able to run alone.

The kangaroos and wombats are almost entirely confined at the present day to Australia, but one genus, *Didelphys*, is found living in South America, while fossil remains occur in Tertiary deposits in Europe. Possibly some of the small extinct mammals, whose remains have been found in the Purbeck and Stonesfield Slate, may have belonged to the Marsupialia.

In Tertiary times, animals of very large size, such as the *Diprotodon*, the *Nototherium*, and *Thylacoleo* existed in numbers upon the Australian continent; but these are all now extinct, and only the existing Kangaroos, the small Wombats, and Opossums, survive.

EUTHERIA: PLACENTAL MAMMALS.—The origin of the two groups of marine placental mammals, the *Cetacea* and *Sirenia*, still remains uncertain, and Palæontology does not afford us any information thereon.

CETACEA.—The largest of all living or extinct animals belong to the whale tribe, probably the great Right-whale, measured not short of 100 ft. in length and was many tons in weight; the Cetacea are all warm-blooded mammals, and have probably been derived from Terrestrial ancestors who at some distant period took up an aquatic existence probably within the tropics; the body in these animals is not clothed in fur, but beneath the skin is a thick layer of fat ("blubber") which as effectually protects the vital organs from the cold in its watery home, as does the fur of any arctic animal on the land. The remains of Cetacea, particularly of the Toothed Whales, the Sperm Whale, the Dolphin, etc., are met with in deposits of later Tertiary age, such as the Crag of Suffolk and of Antwerp.

The earliest known Cetacea (*Zeuglodon*) were provided with cheek teeth with double fangs; whereas the later Cetacea have no distinction in the teeth in their jaws, which are all simple one-fanged teeth of the same pattern. In the Right-whales, teeth, except in the fœtus, are unknown, their place being taken by horny plates of whalebone known as *baleen*, which differs greatly

from teeth, being produced from the ephithelium, the cuticular covering of the lips.

SIRENIA.—The Sirenia form an entirely distinct group of remarkable aquatic vegetable-feeding animals, subsisting entirely on the aquatic plants in rivers, and on the great beds of laminaria and other sea-weeds, which grow just below low-water and especially abound in the North Pacific Ocean. Numerous species formerly existed in the Old World whose remains are met with in Eocene, Miocene, and Pliocene strata in Europe, North Africa, in our own Crag formation, as well as in that of Antwerp. One huge form, about 20 ft. in length, known as "Steller's sea-cow," *Rhytina gigas*, was living on the coast of Behring and Copper Island, off Kamchatka, between 1740 and 1780, but it was entirely exterminated by the hand of man. The adult animal was apparently edentulous (the young only being furnished with milk-teeth); instead of teeth there were horny palates on the upper and lower surface of the mouth, which, being strongly ribbed transversely, served in place of teeth. Two other surviving forms: one, the *Manatee*, inhabiting the shores and rivers of both sides of the Atlantic, near the line of the equator, and met with in the Congo in Africa, and the Amazons and Orinoco in South America; the other species, the Dugong (*Halicore*), being confined to the shores and islands of the Indian Ocean, the Red Sea, and the eastern shores and northern coasts of Australia. Both these forms, being restricted to those localities where sea-weeds and other aquatic plants abound, on which they feed, are rapidly being exterminated by man. Some years ago a company was formed on the east coast of Australia for the production of dugong oil; so that the *Halicore australis* will soon be a thing of the past.

No doubt these forms were at one time derived from terrestrial ancestors. The teeth in the Manatee are tuberculated molars resembling those of the pig and the hippopotamus. The teeth in the Dugong are of a more simple form and fewer in number. The Rhytina, as before stated, had no teeth. The hind limbs in all these Sirenians are only indicated by a rudiment within the body as is also the case in the Cetacea. The Sirenians retain free movements of the bones of the fore-arm, with separate motion between the humerus and the radius and ulna, which is lost in the Cetaceans, the whole fore-arm being rigid, moving only from the shoulder, thus forming a true flipper or fin.

Although owing to their mode of life these two groups are purely aquatic in habit, yet they possess all the attributes of the mammalian class. They bring forth their young alive; they are nourished by the milk of the parent, and the offspring enjoy the same tender care from the mother as do the young of terrestrial animals.

EDENTATA.—The Edentata are not all toothless animals, as their

name would imply. Although without teeth in the front of the jaws, they yet possess cheek teeth; the Ant-eaters, however, have no teeth. The existing forms are all of moderate size, being represented by the Ant-eater *Myrmecophaga*, of which there are three species living in South America, two species of scaly Ant-eaters in Africa, and two in the East Indies. *Orycteropus*, the hairy Ant-eater, or "Aard-vark," of the Cape, is found also in north-eastern Africa, and fossil in the island of Samos. The great body of Edentate animals are characteristic of South America; there are, beside the Ant-eaters, many species of Armadillos and several forms of Tree-Sloths; this group of animals is interesting also as affording illustrations of mammals, in some of which the hairy covering is quite subsidiary; the scaly Ant-eaters having an entire covering of horny scales like some reptiles, whilst in the Armadillos the body and tail are provided with a coat of mail, having a thin horny surface with thick bony plates beneath.

The modern Armadillos have a banded coat of bony, horny scales, arranged in rows, so as to enable the animal to roll itself into a ball like a hedgehog. But in Tertiary times the Armadillos were represented by many species of *Glyptodon* and of *Hoplophorus* of giant size, which had no bands to their armour, but were covered with a solid cuirass of thick bony plates united together into one massive shield, covering the whole body and attached to the bony vertebral skeleton within. The modern Sloths are small, the largest of them not being bigger than a moderate sized dog; they spend their lives in an arboreal existence, climbing by means of their long claw-like nails among the boughs of lofty trees, on the foliage of which they browse; they sleep in the same manner attached by their hooked claws to the branches of trees, and carry their young with them.

The Ancient Sloths were of gigantic size, and being so large they dwelt upon the ground, but like their small modern representatives they fed upon the leaves of trees and obtained them by uprooting the trees with their powerful feet armed with strong claws. The last surviving species of Giant Ground Sloths lived contemporary with early man in South America, probably, indeed, within a hundred years of the present time. In a cave in South America near Last Hope Inlet, in Patagonia, numerous remains of these animals, named *Neomylodon*, had evidently been kept in confinement, and fed upon grass cut by man, as cows are kept in a shed at the present day. They were killed off by their captors from time to time when needed for food, and their bones, with the implements of early man, were found in the cave where they had been eaten. No historic record of these South American Indians is known; we cannot, therefore, fix the exact date when these great animals were last seen alive. Like the Moa in New Zealand, the *Æpyornis* in Madagascar, and the great sea-cow

(*Rhytina*) of Behring Island, and many other animals, they have all been destroyed by man.

UNGULATA CONDYLARTHRA.—This is a small, generalised, early group of ungulates approaching the ancestors of the carnivora. The feet are pentadactyle and plantigrade; the brain is diminutive. *Hyracops* and *Phenacodus* are typical examples. The teeth have a low crown, bearing tubercles. They occur in the Eocene formation.

HYRACOIDA.—In this order there are two surviving genera, *Hyrax* and *Dendrohyrax*, of Africa and Syria. They occur fossil at Pikermi, in Samos, in Egypt, and Patagonia.

AMBLYPODA.—The Amblypoda, or blunt-toed animals, make their appearance in the Lower Eocene. Many of these animals attained a very large size, nearly equal to that of the Elephant, their limbs being adapted to support the weight of very ponderous bodies. The brain in these early animals was extremely small; the teeth are brachyodont, the tubercles being fused mostly into transverse ridges, the full number of teeth being forty-four.

Coryphyodon and *Dinoceras* are from the Lower and Middle Eocene formations, and are striking examples of this now extinct group. *Dinoceras* and *Tinoceras* are provided with horns on the skull, and a full series of teeth are present; the skeleton and limbs closely resemble those of the Elephant in their general characters. They have no living representatives at the present day.

Arsinoitherium Zitteli Beadn.—There has lately been obtained from the Upper Eocene of the Fayûm, Egypt, a most remarkable and novel form of large extinct Mammal, belonging to the Amblypoda, as big as a large rhinoceros in size, and having a most *bizarre* and remarkable skull. The brain was small, and placed near the hind part of the cranium; the whole of the top of the skull being occupied by two very small and two immense horn-cores, the latter of which measure, from the occipital condyle to the tip of horn, 99 cm.; their points are directed forwards; the nasal openings are beneath them in front, divided by a very narrow septum. The jaws are compressed in front, and provided with numerous teeth adapted to vegetable food. The mouth had probably a prehensile upper lip, or a proboscidiform snout like that of a tapir, to enable it to gather its food, whether leaves or grasses. It is probable these animals possessed a horny sheath, covering their great bony horns, as the surface of the bone is marked by vascular canals. The skeleton in the Amblypoda—save the skull—was not unlike that of the elephants, and these great pachyderms probably may have been derived from a common ancestor in the far distant past.

PROBOSCIDEA (Elephant, Mastodon, etc.)—Although the existing Elephants form a well-known group of hoofed quadrupeds, they have been for a very long time separated from all the other herbivorous animals by many peculiarities in their structure and

dentition, and we were for a very long time unacquainted with any older forms showing a more generalised type of structure. Until about a year ago the only forms of Elephants with which we were acquainted were (1) the African Elephant, (2) the Indian Elephant, (3) the *Mastodon*, (4) the *Tetrabelodon*, and (5) the *Dinotherium*. The extinct forms of Elephant approach either the African or the Indian type: for instance, the Mammoth agrees most nearly with the modern Indian form; the *Elephas meridionalis* of the Norfolk Forest Bed and other deposits suggests affinities with the African species. Certain small pigmy forms, occurring fossil in Malta, Sicily, and Cyprus, may also have had affinities with the African species. But it is only in the molar teeth that these Elephants differ in any material degree from one another. The *Mastodon* has the character of the molars considerably changed from those of the true Elephants. In the Indian Elephant and in the Mammoth, the transverse ridges—which are placed closely together, forming the massive molar teeth—have sometimes as many as thirty ridges in one tooth; in some of the American Mastodons the molars had only three ridges. Another peculiarity is the occasional presence of milk-incisors in the lower jaw of the American Mastodon. Otherwise, modern and extinct Elephants and *Mastodons* agree in having only one pair of incisor teeth, and those always being in the upper mandible. In *Tetrabelodon*, which was a Miocene form, two pairs of incisors seem always to have been present, the upper pair being bent downwards, and the lower pair being directed nearly straight in front, or a little curved upwards. On account of the large size of the molar teeth in modern Elephants, we usually find not more than two molar teeth on each side in use in the jaws at the same time; these are renewed from behind—not from below, as in most other mammals, and in the earlier forms of Proboscidea—and are pushed forward and worn away in front by the new molars gradually taking their place from behind. In the earlier forms of the Elephant and Mastodon, the teeth being smaller, a larger number could be in use in the cheek-series at the same time than in *Elephas*; in *Tetrabelodon* this is also the case.

The gradual increase in the complexity of the proboscidean molars is one of their most striking characteristics. We notice also the loss of the incisors, only two upper ones remaining; the canines are also lost. In the earliest forms some at least of the cheek-teeth are replaced by premolars in the usual manner; these teeth remain in wear simultaneously with the true molars, but in later forms no vertical succession takes place, and as the milk-molars are worn they are shed, being replaced from behind by the true molars.

In *Palæomastodon* (Upper Eocene) the molars are trilophodont; in *Moerithium* the teeth are simple brachyodont bilophodont (quadritubercular molars), and molars, premolars and incisors are all present. In the earliest forms the skull had not attained the

elevation seen in the modern Elephants, but resembled that of an ordinary form of mammal such as the Pig or Tapir. With the increased length of the proboscis the length of the jaws diminished, the teeth were reduced in number, and became deeper and larger, and the jaws also correspondingly deeper, also the facial angle became more vertical, and the jaw shorter. In the modern Elephant we may observe that the brain actually is just above the palate and over the grinding-surface of the teeth, which no longer occupy a position anterior to the brain, as in ordinary mammals.

In *Dinotherium* the incisors so characteristic of modern Elephants are wanting in the upper jaws, but two exist in the lower jaw curved downwards, quite unlike that in any other of the Proboscidea known; molars and premolars seem to have been present in the jaw at the same time.

The Ancylopoda represent another primitive sub-order of ungulates, with a very wide range in Miocene and Pliocene times. They resemble the great extinct ground sloths of America, and the existing ant-eaters of the old world, and when the limbs alone were known they were referred to the Edentates. *Homalodontotherium*, *Macrotherium*, and *Chalicotherium* belong to this sub-order, and are met with in Patagonia, North America, Europe and Asia.

Typotheria.—These form a group of extinct ungulates from South America, found in the Pampas formation, some of them of considerable size, comprising *Typotherium*, *Pyrotherium*, and *Pachyrucus*. The teeth are more or less rodent-like. They appear to be little-modified descendants of very primitive mammalia.

Toxodontia.—Named from the typical genus *Toxodon*. The complete skeleton of *Toxodon* is known. The animal was shorter-limbed, but more bulky than a horse, having rodent-like incisors in its jaws. The teeth are deepened, and more or less curved, often growing persistently throughout life. The dental series is nearly complete, only the canines being reduced or absent. The name *Toxodon* is derived from the bow-like form of these teeth.

Lytopterna.—This is a South American group of animals which in their foot and tooth structure resemble the uneven-toed ungulates (the Perissodactyla), though they are not related to them. *Proterotherium* and *Thoatherium* belong to this sub-order. A better known genus is that of *Macrauchenia patagonica*, an animal with a long neck and three complete digits. The original fossil remains of this animal were obtained by Darwin during the voyage of the 'Beagle.'

Perissodactyla (Uneven-toed Ungulates).—Many early forms are included in this division, the Perissodactyla, or uneven-toed Herbivora. Nearly all the ancestors of these animals had pentadactyle (five-toed) feet. One of the earliest of these families are the Tapirs, the living representatives of which being found as far apart from one another as South America and the Malay Peninsula.

Many fossil forms of tapirs occur as far back as the Eocene period; others are met with in the Miocene and Pliocene formations of North America; their teeth are found in the Red Crag of Suffolk, in the Antwerp Crag, in the Lower Pliocene of Hesse-Darmstadt, Austria-Hungary, France, and Italy; one species occurring as far off as in the Pliocene formation of China; their geographical range, as well as their geological antiquity, being very great.

Among the ancestors of the horse may be mentioned the *Hyracotherium* (*Protorohippus venticolum*), from Wyoming, in which there are four toes present in the fore foot, and five toes in the hind foot; *Orohippus* is a closely allied genus, also from the Middle Eocene of Wyoming. *Palæotherium* is found only in the Upper Eocene of Europe, its remains having been obtained in a very perfect state from Montmartre, Paris.

Anchitherium closely resembles *Palæotherium*, but the incisor teeth exhibit an apical pit or depression, which characterises the front teeth in the existing horse. *Mesohippus* is another early form allied to these, from the Miocene of Dakota.

The lower Pliocene makes us acquainted with another three-toed ancestor of the horse in which the crown of the worn upper molar displays a more marked complexity in the folding of the enamel, and a shortening of the second and fourth digits, which no longer take any part in supporting the foot on the ground.

In *Pliohippus*, the second and fourth digits have lost their phalangeal bones; and only the slender splint-bones seen in the leg of the horse, represent the second and fourth digits, the animal, like the horse, being supported on the third digit alone.

In the RHINOCEROTIDÆ we have several curious ancestral forms preserved to us, of which *Titanotherium*, from the lower Miocene of Dakota, is a remarkable example. In this animal a pair of blunt bony horns are placed side by side on the nasal bones. In the modern Rhinoceroses there is no bony base to the horn; the whole being composed of a mass of coalesced hair of the same nature as the outer investing sheath of the cow's-horn, only the interior is solid and entirely composed of the same epidermic material. Numerous fossil species of Rhinoceros have been met with in America, in this country, throughout Europe, and in India; and its geographical range formerly extended North, even to Arctic Siberia. Species of Rhinoceros still survive in Africa and in India. One of these African species, *Rhinoceros simus*, is probably closely related to the *Rhinoceros antiquitatis*, found fossil in Siberia.

The tichorine or woolly rhinoceros is found in most English bone-caves and river-deposits, and on the Dogger Bank, in the North Sea, and other submerged old land-deposits off the Norfolk and Suffolk coasts. In Siberia it wandered even within the Arctic Circle, its mummified remains having been discovered in the frozen

earth in Northern Siberia, from which it is seen that the animal had been thickly clothed with hair and wool. Its huge horns have also been found in the same deposits.

A remarkably specialised fossil form occurs in Southern Russia, known as *Elasmotherium*, in which the nasal bones are slender, but the nasal septum is ossified; and there is an enormous bony prominence on the frontal region of the skull, which must have borne a relatively large horn.

Numerous species of Rhinoceros occur fossil in the Siwalik Hills of India; at Maragha, in Persia; at Pikermi, in Greece; in Italy, France, and Britain.

ARTIODACTYLA (even-toed Ungulates).—The even-toed hoofed animals are traceable from early Eocene times; they have the third and fourth digits almost equally developed in both fore, and hind feet; the hoof-bones are flattened on their inner or contiguous surfaces. They are sub-divided into four groups: (1) pigs, peccaries, and hippopotami (Suina); (2) camels and llamas (Tylopoda); (3) chevrotains (Tragulina); (4) deer, sheep and cattle (Pecora).

Such divisions as Artiodactyla, Perissodactyla, lose much of their significance when we follow them down to their earliest ancestral types. One of the most well-known families is that of the Hippopotamidæ. These large Amphibia, now only met with in the rivers and lakes of the interior of tropical Africa, were once equally abundant from the Cape to the Delta of the Nile; where they occupied the sea-shores and estuaries, as well as the internal rivers and lakes. In late Tertiary times they were most abundant in Britain, France and Italy, whilst pigmy species occurred in the islands of Malta, Sicily and Cyprus. Numerous species have also been found in the Siwalik Hills of India, and the fossil remains of a small form occurs abundantly in the Island of Madagascar. Large species of fossil pigs occur both in India and in America; at Pikermi, in Greece; in Tuscany; and at Eppelsheim, Hesse-Darmstadt. Various ancestral forms of these animals go back to Eocene times.

The extinct genera, *Elotherium* and *Cheiropotamus*, each possessing the typical number of forty-four teeth, occur in the lower Miocene of France, and in the Hempstead beds of the Isle of Wight. Another Eocene form, *Anthracotherium*, occurs in Piedmont, in France and in Hampshire. *Hyopotamus*, from the Isle of Wight, and *Merycopotamus* are closely related; the latter is from the Siwalik Hills, India.

Anoplotherium represents another of the early Eocene Mammals, once abundant in this country and in France, but it does not appear to have left any descendants behind.

Passing over a large number of small Eocene and Miocene Mammals, as *Cœnotherium*, *Xiphodon*, *Orcodon*, and *Agriochœrus*,

the two former from French localities, and the two latter from the American Miocene deposits, we come to an ancestor of the existing Camelidæ, camels and llamas (Tylopoda, in allusion to their cushion-like feet).

Of these, *Macrauchenia* occurs in Patagonia, *Pœbrotherium* and *Procamelus* in Colorado and New Mexico. *Protoceras* is another remarkable horned form from the lower Miocene of Dakota, having bony prominences, probably supporting horns, on the nose, on the frontal bones, and a third pair on the parietal bones of the skull.

The CERVIDÆ, true deer, appear for the first time in the middle and upper Miocene of North America, and in the Miocene of France, etc. The earliest members of the deer-tribe appear to have had very prominent bony pedicles on their skulls giving rise to small deciduous Antlers, which seem to have attained their greatest size in Pleistocene or Quaternary times.

The gigantic Irish deer, the Reindeer, and the Elk, have all been living inhabitants of Britain within the human period.

The GIRAFFIDÆ are represented by two surviving forms, the Giraffe and the Okapi, both confined at present to the interior of Africa.

The extinct forms are *Helladotherium*, and *Samotherium*, from Samos, Greece, and Persia; *Palæotragus* from Greece; and *Sivatherium* from the Siwaliks of India.

The ANTELOPIDÆ are almost confined to Africa, but they formerly ranged, in Tertiary times, into France, Spain, England, Austria, Italy, Greece, Samos, Persia, and India. The *Saiga tartarica* once inhabited the Thames Valley, and is still living on the Siberian steppes of the Volga.

Of the ancient stocks from which our domestic cattle have arisen, the only ones of geological interest are the musk-ox (*Ovibos moschatus*), the Bison, occurring both in Europe and North America, the great *Bos primigenius* (probably the "Urus" of Cæsar), and the small *Bos longifrons*; this last having survived down to Romano-British times.

RODENTIA.—The Rodentia are a well-defined group of small gnawing mammals, destitute of canine teeth, and with one pair of large chisel-shaped incisor teeth above and below, growing with persistent pulps throughout life. The Hare, Rabbits, Porcupines, Beaver, Rats, Mice, Dormice, Squirrels and Marmots, offer examples of existing forms of this group.

The Marmot, *Sphermophilus*, occurs in the Pleistocene deposits in this country; the Beaver was once a common animal with us, its remains being abundantly met with in the Pleistocene deposits of Essex and Cambridgeshire; it is still living in the estuaries of the Rhone and the Danube, and in some Russian rivers; it is also to be met with in Canada, and Vancouver's Island, British Columbia. In the Forest Bed series of the Norfolk coast, in South Russia, in

Ohio, New York, Mississippi, etc., several gigantic forms of Beaver are known, e.g. *Trogontherium Cuvieri, Castoroides Ohioensis,* twice as large as the existing Beaver. An extinct giant Dormouse, *Myoxus melitensis,* has been found in the newer Tertiary deposits of the Island of Malta, associated with the remains of the Pigmy Elephant. The *Lagomys,* or Tail-less Hare, occurs in Brixham Cave and Kent's Cave, Torquay, and in the Miocene deposits of Oeningen.

Carnivora.—Before the appearance of warm-blooded mammals the duties of the Carnivora, or flesh-eating animals, were performed by the carnivorous Dinosaurs, and in earlier times by the carnivorous Theriodonts. With the advent of the herbivorous mammalia Lions, Tigers, Hyænas, Bears, Wolves, and lesser Carnivora made their appearance; one of the most striking of these early forms was the great Sabre-toothed Tiger, *Machærodus,* whose remains have been discovered in North and South America, in England, in France, in Italy, in India, and various localities, associated with the early species of Elephants. There is little doubt that this formidable extinct Tiger preyed upon these great herbivores, and that the huge canine teeth protruding from the upper mandible enabled it to fasten upon the flanks of the Elephant, whose blood it doubtless sucked. Hyænas and Bears were both abundant in this country in late Tertiary times, their remains with those of the *Machærodus* being found in the cave deposits of Britain, France, Germany, etc.

Pinnipedia (*Fin-footed*).—The Seals represent in the marine deposits the Carnivora of the Land. Gigantic species of the clam-eating Walrus have left their remains in the Suffolk Crag and the Dogger Bank in the North Sea. Seals were once also abundant in these later deposits and upon our coasts.

Insectivora.—The small mammals belonging to the *Insectivora,* —the Moles, Shrews, and Hedgehogs—do not go back in time beyond the Eocene and Miocene deposits. One form, *Necrogymnurus,* occurs in the Eocene of Hordwell, and a species of *Erinaceus* in the Miocene of Oeningen; others occur in the Brick-earth of the Thames Valley and the Norfolk Forest Bed.

Chiroptera.—The Chiroptera or Bats have the fingers of the fore-limbs enormously elongated, and united by an expansile membrane (patagium) which joins the fore and hind limbs and the sides of the body together, enabling the creature to pursue an aerial existence somewhat like a bird; but the "flitter-mouse," (the old English name for the Bat), is clothed in fur, not feathers. Some of the large tropical Bats are fruit-eaters, while others are insectivorous in their diet. Remains of a fossil bat have been found in the Upper Eocene of the Gypsum Quarries of Montmartre, Paris.

Primates (*Man*).—The remains of man and of the higher

Anthropoid Apes are seldom found in a fossil state; the earliest human remains known are met with in Caves, in Peat deposits, or, as represented by their weapons, in river valley gravels. Fossil monkeys are extremely rare. A single tooth referred to *Macacus pliocænus* was obtained from the Brick-earth of Grays, Essex. Of the Lemurs, *Adapis* and *Necrolemur* occur in the Eocene of Hordwell, Hampshire, and the older Tertiaries of France; other remains have been obtained from the Miocene of Dakota, North America; and *Megaladapis*, a giant Lemur, from the newer Tertiaries of Madagascar.

I would only remark in conclusion, that the geological record, so far as preserved to us, gives proof of progressive advance in vertebrate life, and we find throughout the rocks undoubted evidence of development from lower to higher forms. Groups like the Sauropterygia, Ichthyopterygia, the Cetacea and Sirenia, are so evidently exceptions, and present cases of retrogression so divergent from the rest of the biological series, that they do not impugn the general conclusion of a gradual onward progression of life to a higher condition of existence.

A few instances of lowly persistent forms occur in the vertebrata as among the invertebrata. Thus the Cyclostomi and the Elasmobranchi have probably lived on but little changed from the Devonian, or even earlier, until recent times; but the great majority of vertebrates give evidence of evolution, not only in their orders and families, but in their individual development. Nor can it be doubted that the advance of mankind from the rude state of primitive savages to the present conditions of culture and development in the arts and sciences, attests the same progress in the human race towards a higher life to which all nature moves.

My friend, Dr. H. Dukinfield Scott, who will presently occupy this chair, which, by your favour, I have been called upon to fill for the past two years, will be able to tell you that in his special branch of investigation (Palæobotany), he has found it to be indispensable not only to know the microscopic structure of living plants in order to compare them with those of fossil ones; but also to know both the living and the fossil plants themselves, the former as they are met with at the present day, and their ancestors as they are found in the rocks.

I shall thus, I hope, obtain from my successor some countenance for my temerity, in having ventured to detain you so long this evening with my sketch of the ancestors of the Vertebrata, which follows as Part II. of my Address to you in January 1903.

V.—*On the Vertical Illuminator.*

By Edward M. Nelson.

(*Read Feb. 17th*, 1904.)

With reference to the Vertical Illuminator, which, after lying more or less in abeyance for some twenty-five years, has lately come into notice for the examination of opaque objects, a few words may be said both on its construction and use.

There are four forms of this appliance now catalogued by opticians.

1. That known as Tolles' interior illuminator. This consists of a minute prism let into the side of the objective mount, either just behind the duplex or triplex front, or the back lens.

This form may be criticised, because (α) it gives, and can only give, oblique illumination; (β) it requires a special modification of the objective mount; (γ) the objective cannot perform so well as it ought to do when it has a portion of its aperture at its periphery permanently stopped out.

(Zeiss' form of Tolles' illuminator blocks out half the objective aperture.)

2. The Beck form: this consists of a nose-piece containing a cover-glass for a reflector, mounted so as to be capable of rotation.

This has the advantage (α) that the objective aperture is left quite clear; (β) that in the objective itself there is neither the modification nor the structural alteration that the Tolles' method requires.

This device may be criticised because (α) only a portion of the back lens can be illuminated by a parallel beam when the circular cover-glass is rotated to an angle of 45°, and (β) it has no means of regulating the illumination.

3. Powell's form, like Beck's, consists of a nose-piece, but it contains a piece of worked glass fixed permanently at an angle of 45° in place of the rotating cover-glass. It has, however, an attached wheel of diaphragms for the purpose of regulating the light. The criticism relating to this device is that the opening is so small that (α) it cuts down the aperture of the objective; (β) the whole of the back lens cannot be illuminated by a parallel beam.

4. Reichert's form is somewhat similar to Powell's, only it is mounted in an eye-piece adapter at the upper end of the draw tube, and it has no light regulator. The criticism upon this device is (α) the reflector is too far from the back lens of the objective, and (β) there is no means of regulating the illumination.

By casting one's eye over the criticisms on these forms of vertical illuminators, it is quite easy to see what is, and what is not wanted.

1. The vertical illuminator must not be an oblique, and an oblique illuminator only.

2. It should be capable of illuminating the full aperture of the back lens of any objective with a parallel beam of light.

3. It must not be a permanent attachment to an objective, so as to impair its performance of ordinary work.

4. The reflector must be placed near the back lens.

5. There must be some method of regulating the illumination.

From the above we may gather that a nose-piece form of apparatus is the best, and it would seem that the Beck and Powell forms more nearly conform to the above named conditions, but the reflecting glass must be made much larger than at present, and the hole in the side of the nose-piece should be as large, or nearly as large as the opening of the Society's gauge.

How to use a Vertical Illuminator to the best advantage.

This form of illumination can only be used to the best advantage with oil-immersion objectives, and it is the peripheral portions of these objectives which play the most important part with this method.

Hence we see it is absolutely necessary that the full opening of the Society's gauge should be left perfectly clear, so that the back lens of any objective may have none of its aperture cut down.

Again, in order that the illuminating source may be focussed upon the object, it is necessary that the path of the light from its source to the mirror, and from the mirror to the objective, should be equal to that from the eye-piece to the objective. To satisfy this condition with the Reichert method, the lamp would have to almost touch the body-tube—a quite impossible condition.

At the hole in the side of the nose-piece there should be a carrier for diaphragms of various sizes—this is preferable to either a wheel of diaphragms or an iris. There should also be a strip of metal with a slit in it, which can be drawn across the hole at the side of the nose-piece. The direction of the slit should be in a line with the edge of the flame of the Microscope lamp. Good illumination can be obtained by carefully attending to the focus of the image of the flame on the object, by placing the lamp at a suitable distance, and by regulating both the size of aperture and the position of the slit. A large cover-glass supplied for compressors would form an excellent mirror; nothing else is required except the nose-piece adapter with a hole in its side, the diaphragm-carrier, which might with advantage be made capable of rotation, and a few loose stops. As the microscopical examination of metals is now of so much importance, perhaps the few moments spent on the consideration of the vertical illuminator will not have been wasted.

SUMMARY OF CURRENT RESEARCHES

RELATING TO

ZOOLOGY AND BOTANY

(PRINCIPALLY INVERTEBRATA AND CRYPTOGAMIA),

MICROSCOPY, ETC.*

ZOOLOGY.

VERTEBRATA.

a. Embryology.†

Determination of Sex.‡—Oskar Schultze communicates a full account of his experiments on mice designed to test whether alteration in nutrition had any effect on the proportions of the sexes in the offspring. His results are decidedly in favour of an answer in the negative. He gives a masterly review of the whole subject, and concludes that sex is determined in the early stages of oogenesis.

General Embryology.§—E. Korschelt and K. Heider give in the first instalment of the "general" part of their treatise on the comparative embryology of invertebrates an account of the structure, maturation, and fertilisation of the germ-cells, and a review of all the recent work on the physiology of development.

Mechanics of Development.‖—S. J. Hickson gives a lucid account of recent work in experimental embryology. "The facts which to-day may convince us that there is no preformation of structures in the animal egg, that there is no 'mosaic' arrangement of the particles of primordial protoplasm, may, in the course of time, be supplanted by others, which will lead us to a reconsideration of our opinion. We have at least learned to realise that no simple, physical or mechanical explanation will ever solve the problem of the living substance of the egg-cell. We may learn the effect of gravity, of temperature, of various kinds of intensities of light, or of chemical and electrical stimuli, upon protoplasm; but we have not yet got within measurable distance 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, etc., 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, Reproduction, and allied subjects.

‡ Arch. Mikr. Anat., lxiii. (1903) pp. 197–257.

§ Lehrbuch. d. vergleich. Entwicklungsges. d. wirbellosen Thiere. Allg. Theil. Erste Lief. 8vo, Jena, x. and 750 pp..

‖ Rep. and Trans. Manchester Micr. Soc., 1902 (published 1903), pp. 28–37.

understanding all of the forces that influence the phenomena of protoplasm."

Conversational Ætiology.*—Franz Krăsan discusses by means of imaginary conversations between half a dozen incognitos the profoundest questions of biology:—How far is organic form a function of organic substance? What is the nature of reaction to environment? Can we distinguish between the original and the accessory characters of individuals? What is the real meaning of metamorphosis and substitution of organs? What is the evolutionary import of variation, mutation, and modification? How are we to define species, variety, and breed? What is the scope of hybridisation and in-breeding, of isolation and selection? The author traverses the whole field of evolution-theory, but his peculiar mode of presentation is not attractive.

Uterine Implantation of the Ovum of Spermophilus citillus.†—J. Rejsek shows that the first fixation and preliminary nutrition of the ovum in this mammal is quite apart in time and space from the placental fixation and nutrition. Fertilisation and cleavage occur in the Fallopian tube, and the segmented ovum passes into the uterus. A portion of the superficial stratum (Rauber's layer) remains composed of high cells, while the rest of the cells of this stratum are flattened. The high cells form a thickening at the pole opposite the blastodermic disc, and give rise to a syncytial prominence which enters into close connection by means of processes with the wall of the uterus. Details of the growth of these syncytial processes are given; they degenerate as the placenta develops.

For a very short time the ovum depends on itself, but there is soon need for maternal nutrition. This is provisionally afforded by the processes of the syncytium, which establish a nutritive connection between the ovum and a fluid material for the most part derived from the maternal uterine cells.

Normal Degeneration of Eggs not Liberated.‡—M. Dubuisson corroborates and extends the observations of C. Perez on the degeneration of unlaid eggs. His material was found in the eggs of sparrow, frog, and newt. He describes the part played by follicular cells and by phagocytes.

Spermatozoa of Discoglossus pictus.§—E. Ballowitz gives a detailed description of the unique spermatozoa of this amphibian. They are remarkable (1) in their extraordinary length ($2\frac{1}{4}$ mm.); (2) in the elaboration of screw-architecture in all the parts; and (3) in the fine details of their structure.

Correlation between Poison-Gland and Ovary in Toad.‖—C. Phisalix notes that the poison-gland of the female toad is almost empty at the spawning time, and in striking contrast to that of the male. He finds that the active principles of the poison are present in the eggs,

* Ansichten und Gespräche über die individuelle und specifische Gestaltung in der Natur. 8vo, Leipzig, 1903, vii. and 280 pp.

† Arch. Mikr. Anat., lxiii. (1903) pp. 259–73 (1 pl.).

‡ Comptes Rendus, cxxxvi. (1903) pp. 1690–1.

§ Arch. Mikr. Anat., lxiii. (1903) pp. 343–64 (1 pl.).

‖ Comptes Rendus, cxxxvii. (1903) pp. 1082–4.

but that they disappear during early embryonic life. "The re-appearance of these toxic substances in the organism is correlated with the development of the poison-glands. The poisons formed by these glands pass into the blood after the manner of internal secretions, and at the time when the ovary becomes active, they become associated with the germ-cells to contribute to the formation and the development of the egg."

Toxic substances are known in the eggs of certain fishes and sea-urchins, and Phisalix thinks that they probably have an important rôle in oogenesis and development. "Perhaps they form a material basis of inheritance, and serve to transmit the chemical characteristics of the species,"—which seems a large conclusion to draw from the premises.

Development of Tarsius Spectrum.*—A. A. W. Hubrecht notes that the placentation of this aberrant type is pronouncedly "deciduate," while the arrangement of the fœtal membranes, with the diminutive yolk-sac, rudimentary allantois, and large extra-embryonic cœlomic space, brings *Tarsius* near the monkeys and man.

The author describes the maturation, fertilisation, segmentation, etc., and pays particular attention to the germinal layers. The material for the extra-embryonic cœlom springs from the posterior end of the blastoderm; in continuity with it is formed the primitive streak in the centre of which is the rudimentary blastopore or neurenteric canal. The mesoderm is formed from an anterior tract of hypoblast (as frequently in Amniota), and from a peripheral ring (as described by the author in the shrew).

To solve the problem of the germ-layers, Hubrecht goes back as far as a Cœlenterate type, and asks us to see in its gastrovascular cavity and stomodæum the fore-runners of the blastopore and notochord respectively.

Development of Lens.†—Em. Mencl discusses the difficult case of the development of a lens apart from any direct contact between the brain and the epidermis.

Notes on Development of Lizard.—Karl Peter finds that while the primitive plate is essentially an ectodermic proliferation, some endodermic cells are included along with it. He re-affirms his conclusion that there are in lizards five pairs of gill-clefts, and that the suprapericardial body is the homologue of a pair of gill-clefts.

b. Histology.

Secretory Phenomena in Poison-Glands and Digestive Glands.§—L. Launoy has made a detailed study of the poison-glands in the viper, newt, scorpion, centipede, etc., and of the digestive glands in crab and hermit-crab. In the active glands, whether poisonous or digestive, the nucleus of an actively secreting cell is the seat of "passive phenomena"

* Furchung und Keimblattbildung bei Tarsius spectrum. Amsterdam, 1902, 115 pp. and plates. See Nature, lxvii. (1903) pp. 341-2.

† Anat. Anzeig., xxiv. (1903) pp. 169–73 (15 figs).

‡ Tom. cit., pp. 156–64 (4 figs.).

§ Ann. Sci. Nat. (Zool.), xviii. (1903) pp. 1–224 (2 pls.).

—"nuclear turgor, anteropulsion, and centrifugal projection of granules of chromatin;" and of "active phenomena"—"variations of chromaticity, emission of fuchsinophilous and cyanophilous granulations into the perinuclear cytoplasm, dissolution of the chromatic substance and its exosmosis, and phenomena of intra-nuclear pyrenolysis."

The process of elaboration is two-fold, a nuclear phase giving rise to "*venogen*" and "*caryozymogen*," and a cytoplasmic phase giving rise to poison and prozymase. Cytologically, caryozymogen and venogen are comparable, and so are prozymase and poison.

In the poisons studied the toxic enzyme does not co-exist with any of the enzymes, such as amylase or emulsin. In the poison of the cobra there is a substance precipitating soluble ferments; there is no catalysing action, either positive or negative, on the soluble ferments, emulsin, amylase, and pancreatin, but there is a slight inhibitory action on pepsin.

Nuclear Changes during Secretion.*—L. Launoy has studied the changes in the nuclei of actively-secreting cells. He distinguishes passive phenomena, concerning the volume and position of the nucleus, and active phenomena, which include profound modifications of structure in correlation with the direct participation of the nucleus in the secretory process, and especially involving the chromatin and the nucleolus.

Brunner's Glands.†—R. R. Bensley has made a detailed study of the cytological characters, staining reactions, and functions of the glands of Brunner in a number of representative mammals. He shows that they are distinctively mucous glands, but does not exclude the possibility that they also form minute quantities of digestive ferments, which escaped detection by available means. It seems to the author probable that the glands of Brunner are cænogenetic structures, developed in mammals from the hypoblast of the midgut. The occurrence of serous tubules in the glands of Brunner in the rabbit is evidence of a new functional need in the intestine. Bensley is against Oppel's theory, that Brunner's glands are developed as a further downward growth of the pyloric glands into the intestine.

Cardiac Glands of Mammals.‡—R. R. Bensley has studied these in man, pig and various rodents. He finds that they are mucin-glands, and interprets them as retrogressive derivatives of the fundus glands. In support of this interpretation, he discusses the phylogeny of the cardiac glands at some length.

Buccal Gland of Lampreys.§—W. Haack describes the paired multicellular gland which lies in the mouth of adult lampreys, imbedded in the musculus basilaris. He shows that multicellular glands also occur in Myxinoids, *Chimæra*, and Elasmobranchs, and as poisonous organs in some Acanthopterygii. Although the skin of aquatic Vertebrates is in general devoid of multicellular skin-glands, doubtless a secondary effect of the medium, and although integumentary glands are rudimentary and

* Comptes Rendus, cxxxvi. (1903) pp. 1479–81.
† Decennial Publications Univ. Chicago, x. (1903) p. 50 (6 pls.).
‡ Amer. Journ. Anat., ii. (1903) pp. 105–56.
§ Zeitschr. wiss. Zool, lxxv. (1903) pp. 112–46 (2 pls.).

salivary glands absent in cetaceans, yet cases like the skin-glands of *Myxine* and *Chimæra*, and the buccal gland of lampreys, show that it is almost impossible to make a phylogenetic series with well-defined steps.

Œsophageal Glands in Reptiles.*—F. Béguin finds distinct œsophageal glands in an African lizard, *Uromastix acanthinurus*, and in *Testudo græca*, but not in the alligator.

Histogenesis of the Intestinal Epithelium in the Frog.†—R. H. Marcelin gives an account of the development of the frog's intestine—its growth in length, the histogenesis of the epithelium, and the development of the glands. The whole intestine is originally ciliated, and this is important before the muscles causing peristalsis have developed. In the buccal cavity and œsophagus the ciliated epithelium persists, aiding in this region of rapid movement the action of the muscles. In the stomach and intestinal regions the cilia disappear as the adult conditions are attained. The calyciform cells, which appear first in the œsophagus and stomach, and subsequently in the small intestine after the cilia have gone, secrete a mucus which is probably both digestive and lubricating. They disappear from the stomach as the gastric glands develop, they are minute in the small intestine, and they disappear completely from the large intestine as the strong musculature develops.

Cardiac Muscle Fibres.‡—F. Marceau discusses the transverse scalariform-striated bands in cardiac muscle fibres which occur in adult mammals, in young mammals some time after birth, and in certain adult birds. He describes their intimate structure, their development, and their distribution in the heart; and then discusses their probable significance in helping to secure rapid and rhythmic contraction.

Egg-Tooth in Sauropsida.§—Margherita Pondrelli finds that the egg-tooth in Chelonia has the same structure and development as in birds. It consists of a mass of epithelial cells, irregularly polygonal in form, dovetailed together, with indurated walls, and without intercellular substance. It is abetted by an epitrichial thickening, which forms a cap with abundant ceratohyaline.

Minute Structure of Blood-Vessels.‖—Drs. Baum and Thienel have completed a laborious research on the peculiarities in the detailed structure of the walls of the arteries and veins in different parts of the body and in different animals. They bring out very clearly the fact that various mammals are quite specific as regards the walls of the vessels.

c. General.

Zoological Essays.¶—R. Lydekker has re-published in volume form a set of his well-known and much appreciated zoological essays—fine examples of the possibility of expressing accurate science in vivid

* Anat. Anzeig., xxiv. (1904) pp. 337–56 (14 figs.).
† Revue Suisse Zool., xi. (1903) pp. 369–92 (1 pl.).
‡ Comptes Rendus, cxxxvi. (1903) pp. 1685–7.
§ Anat. Anzeig., xxiv. (1903) pp. 165–8 (2 figs.).
‖ Arch. Mikr. Anat., lxiii. (1903) pp. 10–34 (1 pl.).
¶ Mostly Mammals. Zoological Essays. 8vo, London, 1903, ix. and 383 pp. 16 full-page illustrations.

literary form. The volume includes essays on extermination in the nineteenth century, domesticated animals and their history, problems of geographical distribution, desert faunas, protective coloration, the whiteness of arctic animals, the colours of cowries, the nursing habits of amphibians, scorpions and their antiquity, and on many other subjects. The book deserves to be widely known and admired.

Economic Zoology.*—E. Ray Lancaster prefixes to F. V. Theobald's *First Report on Economic Zoology* (see INSECTA) a luminous and useful survey of the various sub-divisions which it is found convenient to recognise in the treatment of this subject. This classification of animals in their economic relation to man appears to us so important, that we submit it in condensed outline.

Group A.—Animals *captured* or *slaughtered* by man for food, or for the use by him in other ways, of their skin, bone, fat, or other products. *Examples :*—Animals of the chase ; food-fishes ; whales ; pearl-mussels.

Group B.—Animals *bred* or *cultivated* by man for food, or for the use of their products in industry, or for their services as living things. *Examples :*—Flocks and herds ; horses ; dogs ; poultry ; gold-fish ; bees ; silkworms and leeches.

Group C.—Animals which directly promote man's operations as a civilised being without being killed, captured or trained by him. *Examples :*—Scavengers such as vultures ; carrion-feeding insects ; earthworms and flower-fertilising insects.

Group D.—Animals which concern man as causing bodily injury, sometimes death to him, and in other cases disease, often of a deadly character. *Examples :*—Lions ; wolves ; snakes ; stinging and parasitic insects ; disease germ-carriers, as flies and mosquitoes ; parasitic worms ; parasitic Protozoa.

Group E.—Animals which concern man as causing bodily injury or disease (both possibly of a deadly character) to (*a*) his stock of domesticated animals ; or (*b*) to his vegetable plantations ; or (*c*) to wild animals in the preservation of which he is interested ; or (*d*) wild plants in the preservation of which he is interested. *Examples :*—Similar to those of Group D, but also insects and worms which destroy crops, fruit and forest trees, and pests such as frugivorous birds, rabbits and voles.

Group F.—Animals which concern man as being destructive to his worked-up products of art and industry, such as (*a*) his various works, buildings, larger constructions and habitations ; (*b*) furniture, books, drapery and clothing ; (*c*) his food and his stores. *Examples :*—White ants ; wood-eating larvæ ; clothes' moths, weevils, acari, and marine borers.

Group G.—Animals which are known as "beneficials," on account of their being destructive to or checking the increase of the injurious animals classed under Groups D, E, and F. *Examples :*—Certain carnivorous and insectivorous birds, reptiles, and Amphibia ; parasitic and predacious insects, acari, myriopods, etc.

* First Report on Economic Zoology. By Fred. V. Theobald. British Museum, 1903, xxxiv. and 192 pp., 18 figs.

Variations in Human Ribs.* — J. Dunlop Lickley gives statistics as to the relations of the seventh and eighth ribs to the sternum. He concludes that the lower end of the thorax is degenerating, as shown by the diminution in the number of ribs which unite with the sternum in man and the higher Primates as compared with the lower monkeys. The eighth rib has undergone so much degeneration that it rarely joins the sternum, though when degeneration has been partly arrested it reaches the middle line without becoming incorporated in or joining with the sternum. Similarly the seventh rib may meet its fellow of the opposite side without joining with or being incorporated in the mesosternum. A further change brings the seventh rib in a few cases into the same position as the eighth normally occupies, namely, it fails to reach the middle line and terminates by a secondary connection with the sixth.

Function of Iron in Metabolism and Fermentations.†—N. Sacharoff has elaborated a theory according to which iron plays the essential rôle in vital processes and fermentations, acting as the "enzyme of all enzymes," and operative through an iron-containing nuclein substance, "*bionuclein*," with oxidising and reducing capabilities.

Production of Glucose by Animal Tissues.‡ — MM. Cadéac and Maignon find that all the organs or tissues of the dog and the horse (except the bones) normally include a small quantity of glucose. They all produce it when submitted for a suitable time to conditions of asphyxia; when these are prolonged, the sugar present or formed entirely disappears. This production of glucose is a phenomenon of protoplasmic metabolism, for it is not exhibited when the tissues are killed by immersion in boiling water.

Alleged Alcoholic Fermentation in Animal Tissues.§—F. Batelli criticises the view of Stoklasa and others, that extracts of the tissues of higher animals contain an enzyme capable of transforming glucose into alcohol and carbon dioxide, and the view of Mlle. Borrino that this fermentation is due to nucleoproteids. Batelli's experiments lead to support Cohnheim in the conclusion that the fermentation observed *in vitro* is due to the presence of micro-organisms.

Occurrence of an Animal Diastase at once Oxidising and Reducing.‖—J. E. Abelous and J. Aloy have satisfied themselves that in extract of liver, kidney, lung, etc., there is a ferment which has the power of acting both as an oxidising and as a reducing agent. This double rôle leads the author to regard the ferment as the agent in respiratory exchanges.

Viviparous Lizard's Prolific Multiplication.¶— E. Olivier captured on the Cantal mountains (au col des Gardes) a gravid female of the melanic variety of *Lacerta vivipara* Jacq. It was entirely of a

* Anat. Anzeig., xxiv. (1904) pp. 326–32.

† Das Eisen als das tätige Princip der Enzyme und der lebendigen Substanz. Translated by M. Rechtsamer. 8vo, Jena (1902), 83 pp., 2 pls. and 15 figs. See Centralbl. Bakt. Parasitenk., 2te Abt., x. (1903) pp. 578–93.

‡ Comptes Rendus, cxxxvi. (1903) pp. 1682–4.

§ Op. cit., cxxxvii. (1903) pp. 1079–80. ‖ Tom. cit., pp. 885–7.

¶ Bull. Soc. Zool. France, xxviii. (1903) pp. 180–1.

deep black colour. After eight days of captivity, it gave birth to fifteen black offspring. The normal number is three to five, and twelve has been recorded by Fatio as altogether exceptional.

Habits of the Arboreal Urodele Autodax lugubris.*—W. E. Ritter finds that the usual breeding place of this "unsalamander-like salamander," whose close kinship to the other Plethodons cannot be doubted, is *in holes in trees* (*Quercus agrifolia*). Some were taken from holes at a height of thirty feet at least: in some of the largest cavities as many as twelve individuals were found; more commonly a hole contained two, or occasionally but a single Autodax. Several facts indicate pretty clearly that in some cases all the inhabitants of a single chamber were close of kin, constituting in fact a family. Most of the cavities occupied had very narrow orifices.

The egg clusters, each containing from twelve to eighteen eggs, each egg with its own pedicle about two centimetres in length, were usually suspended from an overhanging surface, where the parent was able to bring its body into contact with them. Both parents, which are not distinguished by secondary sexual characters, may participate in the office. The animals seem to exercise more or less of an active defence either of themselves, or of the eggs, or of both. The unusually large teeth are used viciously in "showing fight." Experimental study on the behaviour of this unique Urodele should yield very interesting results.

Respiration in Torpedo.†—E. Couvreur finds that in *Torpedo marmorata* the water may enter by the gill-clefts, the spiracles, and the mouth, but always passes out by the clefts. There is a synchronism between the movements of the heart and the respiratory movements, as Jorgen Thesen observed in Teleosts, and as the author previously noticed in the lamprey.

Labyrinth of Fishes.‡—Tycho Tullberg has made experiments on various fishes which lead him to conclude that the labyrinth of the ear is not an equilibrating organ, nor an organ "of static sense" (Breuer), nor a "tonus-labyrinth," nor the seat of "a spatial sense" (v. Cyon). It is perhaps in some degree an auditory organ, but it is primarily and rincipally sensitive to the movements—both currents and undulations —of the surrounding water, with its nervous centre probably in the erebellum.

Wild Horses.§—J. Cossar Ewart gave an interesting lecture on Przewalsky's horse, which he regards as a true and valid species. He compares it with the Kiang and with various hybrids which he has reared. "If Przewalsky's horse is neither a Kiang-pony mule nor a feral Mongolian pony, and if, moreover, it is fertile (and its fertility can hardly be questioned), I fail to see how we can escape from the conclusion that it is as deserving as, say, the Kiang, to be regarded as a distinct species. Granting Przewalsky's horse is a true wild horse, the question arises: In what way, if any, is it related to our domestic

* Amer. Nat., xxxvii. (1903) pp. 883–6.
† Ann. Soc. Linn. Lyon, lxxxix. (1903) pp. 78–9.
‡ Bihang. k. Svensk. Vet.-Akad. Handl., xxviii. Afd. 4 (1903) No. 15, p. 25.
§ Nature, lxviii. (1903) pp. 271–3 (3 figs.).

horses? It is still too soon to answer this question; but I venture to think that if we should, by and by, arrive at the conclusion that our domestic horses have had a multiple origin—have sprung from at least two perfectly distinct sources—we shall probably subsequently come to the further conclusion that our big-headed, big-jointed horses, with well-marked chestnuts on the hind legs, are more intimately related to the wild horse than the small-headed, slender-limbed varieties without chestnuts on the hind legs; that, in fact, the heavy horses, whether found in Europe, Asia, or Africa, and Przewalsky's horse have sprung from the same ancestors."

Coloration of the Quaggas.* — R. I. Pocock has an interesting essay on the coloration of the "quaggas,"—i.e. zebras of the type commonly known as Burchell's. The coloration of the coat renders a zebra invisible under three conditions, namely, at a distance on the open plain at mid-day, at close quarters in the dusk and on moonlight nights, and in the cover afforded by thickets. Pocock analyses the various factors which contribute to this "procryptic" result. The protective value is so great that it seems unnecessary to seek for any other interpretation.

Plankton of Scottish Lakes.† — James Murray contributes some notes on the plankton of the lakes of the Tay basin, samples of which were collected in the course of bathymetrical survey undertaken by Sir John Murray and Mr. Laurence Pullar. Of almost constant occurrence at all seasons are *Diaptomus gracilis*, *Cyclops strenuus*, *Daphnia lacustris*, *Bosmina obtusirostris*; two species of *Conochilus*, *Anuræa cochleare*, *Notholca longispina*; and the Diatom, *Asterionella gracillima*. In the summer, *Holopedium*, *Leptodora*, *Bythrotrephes*, and *Polyphemus* are as generally distributed. Only less common are *Asplanchna priodonta*, *Polyarthra platyptera*, *Peridinium tabulatum*, *Ceratium hirundinella*, *Mallomonas*. The rotifers, *Floscularia pelagica* and *Notops pygmæus*, are of frequent occurrence; a not very dissimilar association is found in small ponds, but the species are for the most part different; thus *Diaptomus* is represented by *D. castor*, *Daphnia* by *D. pulex*, *Bosmina* by *B. cornuta*; Rotifers and Algæ will be more abundant and varied, and there will probably be some Ostracods. Even the smallest lochs surveyed had the plankton distinctly lacustrine, but a few nearly or quite stagnant lochans showed a slight approach to the pond type. In some forms, e.g. *Daphnia lacustris* and *Bosmina obtusirostris*, there is great variability. The phenomenon of *Wasserblut*, usually due to Algæ, may also be due to Protozoa and to Rotifers,—on one occasion to the rather uncommon Rotifer, *Dinocharis collinsii*. Many details are given as to individual lochs.

Ceylonese Cephalochorda.‡—W. M. Tattersall reports on a collection made by Prof. W. A. Herdman. Although no new species are recorded, the fact that seven species (including var. *belcheri*) occur around Ceylon, indicates the great wealth of the Acraniate fauna of these waters.

* Nature, lxviii. 1903, pp. 356–7 (1 fig.).
† Scottish Geogr. Magazine, xx. (1904) pp. 41–7.
‡ Rep. Pearl Oyster Fisheries Ceylon. Suppl. Report vi. pp. 209–26 (1 pl.).

Four species are recorded from this neighbourhood for the first time. The depths at which the specimens were taken range from three to fourteen fathoms, in all cases comparatively shallow water. They usually live in clean coarse sand and feed largely on diatoms. The spawning time in tropical seas appears to be the latter half of March, rather earlier in the year than in more temperate seas. It is noted that *Branchiostomum lanceolatum*, now for the first time recorded from the Indian Ocean, is cosmopolitan, that the variety *B. belcheri* is the predominant form, that *B. pelagicum* is truly pelagic, and that *B. californiense* occurs, though showing some slight variation when compared with its American relations. Tattersall's tables show how extremely variable the species of this group are; "the more extended our knowledge of this group becomes, the less distinctly do the species appear to be separated."

INVERTEBRATA.

Enemies of the Sugar Beet.*—A. Stift has notes on the injurious effects of *Eurycreon sticticalis* (caterpillars), *Bibio hortulans*, *Anthomyia conformis*, *Aphis papaveris*, *Iulus guttulatus*, *Heterodera schachtii*, and other forms which prey upon the beet. He also refers to the injuries done to winter wheat by *Geophilus longicornis*.

Mollusca.

γ. Gastropoda.

Blood of Marine Gastropods.†—E. Couvreur has studied the blood of *Murex brandaris*, *M. trunculus*, and *Tritonium nodiferum*. There is a general resemblance with the blood of the snail. The fresh blood is almost colourless, but acquires a faint blue tint due to hæmocyanin; there is no spontaneous coagulation, there being no fibrin-forming substance; a little sugar is present.

δ. Lamellibranchiata.

Variations in Pecten opercularis.‡—C. B. Davenport has compared three lots of individuals from widely separated localities,—Eddystone, Firth of Forth, and the Irish Sea. He discusses change of proportions with age, changes in symmetry, ray frequency, variation of the "ears," colour variations, and abnormalities.

In some studies on *Pecten irradians* from the American coast, Davenport was struck by the gradual change of the shells from place to place; a change of such a nature that one might say that the difference in the place modes was a function of the spatial interval between the places in question.

Davenport's study of *Pecten opercularis* from British coasts yields a similar result. The three lots collected from three places are measurably unlike in size, proportions, and average number of rays. When

* Zeitschr. Zucker Industrie und Landwirtschaft, 1903, p. 3. See Centralbl. Bakt. Parasitenk., 2te Abt., x. (1903) pp. 611–5.

† Ann. Soc. Linn. Lyon, lxxxix. (1903) pp. 79–81.

‡ Proc. Amer. Acad., xxxix. (1889) pp. 123–59, many tables.

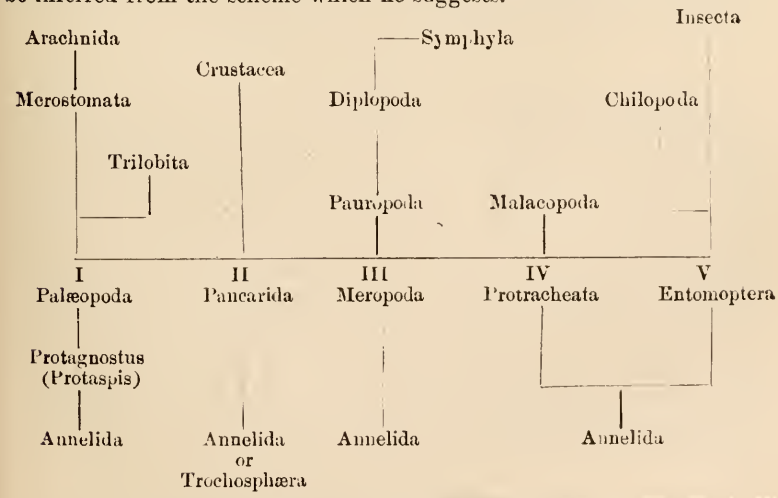
the lots are arranged in the order *a*, *b*, *c*, in which *a* and *c* are the geographical extremes, they are found to be the biological extremes also.

"Where the environmental conditions of the isolated form units are similar, the differences met with are easily accounted for on the assumption of mutations which are preserved. Where, on the other hand, the environmental conditions are dissimilar, it is obvious that they must produce a change either through their "direct and definite" action or possibly by selection. To deny that environment may act directly to produce profound, eventually *specific* changes is to deny the evidence of some of the best experimental work in evolution, and this experimental work has also proved the inheritance of these environmentally induced changes. The mutation theory errs, then, in stating only a half truth. Through mutation, and also through the direct action of environment, specific changes may be produced."

Origin of Fine Pearls.*—L. Boutan maintains that there is no real distinction between nacreous pearls formed external to the mantle like the shell, and fine pearls, said to be formed within the tissues of the mantle. Experiments have convinced him that in all cases the pearl, which is provoked by the presence of a parasitic fluke, as has been previously shown, has an epithelial origin, and represents a secretion of the external epithelium of the mantle. When it becomes possible by artificial trepanning of the shell to imitate precisely the penetration of the fluke, the production of true pearls will be within human control.

Arthropoda.

Classification of Arthropoda.†—A. S. Packard discusses in an interesting paper the affinities and evolution of the Arthropods, which he regards as forming a polyphyletic group. His general conclusions may be inferred from the scheme which he suggests.



* Comptes Rendus, cxxxvii. (1903) pp. 1073–5.
† Proc. Amer. Phil. Soc., xlii. (1903) pp. 142–61 (1 fig.).

Relationships between Classes of Arthropoda.*—G. H. Carpenter contributes a valuable essay on this difficult subject, and comes to the following principal conclusions :—

(1) The Arthropoda are a natural, monophyletic assemblage of animals.

(2) There is exact numerical correspondence between the segmentation of typical Insects, Crustaceans, and Arachnids (worked out in a detailed comparative table).

(3) Such correspondence in three distinct classes cannot reasonably be explained as the result of convergent evolution from ancestors with very numerous segments, which independently became diminished to exactly the same extent.

(4) The ancestral Arthropods must, therefore, have possessed a fixed and definite segmentation ; and the various forms with very numerous segments (Phyllopods, Millipedes, etc.) have undergone abnormal elongation.

(5) The Insecta, Chilopoda and Diplopoda may be derived from common Symphylan ancestors, which branched off from the primitive Crustacea (proto-Leptostraca).

(6) Among the Crustacea, the Leptostraca and the Trilobita show the most primitive characters. The proto-Trilobita had the typical Arthropodan number of segments.

(7) The Arachnida, including the Merostomata, Xiphosura and Pycnogonida, arose from the proto-Trilobita.

(8) The Malacopoda must be regarded as Arthropoda of low type. They have no close relationship to Chilopoda or Insecta, and their Annelidan affinities are doubtful.

(9) The Arthropoda, as a whole, probably sprang from Naupliform ancestors, and not from well-developed Annelid worms. A genealogical tree is given expressing these conclusions in graphic form.

a. Insecta.

Economic Entomology.†—F. V. Theobald discusses a great variety of subjects in his first report on economic zoology, but the majority are entomological. They afford a fine illustration of the multitudinous ways in which man comes into practical contact with animal life, and the author deserves congratulation on the impressiveness of his "First Report." There are discussions on cereal pests, root-crop pests, fruit pests, garden pests ; on dipterous larvæ in human excreta ; on *Anobium tesselatum* in St. Albans Cathedral ; on the cigar beetle ; on the tsetse fly ; on locusts in the Sudan ; and on mosquitos at Blackheath, and so on. And *inter alia* we find information on poison for moles ; tapeworm in sheep ; the origin and varieties of domesticated geese ; green matter in Lewes public baths ; the screw-worm in St. Lucia ; the *Teredo* ; the Ceylon pearl fisheries, and so on, through a variety of subjects as interesting as it is astonnding.

* Proc. R. Irish Acad., xxiv. (1903) pp. 320–60 (1 pl.).

† First Report on Economic Zoology. British Museum, 1903, xxxiv. and 192 pp., 18 figs.

Sex-Determination in Bees.*—Ferd. Dickel has made twelve experiments which seem to him to support his somewhat heretical views in regard to the sex-determination in bees. He believes that "drone-eggs" are fertilised; that drones can be reared from "worker-eggs," and *vice versa*; that all the eggs laid by a normal queen are fertilised; that the ripe ovum has in itself only the potentiality of masculinity; that the sperms bring in the potentiality of femaleness, whether of workers or queens; and that the workers produce a "sex-determining" and a "volume-determining" substance which settles the destiny of any particular egg which they handle.

Parthenogenesis in Porthesia.†—Tad Garbowski reports the occurrence of indubitable parthenogenesis in *Porthesia similis*, which was reared from a pupa-case and kept in isolation. It laid eggs in three batches, and died. All the eggs hatched into active caterpillars.

Sleeping Sickness of Silkworms.‡—J. Bolle and M. Richter find that this disease is in no wise due to the micro-organisms of the mulberry leaves. Six species of bacteria and two yeasts were obtained from the leaves, but inoculations of cultures failed to induce any *Schlafsucht* in the silkworms.

Ants from the Andaman and Nicobar Islands.§—A. Forel reports on a collection, which shows that the ants of these islands are related to those of India and of Indo-China, and include some peculiar forms. There has been an invasion from both east and west. Forel analyses the collection into 9 local forms, 5 occidental, 7 oriental, 3 shared with Hindustan and Burmah, 10 both oriental and occidental, and 4 cosmopolitan—38 in all.

Development of Ovary of Polyxenus lagurus De Geer.‖—A. Lecaillon finds in newly-hatched larvæ two distinct ovarian primordia, each consisting of a small aggregate of oogonia surrounded by an envelope of flattened cells, and including small cells destined to form the follicular elements. In a short time, however, the two oogonial masses unite and form a single ovary—unique among insects. The further history is followed, and noteworthy is the appearance in the cytoplasm of the young ova of a special *cytochromatic substance*, which is probably a differentiation concerned with the elaboration of assimilable substances.

Peculiar Aphid.¶—Alice L. Embleton describes *Cerataphis lataniæ*, which has been called by more than half-a-dozen names. In Britain the species seems now to occur in only one form, the apterous female, which reproduces parthenogenetically in an uninterrupted manner. The occurrence of the winged female was, however, noted in England for one or more seasons a quarter of a century ago. It is suggested that the

* Arch. Ges. Physiol., xcv. (1903) pp. 66-106. See Zool. Centralbl., x. (1903) pp. 740-1.

† Zool. Anzeig., xxvii. (1904) pp. 212-4.

‡ Zeitschr. Landw. Versuchswesen Österreich, 1903, p. 287. See Centralbl. Bakt. Parasitenk. 1te Abt., xxxiii. (1903) pp. 735-6.

§ Revue Suisse Zool., xi. (1903) pp. 399-411.

‖ Comptes Rendus, cxxxvi. (1903) pp. 1691-3.

¶ Journ. Linn. Soc. (Zool.), xxix. (1903) pp. 90-107 (1 pl.).

conditions of life—in orchid-houses—have brought about the simplification of the life cycle, the permanence of the "aleurodiform" stage. The insect is probably one of the migratory Aphides that has been deprived of the series of metamorphoses, owing to an artificial mode of life. Experiments should be made on *Hormaphis hamamelidis*, or on some other migratory Aphis, with a view to ascertaining whether—by affording successive generations a constant supply of food under equable conditions of temperature, etc.—the creature could be maintained for many generations, or permanently, in the aleurodiform stage.

Maturation in Viviparous Aphides.*—J. P. Stschelkanovzew has studied the phenomena of maturation in the summer ova of *Aphis rosæ*, showing that only one polar body is formed. The changes in the chromatin-substance occur very rapidly and in somewhat simplified fashion. The old chromatin thread of the germinal vesicle is partly dissolved, and probably gives rise to several of the nucleoli, though the majority of these arise by new formation. During the formation of the nucleoli, changes occur in the plasma of the ovum, apparently implying a passage of chromatin-like substance from the plasma into the nucleus. The new chromatin thread from which the chromosomes of the polar body arise, is formed directly from the peripheral nucleoli, and shows no trace of a longitudinal splitting. The chromosomes show marked differences in size.

Neapolitan Myrmecophilous Insects.†—F. Silvestri describes the myrmecophilous habits of *Tettigometra impressifrons* Muls., and *T. costulata* Fieb. (Hemiptera), *Hyperaspis reppensis* Herbst. (Coleoptera), *Myrmecophila acervorum* Panz., and *M. ochracea* Fisch. (Orthoptera).

Genealogical Study of Dragon-fly Wing Venation.‡—J. G. Needham seeks to translate the records of natural selection as written in the venational characters of Odonate wings. The result is a most interesting essay on "developmental dynamics," showing how in accordance with mechanical principles, operating in vein-shifting and vein-differentiation, a form of wing is reached, several times independently, that is most efficient,—a wing broad at the base and long and pointed at the apex, rigid at the front and pliant toward the posterior margin—a wing combining the principle of the aeroplane with that of the scull. But this is only a hint of the scope of an elaborate and suggestive investigation.

B. Myriopoda.

Littoral Myriopods.§—F. Silvestri records from the shore of Portici near Naples, six Myriopods, namely, *Pachymerium ferrugineum* C. Koch, *Geophilus poseidonis* Verh., *Henia bicarinata* (Mein.) Silv., and *Schendyla submarina* Grube, among Chilopoda; and *Polyxenus lapidicola* Silv. and *Isobates littoralis* Silv., among Diplopoda. It seems that littoral Myriopods are much more frequent than is generally supposed, but the author distinguishes (*a*) *accidental* halophilous forms (three species of

* Biol. Centralbl., xxiv. (1904) pp. 104–12 (7 figs.).
† Ann. Mus. Zool. Univ. Napoli, new series, i. No. 13 (1903) 5 pp.
‡ Proc. U.S. Nat. Mus., xxvi. (1903) pp. 702–64 (24 pls. and 44 figs.).
§ Ann. Mus. Zool. Univ. Napoli, new series, i. (1903) No. 12, 5 pp.

Lithobius found in Normandy by Gadeau de Kerville); (*b*) *indifferent* halophilous myriopods (eight species); and (*c*) *genuine* halophilous myriopods, namely, *Scolioplanes maritimus*, *Geophilus poseidonis*, *Schendyla submarina*, *Polyxenus lapidicola*, and *Isobates littoralis*.

δ. Arachnida.

British Tyroglyphidæ.*—Albert D. Michael is to be congratulated on the completion of his monograph on this family. We notice the new genus *Fusacarus*, the useful diagnostic tables, the list of foreign species, the bibliography, and the beautiful illustrations. The injury to horticulture caused by *Rhizoglyphus echinopus* is carefully discussed.

New Species of Kœnenia from Italy.†—F. Silvestri describes two new Italian species of this interesting genus,—*K. berlesei*, near *K. mirabilis* Grassi; and *K. subangusta*, near *K. angusta* Hansen.

ε. Crustacea.

Classification of Malacostraca.‡—W. T. Calman gives his reasons for proposing the following new classification:

Series Leptostraca, Claus., 1880.
- Division Phyllocarida, Packard, 1879.
  - Order Nebaliacea, nov. nom.

Series Eumalacostraca, Grobben, 1892.
- Division Syncarida, Packard, 1886.
  - Order Anaspidacea, nov.
- Division Peracarida, nov. nom.
  - Orders Mysidacea, Cumacea, Tanaidacea, Isopoda, Amphipoda.
- Division Eucarida, nov. nom.
  - Orders Euphausiacea, Decapoda.
- Division Hoplocarida, nov. nom.
  - Order Stomatopoda.

Spermatozoa of Decapods.§—Alphonse Labbé points out that the figures usually given represent a stage which is not the final one. The fully ripe spermatozoon is only a portion of the spermatid. A whole series of accessory or transitional structures in the spermatid disappear before the spermatozoon is ripe. The ripe spermatozoon includes an anterior acrosome apparatus enclosing the centrosomes, a nucleus, and radiating cytoplasmic prolongations. Labbé describes the remarkable final transformations of the spermatids in *Homarus vulgaris* and *Maia squinado*, the spermatozoa of the latter, those of other Decapods (more briefly), and the constitution of the acrosome.

Phagocytic Organ of Decapods.‖—L. Cuénot describes the special phagocytic organ which is found in the mid-gut gland on the terminal branches of the hepatic arteries. In Pagurids, where the gland is

* British Tyroglyphidæ, ii. Ray Soc. (1903) pp. 1–183 (pls. xx–xxxix).

† Ann. Mus. Zool. Univ. Napoli, new series, i. No. 11, 2 pp.

‡ Ann. Nat. Hist., xiii. (1904) pp. 144–58 (2 figs.).

§ Arch. Zool. Expér., 4th series, ii. (1904). Notes et Revue, No. 1, pp. 1–14 (27 figs.).

‖ Comptes Rendus, cxxxvii. (1903) pp. 619–20.

abdominal, there are two arteries which correspond in position to the hepatic arteries of other Decapods, but do not go to the "liver." They remain in the cephalothorax, and their fine branches are covered with a mantle of fixed phagocytes. The lymphoid organ in connection with the ophthalmic artery, gives rise to the free amœbocytes of the blood, but is not phagocytic.

New Family of Amphipods.*—H. J. Hansen describes *Ingolfiella abyssi* g. et sp. n., from deep water to the south entrance of Davis Straits, 1870 fathoms, and *I. littoralis* sp. n., from one fathom of water in the Gulf of Siam. The new type is clearly distinguished from all Gammarina and Caprellina by at least four characters. Two of these are of very high rank, viz. the complete separation of the eye-lobes from the head and the peculiar structure of the pleopods. The other two distinctive characters are less important, viz. the elongate styliform shape of the molar process of the mandibles, and the structure of the first two pairs of prehensile hands, in which the fifth joint is developed as a hand, and the two distal joints, together with the real claw, are so completely claw-shaped that a similar structure has not been observed in any other form. It is necessary at present to maintain the Ingolfiellidæ as a tribe of the same rank as the Caprellina.

Study of the Beach-Flea.†—Mabel E. Smallwood has made a study of *Talorchestia longicornis*, a common amphipod of Cold Spring Harbour. She notes that the adult males are very variable in their proportions, especially in regard to the relative lengths of the body and the second antennæ, but this may be due to moulting. The males are larger than the females, and differ from them in the shape and size of the second gnathopods, and, when fully mature, in the relatively longer second antennæ. Unlike most amphipods, these beach-fleas are poor swimmers, but they run rapidly and jump with great agility. They have become secondarily terrestrial, and do not voluntarily enter the water. They die, indeed, if the mouth of the furrow be kept under water. They are responsive to white light, being photokinetic, but not phototactic. They are effective scavengers, and are well protected from birds and fishes by their pale colour and nocturnal habits.

Argulidæ.‡—C. B. Wilson gives an account of North American Argulidæ in the U.S. National Museum, describing four new species. He gives a welcome systematic review of all the known species (over forty), and a bibliography of the family.

Calanoid Copepoda.§—A. M. Norman reports on Calanoida, chiefly abyssal, from the Faroe Channel and other parts of the North Atlantic. The enormous range of these deep-water Copepods is very remarkable. In the Faroe Channel there are species at considerable depths which Nansen found near the surface at the point nearest to the North Pole from which any animals have been obtained; and these are associated

* Journ. Linn. Soc. (Zool.), xxix. (1903) pp. 117–33 (2 pls).

† Cold Spring Harbor Monographs (Brooklyn Inst. Arts and Sci.), No. 1 (1903) pp. 1–27 (3 pls. and 3 figs.).

‡ Proc. U.S. Nat. Mus., xxv. (1903) pp. 635–742 (20 pls.).

§ Journ. Linn. Soc. (Zool.), xxix. (1903) pp. 133–41.

with other forms which are known to occur, some in the Mediterranean, some in the Gulf of Guinea and South Atlantic, one in the Antarctic Ocean, and some from the very centre of the Pacific. At the depth at which they live the temperature conditions are similar, whether under the tropics or under Arctic ice. They are always on the move, and tend to be readily transported. We are beginning to learn more and more how widely diffused large numbers of abyssal genera and species are, but in no group of animals has this fact been more clearly demonstrated than in Canon Norman's notes on these Calanoida.

Annulata.

Leucocytes and Similar Cells in Sipunculus nudus.*—F. Ladreyt finds that there are two very distinct types of leucocytes in this worm. There are minute plastids, with very active fine pseudopodia, and central or slightly excentric nucleus (amœbocytes or phagocytes), which have an important rôle in excretion and phagocytosis; and there are large elements, including numerous transparent spherules, without pseudopodia, with a lateral nucleus (vesicular leucocytes or "glycoleucytes") which are especially devoted to storing nutritive substances, like glycogen. The adult coloured hæmatids absorb carmine injected into the cœlom. When the small amoebocytes absorb excretory substances, they transport these to areas suitable for diapedesis, and the waste is got rid of by epidermic exfoliation, or via the nephridia, or with the fæces. A sheath is formed by the same elements around infecting Bacteria and Nematodes.

Palolo Worm of Samoa.†—W. McM. Woodworth has prepared a summary report on the well-known form, *Eunice viridis* Gray. We note a few points only. At the end of October (1897) the Samoan reef was "literally alive with Palolo," which were discovered by prising off pieces of the rock with a crowbar. The operation of freeing unbroken specimens of these fragile worms is a delicate one; three complete worms were obtained, and an excellent figure is given. The total length averages 400 mm., about one-fourth of which is in the anterior atokal part. In two males about 429 and 359 atokal segments were counted, in a female about 250. The greatest diameter of the atokal part is 4 mm., and that of the epitokal region 1–1½ mm. The colour of the male is reddish-brown, that of the female bluish-green. These colours, which are very marked in the epitokal portions, are there due to the colours of the spermatozoa and ova, after the discharge of which the collapsed integument is translucent and colourless. In the atokous parts the female is more greenish than the male, and the colours are there integumentary. Each epitokal segment bears on its ventral surface a prominent pigmented spot, the *Bauchauge* of Ehlers. These "eye-spots" can be traced into the atokal part through about twenty segments, diminishing in size toward the anterior end; they are lacking on the anal segment, and are usually absent in two to six of the pre-anal segments.

A similar swarming of marine Annelids, and at corresponding seasons, is known for other islands of the Pacific, though the worms have not

* Comptes Rendus, cxxxvii. (1903) pp. 865–7.
† Amer. Nat., xxxvii. (1903) pp. 875–81 (1 fig.).

been everywhere identified. The Palolo makes its appearance in Samoa in the months of October and November, during the last quarter of the moon, the time of the lowest or spring tides. Woodworth is inclined to believe in some thermotropic or heliotropic reaction of the "eyes" on the epitokal part of the worm. The "Palolo time" in Samoa embraces three succesive days. During these days another Annelid—*Lysidice falax* Ehlers, *L. viridis* Gray—exhibits phenomena similar to those of the true Palolo.

Some Woods Hole Pelagic Polychæta.*—J. Percy Moore points out that the pelagic Annelid fauna of southern New England has received but little attention. He describes some forms new to the region—*Amphinome pallasii* Quatrefages, *Hipponöe gaudichaudi* Aud. and M.E., *Drieschia pellucida* sp. n., and *Tomopteris helgolandica* Greef.

Distribution of Oligochæta.†—K. Bretscher has made a special study of the distribution of earthworms in Switzerland, where there are sixteen endemic species. A great deal depends on the degree of humidity and the atmospheric conditions, as is shown by considering the rainfall records.

Negative and Positive Phototropism of the Earthworm.‡—G. P. Adams finds that the phototropism of *Allolobophora fœtida* changes according to the intensity of the light. The negative phototaxis, very marked with intense illumination, gradually decreases as the intensity is lessened. Finally, the earthworm shows itself positively phototactic. This agrees obviously with the habits of the animal in nature, for it hides from the sunlight, but is drawn to the weak nocturnal light.

Regeneration in Lumbriculus variegatis.§—P. Iwanow compares in detail the regeneration of trunk-segments and head-segments in this worm. We can only allude to a few results. The gut is formed similarly in both, by the backward or forward growing of the old gut until it meets a minute proctodæal or stomodæal invagination. The new epidermis differentiates early into a new growing epithelium and into large sub-epithelial "germ-cells," which form nervous tissue and external musculature. The mesoderm of the trunk-segments arises from special indifferent "germ-cells," but in the head-segments the material for mesoderm regeneration is afforded entirely by derivatives of the "germ-cells" of the trunk, especially from the somatic wall. The muscle elements in the head arise wholly from muscle-cells of the old mesoderm; the connective tissue cells come mainly from leucocytes or peritoneal cells. Thus the secondary mesoderm in the head-segments does not form chloragogen cells or nephridia.

Experiments in Æolosoma hemprichii.‖—Antonin Stolč notes that this naïd has normally six double-pairs of bundles of setæ, and that its asexually-produced progeny show the same number. Various parts of

* Proc. Acad. Nat. Sci. Philadelphia, 1903. pp. 793–801 (1 pl.).

† Biol. Centralbl., xxiii. (1903) pp. 634–9 (1 map).

‡ Amer. Journ. Physiol., ix. ((1903) pp. 26–34 (2 figs.). See Zool. Centralbl. xi. (1904) p. 33.

§ Zeitschr. wiss. Zool., lxxv. (1903) pp. 327–90 (2 pls.).

‖ Arch. Entwickmech., xv. (1903) pp. 638–68 (26 figs.). See Zool. Centralbl. x. (1903) pp. 878–9.

such chains may be separated off mechanically, and may give rise to asexually reproductive individuals. These usually differ from the normal individuals in the number of pairs of setose bundles. Their progeny was followed with care, but the normal number always re-appeared.

Nematohelminthes.

Filaria immitis.*—G. Noè gives some details in regard to the passage of this parasite through the medium of a mosquito (*Anopheles*) from host to host.

Filaria perstans in relation to Sleeping Sickness.†—G. C. Low, after studying the distribution and the pathological conditions of this disease, comes to the conclusion that *Filaria perstans* has nothing to do with it, its occasional presence being only a coincidence, as is the presence of *Ankylostoma duodenale*, *Ascaris lumbricoides*, *Trichocephalus dispar*, and *Bilharzia hæmatobia*. The worm probably produces no pathological symptoms whatever.

Platyhelminthes.

Oscillatory Movements of Convoluta roscoffensis.‡—Georges Bohn describes the behaviour of this Turbellarian. There are two main movements. When the tide comes in they bury themselves in the sand; when the tide is out they form green patches on the sand. They avoid the two dangers of being swept away and of being dried up. Their movements are synchronous with those of the sea, like those of the Annelid *Hediste diversicolor*, and are not referable to the influence of light, as they occur as precisely at night as during the day.

Revision of Classification of Polyclad Turbellarians.§—F. F. Laidlaw suggests a revision based mainly on the characters of the vagina and prostate gland. He gives a diagnostic key for the Acotylea and Cotylea, and a grouping of the Acotylean genera in eight families.

Structure of Mesostoma nasonoffii Graff.‖—W. Zykoff gives a description of this Russian Turbellarian, allied to *M. obtusum*, which has not been adequately diagnosed hitherto.

Cysticercus cellulosæ on Dog's Brain.¶—Ball and Marotel record what is a rare occurrence, the presence of numerous (30) bladder-worms on the surface of the cerebral hemispheres of a dog. The characters of *Cysticercus cellulosæ* were unmistakable. The parasitism was fatal.

Cestodes of South American Marsupials.**—F. Zschokke, following up H. von Ihering's suggestion, calls attention to the occurrence of *Oochoristica* and *Linstowia* in these forms. The former never occurs except in the old autochthonous forms; its presence is, as it were, one

* Atti. (Rend.) R. Accad. Lincei, xii. (1903) pp. 476–83 (3 figs.).
† Roy. Soc. Rep. Sleeping Sickness Comm., ii. (1902) pp. 64–9.
‡ Comptes Rendus, cxxxvii. (1903) pp. 576–8.
§ Mem. Manchester Lit. and Phil. Soc., xlviii. (1903) No. 4, p. 16 (5 figs.).
‖ Bull. Soc. Imp. Nat. Moscow (1903) pp. 183–7 (1 pl.).
¶ Ann. Soc. Linn. Lyon, lxxxix. (1903) pp. 55–6.
** Zool. Anzeig., xxvii. (1904) pp. 290–3.

of their insignia. The genus *Linstowia* is restricted to Marsupials and Monotremes; its exclusive occurrence in American and Australian Aplacentalia points to a remarkable similarity in the parasitic fauna of the autochthonous inhabitants of the two continents.

Parasites of Ural Birds.*—W. Clerc collected 408 birds from the Ural, and found parasites in 246. In 233 there were Cestodes, representing 57 species, of which ten are new. Nine species of Nematodes, three of Acanthocephala, and eight of Trematodes were also found. The present memoir contains descriptions of the Cestodes.

Incertæ Sedis.

Lohmannia catenata g. et sp. n.†—E. Neresheimer found in the gonadial cavity of *Fritillaria*, a remarkable mesozoon parasite. It consists of an anterior portion with branched pseudopodia, and a chain of segments without pseudopodia. There is but one layer of cells, and the boundaries are not very clear. The anterior nuclei are larger than the rest and otherwise different. To each of them a pseudopodium seems to be associated.

The young form is like a gastrula, and diploblastic. The internal layer grows actively, and the external layer is reduced to delicate membrane except at the anterior end, where the nuclei are associated with the pseudopodia. The segments formed by the internal body are liberated, bursting the outer membrane, and the anterior region then forms new ones.

Rotifera.

Excretory Organs in the Family Melicertidæ.‡—Stan. Hlava has studied these in *Lacinularia socialis*, *Megalotrocha alboflavicans*, *Melicerta ringens*, and *Limnias ceratophylli*, and finds that these organs conform essentially to the same plan which has been known in *Asplanchna*. The paired thick-walled lateral canals, forming complicated knots in the head region, are accompanied on each side of the body by a fine thin-walled tubule which alone bears the vibratile tags, of which there are five on each side. The two thick-walled canals unite posteriorly into a single short tubular piece which corresponds to the contractile vesicle of other rotifers, but which has no power of contraction. Valentine's statement that this tube opens outward by an independent porus in *Lacinularia* is not confirmed. The narrow thin-walled tubules, bearing the tags, open into the thick-walled canals in two places—in the twisted knot in the head, and posteriorly just before these canals unite. The thin-walled tubules give off small branches bearing the flame-cells at their ends. An additional feature in *Lacinularia* and *Megalotrocha* is a fine connecting tubule between the two sides in the corona. In addition to the flame-cells the author has observed three fine vibratile cilia within the lumen of the thick-walled canals in *Lacinularia* and *Megalotrocha*.

In the same note the author establishes a new genus, *Conochiloides*,

* Rev. Suisse Zool., xi. (1903) pp. 241–368 (4 pls.).
† Biol. Centralbl., xxiii. (1903) pp. 757–60 (3 figs. .
‡ Zool. Anzeig., xxvii. (1904) pp. 247–53 (4 figs.

for the reception of Seligo's *Tubicolaria* (*Conochilus*) *natans* and *Conochilus dossuarius* of Hudson.

Echinoderma.

Study of the Nucleolus in the Maturing Ovum.*—K. Guenther has made a detailed study of the history of the nucleolus in *Holothuria tubulosa* and *Psammechinus microtuberculatus*. It arises in the ripening ovum as a drop or as several drops excreted from the nuclear framework. Into this or these the chromatin of the nucleoplasm penetrates intimately. After a time the chromatin emerges and is re-distributed in the nuclear framework, or it postpones its emergence until the formation of the directive spindle where it takes the form of chromosomes. In both cases there is a residue (Häcker's "*metanucleolus*"), which is either a product of metabolism or superfluous chromatin. This residue may be immediately dissolved, or it may persist for a considerable time. In short, "the nucleolus represents a drop excreted from the nuclear framework; into it the chromatin penetrates, and prepares for division. There may be an intense metabolism involved between the chromatin and the nucleolar fluid."

Development of Echinus miliaris.†—Hjalmar Théel gives a preliminary account of this, dealing in particular with the water-vascular system and with Aristotle's lantern, but including many figures relevant to other parts of the body.

Sea-Urchin Ova Fertilised by Starfish Spermatozoa.‡—Jacques Loeb finds that in certain solutions, not described, the ova of *Strongylocentrotus purpuratus* can be fertilised with the sperm of *Asterias ochracea*, though this hybridisation will not occur in ordinary sea water. About half of the ova, thus cross-fertilised, developed to some extent, and some formed not only blastulæ and gastrulæ, but lived for more than a week, and showed a differentiation of the gut, but at most a rudimentary larval skeleton.

Ova of Sea-Urchins.§—A. Krassuskaja and E. Landau find that the space between the vitelline membrane and the surface of the ovum is occupied by a delicate gelatinous substance, secreted after fertilisation, which absorbs water and swells up so as to remove the vitelline membrane from the ovum.

Parthenogenesis induced by Carbon Dioxide.‖—Yves Delage has shown that the ova of starfishes will develop parthenogenetically if submitted to the influence of carbon dioxide during the formation of the polar bodies. The ova of sea-urchins (*Paracentrotus* = *Strongylocentrotus*) give off their polar bodies in the ovary, and are not susceptible normally to the influence of carbon dioxide as a stimulus to parthenogenesis. But it is possible to make them so susceptible by

* Zool. Jahrb., xix. (1903) pp. 1–28 (1 pl.).

† Bihang. k. Svensk. Vet.-Akad.-Handl., xxviii. (1903) Afd. iv. No. 7, 9 pp. and 3 pls.

‡ Univ. California Publications (Physiology), i. (1903) pp. 1–3. See Zool. Centralbl., x. (1903) p. 885. § Biol. Centralbl., xxiii. (1903) pp. 613–8.

‖ Comptes Rendus, cxxxvii. (1903) pp. 473–5.

shaking them and warming them at the same time. By combining these two methods there is induced a "nuclear lability," which renders these eggs susceptible to the influence of carbon dioxide as a provocative of cleavage. Stages with thirty-two blastomeres were produced.

Influence of Carbon Dioxide on Ova of Echinoderms.*—C. Viguier finds that this influence does not uniformly act, as Delage has asserted, as a temporary poison. Like some other re-agents, it has a variable influence; it is sometimes favourable and sometimes injurious; it acts differently on nearly related types and even on eggs of the same species, according to their condition at the time.

New Genus of Diadematidæ.†—Th. Mortensen describes *Lissodiadema lorioli* g. et sp. n.—a small Echinoid from the Bay of Amboina which was previously regarded by de Loriol as a young specimen of *Asthenosoma varium*. Re-examination shows that the form is an interesting new type of the family Diadematidæ, with a near relative in *Echinothrix*.

Habits and Life-History of Stichopus japonicus.‡—K. Mitsukuri notes that the breeding season of this holothurian ends with the latter half of July. Then the individuals crawl out into dark places under rocks and cease to take food, passing into an inactive state which may be called "summer sleep." The alimentary canal becomes reduced to a slender, almost thread-like tube. In autumn the animals crawl out again, and begin to feed. The branches of the dendritic gonads elongate quickly, and are ripe about the middle of May; the height of the reproductive season lasting till the middle of July.

Mitsukuri thinks that the genital tubes ought to be regarded simply as local lateral growths of the strictly germinal area, which is lodged in the median line of the dorsal mesentery. A certain number of tubes are produced as each year's crop. Some of the next year's crop may be seen as delicate and slender tubes in front of the enlarged and fully-grown tubes of a given year. After the genital products are shed, the tubes seem to be gradually absorbed.

It seems that *Stichopus japonicus* reaches the adult condition in two whole years; and that after reaching this it goes through a regular spawning season only at the end of another year, i.e. the third year from the beginning. Some probably live for five years. Some hints as to protecting, propagating and increasing these holothurians are given, e.g. by providing piles or dykes of loose stones for the summer retreat, and for the shelter of the larvæ. After making this suggestion, the author found that the plan had been tried in the somewhat out-of-the-way island of Oki for a hundred years or more.

Variation in Ophiocoma nigra.§—D. C. McIntosh has studied in this brittle star the most general shape of the disc, the shape and size of the coloured patch (if any) on the disc, the correlation between arm-length and disc-breadth, the percentage of specimens with an abnormal

* Comptes Rendus, cxxxvi. (1903) pp. 1687–90.
† Revue Suisse Zool., xi. (1903) pp. 393–8 (4 figs.).
‡ Annot. Zool. Japon., v. (1903) pp. 1–21 (4 figs. and tables).
§ Biometrika, ii. (1903) part 4, pp. 463–73 (8 figs. and 5 tables).

number of rays, and the number of madreporic plates. The shape of the disc is in general pentagonal, but tends to become circular in more fully developed individuals. Over 75 p.c. had a coloured patch, which varied in shape with its size—from circular to pentagonal. In the first thousand specimens there were five with six rays; in the second thousand there were four with six rays, and one with four rays; in the third thousand there were three with six rays. Out of 3000 specimens, thirty-nine had two or more of the plates so like the madreporite, that one could not tell the real madreporic plate—a confirmation of what Prof. Jeffrey Bell says, that "in ophiurods the stone-canal ends in one or several of the mouth shields." The paper affords a good illustration of the variability of a familiar animal.

Cœlentera.

Medusa from Victoria Nyanza.*—Ch. Gravier calls attention to Ch. Alluaud's discovery of a freshwater medusa in this lake. It seems to be identical with *Limnocnida tanganyicæ*, discovered in Lake Tanganyika by Böhm in 1883, and studied in 1893 by R. T. Günther—a relict of the fauna of the ancient Jurassic sea which once covered the centre of Africa.

Sagartia paguri Verril.†—J. Playfair McMurrich describes this interesting sea-anemone, which adheres to the chela of the pagurid *Diogenes edwardsii* (De Haan). It was previously described briefly by Verrill in 1869, but without any details of structural characters. These are now supplied. The habits of this form suggests its reference to the genus *Adamsia*, but the arrangement of the mesenteries clearly indicates it as a member of the Sagartiinæ, and it is to be assigned to the genus *Sagartia*.

Modification of Hydroid Colonies by Movements in the Water.‡ Madame S. Motz-Kossowska has made many observations and some experiments which show that *Plumularia obliqua*, *Aglaophenia myriophyllum*, *Eudendrium ramosum*, etc., are modified by the movements of the surrounding water. Changes of thickening in the perisarc, increased flexibility or rigidity, may be referred to direct environmental influence. The mechanical action of contact with solid bodies is also discussed. The perisarc of a *free* stolon is much more delicate than that of the *fixed* hydrorhiza, and the growth of the stolon is far more rapid than that of the hydrorhiza.

Alaskan Corymorpha-like Hydroid.§—S. F. Clarke calls attention to a large coral-red Alaskan Hydroid, for which he previously created the genus *Rhizonema*, which he now finds, however, to be a species either of *Lampra* or *Corymorpha*. To settle this it will be necessary to find specimens with well-preserved gonophores. He notes the unusual thickness of the supporting lamella between the ectoderm and the endoderm.

* Comptes Rendus, cxxxvii. (1903) pp. 867–9.
† Proc. U.S. Nat. Mus., xxvi. (1903) pp. 427–8 (2 figs.).
‡ Comptes Rendus, cxxxvii. (1903) pp. 863–5.
§ Proc. U.S. Nat. Mus., xxvi. (1903) pp. 953–8 (7 figs).

New Ceratella.*—S. J. Hickson describes from the Zanzibar collection made by C. Crossland, *Ceratella minima*, a new species of the remarkable family Ceratelladæ. The colony is probably erect, branching irregularly and not very profusely, but strictly in one plane. The mains tems and all the branches are invariably cylindrical in form. The surface is free from spines and relatively smooth, although the hydrophores form very slight ridges. The skeleton consists of longitudinal horny fibres united by numerous loops and bands, which in the larger branches give a slightly spiral ribbed appearance to the surface. The zooids are numerous, bearing usually nine capitate tentacles. They are arranged slightly to one side of the plane of branching either alternately or in pairs.

Septa of Rugosa.†—N. Yakovleff gives a stricter and more complete definition of *the primary counter septum* of Rugose corals. It is that in relation to which the contiguous septa are arranged in a parallel direction, and which has adjoining primary interseptal chambers, containing no secondary principal septa. Duerden is not correct in stating that the main septum and the counter septum lie respectively on the convex and on the concave side of the coral, independently of the arrangement of the contiguous septa.

Protozoa.

New British Freshwater Rhizopods.‡—G. S. West records the occurrence of numerous forms, especially from the west of Scotland and the outer Hebrides. He describes the following new species: *Nuclearia conspicua*, *Hyalosphenia platystoma*, *H. inconspicua* and *Sphenoderia pulchella*. The two genera *Vampyrella* and *Nuclearia* should be removed from the Proteomyxa and placed in a separate order, Vampyrellida.

Nosema anomalum Monz.§—W. Stempell gives a brief account of the development of this parasite, which he found encysted in the subcutaneous connective tissue, body-cavity, alimentary canal, and more rarely in the ovarian eggs of *Gasterosteus aculeatus*. In one case he found it in the skin of *Gobius minutus*. The development turns out to be more complicated than Thélohan supposed, but we may wait for the detailed account which the author promises.

Trypanosoma in Birds.‖—W. Hanna found two different species of Trypanosome in the Indian domestic pigeon and in the Indian crow. He describes these, and gives measurements for future use. A summary is given of the occurrence of Trypanosomes in animals other than mammals—in frogs, fishes, and oysters. Their occurrence in the blood of birds has not been hitherto recorded; and Eberth's report of a Trypanosome in the intestine of birds appears to refer to a totally different parasite from those found by Hanna.

* Proc. Zool. Soc., 1903, pp. 113–6 (1 pl.).
† Ann. Nat. Hist., xiii. (1904) pp. 114–7 (2 figs.).
‡ Journ. Linn. Soc. (Zool.), xxix. (1903) pp. 108–17 (1 pl.).
§ Zool. Anzeig., xxvii. (1904) pp. 293–5 (5 figs.).
‖ Quart. Journ. Micr. Sci., xlvii. (1903) pp. 433–8 (1 pl.).

Trypanosoma in Sleeping Sickness.*—Aldo Castellani describes a species of Trypanosoma which he found in the cerebro-spinal fluid of a marked case of sleeping sickness. He suggests as a working hypothesis that the disease is due to this parasite, and that at least in the last stages there is a concomitant streptococcus infection.

Developmental Forms of the Trypanosome found in Sleeping Sickness.†—Aldo Castellani finds a number of forms structurally different—typical adult forms, atypical adult forms, forms in different stages of longitudinal division, Rabinovitsh-Kempner bodies and Plimmer-Bradford amœboid forms. It seems likely that the multiplication of longitudinal division is not the only mode of reproduction.

Coccidia in Sheep.‡—Moussu and Marotel describe a rare occurrence, the presence of Coccidia in the wall of the small intestine of the sheep. Four cases have been previously reported. The disease is a new one, and the authors propose to call the parasite *Coccidium faurei* sp. n.

* Roy. Soc. Rep. Sleeping Sickness Comm., i. (1903) pp. 1–10.
† Op. cit., ii. (1903) pp. 9–13.
‡ Ann. Soc. Linn. Lyon, lxxxix. (1903) pp. 73–4 (1 pl.).

BOTANY.

GENERAL,

Including the Anatomy and Physiology of Seed Plants.

Structure and Development.

Vegetative.

Anatomy of Seedlings of Labiatæ.*—R. Viguier, who has investigated the structure of the seedlings of *Lamium album* and other members of the order, describes the following general results. The stem structure is independent of that of the hypocotyl, and there is properly speaking no transition from root to stem. The cotyledons in *Lamium album* and other Labiates such as *Leonurus Cardiaca*, *Nepeta Cataria*, *Hyssopus officinalis*, etc., show very plainly an alternate arrangement of the phlœm and xylem bundles. The adventitious roots originating below the cotyledons are two in number, and arise in a plane perpendicular to that of the primary wood bundles of the hypocotyl.

Adventitious Endogenous Buds.†—C. de Candolle has studied the morphology of the adventitious buds arising on the trunk and branches of trees and shrubs. These are always endogenous, arising in the tissue round about the cambium. The actual layer from which they take origin has not been precisely determined except in a few dicotyledons, where it is the pericycle, but the origin is probably the same in other plants of the same class. The shoots formed by these buds always show at first the vegetative characters of the seedling of the same species. They are never exactly like the axillary shoots of the same tree, and sometimes differ from them in a striking manner. They repeat the course of evolution of the leaf on the plant, if we except the cotyledons; that is to say, where the form characteristic of the adult is only gradually assumed in the development from the seedling, the juvenile stages are reproduced in the development of the adventitious shoot.

The author discusses in detail the various species which he studied; they include *Eucalyptus globulus*, the Walnut, Oak, Ivy, Hornbeam, and Horse-chestnut. In every case the buds are clothed with scales on their appearance, and this would seem to be a general character of endogenous buds, occurring even in species such as those of *Pterocarya*, where the axillary buds have no scales, and also where, as in the Chestnut, the seedling does not bear basilar scales. Phyllomes resembling the cotyledons are never found at the base of the adventitious shoot; these seem peculiar to the embryo, and the adventitious shoots reproduce only those phases of individual evolution which are subsequent to the cotyledons. In this respect they are intermediate between the embryos

* Comptes Rendus, cxxxvii. (1903) pp. 804–5.
† Arch. Sci. Phys. et Nat., xvi. (1902) pp. 50–70.

—which, like themselves, are of endogenous origin—and the exogenous vegetative axes of the plant.

Degeneration of the Potato.*—G. Delacroix discusses the tendency of potatoes to produce long slender shoots in place of the normal development. Such tubers when planted show no distinctive characters, and may be softer or harder than usual; when examined microscopically, there may be found, but not necessarily, *Bacillus solanincola*, *B. caulivorus*, and the saprophytic *Fusarium Solani*. As these organisms may be absent, the abnormal development cannot be caused by them. The true cause rests in the inferior vitality to which many varieties of potato have been reduced as a result of the continued vegetative and the absence of sexual reproduction. This has reduced to a minimum the power of originating variation, which can therefore only arise in response to the external medium, soil or atmospheric agencies. If the latter are unfavourable, unfavourable characters are induced which become hereditary in successive generations, and the injury by organisms which in the normal state are without effect, becomes possible. Starting the germination of the tuber in the light, will eliminate the slender shoots, and this, followed by a rational culture, serves as a palliative, but the tendency will reappear at the end of several generations. The only certain method of cure is to start from the seed and select carefully. The problem is one not of plant pathology, but of agriculture.

Reproductive.

Development of Gametophyte and Embryo of Ruppia rostellata.† Murbeck has investigated the development of the pollen, the embryo-sac, and the embryo in this form. He finds that in the anther the initials arise as a sub-epidermal layer, and from this layer on the inside the primary archesporial cells are cut off. The pollen-mother-cells show a well-marked synapsis and dolichonema stage in their nucleus, which exhibits eight chromosomes, the vegetative number being sixteen. The cells of the tetrad become separated from one another, and before they are fully developed, each cuts off from one end a small generative cell. By further growth of the pollen-grain the generative cell comes to lie about the middle of the grain near the vegetative cell. Like *Potamogeton*, and the other genera of the Helobieæ and Spadicifloræ which have been investigated, the generative cell divides while the pollen-grains are still in the anther.

In the ovule a sub-epidermal initial cell appears and cuts off a tapetal cell above which divides to form a single layer of four to six tapetal cells. The lower part becomes the embryo-sac-mother-cell, the nucleus of which soon shows a heterotypic division with synapsis, dolichonema stage and eight chromosomes. The daughter-cells thus formed soon divide again, but the planes of division are not parallel to one another; the two lower cells of the four being placed under each other, the two upper obliquely side by side. This lends support to the view that the division of the embryo-sac-mother-cell is a tetrad division

* Comptes Rendus, cxxxvii. (1903) pp. 1006–7.
† Bihang. K. Svensk. Vet.-Akad. Handl., xxxvi. (1903) pp. 1–21 (3 pl.).

exactly comparable with that of the pollen-mother-cell. The lowest of the four cells becomes the embryo-sac, which develops in the typical way, the two polar nuclei fusing together before pollination. From the author's study of embryo development the views of Wille, as against those of Ascherson, are supported.

Embryology of Juncaceæ.*—M. Laurent gives the following account of the development of the embryo. The fertilised egg divides transversely into two unequal cells, the upper and larger of which constitutes the greater part of the embryo; the lower or suspensor cell divides transversely. The upper of the two daughter-cells again divides in the same sense, and from the uppermost of the three suspensor cells is formed by vertical walls a plate, which separates the developing embryo-cell proper from the two lower suspensor cells, which increase considerably in size. Further development consists in the formation of a large cotyledon from the embryo-cell, a radicle from the upper portion of the suspensor, while the two large suspensor cells completely disappear. The plumule appears at the base of the cotyledon above the radicular meristem. The hypocotyl is suppressed.

Goebel and other authors have referred to the embryo of *Juncus* as undifferentiated. M. Laurent, however, has studied the development here described in several species of *Juncus* and also in *Luzula*. The suspensor plays an important part: reduced at first to a few cells, it develops tardily, but subsequently becomes the chief centre of cell activity and forms the radicle. The cap does not develop till after the exfoliation of the two or three lower elements of the suspensor.

POINDEXTER, C. C.—**The Development of the Spikelet and Grain of Corn.**
[As a preliminary to the study of xenia in maize, the author describes the development of the pistil and fruit.]
Ohio Naturalist, iv. (1903) pp. 3–9 (2 pls.).

Physiology.

Nutrition and Growth.

Influence of Potassium on the Morphology of Sterigmatocystis nigra.†—M. Molliard and H. Coupin are of opinion that data as to the influence of culture media on the growth of fungi have not been accurate enough to be of scientific value. They have therefore selected potassium, one of the ingredients in an artificial solution, and tested the effect of its presence or absence on the morphological development of *Sterigmatocystis*. The absence of the salt, potassium carbonate, had an immediate effect, especially on the fertile hyphæ. The sterigmata instead of bearing conidia grew out into mycelial filaments, and on these were formed secondary smaller conidia-bearing heads. Forms resembling *Aspergillus* and *Penicillium* were also developed, and the conidia when formed in the absence of the potassium were invariably small and the wall less cutinised. Also the conidia germinated readily *in situ* and produced chlamydospores.

* Comptes Rendus, cxxxvii. (1903) pp. 532–3.
† Rev. Gén. Bot., xv. (1903) pp. 401–5 (1 pl.).

Function of the Starch-Sheath.*—F. Tondera concludes from his investigations of internodes of various members of the order Cucurbitaceæ that the function of the starch-sheath is not statolithic. The position of the starch-grains on the cell-wall is not a constant one, nor is their distribution in the layer and on the cell-wall such as we should expect on Haberlandt's Statolithic theory of Geotropism. Nor is the starch-sheath to be regarded as the path for plastic material, but as a store-house for nutrient matter required in the immediate neighbourhood; observation shows that the starch-grains are used up in the thickening of the cellulose walls of the sclerenchymatous ring. No starch-sheath was found in the following three species, *Bryonia dioica*, *Luffa acutangula*, and *Trichosanthes colubrina*. This is explained by the large size of the vascular bundles, the sieve-tube area of which comes to lie close to the thickening ring, which is thus fed directly from the bundle, and obviates the necessity of a temporary storage of starch in a starch-sheath.

Influence of the Nature of the Soil on the Organic Composition of Plants.†—A. Hébert and E. Charabot find, as the result of experiments with peppermint, that in mature plants the proportions of ash, of organic substance and of the elements which compose the latter—carbon, hydrogen, nitrogen and oxygen—show very little variation when different salts are added to the soil. This fact is very evident when the percentage composition of dried plants is examined. Thus in the aerial organs the ash varies from 8·6 to 11, organic matter from 81 to 91·4; while of the component elements of the latter carbon varies from 44·6 to 46·5, hydrogen from 5·6 to 5·8, nitrogen from 1·2 to 1·6, and oxygen from 36 to 40. Calculated in numbers of atoms, the variation is—

C	H	N	O		C	H	N	O
4·1	6·1	·09	2·5	to	4	6·6	·08	3

for aerial organs, and

C	H	N	O		C	H	N	O
3·7	6	·05	2·8	to	4	6·6	·08	3

for roots.

Irritability.

Relation between Light Intensity and Energy of Assimilation in Plants belonging to different Biologic Types.‡—Fr. Weis has experimented with plants of *Marchantia polymorpha*, *Polypodium vulgare*, and *Œnothera biennis*, exposing them to light of different degrees of intensity under conditions in which the amount of oxygen evolved and carbon dioxide absorbed could be determined. In experiments in direct sunlight the tubes containing the plants were placed under bell-jars with double walls, between which passed a continuous current of cold water to absorb the heat rays of the sunlight. The plants were exposed to direct sunlight and light $\frac{1}{60}$ and $\frac{1}{90}$ the intensity of direct sunlight. The intensity was estimated by the time taken by photographic paper

* Bull. Internat. Acad. Sci. Cracov. Cl. Sci. Math. et Nat., 1903, pp. 512–6 (1 pl.).
† Comptes Rendus, cxxxvii. (1903) pp. 799–801.
‡ Tom. cit., pp. 801–4.

to assume a predetermined tint. From the experiments, M. Weis concludes that *Œnothera biennis* is a well-marked sun-plant, which in direct solar light and at a temperature favourable to assimilation, assimilates about three times as much carbon dioxide as in diffused light. On the other hand, *Polypodium vulgare* assimilates with slightly more energy in diffused light, and notably more than does *Œnothera*. *Marchantia* occupies an intermediate position between the other two plants. The author points out that it would be interesting to conduct such a series of experiments with the plants which fight for the light in our fields and woods.

Hydathodes in the Leaves of Woody Plants.*—W. Edelstein has investigated about seventy species of woody plants, and finds that only in fourteen are hydathodes absent; among the latter are *Quercus pedunculata*, *Q. Ilex*, *Rhamnus Frangula* and *cathartica*, Spindle tree, Ash, *Acer platanoides*, Beech, and Horse-chestnut. The structure of the hydathode is as described by Haberlandt and others in herbaceous plants. The physiological investigations were made with well-rooted pot-plants, or cut branches with use of artificial pressure on the lines employed by Moll.

The author finds that cut branches, in the absence of any pressure, retain the capacity of absorbing and excreting water for three to four days without loss of intensity. In a series of experiments undertaken to show how far the hydathodes shared in this process, the author covered either all the leaves or only the hydathodes with vaselin, albumin, or Cacao-butter. In neither case was any influence shown on the absorption of water. The hydathodes were now removed by cutting off the leaf-edges; water-absorption went on as before, while great drops of water appeared on the cut edges of the nerves. On the other hand, absorption was almost completely stopped by etherising the branch, and by removal of all the leaves. The author is unable to explain the relation between absorption and excretion of water; his experiments show at any rate that absorption is not influenced by the presence of the hydathodes.

General.

Ecologic Study of the Flora of Mountainous North Carolina.†—J. W. Harshberger gives a detailed account of the factors determining the character and the nature of affinities of the flora of this region. The area embraces several mountain ridges with the associated valleys, the former often attaining heights between 4000 ft. and 5000 ft. The effect of the physiographic changes which have occurred in the history of the geologic formation of the area on the distribution of the plants is discussed. Four kinds of plants, with reference to their phenologic distribution, may be distinguished in the vegetation of the forests of eastern North America, viz.—plants of boreal genera (Arctic, Hudsonian and Canadian species); plants of temperate genera (Alleghanian and Carolinian); plants of warmer temperate climate; and neotropic genera.

* Bull. Acad. Imp. Sci. St. Petersb., xvii. (1902) pp. 59–64.
† Bot. Gazette, xxxvi. (1903) pp. 241–58.

Upon the retreat of the ice-sheet, that portion of the continent north of the terminal moraine was tenanted again by plants migrating northwards which were adapted to a cold temperate climate. Many of these came from the southern Appalachians, where they had remained undisturbed during the long Ice Age ; these mountains served as a centre of distribution from which a considerable area in the south-eastern states was populated. A study of the principles underlying the distribution of plants in eastern America, shows the great antiquity of the flora of the mountains of western North Carolina. The presence of so many peculiar types of plants not found elsewhere in America, and having their closest relations in eastern Asia, makes it more certain that groups now broken up and detached were once continuous, and that fragmentary groups and isolated forms are but the relics of widespread types, which have been preserved in a few localities where the physical conditions were especially favourable, or where organic competition was less severe. Evidence of this antiquity is found in western North Carolina in the large size of the trees, the close commingling in a dense forest of a great variety of species, the graded-down appearance of the land surface, and the rounded contour of the mountains, all suggesting that the country has been subjected through long ages to the continued action of climatic forces. The deep soil in the North Carolina mountains, rich in organic detritus, points to the long occupation of the territory by dense forests, the most magnificent (excepting those of the Pacific slope) to be found anywhere in the Western Hemisphere.

The characteristic features of the vegetation are found in the broad-leaved species of which it is largely composed, associated with deciduous and evergreen shrubs, while lianes stretch from tree to tree, and herbs grow beneath the dominant forest species, or clothe the natural meadows of the higher mountain summits and the alluvial bottoms of the principal mountain streams. The association of these plants in the forest is due largely to their relation to light, soil and moisture. Ecologically, the following formations may be distinguished :

1. Mixed deciduous forest formation, 2000–5000 ft.
2. Coniferous forest formation, 5000–6700 ft.
3. Sub-alpine dwarf tree-shrub formation, about 6000 ft.
4. Sub-alpine treeless formation, above 6000 ft.

Polar Climate in Time the Major Factor in Evolution.*—G. R. Wieland, as a result of the study of the facts of distribution, concludes that climatic changes of a character affecting life must in the course of time be of minimum amount at the equator, and increase towards the poles, where the maximum amount of such change occurs. Hence the nearer a given locality to either pole, the greater the seasonal vicissitudes to which its life is subjected. The origin of life probably took place at the north, or both the poles, though the possibility of a supplementary or extra-terrestrial origin requires consideration. The Palæozoic period, from climatic and other reasons—such as freer circulation of oceanic waters, and the greater number of aquatic animals, and lowly organised or spore-bearing plants—must have been one mainly of generalised

* Amer. Journ. Sci., xvi. (1903) pp. 401–30.

origin. Hence there can be slight stratigraphic record of the distributory movements of faunas and floras in the Palæozoic, though even then polar climates were probably the most important of evolutionary factors. From the origin of life down to the Mesozoic the north and south polar areas may have played a nearly equal part in creating a certain southward and northward stress, together with a sort of breaking up of species in the tropics. But from the Mesozoic to the Glacial period, evidence points to the polar origin, and continuous outward dispersion from the north polar area of most of the great plant and vertebrate groups. The similarity in successive unrelated and diverse faunas synchronously appearing on both sides of the Atlantic cannot be accounted for throughout long periods of time on the basis of lateral interchange. The record of the post-Palæozoic flora is in all essentials the complement of the vertebrate record, and far more complete. Moreover, the outward movement, especially of Conifers and Dicotyledons, from the Arctic area for long periods of time, has frequently been recognised. Some traces of this movement are still evident in the present strikingly homogenous circumboreal flora, although its main development was obscured and partially checked by the appearance of glacial conditions. It seems conclusive that all the factors of climate—and, therefore, the main alternative potentialities producing organic evolution—have been in the highest degree variant in the polar areas. This being true, the grouping of the continents about the north polar area would render it probable, were there not abundant direct evidence pointing to the fact, that the northern circumpolar area has probably been, ever since the older Palæozoic at least, the main evolutionary centre from which animal and plant life has radiated. This view is supported by overwhelming proof that it is from the Arctic area that the greatest waves of change have swept out to lessen and disintegrate in the more static conditions of the tropics.

Racial Variation.*—Witmer Stone, who has for a number of years studied racial variation amongst terrestrial vertebrates, and its relation to environment and climatic conditions, has recently investigated the genus *Viola* in the neighbourhood of Philadelphia on the same lines. His studies, while throwing little light on the relation of variation to conditions of environment, have enabled him to give a fairly complete account of the variations shown by the local violets, which may be a help to those interested in the genus. The author emphasises his view of the advantage of the trinominal for denoting races. Among terrestrial vertebrates racial variation corresponds closely to geographic environment, and in many groups it is easy to recognise the effect of the environment on several different life-areas in producing recognisably distinct races from the same type. As is well known, trees and shrubs, as well as other plants in a less degree, conform with more or less exactness to the same general laws of geographic distribution that pertain to animals; and the ranges of many species are limited by the life-zones established originally from a study of birds and mammals. When, however, a genus is represented by different forms in several life-zones, they are usually very distinct species, and not closely related variants which

* Proc. Acad. Nat. Sci. Philadelph., 1903, pp. 656–99 (9 pls.).

have obviously been differentiated from a common parent-type by prevailing environmental conditions in the several life-areas in question, such as is so often seen among vertebrates. At the same time, many closely related variants do exist among plants, differentiated to the same varying extent as in the geographic races of birds and mammals, but all occurring in the same life-zone, and often side by side. They are, moreover, quite constant in their racial characters, and are not cases of individual variation. The agency responsible for this differentiation is in many cases to be found in the varying soil conditions and other local peculiarities not strong enough to affect higher animal life. Owing to the fixed nature of plant life, such conditions may have a very marked effect in producing local forms; to these the author would apply the trinominal nomenclature, to distinguish them from the clearly defined species. The author points out at the same time that nomenclature becomes absurd when applied to variants which can only be recognised by one or two specialists, who have devoted years to the study of the group, as has happened in the genus *Cratægus*.

The species of *Viola* fall into two groups, the caulescent and the acaulescent; those of the former show but little of the tendency to racial variation which characterises the latter group. Three types of colour—blue, yellow and white—occur in each group; parti-coloured forms also occur in the caulescent. The blue-flowered acaulescent species show by far the greatest racial and individual variation, and it is upon these that the author bases his general statements. Leaf-form supplies the most striking character. There is often a marked similarity in the general shape of the early leaf in a number of species, which is more or less entire, passing later into a lobing characteristic of the species. Starting from the most primitive type, the cordate leaf, the author indicates various racial variations, tending in the one direction towards extreme lobing or leaf-division, in the other towards the triangular and narrow sagittate-leaved forms. There seems to be a tendency towards narrow leaves in many wet-ground species. Variation also occurs in the degree of pubescence of the leaf. In using the relative length of petiole and scape comparison should explicity be made with either the first or second set of leaves, as the flowering period often covers the growth of the second leaves, so that early flowers are longer than the leaves, while later ones are shorter. The length and character of the peduncle of the later cleistogamic flowers is an important specific character; except that in all wet-meadow species it is erect, no correlation is possible between this character and the nature of the habitat. In floral characters there is a great amount of individual variation. The extent of pubescence on the petals is an important specific character.

As regards geographic distribution of the forms found, both acaulescent and caulescent, in eastern Pennsylvania and southern New Jersey, six are characteristic boreal species; three others also occur in the higher Alleghanies. Another group seems to be decidedly southern. The other forms range indiscriminately over the intervening country.

The author gives a clavis of the species (thirty in number) and forms, based on the above-mentioned characters; this is followed by descriptions, including the range and habitat of the individual species and forms.

Studies in the Cyperaceæ: the Grouping of the Carices.*—T. Holm criticises the various sub-divisions of the genus *Carex*, which have been proposed from the time of Linnæus onwards. He attempts a classification of the two groups, *Vigneæ* (with two stigmas), and *Carices genuinæ* (with three stigmas), which he considers must be maintained, in accordance with the principles suggested by Drejer. The author considers the two to be parallel groups evidently sprung from certain monostachyous types, and branching out in several more or less restricted "greges." He gives a synopsis of the characters of these "greges" and the species assigned to them, placing first the simplest species (when such are represented in the shape of monostachyous species) as *Hebetatæ*, then the supposed *central* types, and thirdly as *Desciscentes*, certain species which cannot be placed in direct sequence with the *centrales*, and which to some extent show transition to other "greges." Thirty-nine greges are maintained, fifteen under *Vigneæ*, and twenty-five under *Carices genuinæ*; many of these are established for the first time by the author.

Association of Chalk-loving and Chalk-avoiding Species.†—S. Aubert describes a remarkable association of *Calluna vulgaris* and *Vaccinium uliginosum*, two well-marked calcifuge species with an otherwise typical chalk-loving flora, in a dry chalky grassland on the high Jura. The predominating species in the area, which formed a rectangle of about 200 by 30 metres, sloping to the south-east at an elevation of 1090 metres, was *Calluna vulgaris*. The other dominant plants were *Alchemilla vulgaris*, *Potentilla Tormentilla*, *Phyteuma orbiculare*, *Sanguisorba dictyocarpa*, *Carex glauca*, and *Hypericum quadrangulum*. In a turf-pit, several hundreds of metres to the east, *Calluna vulgaris* grew in abundance, and this may have been the source of the *Calluna* found on the chalk-soil. It is affirmed that the latter had been dominant on the area in question for fifty years. The author gives the result of a chemical analysis of the soil, and discusses at length the question of calcicolous and calcifuge species, but is fain to admit that he can find no explanation for the fact which he describes in the present case. "It is simply a fact of observation which shows how little general theories are verified by local facts, and how little is the advance we have made in the knowledge of the intimate relations between the different elements of the soil and the vegetation which it supports."

American Plants Naturalised in Spain.‡—D. L. Aterido describes the extensive growth near Santander of *Stenotaphrum americanum*, an American grass which occurs also in West Tropical Africa and at the Cape. Associated with it are other American plants, such as *Agave americana*, *Nothoscordum fragrans*, *Cyperus vegetus*, and another grass *Digitaria paspaloides*. The author also gives a list of nearly sixty plants of American origin which have become established in the peninsula, among which we note *Lepidium virginicum*, five species of *Œnothera*, including *Œ. biennis*, seven species of *Opuntia*, *Solidago canadensis*, four species of *Datura*, and eight of *Amarantus*.

* Amer. Journ. Sci., xvi. (1903) pp. 445–64.
† Bull. Soc. Vaudois Sci. Nat., xxxix. (1903) pp. 369–84.
‡ Bolet. Soc. Esp. Hist. Nat., iii. (1903) pp 326–9.

Australian Botany.*—F. Turner gives an account of the Botany of two districts in New South Wales, namely, New England and the Darling river country. Besides a systematic list of the plants (flowering plants and ferns), the author gives notes on the climate and soil of the districts, and also a general descriptive account of the vegetation, and a statistical comparison with the flora of New South Wales as a whole. In the New England districts several genera of orchids are well represented (including *Dendrobium*, *Pterostylis* and *Caladenia*) and also the ferns and fern-allies; while in the Darling river country only one orchid is recorded—an epiphyte, *Cymbidium canaliculatum*, and five Acotyledons, including two species of *Azolla* and *Marsilea Drummondii*. Apropos of the orchid, the author remarks that "it was of some slight food value to the aborigines, who used to eat its pseudo-bulbs, which contain a small amount of starch."

ARECHAVALETA, J.—**Flora Uruguaya.** (Tom. ii.)
[Contains a synopsis of the series, cohorts and natural orders of polypetalous dicotyledons, according to the arrangement of the Genera Plantarum of Bentham and Hooker, an historical introduction, and an elaboration of the orders from Saxifragaceæ to Begoniaceæ inclusive.]
Anal. Mus. Nacion. Montevideo, v. (1903).
Fl. Uruguaya, ii., xlviii. and 160 pp.

ORAMAS, D. P. — **Algunos datos más sobre el tan célebre Drago de Orotava.** (Some facts about the celebrated Dragon-tree of Orotava.)
[A few points of historical interest on the growth of this famous tree.]
Bol. Soc. Esp. Nat. Hist., iii. (1903) pp. 324–6.

SCHAFFNER, J. H.—**Poisonous and other injurious plants of Ohio.**
[Contains notes of some interest on the nature of the poison and its effects on man and other animals in a large number of plants found in Ohio, including fungi and seed-plants.]
Ohio Naturalist, iv. (1904) pp. 16–19, 69–73.

CRYPTOGAMS.

Pteridophyta.

Vascular System of the Rhizome and Leaf-trace of Pteris Aquilina and P. incisa.†—A. G. Tansley and R. B. Lulham give a detailed account, illustrated by numerous diagrammatic figures, of the course of the bundles in these two ferns. In *Pteris incisa* the stele of the internode is a solenostele, rather flattened in the horizontal plane, and wavy on the ventral side, from which roots are given off; but as the node is approached complications arise, which are explained by comparison with the vascular structure previously described by Gwynne-Vaughan in *Hypolepis* as referable to a false dichotomy of the stem. The vascular structure of the rhizome of *Pteris Aquilina* is well known, but the connexion of the petiolar strands of the base of the petiole with those of the rhizome, has never been previously accurately described. This is now done in detail, and the authors conclude that the vascular system of this fern is a dorsiventral dictyostele of the *Polypodium* type, with an internal system of accessory strands developed in connexion with lateral elaboration of the leaf-trace.

* Proc. Linn. Soc. New South Wales, xxviii. (1903) pp. 276–311, 406–42.
† New Phytolog., iii. (1904) pp. 1–17 (59 small figs.).

The authors point out in conclusion, that the probability of the modification of vascular structure at the node of the plant—in relation to an alteration of the leaf-trace—and the effect of leaf-traces in modifying stem-structures generally, has been noted in one form or another by nearly all recent writers on vascular morphology. The principle of the decurrency of such a new structure from the node into the internode below, and its eventual establishment throughout the internode, to join a similar structure at the next node below, is evidently one of very wide application in the Filicinean series. The particular instance of it described in the present paper is of special interest, since it brings before us a mode of origin of an internal system of rhizomic vascular strands, differing from that described by Gwynne-Vaughan in a number of types. Whereas the internal ridges and strands in *Dicksonia*, *Cyathea* and *Pteris elata* arise at the node as a local thickening of the leaf-gap, those of the plants here described arise as lateral elaborations of the leaf-trace itself.

Germinating Spores in a Fossil Fern.* — D. H. Scott figures a section of a fern-sporangium cut from a nodule obtained from the Halifax Hard Bed. In the multiseriate structure of its wall, the sporangium resembles those of the Eusporangiate Ferns ; there is also evidence of the existence of an area of enlarged cells, comparable to the group which discharges the functions of an annulus in the Osmundaceæ. This accords with the close agreement pointed out by Bower between certain carboniferous sporangia and those of this recent family.

The sporangium contains a considerable number of spores, approximately spherical in shape, many of which had begun to germinate within the sporangium. Several of the latter are figured, and show a close agreement with the stages of germination in recent fern-spores. The author refers to germination of spores as being not uncommon in recent Ferns when effectual dehiscence has been hindered, and remarks on the interest of his observations—as showing that some at least of the Carboniferous Ferns followed the same course of development as their recent allies. The agreement with corresponding stages in the development of fern-prothalli at the present day, leaves little doubt that in this Carboniferous Fern also the spores produced the sexual generation in the way familiar to us. It is uncertain to what Fern the sporangium belonged ; a frond of the *Sphenopteris* type occurred in the same preparation, but there is no evidence to connect it with the sporangium.

Two Megasporangia in Selaginella.†—F. M. Lyon figures a longitudinal section of a megasporophyll of *Selaginella rupestris*, showing two sporangia in nearly median longitudinal section. They are not placed side by side, as in the *Lycopodium* described by Bower, but as if the additional sporangium was developed in the line connecting the normal megasporangium with the ligule. The figure also shows the normal reduction of the megaspores to one or two, so common in *Selaginella rupestris*.

Ferns of the Philippines.‡—L. M. Underwood publishes a summary of our present knowledge of the ferns of the Philippines, giving an

* New Phytolog., iii. (1904) pp. 18–23 (2 figs.).
† Bot. Gazette, xxxvi. (1903) p. 308 (1 fig.).
‡ Bull. Torrey Bot. Club, xxx. (1903) pp. 665–683.

historical account of travellers, collections and literature. In all, 105 genera and 633 species have been recorded from the islands; the Isoctales and the Matoniaceæ are at present unrepresented. To facilitate research, a series of simple synopses of the genera is given. The arrangement adopted approximates to that employed by Diels in *Die Naturlichen Pflanzenfamilien*. Suggestions are added as to the parts of the plants that should be collected, and as to the points that should be noted in the field.

American Ferns.—B. D. Gilbert * gives a list of 53 species and 12 varieties of ferns, and 23 species and 7 varieties of fern allies, that occur in the State of New York; and adds notes upon their distribution and the geographical characteristics of the region. The flora is a large one, owing to the mingling of northern and southern types W. N. Clute † publishes some Fernwort Notes. *Nephrodium molle* being reported as growing in Florida, he inquires whether it is really native, and points out the characters by which it is distinguished from *N. patens*. He quotes four instances of exotic ferns which have become naturalised in the States, and adds another record in *Lygodium japonicum*, which seems to have escaped from a greenhouse in Georgia. He gives reasons for regarding *Nephrodium spinulosum* var. *intermedium* as a mere form of a variable species. He quotes J. B. Flett's opinion that *Lycopodium Selago* may be regarded as an alpine or arctic form of *L. lucidulum*, but by no means as a xerophytic form. A. A. Eaton,‡ in publishing his fifteenth paper on *Equisetum*, treats of the varieties of *E. hiemale*. He describes in detail eleven varieties, three of which are new, and gives their distribution. W. N. Clute,§ having studied carefully the ternate forms of *Botrychium*, gives his views about the classification of these difficult and variable plants.

DUCAMP, L.—**Note sur l'acclimatation de l'Azolla filiculoides Lam. dans le Nord de la France.** (Note on the acclimatisation of *Azolla filiculoides* Lam. in the north of France.) *Bull. Acad. Internat. Geogr. Bot.*, xii. (1903) p. 488.

EATON, A. A.—**Additional notes on Botrychium tenebrosum.**
[Description of this common but little known North American species, with critical notes upon the characters that distinguish it from *B. simplex* and *B. matricariæfolium*.] *Rhodora*, v. (1903) pp. 274–6 (1 pl.).

" " **Three new varieties of Isoetes.**
[Descriptions of three Massachusetts plants, with critical notes.] *Op. cit.*, pp. 277–80.

FREEMAN, G. F.—**Lycopodium Selago on Mount Holyoke, Massachusetts.**
[Second record of this species in Massachusetts.] *Rhodora*, v. (1903) p. 290.

LUISIER, A.—**Apontamentos sobre a Flora da Região de Setubal.** (Notes on the flora of the district of Setubal.)
[List of 16 Portuguese ferns in a total of 1004 plants.] *Bolet. Soc. Broter.*, xix. (1903) pp. 172–274.

MAXON, W. R.—**A Fern new to the United States.**
[*Asplenium auritum* Sw., a central American species, which has been found in Florida.] *Torreya*, iii. (1903) pp. 184–5.

STRAW, C. E.—**Ferns of Smugglers' and Nebraska Notches.**
[Field notes.] *Plant World*, vi. (1903) pp. 180–1 (1 pl.).

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* Fern. Bulletin., xi. (1903) pp. 97–105.
† Tom. cit., pp. 105–107.
‡ Tom. cit., pp. 108–114.
§ Tom. cit., pp. 115–117.

WATERS, C. E.—**Asplenium ebeneum proliferum.**
[A note on the conditions that cause proliferation in this species.]
Rhodora, v. (1903) pp. 272–3 (fig. in text).

WELLS, W. E.—**Adaptability in Ferns.**
[A list of 28 ferns from very varied habitats successfully acclimatised in a simple fernery.] *Ohio Naturalist*, iii. (1903) pp. 358–9.

WOOTON, E. O.—**The Ferns of the Organ Mountains.**
[List of 20 species and a variety gathered in New Mexico.]
Torreya, iii. (1903) pp. 161–4.

Bryophyta.

Mosses of Java.*—M. Fleischer publishes the first volume of the mosses of the Flora of Buitenzorg, including all the mosses of Java, with many of the species of the Malay Archipelago, Polynesia, Australia, Ceylon and India, which are included for the sake of critical comparison. Every species is fully described, many novelties are inserted, and keys to the genera and species are supplied. The author is so convinced of the systematic importance of the characters of the capsule and especially of its peristome, that he makes these the foundation of his classification, and attaches far less value to such vegetative characters as the acrocarpic or pleurocarpic position of the inflorescence, the distichous or spiral arrangement of the foliage, the areolation of the leaves, etc. His long residence of five years at Buitenzorg enabled him to make a thorough study of the peristome, as well as of the development and anatomy of the mosses, and to investigate biological and phylogenetic details, e.g. the curious diœcism of *Macromitrium*, the water-sacs of *Cyathophorum taitense*, the formation of gemmæ in an inflorescence or at the foot of a sporogonium, the emission of rhizoids from a seta; and he discovered the sporogonium of the protonematoid *Ephemeropsis*. The beautifully illustrated "Bryologia Javanica" (1855–70) of Dozy and Molkenboer has now fallen behind the times, and subsequent papers on the subject are very scattered. Fleischer's work adds much to what was previously known, and is on quite modern lines. The first volume contains the Sphagnales and the Haplolepideæ, with descriptions of 194 species. It is entirely in German.

Danish Species of Amblystegium.†—A. Hansen publishes a revision of this genus, redescribing the species, fourteen of which occur in Denmark. Three of these are new to science: *A. paludosum*, *A. saxicola* and *A. atrovirens*, and their descriptions are given both in Danish and English. A key to the species is supplied, based chiefly upon the presence or absence of a leaf-nerve, the transverse section, and the breadth and the length of the nerve, the shape of the leaf-apex, and the character of the leaf-cells and basal cells. The author describes also another new species, *A. littorale*, from the Faröes, previously regarded as a variety of *A. serpens*.

American Mosses.—M. F. Miller‡ publishes a note on *Pogonatum urnigerum*, describing how the calyptra gradually is turned inside out

* Die Musci der Flora von Buitenzorg, i., Leiden, 1904, xxxi. and 386 pp., 71 figs. in text. † Bot. Tidsskrift., xxv. (1903) pp. 387–408 (11 figs. in text).
‡ Bryologist, vii. (1904) pp. 4–5 (with fig.).

and stands straight up from the point of the operculum before it is cast off by the mature capsule. A. J. Grout * gives a list of twenty-one additions to the Vermont moss flora, including a new variety, or perhaps species, of *Grimmia*. J. M. Holzinger † discusses the genus *Hymenostomum*, and claims that *H. rostellatum* occurs in the States and is practically identical with *Systegium* (*Astomum*) *ludovicianum* Sulliv., the differences in the size of the spores and the length of the operculum being but slight. E. G. Britton ‡ discusses *Papillaria nigrescens*, and shows how it is to be distinguished from *Leptodon trichomitrion*, which has been confounded with it. The former is a tropical American species and its record from Lake Huron is suspicious. She believes that the Floridan var. *Donnellii*, when compared with the type, will prove to be specifically distinct.

Leucobryaceæ of the East African Islands.§—J. Cardot publishes a monograph of the Leucobryaceæ of Madagascar, and the other African islands of the Indian Ocean. Five genera are concerned. *Ochrobryum* contains one species, *Leucobryum* twelve, *Leucophanes* six, *Cardotia* one, *Octoblepharum* one. Seven species and some varieties are described for the first time, and most of the rest are redescribed, and critical notes are added.

Oil-bodies in the Jungermanniales.‖—A. J. M. Garjeanne gives an account of the observations previously published on this subject, and describes his own researches. His conclusions are that the oil-bodies arise from vacuoles; the oil-drops lie probably in a semi-liquid medium; the oil-bodies possess a proper envelope—the original tonoplast; they multiply in the young stages by division, and when mature remain unaltered; their envelope is an artificial product, and consists probably of tanned albumen; the possibility of movement of the drops within the oil-body is a proof of the semi-liquidity of the contents; in secondary meristem several oil-bodies always arise.

Explosive Discharge of Antherozoids in Hepaticæ.¶—F. Cavers has made a series of experiments with thalloid hepatics to ascertain the force with which the antherozoids are ejected, the mechanism by which the process is effected, and the conditions which influence it. The phenomenon is a mechanical and not a vital one; for explosive discharges were obtained when plants, which had been dehydrated in absolute alcohol, were moistened with warm water. With living plants the discharges were quite as active in darkness as in full sunlight. When the plants were well sprayed with water, the jets of antherozoids reached a height of 10 or 12 cm. in many cases.

Exogenous Antheridia in Anthoceros.**—E. Lampa made a laboratory culture of *Anthoceros dichotomus*, and observed that, while the majority of the plants produced normal endogenous antheridia, a

* Bryologist, vii. (1904) pp. 5–7. † Tom. cit., pp. 8–10.
‡ Tom. cit., pp. 14–15 (fig. in text).
§ Bull. Herb. Boissier, iv. (1904) pp. 97–118.
‖ Flora, xcii. (1903) pp. 457–82 (18 figs. in text).
¶ Torreya, iii. (1903) pp. 179–83.
** Oesterr. Bot. Zeitschr., liii. (1903) pp. 436–8 (figs. in text).

few etiolated thalli bore *exogenous* antheridia which were otherwise quite normal in structure and development. While a differentiated parietal layer is necessary to an exogenous antheridium, its presence in the endogenous antheridia which are peculiar to *Anthoceros* has been a matter of speculation; and Waldner's theory, that the antheridia of the ancestral *Anthoceros* may have been exogenous formations, receives support from this discovery. The laboratory culture appears to have produced some reversions to an original type.

Chemistry and Biology of Hepatics.* — C. E. J. Lohmann discusses the question of what are the protective substances that render hepatics distasteful to slugs and other animals, giving a *résumé* of the work done by Stahl and others. Several hepatics have a strong aromatic smell, or a sharp or bitter flavour, which are capable of being extracted by alcohol; and, until this has been done, these plants are avoided by slugs. The author describes his attempts to determine the chemical nature of these protective substances; how he analysed the ashes and found that silica affords no mechanical protection; and how he determined that the immunity is not due to indigestible proteids nor to alkaloids, but mainly to the ethereal oils as previously indicated by Stahl. He details his analysis of these volatile oils, and describes the composition of the oil-bodies, etc. Ethereal oils are present in hepatics, absent in mosses; they appear in the early stages of growth, and have an aplastic nature; they are absent from spores and rhizoids (which are not easily attacked), and tend to abound in peripheral positions. These are facts that point to the protective function of ethereal oils, as also does their absence from *Anthoceros* and *Blasia*, in which occur colonies of *Nostoc* —an alga distasteful to slugs.

Structure of some North American Hepatics.† — W. C. Coker publishes some notes on the structure of *Dumortiera*, *Blasia* and *Sphærocarpus*. *Dumortiera hirsuta* is of semi-aquatic habit, and if sufficiently inundated has no air-chambers in its thallus; but if less irrigated it produces air-chambers which mostly disappear with age, and in subdued light its upper surface may produce a number of unicellular papillæ. No trace of mycorhiza was found in the thallus. In *Blasia pusilla* it was found that the *Nostoc*-colonies are pervaded by a remarkable tree-like out-growth of the thallus, which serves to abstract nourishment from the alga. This ramifying hair appears to arise from the subsequent growth of the original slime-secreting cell of the air-cavity. This is explained by figures. In the sporangium of *Sphærocarpus terrestris* occur peculiar sterile cells conspicuous for their bright green chlorophyll-granules, which persist until the spores are ripe. They probably are the homologues of elaters, but are strikingly different. Their function is photosynthetic.

Odontoschisma in North America.‡—A. W. Evans gives the history of the genus *Odontoschisma*. It contains about fourteen species, and

* Beih. z. Bot. Centralbl. xv. (1903) pp. 215–56.
† Bot. Gazette, xxxvi. (1903) pp. 225–30 (figs. in text).
‡ Tom. cit., pp 321–48 (3 pls.).

five of these occur in North America. One of the generic characters is the postical origin of the branches; but some of the American species vary markedly in this respect, and deviate also with regard to the mouth of the perianth and the development of the under-leaves. The author considers that the genus is distinct from both *Anomoclada* and *Cephalozia*, and regards the position of the branches as liable to be influenced by the environment of the plant. The trigones and the thickenings of the cell-walls are characters of generic and specific importance. The under-leaves present peculiarities which have been much overlooked hitherto, especially the slime-secreting papillæ on the margins. Under-leaves occur in all the American species. The apical thickening of the female branch after fertilisation is another character that deserves more attention. The gemmiparous branches are of use in specific discrimination. The author gives the distribution and synonomy of the five North American species, with full descriptions of *O. Macounii*, *O. Gibbsiæ* (sp. n.) and *O. prostratum*, also of *O. portoricense*, an exotic species which resembles *Anomoclada mucosa*.

Hepaticæ of Puerto Rico.*—A. W. Evans also gives a critical account of the four genera *Harpalejunea*, *Cyrtolejeunea*, *Euosmolejeunea*, and *Trachylejeunea*, based upon material gathered by himself and by Heller in Puerto Rico. He restricts *Harpalejeunea* to Spruce's well-marked section *Cardiostipa*, and describes two new species (*H. subacuta* and *H. heterodonta*). *Cyrtolejeunea* is a new genus established for the reception of *C. holostipa*, a species about whose systematic position great diversity of opinion has been expressed hitherto. In all, the paper treats of eight species, with full descriptions and figures, and comparative notes on allied species and genera.

Pallavicinia Flotowiana.†—F. Cavers gives a detailed morphological description of this plant which grows in Coatham Marshes, Yorks. It belongs to the subgenus *Mörckia*, and is synonymous with *P. hibernica* var. *Wilsoniana*. The most interesting feature in its structure is the presence of two lateral strands of water-conducting tissue; their function was easily demonstrated in living plants; but these strands were not differentiated in plants which had been cultivated in moist covered dishes—a modification which the writer has observed in laboratory cultures of other thalloid hepatics. The sexual organs and the development of the sporogonium are described.

Fegatella conica.‡—F. Cavers also describes in detail the structure and biology of *Fegatella conica* under the following headings: Apical growing-point and branching; Air-chambers; Ventral tissue; Ventral scales; Rhizoids; Mycorhiza; Asexual reproduction; Sexual organs; Sporogonium; Germination of the spore. The high degree of differentiation attained by the thallus is indicated by the evaporation-tissue in the air-chambers and the mucilage-organs in the mid-rib. The presence of the symbiotic mycorhiza is indispensable for the normal development

* Bull. Torrey Bot. Club, xxx. (1903) pp. 544–63 (3 pls.).
† Naturalist, 1903, pp. 441–4, 451–5 (1 pl. and 5 figs. in text).
‡ Ann. Bot., xviii. (1904) pp. 87–120 (2 pls. and 5 figs. in text).

of the thallus, and supplies a semi-saprophytic mode of nutrition. The antheridial receptacle is sessile, and, with its four to eight growing-points, each producing acropetal rows of antheridia, represents a branch-system. The antheridia are usually solitary in each cavity, but sometimes occur closely joined in pairs. The antherozoids are larger than in other Marchantiaceæ, and are ejected explosively. The archegonial receptacle also represents a branch-system; each of the five to nine growing-points produces a single archegonium. The stalk of the receptacle suddenly lengthens out when the sporogonia are mature. The cover-cell of the young archegonium splits into four and takes no part in the growth in length of the archegonium. The young sporogonium usually shows an octant-stage, and does not grow by means of an apical cell. The large, green, thin-walled spores begin to germinate within the capsule. The elaters are short and often branched. The capsule dehisces by the separation of an apical disc, followed by longitudinal splitting into four to eight valves. *Fegatella* occupies an intermediate position between the two highest series of the Marchantiaceæ. The process of fertilisation can be readily followed in *Fegatella* owing to the large size of the antherozoids. A bibliography is supplied.

British Hepaticæ.*—P. Ewing gives a list of the hepaticæ of the Breadalbane mountains, 133 species. The determinations have been made or checked by S. M. Macvicar. Fourteen are additions to the British Flora, and twenty-two are new to the district. W. H. Pearson † gives some field-notes upon eighteen hepatics gathered at Aysgill Force and Hardraw Scour in Yorkshire. W. Ingham ‡ records the gathering in 1897 of the recently described *Martinellia calcicola* Arn. and Pers.,§ intermixed with *Ditrichum flexicaule* and *Trichostomum tortuosum*, on magnesian limestone at Tadcaster, Yorks. He translates the original description of the plant.

Census of Scottish Hepaticæ.‖—S. M. Macvicar is collecting materials for a definitely localised hepatic flora of Scotland, and publishes a list of 205 species with their distribution according to counties, so far as he has been able to ascertain it hitherto from a personal examination of the specimens preserved in public and private herbaria. He adds a few critical notes upon *Riccia*, *Marsupella*, etc.

Irish Hepaticæ.¶—D. McArdle publishes a list of the Irish hepaticæ, containing 172 species and 63 varieties, with full records of their geographical distribution so far as it is known. The last previous trustworthy list was D. Moore's report published in 1876; it contained 137 species. The author gives a short account of the earlier Irish collectors, of the physical features of the country, of the peculiarities of the Irish hepatic flora, and a bibliography of the principal papers on the subject.

* Ann. Scot. Nat. Hist., 1903, pp. 235–43.
† The Naturalist, 1903, pp. 403–4.
‡ Rev. Bryol., 1904, pp. 11–12. § Op. cit., 1903, p. 97.
‖ Ann. Scot. Nat. Hist., 1904, pp. 43–52.
¶ Proc. Roy. Irish Acad., xxiv. B. (1904) pp. 387–502.

BLOOMFIELD, E. N.—**Hepaticæ of Norfolk.**
[A list of 47 species, with localities.]
Trans. Norf. and Norw. Natur. Soc., vii. (1903) pp. 552–7.

BROTHERUS, V. F.—**Die naturlichen Pflanzenfamilien von Engler und Prantl, i. 3.** Lief. 219, Musci, Leipzig, 1904, pp. 577–624, figs. 434–72.

CAMUS, F.—**Catalogue des Sphaignes de la Flore Parisienne.**
[Beginning with an historical sketch of publications on the subject, he gives a detailed key to the species, with descriptions, and then sets forth the full distribution and synonymy of each species, adding critical notes.]
Bull. Soc. Bot. France, l. (1903) pp. 239–52, 272–89.

" " **Notice sur M. Ém. Bescherelle.**
[An account of his bryological work, and a detailed list of his publications.]
Tom. cit., pp. 227–39 (portrait).

CARDOT, J.—**Le genre Cryphæadelphus.**
[A new North American species, *C. robustus.*]
Rev. Bryol., xxxi. (1904) pp. 6–8.

CARDOT & THERIOT—**The Mosses of Alaska.** *Bryologist*, vi. (1903) pp. 83–6.

CARDOT & RENAULD—**New Mosses of North America.** *Tom. cit.*, pp. 86–9.

CLAASEN, E.—**On Discelium nudum Bridel.**
[This inconspicuous moss, regarded as very rare in the United States, occurs abundantly in Cuyahoga County, Ohio.]
Ohio Naturalist, iii. (1903) p. 361.

" " **On the occurrence of Fossombronia cristula in Ohio.**
[Measurements of plant.] *Op. cit.*, iv. (1904) p. 58.

CORBIÈRE, L.—**Sur quelques Muscinées de Maine-et-Loire.**
[Notes on two mosses and two hepatics.]
Rev. Bryol., xxxi. (1904) pp. 8–13.

DISMIER, G.—**Le Lejeunea Rossettiana Mass. dans le Dauphiné.** (*Lejeunea Rossettiana* in Dauphiné.)
[An account of a successful search for this rare species at the Grande-Chartreuse, and of other Muscineæ found in the neighbourhood.]
Bull. Soc. Bot. France, l. (1903) pp. 289–90.

DIXON, H. N.—**Supplementary list of Norfolk Mosses.**
[Twenty-one species are added to the county list, bringing the total number hitherto recorded to about 190.]
Trans. Norf. and Norw. Natur. Soc., vii. (1903) pp. 558–65.

DOUIN, I.—**Jungermannia alicularia De Not. et Calypogeia ericetorum Raddi.**
[Notes on these species, which are indistinguishable in the sterile state, save by the odour and by the soil; the former plant is calcicolous, the latter silicicolous.] *Rev. Bryol.*, xxxi. (1904) pp. 1–4.

" " **Nardia silvrettæ (Gottsche) en Auvergne.**
[Occurrence of this species and other hepatics at Mont-Dore, in Auvergne.]
Tom. cit., pp. 4–5.

GOZZALDI, M. T. J.—**Thomas Potts James.**
[Obituary of the American bryologist, part author of the *Manual of North American Mosses.*] *Bryologist*, vi. (1903) pp. 71–4 (portrait).

HERZOG, T.—**Die Laubmoose Badens; eine bryogeographische Skizze.** (Bryogeographical sketch of the mosses of Baden.)
Bull. Herb. Boissier, ser. 2, iv. (1904) pp. 137–52.

HILL, E. J.—**Branched Paraphyses of Bryum roseum.**
[Protonemic character of these paraphyses.] *Tom. cit.*, pp. 80–1 (fig. in text).

HOLZINGER, J. M.—**Fabroleskea Austini in Europe.**
[Identity of this North American species with the Caucasian *Leskea grandiretis* Lindb.) *Bryologist*, vi. (1903) pp. 74–5.

KINDBERG, N. C.—**Note sur les espèces scandinaves du genre Bryum.** (Note on the Scandinavian species of the genus *Bryum*.)
[List of more than 100 species, most of which occur in the Dovrefjeld.]
Rev. Bryol., xxxi. (1904) pp. 13–14.

LENGYEL, B.—**Uber das Vorkommen eines seltenen Lebermooses in Ungarn.** (Upon the occurrence of a rare Liverwort in Hungary.)
[Fertile specimens of *Hypenantron fragrans*, an addition to the Hungarian flora, have been discovered in limestone clefts on the Turulberg near Bánhida.] *Mag. Bot. Lapok*, ii. (1903) pp. 182–3.

LIMPRICHT, K. G., & W.—**Rabenhorst's Kryptogamen-Flora von Deutschland, Österreich und der Schweiz.** IV. iii. Leipzig, 1904. Die Laubmoose (Mosses), Lief. 41, pp. 33–79.
[End of the work: index of synonyms, bibliography, title-pages, and preface.]

LINDBERG, H.—**Stereodon plicatulus Lindb.**
[Characters which distinguish it from *S. revolutus* Mitt.]
Bryologist, vi. (1903) pp. 82–3 (1 pl.).

MIGULA, W.—**Thomé's Flora von Deutschland, Österreich und der Schweiz.**
v. (Gera, 1903) Lief. 15, Cryptogamen, pp. 385–400 (5 pls.).

RÖLL, J.—**Beiträge zur Moosflora der Transsilvanischen Alpen.** (Contributions to the moss-flora of the Transsylvanian Alps.)
[An annotated list of mosses gathered in July 1900, with descriptions of one new species and sixteen new varieties.]
Hedwigia, xlii. (1903) Beiblatt, pp. 297–305.

ROTH, G.—**Bedeutung der Moose für den Waldbau.** (Significance of mosses in forestry.)
[Value of the information afforded by mosses as to moisture, climate, soil, etc., in connection with the planting of trees suitable to a given district.]
Allgem. Bot. Zeitschr., 1903, pp. 122–3.

STEPHANI, F.—**Species Hepaticarum.**
[Monograph of *Plagiochila*.]
Bull. Herb. Boiss., ser. 2, iv. (1904) pp. 18–32, 153–68.

STOW, S. C.—**Mosses at Grantham.** *The Naturalist*, 1903, p. 265.

TORKA, V.—**Bryologische Beiträge.** (Bryological notes.)
[Field notes on *Cinclidium stygium* and its spore-ripening, and on *Racomitrium patens* var. *crassifolium*, a new variety found in the German plain.]
Allgem. Bot. Zeitschr., 1903, pp. 145–6.

Thallophyta.

Algæ.

Phytoplankton of the Volga.*—Bolochonzew details the results of his investigations into the plankton of this river. He divides his paper into three chapters. The first contains a list of organisms found by him, arranged under special headings :—(1) True plankton, which is principally adapted for existing in a condition of suspended life ; (2) Ground plankton, which occurs most frequently in the flora of the bottom or on the shore ; (3) Casual plankton, i.e. those organisms which really belong to the bottom or littoral flora, and occur only by chance among true plankton, when brought by waves or currents, sooner or later sinking to the bottom ; (4) Passive plankton organisms, which fasten on to other plankton. The author also takes into account a portion of the Volga which is almost entirely cut off from the main stream, and he points out the gradual change in the plankton species.

* Jahrb. Biolog. Wolga-Station, Ssaratow, 1903 (1 pl.). See also Bot. Centralbl., xcv. (1904) pp. 83–6.

In the open river *Asterionella* was most abundant, and, speaking generally, the plankton of the Volga consisted mainly of diatoms. The second chapter is devoted to a systematic account and geographical distribution, together with descriptions of new species. The third chapter contains a tabulated comparison of the plankton of the main river, and that of ponds and other waters cut off from it.

Plankton of the Elbe.*—R. Volk publishes his report on the biological conditions of the Elbe and its tributaries in the neighbourhood of Hamburg. The paper deals with the animal life of the river plankton, as well as the phytoplankton, which includes 159 species of Chlorophyceæ and of Rhodophyceæ, 267 of Diatomaceæ, and 45 of Schizophyceæ. The chemical composition of the water is discussed, and the methods of work are described. An analysis of the phytoplankton is presented in the form of a table showing the occurrence of each species according to season and locality.

Atlas of Diatoms.† —Heiden, of Rostock, has brought out the 61st fascicle of A. Schmidt's Atlas, comprising plates 241–4. Many species of *Stauroneis* and *Navicula* are figured, belonging to the sections *humerosæ* and *granulatæ*. Eleven new species are figured, as well as some new varieties.

Diatoms from the Jura.‡—P. Prudent gives a list of diatoms collected in two lakes of the Jura, Nantua and Silans. The flora of both are very similar, and the total number of species amounts to 152. The most interesting records are :—*Cymbella Loczyi* Pantocs., *C. affinis* Kütz., with an undulated dorsal margin, *Caloneis rupestris* var. *inflata* Pantocs., *Fragilaria mutabilis* var. *trinodis* n.v., and *Nitschia angustata* var. *producta* Pantocs.

Cultures of Diatoms.§—P. Miquel continues his researches into the physiology, morphology and pathology of diatoms, and describes his cultivation of *Nitzschia linearis*. After a successive series of ten cultures, each new one being made from the last one, he found that the size of the frustule diminished 17 μ, namely, from 115·2 μ to 98·1 μ. The greater number of frustules contained in the ten cultures were of medium size; those showing either extreme in size were excessively rare. The author notes that in *Melosira* and *Cyclotella* those individuals which formed auxospores were far from being of the smallest size.

Caulerpa anceps.‖—K. Yendo adds some interesting facts to our knowledge of this alga. A plant was collected in Japan by Prof. Okamura, and at first identified by him as *C. brachypus* Harv., but subsequently corrected to *C. anceps*. K. Yendo found a plant on a small reef at Misaki, in October, 1888, and identified it as *C. brachypus*, but on the same reef he found in summer *C. anceps*. Feeling doubtful whether

* Jahrb. Hamburg. Wissensch. Anstalt., xix. Beih. 2 (1903) pp. 65–154.

† Atlas der Diatomaceenkunde, Leipzig, 1903, Heft. 61. See also Nuov. Notar. xv. (1904) p. 47.

‡ Contrib. à la flore diatomique des lacs de Jura, Lyon, 1903. See Nuov. Notar. xv. (1904) p. 38.

§ Micrographe Préparateur, xi. (1903) pp. 174–9 (figs. in text).

‖ Bot. Mag. Tokyo, xvii. (1903) pp. 153–7 (6 figs. in text).

two species of *Caulerpa* grew on this one small reef, he made collections himself by diving in January, April, July, August, October, and December. He has no longer any doubt that his plants are of the same species, which assumes different appearances according to the season. Both forms are described in this paper, and it is suggested that *C. Stahlii* Web. v. B. may be synonymous with the Japanese species. A great characteristic of Yendo's plant is the inflation of the short pedicels. If this character occurs in *C. Stahlii* and also in the types of *C. anceps* Harv. and *C. brachypus* Harv. (to which types the author has unfortunately not had access), the three species would lose any character which could distinguish them from one another.

A New Species of Hedophyllum.*—K. Yendo also describes and figures a new species of this genus, under the name of *H. spirale*, collected by him at the island of Shimushu, Kurile Islands. A form, *kamtschatkensis*, is also described from the shores of Yavina, Kamtschatka. The plant is common on the reefs at Shimushu. It differs from *H. subsessile* Setch. in having a spiral rolling of the margins of the lamina at the transition region. The author has also studied the development of *Thalassiophyllum* and *Arthrothamnus*, and finds he can add nothing to the description of the former as given in Setchell and Gardner's "Algæ of N.W. America." But of the development of *Arthrothamnus bifidus*, nothing has hitherto been published, and the author therefore describes it here. He states also that in *A. kurilensis* the entire plant is erect, and, consequently, the dorsiventrality of the stems is not clearly manifested. The primary stem and holdfast are persistent, and the successive holdfasts or rhizomes are not normally found. Otherwise, the development is the same as that of *A. bifidus*. Comparisons are drawn between *Hedophyllum*, *Thalassiophyllum*, and *Arthrothamnus*, which greatly resemble each other in their mode of branching. As regards the systematic position of *Hedophyllum*, the author places it near to these two genera on account of the erosion of the primary lamina, the spiral rolling and the differentiation of the dorsiventrality in *H. spirale*; and if the first of these characters be omitted there is also a likeness to *Agarum*. As regards the genus *Eisenia* the author suggests that it should be detached from the subtribe Eckloniæ and placed near *Arthrothamnus* and *Hedophyllum*, if it be granted that erosion of the primary lamina is a character of importance.

Halimeda Fuggeri.†—This fossil alga was described by J. L. von Liburnau in 1897, and the same author now adds further details as the result of an examination of several fresh specimens which have been found in the same locality, Muntigl near Salzburg. They are preserved in the Salzburg museum. Careful comparisons are made between these fossil plants and recent specimens of *Halimeda*, and the points of dissimilarity are fully dealt with. They are small in themselves, consisting of an apparent scaliness of the surface in the fossil alga, a want of incrustation, the breadth of the mid-rib, the length of the internodes, the much-lengthened, rod-like, unjointed end to one of the specimens,

* Bot. Mag. Tokyo, xvii. (1903) pp. 167–71 (1 pl.).
† SB. k. Akad. Wiss. Wien., cxi. (1902) pp. 685–712 (2 pls. 9 figs. in text).

and the lack of all branching of the thallus. Taken singly, none of these variations from existing types of *Halimeda* would separate *H. Fuggeri* from that outwardly variable genus, but taken together they constitute in the author's opinion a sufficient reason for placing *H. Fuggeri* in a new genus *Halimedides*.

Ægagropila Sauteri.*—C. Wesenberg has made a special study of this alga as it appears in the Lake of Sorö in Denmark, where the form of the balls is absolutely regular and the size that of a fist or a child's head. The author reviews shortly some of the literature on the subject, and declares himself almost entirely in accord with F. Brand. A description is given of Lake Sorö, with details concerning the geological composition of its beds, the temperature of the water, the plankton, etc. Then follows an account of the different forms of the thallus of *Æ. Sauteri*, which appear in the lake: (1) individual separate plants; (2) adherent thallus; (3) globulous thallus, (*a*) balls resting on the bottom of the lake, (*b*) floating balls; (4) felty masses. The author then deals with the origin and mutual dependence of the different forms of thallus of *Æ. Sauteri*, treating each form separately. He discusses the question of the rising and falling of the floating balls, and the possibility of a connection between this phenomenon and the presence of a rich plankton and much detritus. He believes, with Brand, that much light is prejudicial to *Æ. Sauteri*. The formation of the balls is, in his opinion, caused by the incessant destruction of the terminal filaments which are directed outwards, this destruction causing the formation of new adventitious filaments. The beating of the waves and the friction against the bottom cause the globular shape, which becomes more pronounced in proportion to the hardness of the earth.

Fucus serratus in America.†—C. B. Robinson has studied the distribution of this species in America, and finds that it grows plentifully in the district lying between Pugwash in Nova Scotia and Eastern Harbour on the west side of Cape Breton. It also occurs at the extreme south-east of Prince Edward Island, in the neighbourhood of Murray Harbour and Cape Bear. On the coast of Pictou Island it is nowhere wanting.

Sphacelaria cirrosa.‡—C. Sauvageau gives a *résumé* of part of his long paper on the different genera of Sphacelariaceæ, which is appearing in the *Journal de Botanique*. This *résumé* deals with *Sphacelaria cirrosa*, and the species which have from time to time been regarded as synonyms and forms of it. *S. Hystrix* is regarded by the author as quite distinct from the *cirrosa* group, and the life-history of this parasite of *Cystoseira ericoides* is described. The early stages of the plant bear well-developed sexual organs in plurilocular sporangia, and these disappear in May to make room for long and numerous filaments which bear the propagula. It is in this latter stage that the plant has been mistaken for *S. cirrosa*. During the winter no trace of it is to be found, and in what form it passes through this period of rest is not yet

* Overs. k. dansk. Vidensk. Selsk. Forh. ii. (1903) pp. 168–203.
† Torreya, iii. (1903) pp. 132–4.
‡ Mém. Soc. Sci. Phys. et Nat. Bordeaux. iii. (1903) 11 pp.

known. *S. Harveyana* Sauv. is regarded as the southern homologue of *S. Hystrix*. The author re-establishes *S. bipinnata* Kütz., a parasite of *Halidrys siliquosa* and *Cystoseira fibrosa*. This species bears numerous unilocular sporangia, but the propagula are very rare. Plurilocular sporangia of one size only occur. *S. fusca* is also revived as an independent species. The only reproductive organs hitherto known for this plant are trifurcated propagula bearing cylindrical or gradually attenuated rays. The real *S. cirrosa* is very variable as regards its propagula, and as a result of prolonged study the author divides the forms into *septentrionalis*, *meridionalis*, and *mediterranea*. Between these forms are, of course, many intermediate ones, but the extremes are markedly characteristic. The author describes the chief points, and gives the general distribution of each of the three forms. The paper closes with some interesting remarks concerning the modes of reproduction in the species mentioned. Those species which are parasitic show much more perfectly developed organs of reproduction than those which are independent and free. For example, *S. Hystrix* and *S. furcigera*, two parasitic species, possess well-developed plurilocular sporangia of two kinds, probably oogonia and antheridia; and *S. bipinnata*, also a parasite, has plurilocular sporangia of one kind pointing to the possibility of isogamy, while its propagula are very rare. On the other hand, *S. cirrosa*, a free plant, appears to have lost its sexual reproduction and multiplies by means of propagula, and so far as is known of *S. fusca* the same facts hold good. The difference between the effect of parasitism on *Sphacelaria* and on the higher plants is remarkable: in the former case it acts as a stimulant, in the latter it leads to degeneration.

Kelps of Juan de Fuca.*—C. McMillan gives a general account of the Laminariaceæ of this region. Seventeen out of the twenty-five genera of this order are represented in the Straits of Fuca, and of many of them the author has made a special study. His results are presented here in a more or less generalised form, and the paper closes with a description of the external characteristics of each genus.

Alternation of Generations in the Dictyotaceæ.†—L. Williams gives a short abstract of a paper which is to appear in full in the *Annals of Botany*. In this group the asexual cells are borne on plants distinct from those that bear the sexual cells. Cytological evidence has been obtained showing that the cells of the tetraspore-bearing plants contain twice as many chromosomes as those of the sexual plants. The mother-cell of the four tetraspores shows synapsis, has all the characters of a heterotype division and shows sixteen chromosomes. In the male plant of *Dictyota* the reduced number is present in all the divisions of the antheridium, and in the female plant the division which cuts off the stalk-cell of the oogonium also shows the reduced number. The fertilised egg-cells show, naturally, the double number. There is thus complete cytological evidence for the alternation of gametophyte and sporophyte, though experimental cultivation from spore to spore has hitherto been unsuccessful.

* Postelsia, 1902, pp. 195–220 (5 pls.).
† New Phytologist, ii. (1903) pp. 181–6.

Hair-like Growths of the Rhodomelaceæ.* — L. K. Rosenvinge has made a special study of these organs, which he calls trichoblasts, on the thallus of Rhodomelaceæ, and describes his results under seven different headings:—(1) branching of the trichoblasts; (2) trichoblasts of aberrant structure; (3) function of the trichoblasts; (4) are there any species of *Polysiphonia* without trichoblasts? (5) forms intermediate between stems and trichoblast; (6) position of the sexual organs in *Rhodomela*; (7) communication between the basal cell of the branch with the trichoblast, in Polysiphoniæ with axillary shoots. The mode of ramification is essentially the same throughout the order, but the degree of branching varies considerably, sometimes even in the same species. Several functions have been assigned to these trichoblasts by various authors, but Rosenvinge is inclined to believe they serve for absorption or respiration. Although it has been stated that certain species of *Polysiphonia* are without trichoblasts, it is here shown that every species possesses at least fertile trichoblasts. Sterile trichoblasts are capable of being transformed into stems. The sexual organs of Rhodomelaceæ are more generally attached to the trichoblasts than has been admitted by Falkenberg. The paper closes with some interesting remarks on the pores between contiguous cells.

Lithothamnia from the Indian Ocean.† — M. Foslie publishes a report on the species of Lithothamnia collected by J. Stanley Gardiner during his Expedition to the Maldive and Laccadive islands in 1899–1900. The species are nine in number, and constitute the first authentic record of these algæ between the Red Sea and the East Indies. General observations are made on the distribution of Lithothamnia and on the conditions of their growth. The author finds that *Lithophyllum craspedium* plays a prominent part in reef-building in general, and is therefore well represented in certain atolls of the Maldives, at Funafuti, and at Onoatoa, Gilbert islands. *Goniolithon frutescens* is the next most abundant species in the Maldives, and *Lithophyllum oncodes* appears to act as a kind of cement. Three new forms are described of species already existing, and critical remarks are appended to each species' name. Two large plates give reproductions of most of the species in natural size.

Marine Algæ of Iceland.‡—H. Jonsson publishes Parts III. and IV. of this Flora, consisting of Chlorophyceæ and Cyanophyceæ respectively. Critical and interesting notes are appended to the species-names, and there are nineteen figures in the text, to show various details of structure described. *Acrosiphonia flabelliformis* is described as a doubtful new species. The Cyanophyceæ, six in number, were determined by J. Schmidt.

Marine Algæ from Sicily.§—A. Mazza publishes the first part of a list of marine algæ from this island, with critical notes on many of the species. The plants recorded were either gathered by himself or

* Overs. k. Dansk. Vidensk. Selsk. Forh., 1903, pp. 439–71 (16 figs. in text).
† Fauna and Geogr. Maldive and Laccadive Archip., ed. J. S. Gardiner, i. (1903) pp. 460–71 (2 pls.). ‡ Bot. Tidsskrft., xxv. (1903) pp. 337–81 (19 figs.).
§ Nuov. Notar., xv. (1904) pp. 5–30.

were sent to him by other botanists. All sides of the island are represented, and the locality of each species follows the record of its occurrence. The present paper includes fifty-seven algæ, belonging to Florideæ. Many of the notes deal with questions of nomenclature.

Arctic Algæ.*—J. Palibin reports on the botany of the south-east portion of the northern island of Nova Zembla, and gives a short list of marine algæ, all of them characteristic of the Arctic region. The collection was made during the Expedition of the *Ermak*, during the summer of the year 1901. A few fresh-water species were found above Cape Flora on Franz Josef Land. The report is in Russian. F. R. Kjellman † gives a list of 22 algæ from the coasts of this island, among which are several new records for the locality, including *Halosaccion pubescens*, hitherto only known on the Norwegian coasts.

Marine Algæ from the Red Sea.‡—Th. Reinbold publishes a list of 32 species, collected at Tor on the Sinai Peninsula, of which four species have not hitherto been recorded from the Red Sea. In the case of the more interesting specimens, critical notes are added. The material was collected on coral reefs at a depth of about 1–3 metres.

Indian Ocean Algæ.§—E. S. Barton publishes a list of 27 species of marine algæ from the Maldive and Laccadive islands. They were collected by J. Stanley Gardiner, and form the first published record from these islands. Among the species is *Ralfsia ceylanica* Harv., till now a *nomen nudum*, though authentic specimens exist in herbaria. *Ectocarpus spongiosus* Dickie is recorded in fruit, and the original description of the plant is here supplemented by an account of the plurilocular sporangia. It is interesting to note that the fruits occur on the original specimens of *E. spongiosus* in the British Museum and Kew herbaria, but they were overlooked by the author. A new species, *Liebmannia Laccadivarum*, is described.

Marine Algæ from the Gulf of Manaar.‖—E. S. Barton also gives a list of 25 species collected in this region by Herdman when examining the Pearl Oyster Fisheries in 1902. The most interesting record is that of *Halimeda gracilis* in fruit, which has not been described up to the present. Sporangia are borne in a kind of loose raceme on sporangiophores, and these arise from the filaments of the central strand which have branched to form lateral strands. The tufts of sporangiophores are limited to those points of the margin of a joint at which the lateral strands issue, and in this manner differ from the fruits of *H. Tuna*, in which the sporangiophores are said to form a fringe round the upper margin of a joint.

Three New Japanese Algæ.¶—K. Yendo describes a new *Caulerpa*, *C. Tateyamensis*, which resembles *C. sedoides*, but is distinguished from it by the stipitated cylindrical ramules and the character of the branch-

* Bull. Jard. Imp. Bot. St. Pétersb., iii. (1903) pp. 29–48, 135–67.
† Arkiv. Bot. Stockholm. i. (1903) pp. 1–6.
‡ Hedwigia, Beibl., xlii. (1903) pp. 227–32.
§ Journ. Linn. Soc. Bot., xxxv. (1903) pp. 475–82 (1 pl.).
‖ Report to Govt. Ceylon on Pearl Oyster Fisheries, Royal Soc., 1903, pp. 163–7 (3 figs. in text). ¶ Bot. Mag. Tokyo, xvii. (1903) pp. 99–104 (2 pls.).

lets. *Hirome undarioides* represents a new genus closely allied to *Undaria*, from which it differs in having no ligule at the transition-point, and by the shortness of the stipe. The principal characteristic of the plant lies in the position of the sori on the costal area of the lamina, the sporophyll being often absent. In *Undaria pinnatifida*, on the other hand, the sporophyll is the principal soriferous area, though in certain forms this area is continued into the lamina. *Hirome undarioides* is collected in large quantities and sold in the market. *Champia expansa* differs externally from the other species of the genus. It approaches most nearly to *C. bifida* Okam., but is distinguished from it by the regular dichotomous branching, and the broad, much compressed segments.

Uses of Marine Algæ in Japan.*—K. Yendo also gives an account of the preparation of various algæ for food and decoration, as well as for laundry and other purposes. Species belonging to 23 genera are enumerated, with the special method employed for each. A table of statistics shows that the export of *Laminaria* for commercial purposes is large, and it is stated that not less than 11,232,900 sheets of *Porphyra*, each sheet being the final edible production from the alga, were manufactured in one year. This paper is illustrated by three Japanese prints.

Distribution of Marine Algæ in Japan.†—The same author divides the algal region of Japan into the following sections: (*a*) *Pacific side*:—1. From Kurile islands to Kinkwa-san island. 2. From Kinkwa-san island to the southern end of Kin-shu island. 3. From the southern end of Kin-shu island to Formosa. (*b*) *Japan Sea side*:—1. From Iki Island to Ojika Peninsula. 2. From Ojika Peninsula to the north. In these various sections of the coast area the character of the algæ varies from subarctic to tropical, according to whether the section in question is washed by the cold currents originating at Kamschatka or by the main north equatorial stream. The principal species characterising each section are enumerated.

North American Algæ.‡—F. S. Collins continues his notes on North American algæ. He definitely adds *Gracilaria confervoides* to the list of species found in that country, having collected it himself at Mattapoisett, Mass. *Actinococcus peltaeformis* Schmitz has been found on the coast of Maine, growing on its host-plant *Gymnogongrus norvegicus*. *Codiolum pusillum* Foslie occurs at Cutler, Maine, in all stages of variation, from the typical European form to that known as *forma americanum*. A new variety, *triplicata*, is described for *Spirogyra decimina*; *Plectonema Battersii* Gom. is now recorded from three localities in Massachusetts, *Microcoleus tenerrimus* Gom. from Maine, and *Xenococcus Kerneri* Hansg. from Cohasset, Mass.

Cell-growth and Plant-form in Marine Algæ.§—F. Tobler publishes further details of his researches in this connection, dividing his paper into the following sections: (1) The material and its treatment;

* Postelsia, Yearbook Minn. Seaside Stat., 1902, pp. 1–18 (3 pls. 3 prints).
† Tom. cit., pp. 179–92 (3 pls.). ‡ Rhodora, v. (1903) pp. 231–4.
§ Jahrb. wiss. Bot., 1903, pp. 527–80 (1 pl.).

(2) Habit and characteristics of the forms; (3) Unequal growth (Epinasty and Hyponasty); (4) Manifestations resembling etiolation; (5) Adventitious formations and deformities; (6) Decay; (7) Reproduction and general remarks. A bibliography is appended.

BRUNNTHALER, J.—**Phytoplankton aus Kleinasien.** (Phytoplankton from Asia Minor.) *SB. Akad. Wiss. Wien, Math.-Nat. Kl.*, cxii. Abt. i. (1903) pp. 289–93.

CHALON, J.—**Quelques Algues de mer récoltées à Roscoff (Finisterre) en 1903.** (Some marine algæ collected at Roscoff (Finisterre) in 1903.)
[A list of 42 species.] *La Nuov. Notar.*, xv. (1904) pp. 1–4.

CLEVE, P. T.—**Report on Plankton collected by Thorild Wulff during a voyage to and from Bombay.**
[Forty-two species of Diatomaceæ are recorded, and 64 species of Peridiniales, among which are the new species *Goniodoma* (?) *bipes* and *Steiniella* (?) *complanata*. The latter is figured.]
Arkiv. för Zool. K. Svenska Vetensk., i. (1903) pp. 329–81.

GAIDUKOV, N.—**Ueber den braunen Algenfarbstoff. Phycophaeïn und Phycoxanthin.**
[Concerning the brown colouring matter of algæ.]
Ber. Deutsch. Bot. Gesell., xxi. (1904) pp. 535–9.

GASPARIS, A. DE—**Le algue delle argille pleistoceniche di Taranto.** (The algæ of the pleistocene clays of Taranto.)
Rendic. Accad. Sc. fis. et Matem. Napoli, 1903, p. 228.

LAGERHEIM, G.—**Untersuchungen über fossile Algen, I., II.** (Investigations of fossil algæ.) *Geol. Fören. Förh. Stockholm*, xxiv. (1903) pp. 475–500.

LOHMANN, H.—**Neue Untersuchungen über den Reichtum des Meeres an Plankton.** (New investigations of the riches of the sea in plankton.)
Wiss. Meeresuntersuch. Abt. Kiel, N.F. vii.

" " **Untersuchungen über die Tier-und Pflanzenwelt, sowie über die Bodensedimente des Nordatlant Oceans zwischen 38° und 50° N. Br.** (Investigations into the animal and plant world, as well as into the sedimentary deposits of the North Atlantic Ocean between 38° and 50° north latitude.)
SB. Kgl. Preuss. Akad. Wiss., 1903, pp. 560–83.

MAGNIN, A.—**Les microphytes des lacs du Jura, notamment les Diatomées du Lac de Chalin d'après Prudent et Roesch.** (The microphyta of the Jura lakes, notably the Diatomaceæ of the lake of Chalin after Messrs. Prudent and Roesch.)
Arch. Flore Jurass, 1903, pp. 108–10.

PROTIC, G.—**Peti prilog poznavanje flore okoline Varešа n Bosni.** (Fifth contribution to the knowledge of the flora of the surroundings of Vareš in Bosnia.)
[A list of diatoms is included among the other cryptograms.]
Glasnik. Zernalj muz za Bosne i Herceg., xv. (1903) pp. 273–318.
See also *Bot. Centralbl.*, xcv. (1904) p. 71.

Fungi.

Phytophthora infestans.* — L. Matruchot and M. Molliard have made a series of cultures of this fungus. They found that on a slice of living potato it grew freely, also on cucumber and Spanish melon. On the two latter it grew after they had been cooked, but not on the potato. Probably the starch of the potato had swelled to an extent that prevented the mycelium from penetrating the tissues. Spores were produced normally only on living material, and in no case were oogonia or chlamydospores formed. The writers conclude that the fungus persists by means of the mycelium. They find also that the

* Ann. Mycol., i. (1903) pp. 540–3.

rotting of tubers attacked is not directly due to the fungus, but to accompanying Bacteria. They note also in this fungus the absence of differentiated haustoria, a peculiarity confined to this one member of the Peronosporeæ, it being also the only one that can live as a saprophyte.

The Genus Harpochytrium in the United States.*—G. F. Atkinson describes in detail the plant that forms the basis of his paper, which he found growing on *Spirogyra*. The organism is composed of a long slender more or less fusoid and usually curved sporangium. It is pointed at the base where it pierces the wall of the host-cell. Zoospores are formed in the parasite which escape at the tip, and after swarming attach themselves to the host. After the zoospores have escaped, a new sporangium grows out within the old one from the sterile basal part. Atkinson found that the plant belonged to the genus *Harpochytrium* Lagerh. He considers also that the genus *Fulminaria* Gobi is synonymous, and that the plant *Rhabdium acutum* of Dangeard is also a member of the same genus. He gives his reasons at length for this grouping. There are three species known, two of them found also in Europe. They are all parasitic on some green alga.

Structure and Classification of the Phycomycetes.†—C. E. Bessey holds that the Phycomycetes do not form a natural group, that they are derived though fungal modification from different algal types, and that in any scheme of classification the algæ must be considered first. He claims that they come from three different groups of algæ: the Synchytriaceæ from the Protococcoideæ; the Chytridiaceæ from or near the Botrydiaceæ, in the order Siphoneæ; and the Saprolegniaceæ from or near the Vaucheriaceæ, also in the order Siphoneæ. The other members of the Phycomycetes are derived from the Saprolegniaceæ, with the exception of *Monoblepharis*, which suggests the Œdogoniaceæ. In all these classes the fungi or "hysterophytes" are parasitic or saprophytic, and show more or less morphological degradation. Bessey follows the order laid down; he gives the key to the combined families of algæ and fungi, and gives a descriptive account of each of the fungal genera.

Critical Notes on Exoasceæ.‡—R. Sadebeck reviews the species of *Taphrina* and *Exoascus*, noting the points in which they differ and the variations within the different species. Points to be noted are the persistence of the mycelium in the host from year to year, the formation of a hymenial layer, the depth to which the hyphæ penetrate the leaf, and the different forms of the asci and of the basal cells. He makes a comparison between these genera and *Endomyces*.

Mould Yeasts.§—M. Hartmann experimented with a species of *Torula* which he isolated from colonies of *Mucor amylomyces*, where it formed slight elevations on the surface of the *Mucor* growth, and which he named *T. colliculosa*. Young cultures could not ferment maltose,

* Ann. Mycol., i. (1903) pp. 479–502 (1 pl.).
† Trans. Amer. Micr. Soc., xxiv. (1903) pp. 27–54 (1 pl.).
‡ Ber. Deutsch. Bot. Ges., x. (1903) pp. 539–46.
§ Wochenschr. f. Braueri, xx. (1903) pp. 113–14 (5 figs.). See also Ann. Mycol., i. (1903) p. 567.

but at a later stage not only maltose, but cane, grape and fruit sugars and raffinose, were quickly fermented.

W. Henneberg* isolated two moulds from brewers' yeast, which he terms *Mycoderma* (*a*) and (*b*). He made a series of experiments to test if these yeasts would have an injurious influence on the fermentation process. He proved that they did no harm.

O. Hinsberg and E. Ross † examined the yeast of beer to determine some of the chemical constituents of the yeast cells. Among other substances, acids, etc., they detected an ethereal oil with a hyacinth odour.

Disease of Currant and Gooseberry.‡—C. J. J. Van Hall describes a disease that has wrought great havoc on currant and gooseberry bushes in Holland. The first evidence of attack is the wilting of the leaves, and examination shows that the stem is affected close to and under the ground. The tissues were found to be full of a delicate mycelium. Cultures were made to induce fruit formation, which were unsuccessful, until accidentally they were subjected to a severe frost. With a higher temperature the fungus revived and perithecia were formed, which have been determined to be *Cytosporina Ribis* n. sp. The fungus forms a black stroma, which contains a labyrinth of spore chambers. The spores are thread-like and bent, and escape by one or more openings in a yellowish mass. The author gives his reasons for placing the fungus in the genus *Cytosporina*, and discusses other fungi that attack species of *Ribes*. This fungus, like other subterranean forms, is difficult to eradicate. Some hints are given as to the best means of prevention or cure.

Disease of Cultivated Mushrooms.§ — G. Cuboni and G. Megliola have determined this disease to be due to the ravages of a Hyphomycete already described as *Monilia fimicola*. In July, when the first fruiting forms of the mushroom should appear, a number of little white points are visible on the surface of the bed, which increase, and look like a covering of chalk powder. After the invading fungus has exhausted itself towards the end of September, a few diminutive mushrooms make their appearance. The authors are of opinion that the fungus belongs to the genus *Oospora* rather than to *Monilia*, on account of the small development of hyphæ and the minute dimensions of the spores. It is not parasitic on the mycelium of the Agaric, but does harm by withdrawing the nourishment intended for the higher fungus. They do not recommend any cure except the careful destruction of damaged spawn.

New Helminthosporium.‖—P. Magnus names the new species *H. Diedickei*. It was found growing as a parasite on the leaves of *Ophioglossum vulgatum*, forming dark-brown spots. The conidia are 3-septate and bent. The mycelium spreads between the cuticle of the

* Wochenschr. f. Braueri, xx. (1903) pp. 137–9, 178–80. See also Ann. Mycol. i. (1903) pp. 567–8.

† Zeitschr. Physiol. Chemie., xxxviii. (1903) pp. 1–16. See also Ann. Mycol. i. (1903) p. 569. ‡ Ann. Mycol., i. (1903) pp. 503–12 (1 pl.).

§ Atti. Reale Accad. Lincei, ccc. (1903), pp. 440–3.

‖ Hedwigia, xlii. (1903) pp. 222–5 (1 pl.).

leaf, and the epidermal cells and hyphal branches pass down between the cells and permeate the intercellular spaces.

Phellomyces Sclerotiophorus.* — T. Johnson records an attack of this fungus on potatoes. It forms minute sclerotia on the skin of the tuber; the mycelium penetrates the cortical cells, giving the skin a scabbed appearance; in a more advanced stage it causes dry potato-rot. The cells of the potato are killed, but the starch-grains remain essentially unaltered, and a white dry powdery substance appears in the tuber. The author recommends the soaking of seed tubers in a weak solution of formalin or other fungicide before planting. This treatment was found by experiment to have destroyed the fungus without injuring the potato.

American Uredineæ.† — John M. Bates notes the finding of the æcidia of *Puccinia Phragmitis* in Nebraska on four different hosts, three species of *Rumex* and one of *Rheum*.

W. A. Kellerman‡ summarizes the infection experiments and their results, conducted by him during the past year. He worked with the teleutospore, and in nine cases he records the successful growth of the æcidia on a separate host-plant. In some cases there was more than one host discovered for the æcidial stage. He records also the failures to induce infection, a long and equally instructive list.

The same author commences an index to Uredinous culture experiments, with list of species and hosts for N. America. In a preliminary note he gives an account of work done on the life histories of rusts. He carries the host list alphabetically down to *Euphorbia*.

On the Fertilisation, Alternation of Generations, and General Cytology of the Uredineæ.‖—V. H. Blackman publishes a preliminary statement as to the result of his research on Uredineæ. He reviews the opinions held on the sexuality of the Uredineæ and proceeds to record the results of his own observations. After careful examination he finds that the spermatia, though now functionless, have all the characteristics of male cells. He verifies the bi-nucleate condition of the cells, both of hyphæ and spores, from the æcidium stage onwards to the teleutospore, which is also bi-nucleate in the young stage, and uni-nucleate when mature. He does not accept this fusion as sexual, but rather considers it a reduction-process as in the spore-mother cells of the higher plants, and followed in both cases by the tetrad division—in the teleutospore the production of the four sporidia. These are uni-nucleate, as are also the cells in the early stage of the æcidium. The bi-nucleate condition is reached by the passage of a nucleus from a vegetative cell into the spore-mother cell of the æcidium. Blackman considers this cell to be the female fertile cell, and looks on this association of two nuclei as an act of fertilisation. They do not fuse until the teleutospore is formed. His view is that formerly the æcidia were fertilised by the

* Econ. Proc. Roy. Dublin Soc., i. (1903) pp. 161–5.
† Journ. Mycol., ix. (1903) pp. 219–20. ‡ Tom. cit., pp. 225–38.
§ Tom. cit., pp. 244–57. ‖ New Phytologist, iii. (1904) pp. 23–7.

spermatia, and that there is now only a reduced process of fertilisation, which is mid-way between the normal process and that discovered in the case of apogamy in ferns, where the acting male and female cells are ordinary vegetative cells. He gives some notes on nuclear division as observed by him in the Uredineæ. A fuller account is promised at an early date.

Cultures with Rusts.*—H. Klebahn gives the results of his various cultures, and notes the points of interest in connection with the infections. He found that *Nemesia versicolor* was extremely susceptible to *Cronartium asclepiadum*, and he concludes that a fungus may suddenly choose a new host. Specialisation may proceed from many hosts to one (plurivore fungus), or from living on a single host (univore) the rust may develop a capacity to infect several. He finds, also, that in the course of several generations the power of infecting hosts other than the one on which the fungus has been cultivated, gradually declines.

Agaricineæ on Trees.†—P. Hennings has gone carefully over the species found in Germany on stumps, roots, stems and branches. He notes those that are parasitic. The largest number is recorded on the Alder. He does not give many that grow on Conifers, as trees of that order were rare in the district examined. He found none on Ash trees. *Armillaria mellea* causes much damage in the woodlands, and attacks a large number of trees, Conifers as well as deciduous trees.

Polyporaceæ of North America.‡—W. A. Murril continues his studies of this great group, and deals in the present paper with the genus *Polyporus*. He confines the name mostly to species of "small dark-coloured plants attached to fallen branches and other decaying wood on or near the ground." They are all furnished with a stipe centrally or variously attached. There is the usual shifting of names to establish priority. *Polyporus brumalis* becomes *P. polyporus* Murril, as it was described as *Boletus Polyporus* by Retz in 1769. The author records twenty-three species of the genus as understood by him for North America.

Merulius lacrymans as a cause of Cancer.§—A. Klug has given much attention to this subject. He claims to have found in the secretions from cancer a form of yeast-spores identical with some stages in the development of dry-rot. He calls these cells "Meruliocyten." The fungus would thus be a dangerous parasite to men and animals.

Spore-formation in Naucoria nana.‖—L. Petri reviews the work done on the basidiospore by Maire, Wager and other writers. He finds the two nuclei (the synkarion) present in the hyphæ of the trama, as described for other hymenomycetes; they are of extremely minute dimensions. Fusion takes place in the basidium in the spirem stage,

* Jahrb. Hamburg. Wiss. Anst., 1902, 3 Beiheft., 56 pp. Hamburg, 1903. See also Bot. Zeit., lxi. (1903) pp. 322–4.

† Hedwigia Beibl., xlii. (1903) pp. 233–40.

‡ Bull. Torrey Bot. Club, xxxi. (1904) pp. 29–44.

§ Freih. Johannisbad, Sebbstverlag, 139 pp. (42 figs. and 1 pl.). See also Ann. Mycol., i. (1903) pp. 466–7.

‖ Nuovo Giorn. Bot. Ital. x. (1903) pp. 357–71 (1 pl.).

true fusion occurring between the nucleoli. The secondary nucleus thus formed surrounds itself with a membrane. At the same time the cytoplasm of the basidium shows a longitudinal fibrillar structure in the upper part. Petri gives a detailed account of the different phenomena noted in the cell and the nucleus, which divides in two, corresponding to the two sterigmata of *Naucoria nana*. In conclusion, he examines the theory of sexuality. He does not think that the synkarion has the value of a fecundation, but rather that it represents the origin of a sexual difference limited to the nuclei.

Polyporus fraxinophilus.*— Hermann von Schrenk describes the mischief wrought by this fungus on the white ash in North America. The mycelium penetrates to the heart wood of stem and branches, so destroying the tissue that the tree falls to the ground. The fruiting form makes its appearance not far from the place of infection. The author gives a careful description of it and of its occurrence on dead wood, and suggests methods of curing the disease in the early stages.

Oidium Tuckeri.† — Appel found that the fungus passed the winter as mycelium in the tissue of the new wood of the vine. Numerous haustoria were formed, and in the early part of the year a normal mycelium was developed with conidia that again infected the growing vines.

American Mycology.‡— A. P. Morgan records some interesting fungi for British Columbia. He writes also a note on *Corticium leucothrix*. J. B. Ellis and B. M. Everhart describe a series of new species from various localities in the United States, and W. A. Kellerman begins a series of mycological notes—new observations on forms already recorded.

Subterranean Fungi in Italy.§—O. Mattirolo writes a short treatise on the growing importance of these fungi in view of their connection with the mycorhiza of the higher plants, and then proceeds to give a detailed account of many of the forms. The whole forms part of a complete monograph of these fungi now in progress. His survey includes Tuberaceæ, Hymenogastreæ, an unusual type of Lycoperdaceæ, *Gastrosporium* gen. nov., which grew among the roots of grasses, and some other forms, such as *Onygena equina* found on the decaying hoof of an ox, which he includes in his underground series.

Mycorhiza of Conifers.‖— A. Möller has attacked the problem of mycorhiza, and the results of his researches contradict the conclusions come to by Frank and other workers. The pines of one and two years growth developed well in sandy soil, more especially under a top covering of leaves; but this was due to the protection against drought and not to mycorhiza. He found no fungus developed on the tips of the

* U.S.Dept. of Agric. Bureau of Plant Industry, Bull. No. 32 (1903) 20 pp. 5 pls See also Centralbl. Bakt., x. (1903) pp. 799–801.

† Centralbl. Bakt., xi. (1903) pp. 143–5.

‡ Journ. of Mycol., ix. (1903) pp. 161–2, 164–8, 169–70 (1 pl.).

§ Mem. Reale Accad. Sci. de Torino, liii. (1903) pp. 331–66 (1 pl.).

‖ Zeitschr. Forst. u. Jagdwesen, Heft 5 (1903). See also Bot. Zeit., lxi. (1903) pp. 329–30.

main roots; and on the other rootlets, its growth was more luxuriant in soil free from humus. He made a series of experiments to determine the species of the fungus; he does not find that it is identical with any form of *Mucor*.

Sporangioles of Endotropic Mycorhiza.* — L. Petri criticises the term sporangiole as applied by Janse to small protuberances on the hyphæ of endotropic mycorhiza. They have no connection with the production of spores, and Petri proposes to call them "prosporoidi" for morphological reasons. He examined them in the roots of a number of plants, and was able to produce them on various moulds in artificial cultures, when grown deep down in the substratum. They arise, he holds, on the hyphæ, where, in normal conditions, the spores would originate. The contents break up into granules, which in the roots escape into the surrounding protoplasm; the cells of an old tubercle are full of them; in cultures they showed no sign of germination. They are formed from the contents of the prosporoid by the agency of a proteolitic enzyme. The writer gives a long account of his observations on endophytic mycorhiza. He has identified the fungus inhabiting the tubercles of *Podocarpus* as a hyphomycete, *Thielaviopsis Podocarpi* sp. n., and has cultivated it successfully. It forms two kinds of fructification, macrogonidia—dark-brown gonidia in chains something like a *Torula*,—and microgonidia, which are produced endogenously in upright hyphæ.

Diseases of Yellow Pine.†—H. von Schrenk describes two forms of fungus disease both following on the attack of a beetle, *Dendroctonus ponderosæ*. The first, causing a bluing of the wood tissue, is due to a Pyrenomycete, *Ceratostomella pilifera*. Much greater damage is done by the attack of a *Polyporus*, which causes the wood to turn red. Schrenk considers it a new species, *P. ponderosus*.

Injury by Frost followed by Fungoid Attacks.‡ — Sorauer describes the cases in which plants have succumbed to frost and the fungi that are to be found on such plants. Very often they are merely aftergrowths and have nothing to do with the death of the plant. He gives an account of forms of *Alternaria*, *Ascochyta*, *Septoria* and *Cladosporium*, which occur in every field of cereals. *Fusarium* he considers can grow either as a parasite or a saprophyte, and attacks plants under snow. He further discusses the conditions that tend to make frost a danger to the crops.

Wood-destroying Fungi.§ — P. Hennings writes an account of all the forms that have been found to attack the wood-work of our dwellings. *Merulius lacrymans* is the most frequent and the most harmful, but *Polyporus vaporarius* is, he says, almost as destructive and as wide-spread. He describes a considerable number that do more or less damage; nearly all of them Hymenomycetes. There are one or two Ascomycetes in his black list, notably *Xylaria polymorpha*, and a small

* App. al Nuovo Giorn. Bot. Ital., x. (1903) pp. 541–62 (5 figs.), and pp. 582–4 (2 figs.).

† U.S. Dept. of Agric., Bureau of Plant Industry, Bull. No. 36 (1903) 40 pp. and 14 pls.). See also Ann. Mycol., i. (1903) pp. 464–5.

‡ Landw. Jahrb., xxxii. pp. 1–68 (4 pls.). See also Centralbl. Bakt., x. (1903) p. 806–8.

§ Hedwigia, xlii. (1903) pp. 178–91.

Pyrenomycete, *Ceratostomella pilifera*. He records a new species of *Coniothyrium*, which he found on damp boards, and describes it as *C. domesticum*. Many kinds of fungi make their appearance in damp cellars, etc.; but he has only taken into account those that have wood-destroying properties.

Notes on German Fungi.* — P. Hennings describes a variety of *Boletus granulatus*, the pores of which were covered with small crystal-like cushions, white, then brown. These were composed of small tufts of clavate paraphyses. A specimen of *Collybia platyphylla* was collected with a very long rooting rhizomorph. The young tips of the mycelium were faintly phosphorescent. He describes also an abnormal form of *Tricholoma conglobatum* and a peculiar species of *Cortinarius*.

Seed-fungus of Lolium temulentum.† — E. M. Freeman has examined this fungus. He finds that it spreads outside the aleurone sheath—through the scutellum up to the vegetative apex of the embryo. It develops anew with the seed and is found in the stalk, at the base of the leaf, and in the flower. No spore-formation could be detected. Probably there is a condition of symbiosis between the parasite and the host, as the seed is not injured by the fungus.

Disease of Coco-Palm.‡—M. Hollrung examined diseased material from New Guinea, where great damage had been done to the Palms. Much of the injury was found by him to be due to insects, but there were present the pycnidia of a fungus which could not be determined. He found also *Pestalozzia palmarum*, but the author is rather of the opinion that these fungi were saprophytes, and had not caused the disease.

Biological Test for the Presence of Arsenic.§—A. Maassen has worked over Gosio's results on this important subject. He found that not only *Penicillium brevicaule* but other moulds and also bacteria absorb soluble arsenic, selenium, tellurium, etc., giving out at the same time a characteristic odour. The author explains the chemical reaction that takes place. He discusses also the reducing and other properties of the cell. He entirely confirms the value of Gosio's discovery of the biological test for the detection of arsenic.

Morphological Researches.‖—W. Magnus has directed his attention to the capability of fungi to recover from injury. Renewal of tissue is always more or less retarded by the reproductive activity of the plant, but there is a strong tendency to renew the original form, though in many cases hymenial gills may be replaced by teeth, pores, or a reticulate form. This is due to mechanical conditions of growth.

Harmful Fungi.¶—Julius von Istvánffi describes the damage done by *Ithyphallus impudicus* to the vines in Hungary on a loose sandy soil.

* Hedwigia, xlii. (1903) pp. 214–17 (1 pl. and 2 figs.).

† Phil. Trans. Roy. Soc., ser. B, cxcvi. (1903) pp. 1–27 (3 pl.).

‡ Zeitschr. f. trop. Landwirtsch., vii. (1903) p 136. See also Ann. Mycol., i. (1903) p. 559.

§ Arbeit. Kaiserl. Gesundheits., xviii. (1902) pp. 475–89. See also Ann. Mycol., i. (1903) pp. 569–70.

‖ Ber. Deutsch. Bot. Ges., xxi. (1903) pp. 129–31. See also Ann. Mycol., i. (1903) p. 565.

¶ Zeitschr. Magyar. bot. Lapok., ii. (1903) pp. 133–4.

The pale-red mycelium of the fungus had penetrated the tissue of the root and caused the death of the vine. The fungus fructification appeared in the vineyard in May and August.

The same writer * has studied the best methods of destroying *Botrytis* and *Monilia*. A solution of calcium bisulphide was found to be most effectual. He tested the influence of cold and heat on the spores, and other conditions that would influence their vitality.

Vegetable Pathology.† — Under this heading P. Viala and P. Pacoltet give the results of their culture of the fungus, *Guignardia Bidwellei*, which causes black rot of the vine. After isolating the fungus they tested its growth on various media. They found as a result of these experiments that its vitality depended on the amount of acid and of sugar in the culture, and also in the host plant at the time of attack. It flourishes most luxuriantly after a fall of temperature, and at the stage before the fruit ripens. This also explains why some fruits are more susceptible than others to the attack of this fungus.

The Action of Fungi on Woody Cells.‡—It has been stated by various workers that the action of parasitic fungi on trees is to delignify the vessels and fibres of the wood. M. C. Potter found that boiling, or prolonged immersion in water, had the effect of destroying the lignin and leaving a layer of cellulose. He found the cellulose layer present in the wood vessels of a number of living trees that were unattacked by any fungus. He comes to the conclusion that the extraction of the lignin and consequent exposure of the cellulose is due in many instances to the method employed for sterilizing the wood used in experiments, and that where the cellulose layer is present in the living tree, it probably represents a stage of arrested development.

Annual Record of Plant Diseases.§—In the yearly volume for 1902, which has just been issued, M. Hollrung, the editor, has introduced several new features. He gives more attention to the manifestation of disease, and he has associated with him a number of coadjutors in his work. In the different sections he gives abstracts of the more important papers bearing on the subject under discussion, and also a bibliography of all recent papers connected with it. The subjects treated in order are general Phytopathology and Pathological Anatomy; the cause of disease, whether the parasite be plant or animal, discussed generally, and then with reference to definite hosts; plant hygiene, including considerations of climate, soil, immunity, etc.; and, finally, the various methods of combating disease, organic and inorganic. Organic methods may be illustrated by the attempt to infect locusts with the fungus *Empusa Grylli*, which is fatal to the grasshopper tribe. Inorganic includes all the chemical and mechanical appliances that have been found useful in this warfare. A copious subject index adds to the value of the book.

* Zeitschr. Magyar. bot. Lapok., ii. (1903) pp. 132-3. See also Ann. Mycol., i. (1903) p. 559.

† Comptes Rendus, cxxxviii. (1904) pp 306-8.

‡ Annals of Botany, xviii. (1904) pp. 121-40 (1 pl.).

§ Jahresb. Pflanzenkrank., v., Berlin, 1904, viii. and 408 pp.

French Mycology.*—L. Rolland describes *Inocybe repanda*, which had been placed in *Entoloma* by Berkeley on account of the reddish tinge of the spores. Rolland has found that the colour varies between red, green and brown. He discusses several other forms of *Inocybe*, and notes the change of colour that may be looked for, and also the change in odour at different stages of development.

N. Patouillard † publishes a note on the genus *Paurocotylis* Berk., which has been classed among the Gasteromycetes. Careful re-examination shows that the spores of *P. pila*, the typical species, are arranged as if in asci, and that, with other characters, places it among the Ascomycetes, near to *Hydnocystis*. The other species *P. fulva* belongs to the genus *Endogone*.

G. Delacroix ‡ has studied a disease affecting the mulberry trees in Madagascar. The under sides of the leaves were covered with a white coating of mycelial filaments. Conidia are produced singly at the apex of the conidiophores. Delacroix considers it to be a new species, *Ovulariopsis moricola*. With it is associated a species of *Phoma*, which he considers also belongs to the life cycle of the fungus.

Delacroix § has also published notes on *Stromatinia Linhartiana*, of which the conidial form *Monilia Linhartiana* grows on the leaves and twigs of *Prunus Padus*, and which he finds to be identical with *Ovularia necans*. The Peziza form grows on the mummified fruits in the spring of the year, and is intermediate between *Sclerotinia Padi* and *S. Aucuparia*. A fungus ‖ that grows on the bark, leaves and fruit of the pear, apricot, etc., has been described in America as *Sphæropsis malorum*. Delacroix finds that it is identical with *Diplodia pseudo-Diplodia*. *Macrophoma malorum* he considers is another stage of the life-cycle of the fungus. *Dothichiza* ¶ *populea* has been described as a saprophyte on dead poplar branches. The writer has proved it to be a wound parasite which kills the tree or branch when it has completely circled it. He also discusses ** the rottenness of potatoes caused by *Phytophthora infestans*. He contrasts the mycelium and especially the haustoria with those found in the fruits of a tomato attacked by the same disease. He describes the effect produced by other diseases, such as scab and gangrene caused by *Bacillus caulivorus*. *Fusarium Solani* he considers to be a saprophyte, attacking tubers already invaded by the mycelium of *Phytophthora*. Finally, he examines the cases of immunity from disease and the influence of the soil on the growth of the potato-disease.

New British Fungi.†—The mycological members of the Yorkshire Naturalist Union have been successful in adding no less than seventeen species of fungi to the British Flora, and of these nine are new to science. Diagnoses and notes of all the species have been published, and a special account given of an interesting form, *Symphosira parasitica* Mass. and Crossl. It somewhat resembles a very large species of *Stilbum*,

* Bull. Soc. Mycol. France, xix. (1903) pp. 333-8.
† Tom. cit., pp. 339-41.
‡ Tom. cit., pp. 342-6 (4 figs.).
§ Tom. cit., pp. 347-9.
‖ Tom. cit., pp. 350-2.
¶ Tom. cit., pp. 353-5 (3 figs.).
** Tom. cit., pp. 356-76 (2 figs).
†† The Naturalist, 1904, pp. 1-8 (1 col. pl.).

the head being formed of conidia in chains. It was found on the fallen mericarps of *Conium maculatum*, and in one instance on *Heracleum Sphondylium*. Healthy plants of *Conium* were successfully inoculated with the fungus by depositing conidia on the stigma of the host-plant. The diseased mericarp was found to be filled with a dense mass of colourless hyphæ. It fell to the ground when fully developed, and produced conidiophores in about ten days. Only one other species of *Symphosira* has hitherto been recorded. It occurs in Germany, and is not a parasite.

American Mycological Notes.*—F. L. Stevens records his personal experience after eating a small portion of uncooked *Lepiota Morgani* Pk. The poisoning was very severe.

W. A. Kellerman † supplies notes on the different species of *Calostoma* found in America. He also records the finding of large quantities of *Darluca filum* on carnation rust.

Brown-rot of Swedes.‡—M. C. Potter notes the outbreak of this disease within recent years in the North of England. It is well-known and has been fully described in America, where the injury has been traced to the presence of a bacterium, *Pseudomonas campestris*. It attacks the plant by the leaves or by the roots and spreads through the tissues by way of the vascular bundles. The disease has been already recorded in this country on cabbage; it seems to attack any cruciferous plant. Methods of avoiding infection are recommended.

ARTHUR, J. C.—**New Species of Uredineæ, III.**
[An account of 16 new species of unrelated forms from the States or from Porto Rico.] *Bull. Torrey Bot. Club*, xxxi. (1904) pp. 1–8.

BECK, GUNTHER VON—**Ueber das Verkommen des auf der Stubenfliege lebenden Stegmatomyces Baerii Peyr. in Böhmen.** (On the occurrence of *Stegmatomyces Baerii* Peyr. on house-flies in Bohemia.)
[The author finds that it is restricted to a limited area round Vienna and Graz, and that it is not to be found in either neighbourhood except in the vicinity of the railway.]
SB. Deutsch. Nat. Med. Ver. Böhmen, xxiii. (1903) pp. 101–2.
See also *Ann. Mycol.*, i. (1903) p. 550.

CONSTANTINEAU, J. C.—**Contribution à l'étude de la flore mycologique de la Roumanie, II.**
[This paper deals entirely with Uredineæ.]
Ann. Sci. Univ. de Jassy, ii. (1903) pp. 212–30.
See also *Ann. Mycol.*, i. (1903) p. 550.

DIETEL, P.—**Eine neue Puccinia auf Senecio.**
[The new *Puccinia* was found in Tasmania. Æcidia were developed on the same host as the teleutospores.] *Ann. Mycol.*, i. (1903) p. 535.

ELLIS, J. B., & EVERHART, B. M.—**New Species of Fungi.**
[Microfungi found on various leaves and branches throughout North America.]
Journ. Mycol., ix. (1903) pp. 222–5.

HENNINGS, P.—**Biatorellina P. Henn, n. g. Patellariacearum.**
[A new genus found growing on wood, described at length.]
Hedwigia, xlii. (1903) Beibl., p. 307 (5 figs.).

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* Journ. Mycol., ix. (1903) pp. 220–2. † Tom. cit., pp. 238–9.
‡ Journ. Board Agric., x. (1903) p. 314–18 (1 pl.).

HENNINGS, P.—**Squamotubera P. Henn. n. g. Xylariacearum.**
[A subterranean fungus from New Caledonia, in form of a tuber with a white coating of conidia, bearing hyphæ and fusiform, simple spores.]
Hedwigia, xlii. (1903) Beibl., pp. 308–9.

" " **Ein stark phosphoreszierender javanischer Agaricus, Mycene illuminans P. Henn.**
[A new example of phosphorescent fungi from the tropics. The writer also draws attention to other fungi with the same property.]
Tom. cit., pp. 309–10.

" " **Ein Sklerotien-Blatterpilz, Naucoria tuberosa P. Henn, n. sp. ad. inter.**
[An addition from Russia to the small number of Hymenomycetes that arise from Sclerotia.] *Tom. cit.*, pp. 310–12 (4 figs.).

" " **Eine neue deutsche Clathracee.**
[An account of this fungus was published some time ago. It now appears that it was recorded in 1866, also from the same district in Germany.]
Naturwissensch. Wochenschr., xix. n.l. pp. 10–12 (8 figs.).
See also *Hedwigia*, xlii. (1903) Beibl., p. 318.

" " **Einige im Berliner Botanischen Garten 1903 gesammelte neue Pilze.**
[A number of new microfungi found on the leaves, etc., of plants in the Berlin Botanical Garden.] *Hedwigia*, xlii. (1903) pp. 218–21.

HOHNEL, FRANZ V.—**Mycologische Fragmente (Fortsetzung).**
[Notes on various fungi, with diagnoses of new forms. The new genera recorded are *Bresadolella*, *Myxolibertella*, *Sporodiniopsis*, *Cirrhomyces*, and *Ægeritopsis*.] *Ann. Mycol.*, i. (1903) pp. 522–34.

HOLLOS, L.—**Glasteropsis n. g. (Hungarian).**
[The habit of this plant recalls that of *Welwitschia mirabilis*.]
Bot. Sec. Kgl. Ungar. Naturwiss. Gesellsch., ii. (Budapest, 1903), pp. 72–5 (5 figs.). See also *Ann. Mycol.*, i. (1903) p. 551.

" " **Two new species of Lycoperdon (Hungarian).**
Tom. cit., pp. 75–6 (1 fig.), See also *Ann. Mycol.*, i. (1903) p. 557.

MAGNUS, P.—**Bemerkungen zur Benennung einiger Uredineen in P. und H. Sydow's 'Monographia Uredinearum.'**
[Magnus criticises the nomenclature of some of the species in the monograph.] *Hedwigia*, xlii. (1903) Beibl., pp. 305–6.

" " **Ein von F. W. Oliver nachgeweisener fosiler parasitischer Pilz.**
[Oliver detected the fungus on *Alethopteris aquilina*. Magnus considers it to be near *Urophlyctis*, and has named it *Urophlyctites Oliverianus*. The genus *Urophlyctis* thus dates back to the Carboniferous era.]
Ber. Deutsch. Bot. Ges., xxi. (1903) pp. 248–50.

MALENCOVIÉ, B.—**Zur Hausschwammfrage.** (Study of dry-rot.)
[The writer discusses the best means of sterilising the wood, and rendering the development of the fungus impossible.]
Centralbl. Ges. Forstwes., xxix. (1903) pp. 281–95.
See also *Ann. Mycol.*, i. (1903) p. 566.

MORGAN, A. P.—**A new species of Berlesiella.**
[The genus is characterised by the setulose perithecia. *B. hispida* sp. n. was found growing on bark.] *Journ. Mycol.*, ix. (1903) p. 217.

NEGER, F. W.—**Uber die geographische Verbreitung der Meliola nidulans Cooke.** (On the geographical distribution of *Meliola nidulans*.)
[The writer found the fungus on *Vaccinium Vitis Idaea*, as far north as Sweden.] *Ann. Mycol.*, i. (1903) p. 513.

OUDEMANS, C. A. J. A., & KONING, C. J.—**Sclerotinia Nicotianæ Oud and Kon.**
[A new *Sclerotinia* injurious to the cultivation of tobacco. The sclerotia, about 10 × 5 μ in size, grow on the stems and leaves of the plant.]
Kon. Akad. Wetensch. Amst., 1903, pp. 48–58, 85–6 (2 pls.).
See also *Hedwigia*, xlii. (1903) Beibl., p. 320.

PATOUILLARD, N. ET HARIOT, P.—**Une algue parasitée par une Spheriacée.** (A fungus parasitic on an alga.)
[The Alga *Stypocaulon scoparium* was attacked by *Zignoella enormis* sp. n.]
Journ. de Bot. xvii. (1903) p. 228. See also *Ann. Mycol.*, i. (1903) p. 552

POPOVICI, AL. P.—**Contribution à l'étude de la flore mycologique du Mont Ciahlan.**
[The list includes a large number of species; the larger forms are more particularly dealt with.]
Jassy, Imprimerie 'Dacia,' P. Iliescu and D. Grossu, 1903, 66 pp.
See also *Ann. Mycol.*, i. (1903) p. 553.

REHN, R.—**Die Discomyceten-Gattung Aleurina Sacc.** (The genus *Aleurina.*)
[The writer thinks that the brown colour of the spores is not distinctive enough as a generic character. He has drawn up a synopsis of the genus.]
Ann. Mycol., i. (1903) pp. 514–6.

ROSTRUP, E.—**Islands Swampe.**
[A list of 513 species of fungi from Iceland, with diagnoses of a number of new species.] *Botan. Tidsskr.*, xxv. (1903) pp. 281–335.
See also *Hedwigia*, xlii. Beibl. p. 320.

ROSTRUP, E, & MASSEE, G.—**Fungi in Schmidt: I. Flora of Koh Chang.**
[Contributions to the knowledge of the vegetation in the Gulf of Siam. A number of new species are recorded by the authors.]
Botan. Tidsskr., xxiv. (1902) pp. 205–17.

SPEGAZZINI, C.—**Notes synonymiques.**
[The author revises the nomenclature of a number of species, and finds several identical forms described under different names.]
Ann. Mus. Nation. Buenos Ayres, ser. 3A, ix. (1903) pp. 7–9.
See also *Hedwigia*, xlii. (1903) Beibl., p. 321.

SYDOW, H. & P.—**Ein Beitrag zur Pilzflora Portugals.**
[The authors record 84 fungi, of which three species are new to science.]
Broteria, ii. (1903) pp. 149–55. See also *Ann. Mycol.*, i. (1903) p. 554.

„ „ **Urophlyctis hemisphærica (Speg.) Syd.**
[The species was described as *Uromyces hemisphærica* by Spegazzini, and since then has been redescribed under various other names. It causes galls on the stems. *Bowlesiatenera* in South America and in Europe is found on *Carum Carvi* and *Pimpinella magna.*] *Ann. Mycol.*, i. (1903) pp. 517–8.

SYDOW—**Mycotheca germanica, Fasc. I. (Nos. 1–50.)**
[Diagnoses of the six new species are given.] *Tom. cit.*, 519–21.

„ **Mycotheca germanica, Fasc. II. (Nos. 51–100).**
[The second fascicle contains also six new species.] *Tom. cit.*, pp. 536–9.

Lichens.

Lichen Flora of Heidelberg.*—W. Ritter von Zwackh-Holzhausen published in 1883 a Flora of this region. Since that date he had added largely to his collection, and was arranging for the publication of the new list, when he died. Hugo Gluck has taken up the task, and publishes the revised and enlarged list compiled from von Zwackh's notes. The species number 559. Nylander's classification is followed throughout.

Contributions to our knowledge of the Chemistry of Lichens.† O. Hesse has studied the constituents of Lichens, and gives an account of the various substances he has found in the different forms. A number of these are new discoveries: Pannarol, Areolatin, Areolin, Poronin and Talebraracid, etc. He gives the chemical formulæ of these and of some of the other substances. In *Evernia furfuracea* he found a new constituent Furevernacid, but he failed to find Everniol or Olivetoracid.

* Hedwigia, xlii. (1903) pp. 192–213.
† Journ. prakt. Chemie, Neue Folge, lxviii. (1903) pp. 1–72. See also Ann. Mycol., i. (1903) p. 574.

W. Zopf * also contributes a paper on the same subject, and gives the substances found in a series of Lichens. He records several new bodies. Strepsilin, which becomes bright olive-green on addition of chloride of lime, is the cause of the colour reaction of *Cladonia strepsilis*. Destrictinacid, a colourless substance, was found in *Cladonia destricta*, and Leiphamacid in *Hæmatomma leiphæmum*; and in *Usnea hirta*, a substance which is termed Hirtellacid.

HASSE, H. E.—**Contributions to the Lichen-flora of the Californian Coast Islands.** *Bull. South Calif. Acad. Sci.*, ii. (1903) pp. 33–5.

" " **Additions to the Lichen-flora of Southern California.** *Tom. cit.*, pp. 52–4, 58–60, 71–3.

" " **The Lichen-flora of San Clemente Island.** *Tom. cit.*, pp. 54–5. See also *Ann. Mycol.*, i. (1903) pp. 573–4.

[In these three publications the author gives contributions to a Lichen-flora of California. There are several new species determined by Nylander.]

SENFT, E.—**Beitrag zum Vorkommen von Flechten auf offizinellen Rinden. ii. Cortex Cascarillæ.**

[The author gives an account of the most characteristic Lichens found grow- on medicinal bark. He has discovered one new species, *Arthonia Voglii*.] *Apoth.-Ver.*, 1903, No. 32, pp. 891–9 (8 figs.). See also *Ann. Mycol.*, i. (1903) p, 575.

ZAHLBRÜCKNER, A.—**Vorarbeiten zu einer Flechten flora Dalmatiens, II.**

[The author has worked on Lichen material collected by several botanists. A number of new species are described.] *Österreich. Bot. Zeitschr.*, liii. (1903) pp. 147–9, 177–85, 239–46, 285–9, 332–6.

Schizophyta.

Schizophyceæ.

Schizophyceæ in Marine Plankton.†—N. Wille publishes a *résumé* of the forms of Schizophyceæ hitherto met with among marine plankton, as an introduction to Brandt's Nordisches Plankton. Among other novelties in the systematic treatment of the Myxophyceæ, he places the genus *Chroothece* Hansg. in Glaucophyceæ (Bangiales); *Heliotrichium radians* Wille is identified with *Trichodesmium Thiebautii* Gomont, and a more complete and accurate description of *Xanthothricum contortum* Wille is given under the name of *Trichodesmium contortum* Wille. All the genera are illustrated by figures taken from the works of Kützing, Bornet and Thuret, Gomont, Möbius, Schütt, J. Schmidt, and others.

Schizomycetes.

Slime Bacterium from the Peach, etc.‡ — R. Greig Smith has separated from the peach, the almond, and the cedar, races of an organism, *Bacterium persicæ*. This is an aerobic, spore-bearing non-motile rod, measuring $1 \cdot 2$–$3 \cdot 6\mu$, or even $7 \cdot 5\mu$ in hanging drop preparations, and decolorised in parts by Gram. It produces a slime when grown upon solid media or in fluid media containing saccharose. When grown upon solid media the saccharose can be replaced by many other

* Ann. Chem. cccxxvii. (1903) pp. 317–54. See also Ann. Mycol., i. (1903) pp. 576–7.

† Nordisches Plankton. K. Brandt, Leipzig, 1903. See Nuov. Not., xv. (1904) p. 45.

‡ Proc. Linn. Soc. N.S.W., xxviii. (1903) pp. 338–48.

carbohydrates and by glycerin. The essential carbohydrate of the slime is soluble in water, but upon drying it becomes readily altered to an insoluble modification. The carbohydrate hydrolyses to arabinose and galactose, the latter predominating. Besides forming galactan-arabinian gum, the organism inverts the saccharose, producing ethyl-alcohol, carbon dioxide, lactic, butyric, and traces of succinic, formic and acetic acids.

Presence of Cilia in the Genus Bacterium.* — D. Ellis, having formerly demonstrated the presence of cilia in the Family *Coccaceæ*,† has set himself to show that the members of the genus *Bacterium* also possess cilia, although Migula classifies them as being destitute of these organs. The author made his investigations with *Bact. hirtum* (Henrici), *Bact. tomentosum* (Henrici), *Bact. filamentosum* (Klein), *Bact. rugosum* (Henrici), and *Bact. cervinum* (Henrici). The author suggests that in classification the genus *Bacterium* be omitted, and only the two genera *Bacillus* and *Pseudomonas* retained, as follows :—

Family *Bacteriaceæ*.

Cylindrical forms. Organs of motion in the form of cilia.
Endospore formation common.
Genus *Bacillus*. Forms with peritrich cilia.
Genus *Pseudomonas*. Forms with polar cilia.

Bacillus carnis.‡—E. Klein has obtained from a putrid meat infusion a very virulent essential anaerobe, and has grown it under strictly anaerobic conditions. It is a slender motile bacillus, $1 \cdot 5$–$2 \cdot 5\mu$ by $0 \cdot 6\mu$, with rounded ends. It stains with the usual dyes and is positive to Gram. Its motility is marked in young cultures, and in the exudate in animals after subcutaneous injection, and is due to the presence of peritrich flagellæ. The microbe forms large oval spores. Spore formation can be well observed by sucking into capillary tubes the exudate above mentioned, sealing the ends and incubating at 37° C. *B. carnis* grows well in all media. It is gas-forming. It does not liquefy gelatin. Guinea-pigs and mice succumb after subcutaneous injection in about 10 hours, one drop being a lethal dose for the former. Intra-peritoneally it is much less virulent, and doses of $0 \cdot 25$–$0 \cdot 5$ c.cm. have very little effect.

Bacterium cyprinicida (n. sp.).§—M. Plehn describes a bacterium obtained from carp and tench suffering from red disease (Rotseuche). 1 c.cm. of a 10 times diluted bouillon culture, introduced into the stomach by the mouth, or $0 \cdot 2$–$0 \cdot 3$ c.cm., injected intra-peritoneally, produced the disease in healthy carp and tench. The bacterium was pathogenic also to the Salmonidæ. It is a capsule-forming, slime-producing organism, about 1μ by $0 \cdot 8\mu$, neither spore-forming nor motile, but positive to Gram. It stains best with carbol-thionin, which dyes the capsule reddish, and the bacterium itself blue-violet. It is aerobic. It grows on

* Centralbl. Bakt. 2te Abt., xi. (1903) pp. 241–5.
† See this Journal, 1903, p. 109.
‡ Centralbl. Bakt., 1te Abt., xxxv. (1904) pp. 459–61.
§ Tom. cit., pp. 461–7.

the ordinary media, and best at 10° C.–20° C. Its growth is stopped at 37° C.

Two new Fluorescent Denitrifying Bacteria.*—H. R. Christensen, in the course of studies on earth bacteria, has come across two new denitrifying bacteria which differ from *Bac. pyocyaneus* and *Bac. fluorescens liquifaciens* in not liquefying gelatin. As culture media he used the following :—(1) *Nitrate and nitrite bouillon :* 5 gr. Liebig's extract ; 5 gr. peptone (Merck, Darmstadt) ; 2 gr. KNO_3 or KNO_2 ; 1000 cc. tap water. (2) *Meat peptone bouillon :* 5 gr. Liebig's extract ; 5 gr. peptone ; 1000 cc. tap water. (3) *Meat peptone-gelatin or agar :* 5 gr. Liebig's extract ; 5 gr. peptone ; 120 gr. gelatin or 10 gr. agar ; 1000 cc. tap water. All the media were made slightly alkaline with K_2CO_3. The first form, named by the author *Bac. denitrificans fluorescens* α, when grown on agar or gelatin, measures $0 \cdot 5$–$1 \cdot 25\mu$ by $0 \cdot 5$–$0 \cdot 75\mu$. It is larger, however, when grown in bouillon, and in anaerobic cultures takes the form of a large ovoid with polar staining. It is enveloped in a mucus capsule. There is very slight or doubtful movement. The organism stains well with carbol-fuchsin, but not with Gram. It does not liquefy gelatin, but imparts to it a bright green tinge. Anaerobically the growth is very slow.

The second form, *Bac. denitrificans fluorescens* β, measures $0 \cdot 5$–$1 \cdot 5\mu$ by $0 \cdot 5$–1μ from agar, more from bouillon. Many are spherical. It has a zig-zag or twisting movement. It stains readily with carbol-fuchsin, but not with Gram. It does not liquefy gelatin, but imparts to it a brown tint. It also grows anaerobically, but slowly.

Both decompose the nitrate or nitrite with the evolution of free nitrogen.

Anaerobes and Symbiosis.†—Bienstock has carried out numerous experiments on the question of a natural symbiosis of putrefactive anaerobes with aerobic bacteria. Using as a representative of the former, chiefly *B. putrificus* (Bienstock), he cultivated it with a large number of different aerobes, in the following manner : Shreds of fibrin, well washed and sterilised in Uschinsky's fluid, were inoculated with the aerobe, and after some days *B. putrificus* was added. It was observed that amongst aerobes there were some which favoured the development of the anaerobe and also the putrefaction of the fibrin ; on the other hand others, while not preventing the development of the organism, retarded putrefaction. Several other anaerobes were used with similar results. Search was also made in cultures of many aerobes for the ferment suggested by Kedrowsky as the essential for the aerobic growth of anaerobes. The cultures were filtered, and killed in various ways ; but the results with over thirty species were, except in the case of *B. pyocyaneus*, uniformly negative. *B. putrificus* neither grew nor caused putrefaction, as with living aerobes. If, however, fibrin, in Uschinsky-Fraenkel fluid containing $1 \cdot 2$ p.c. sugar, is inoculated with *B. pyocyaneus*, it shows after some days change in texture, it loses its white colour, and from being firm becomes flabby ; if now the culture be killed by heat to 100° C.,

* Centralbl. Bakt. 2te Abt., xi. (1903) pp. 190–4.
† Ann. Instit. Past., xvii. (1903) pp. 850–6.

and then inoculated with *B. putrificus*, growth of the latter and putrefaction is produced in two or three days, and this under non-anaerobic conditions. Sterile ascitic fluid gave the same results. The presence of coagulated albumen, however, seemed essential in both cases, for when this was removed the results were negative. All experiments were checked by many controls.

Resistance to Heat of Bacillus anthracis.* — A. Mallock and A. M. Davis from the results of 113 experiments are of opinion that the heat-resisting power of *B. anthracis* and its spores is much less than is generally supposed: indeed, they rarely found any survival of living matter in fluid which had been raised to a temperature of 100° C., even for as short a time as 20 to 30 seconds. Their method was to inoculate sterilised tubes of distilled water from a broth or agar culture of the bacillus. Within 2 to 3 hours the tubes were sealed at the top with heat, and submitted to different degrees and durations of heat in a special apparatus furnished with a steam boiler. This done, the tops of the tubes were filed off and the contents sown into broth with the least possible delay. The authors relied on the following appearances as indicating growth of *B. anthracis*.

Nutrient broth at 37° C.—After 24 to 48 hours, whitish deposit and presence of small flocculent masses in upper part of tube, which fall down on shaking; the broth itself remains clear: absence of any pellicle.

Agar stroke at 37° C.—Whitish, thin defined growth along the stroke, with irregular edges, not spreading widely.

Microscopic appearances.—Rods, threads and felted masses, with spores either free or lying within the rods. Rods non-motile.

Fat of Tubercle Bacilli.†—K. J. Krisling has found that the dry substance obtained from tubercle bacilli in the preparation of tuberculin contained 3·94 p.c. water, 8·57 p.c. N, 38·95 p.c. fat, and 0·97 p.c. of other organic substances not containing nitrogen. The fatty substances extracted by chloroform melt at 46° C., have an acid number 23·08, Reichert-Meissl number 2·01, Hehner number 74·23, saponification number 60·70, ester number 37·62, and Hübl iodine number 9·92. They contain 14·38 p.c. of free fatty acids, 77·25 p.c. of neutral fats or esters, 39·10 p.c. of alcohols extracted from the esters and melting at 43·5° C. to 44° C., 0·16 p.c. of lecithin, and 7·3 p.c. of substances soluble in water. 25·76 p.c. of substances soluble in water are extracted after the complete hydrolysis of the fats.

Composition of Tubercle Bacilli derived from Various Animals.‡ E. A. Schweinitz and M. Dorset found the following amounts of ether, alcohol and chloroform extracts in (1) bovine, (2) swine, (3) horse, (4) avian, (5 and 6) attenuated and virulent human tubercle bacilli,

* Proc. Roy. Soc., lxxii. (1903) pp. 493–9.

† Chem. Centr., i. (1903) p. 1153. See also Journ. Chem. Soc., ccccl xxxix. (1903) p. 504.

‡ Journ. Chem. Soc., xxv. (1903) pp. 354–8. See also Journ. Chem. Soc., ccccl xxxix. (1903) p. 504.

after washing out any adherent culture-media and most of the constituents soluble in water.

	(1)	(2)	(3)	(4)	(5)	(6)
Ether extract . .	17·70	12·56	23·38	17·36	28·27	20·31
Alcohol extract .	8·13	7·83	8·18	13·27	7·36	7·22
Chloroform extract .	0·49	0·20	0·20	0·02	1·33	0·48

The acid values of the ether and alcoholic extracts, the total ash and the phosphoric acid, were also determined.

It is suggested that the virulent human, bovine, horse, and swine tubercle bacilli, which contain less harmless matter than the attenuated human tubercle bacilli, produce greater amounts of poisonous proteids.

It was previously shown* that cultivations of human tubercle bacilli contain a very virulent acid-like necrotic substance. This, being readily soluble in water, would not be included in the above extracts.

Decomposition of Cellulose by Aerobic Micro-organisms.†—G. van Iterson has studied the decomposition of cellulose by denitrifying bacteria. He experimented with Swedish filter paper and found that the cellulose is broken down by the action of denitrifying, non-spore-forming, aerobic bacteria, provided that there is a limited supply of air. If nitrates be present in the nutritive medium, only nitrogen and carbon dioxide are evolved.

Amongst the aerobic, non-spore-forming bacteria which attack cellulose, the brown pigment bacterium, *Bact. ferrugineus*, is predominant. A chief cause of the brown colour in humus is a pigment formed by the action of bacteria or moulds on cellulose. The aerobic destruction of cellulose accounts for the fact that wood or rope partly immersed in water become weak at the place of contact of water and air.

* Centralbl. Bakt., 1te Abt., Orig., xxii. (1903) pp. i., 209.

† Proc. K. Akad. Witensch. Amsterdam, v. (1903) pp. 685–703. See also Journ. Chem. Soc., ccccl xxxix. (1903) p. 503.

MICROSCOPY.

A. Instruments, Accessories, &c.*

(1) Stands.

Ross' Improved No. 2 "Standard" Microscope.† — This instrument (fig. 24) is constructed upon the basis of the original Oberhauser-Hartnack model, and claims to have important improvements not

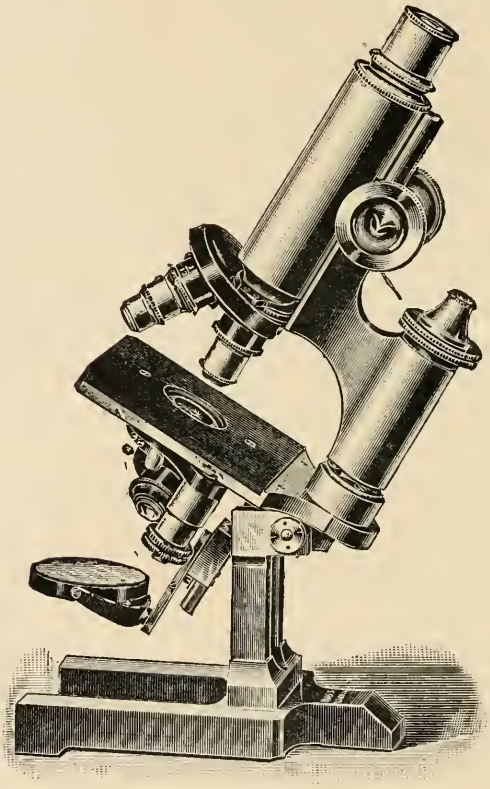


Fig. 24.

embodied in any other instrument. The very best workmanship has been introduced throughout, and special care has been bestowed upon

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

† Ross' Catalogue of Latest Improvements in Microscope Construction, 1903.

the exact fitting and working of the wearing parts, so as to secure perfection of alignment in the optical parts. When the Microscope is used vertically, the stage is extremely rigid under manipulation even with the highest objectives, and in this position the stage rests upon the step-like supports of the pillars. The mirrors are mounted with a swinging bar on an exceptionally strong focussed slide-bearing, the swinging bar being provided with a "clock" for indicating central illumi-

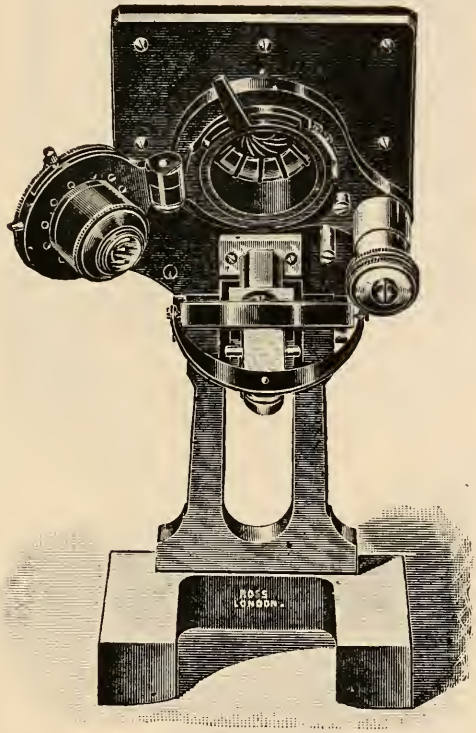


Fig. 25.

nation. For facilitating rapid work of a variable nature, such as occurs in general medical work, a special and unique substage fitting (fig. 25) can be supplied, the condenser being hinged to the mounting of the upper dome-shaped iris diaphragm, so that it can be instantly swung downwards, leaving this iris *in situ*, the distance of this diaphragm from the stage being readily varied by the substage screw. The condenser can be immediately reinserted by a single movement without disturbing the position of the instrument, and thus altering the lighting.

The mechanical stage can be attached or removed in a few seconds, and is so constructed that it will always register to the exact position it previously occupied, in order that an object can be

readily found by means of the vernier. Both rectangular movements are attained by smoothly-working diagonal racks-and-pinions of superior workmanship. The pinion-boxes are automatically self-adjusting to

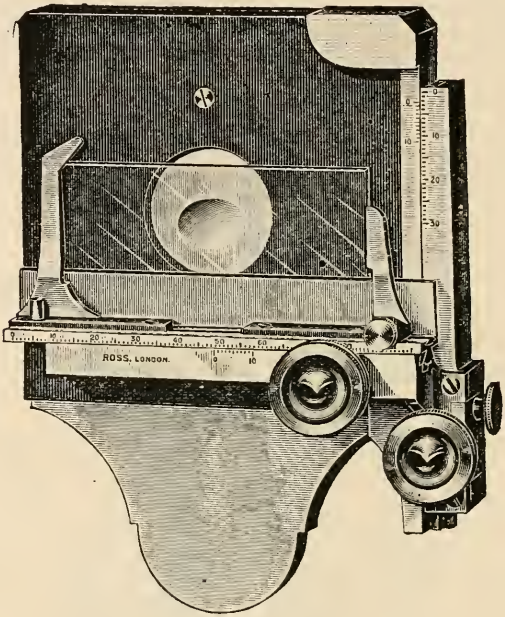


FIG. 26.

take up wear. The range is sufficient to allow the systematic search of a very large slide, and the fixed stage itself is of corresponding dimensions. The milled heads are extra large, to secure perfect control

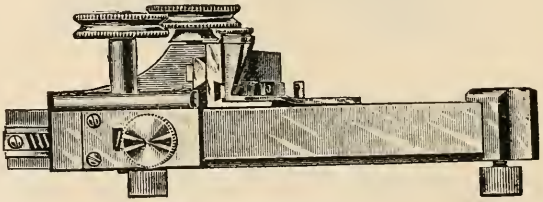


FIG. 27.

over the movements with high-power objectives. Fig. 26 shows the general view of the mechanical stage, and fig. 27 gives a side view.

Watson and Sons' New "Argus" Microscope.*—This instrument has a tripod foot with a spread of $6\frac{3}{4}$ in. The coarse adjustment is

* W. Watson & Sons' Supplemental Catalogue, Oct 1903.

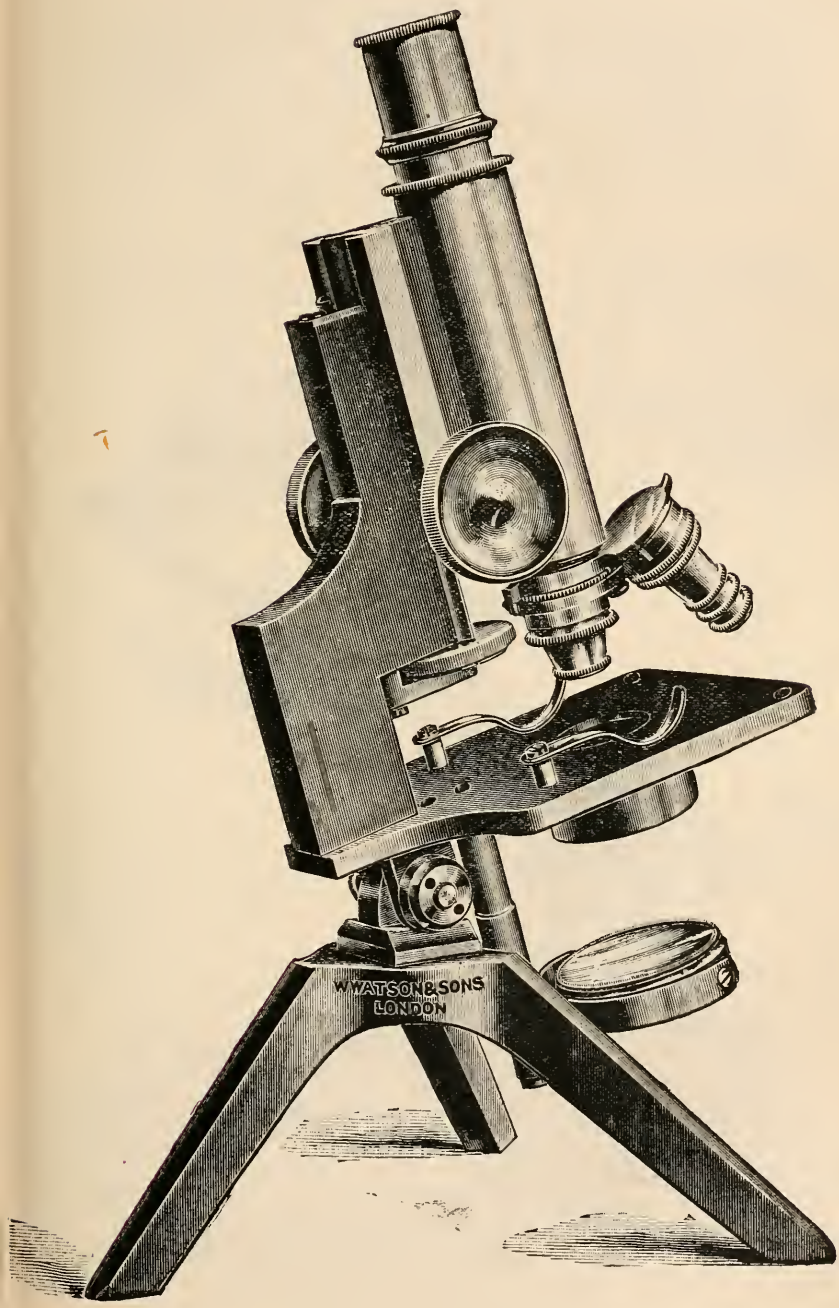


Fig 28.

effected by means of a helical rackwork and pinion of a new design, and the fine adjustment by the rotation of a direct-acting screw. The stage and body are of brass, and the height of the instrument when placed vertically is $10\frac{3}{4}$ in. All the fittings are of the universal size, and compensating screws enabling the working parts to be adjusted are provided (fig. 28).

Hitchcock, R.—The ideal projecting Microscope.
Journ. New York Micr. Soc. Annual, 1902 (1904) pp. 19–23.

(3) Illuminating and other Apparatus.

Heele's Heliostats.*—These are shown in the accompanying illustrations. Fig. 29 is of Silbermann's construction with accurate clock-

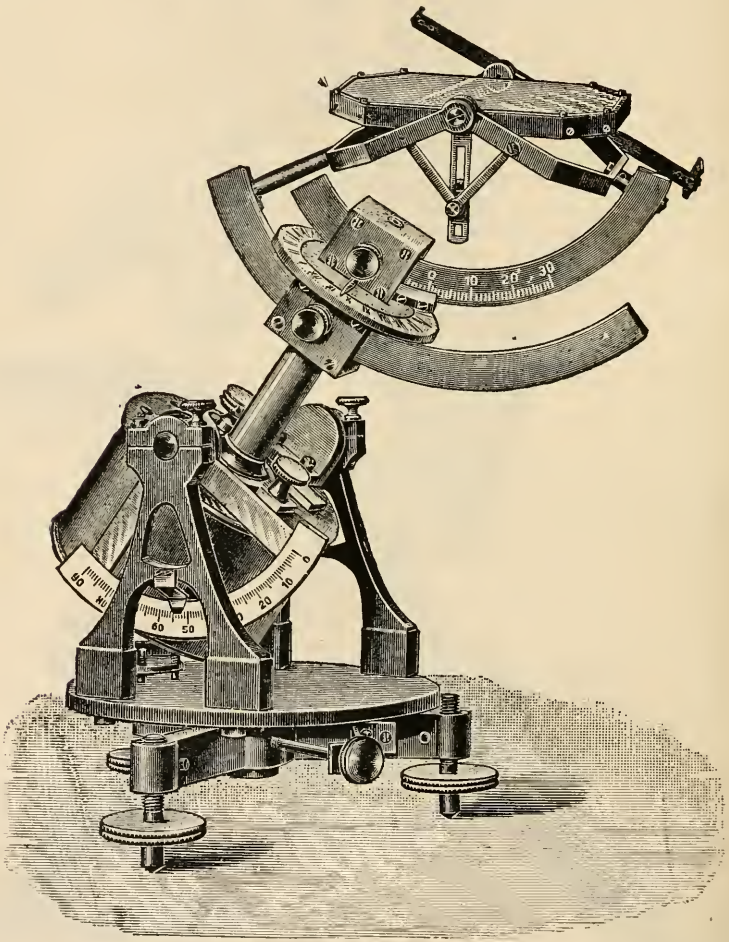


Fig. 29.

* Catalogue, pp. 21–3, Nos. 83–6.

Fig. 30.

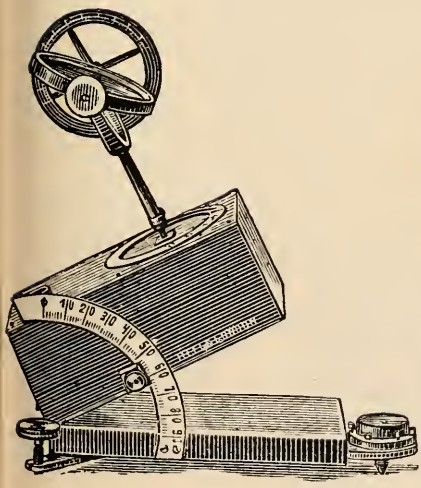


Fig. 31.

Fig. 32.

work, escapement and compensation balance. The size of the mirror is $2\frac{1}{2}$ by 4 in. Fig. 30 is an instrument with Heele's modifications. The size of the mirror is 3 by 5 in. Fig. 31 is of simpler form. The clock-work is contained in a mahogany case. The instrument is fitted with spirit-level and levelling screws. Fig. 32 is of still simpler construction.

DOWDY, S. E.—**Microscope condenser fitting.**
[Describes how an effective condenser can be cheaply improvised.]
English Mechanic, lxxix. (1904) p. 59.

(4) Photomicrography.

Photographing Microscopic Crystals.* — W. Bagshaw shows that a combination of transmitted and reflected light is necessary to throw objects like microscopic crystals into relief and impart a pleasing and faithful representation. The transmitted light, subdued so as not to dominate the reflected light, ensures the outlines in their finest ramifications, whilst the reflected light casts the shadows.

The How and Why of the Lippmann Colour Process.† — T. A. O'Donohoe reminds his readers that the Lippmann film is usually a very thin transparent film of gelatin containing a very small proportion of perfectly emulsified silver bromide. The glass support must be between the film and the lens, and the film must be backed by mercury to form the reflecting surface. Suppose fig. 33 to represent a section of the film; A B the glass surface in contact with the film, and C D the mercury, also in contact with the film. Let R be a ray of monochromatic light passing through the film in a sinuous unbroken line, and impinging at right angles on the surface of the mercury. At the moment of reflection it loses half a wave-length, and according to Young its phase is reversed, so that it returns in the form of the dotted sinuous line, interfering more or less in its course with the entering wave. The two systems of waves are now, as it were, locked up in the film, and are called "stationary waves," because they have lost their forward motion and can only move up and down within the film. They rise and fall with incredible rapidity and act chemically, all the time producing the greatest effect where their motion is greatest, and the least or no effect in the nodal planes where the two waves intersect. In the figure the planes of highest chemical activity are represented by lines *max*, and from these to the shorter lines *min*, where there is no chemical effect, there is a gradual waning of actinic power. There are thus alternate planes parallel to the mercury, showing the maxima and minima of chemical action, and should the theory be correct, a transverse section of such a film should, after development and fixation, show these maxima and minima by alternate bands of black, where the deposit of silver bromide is greatest, and of white bands, where the deposit of silver bromide is little or none. Other colours of the spectrum will,

* Amateur Photographer, xxxix. (1904) p. 69 (4 figs.).
† Photogram, x. (Sept. 1903) pp. 271–4 (6 figs.).

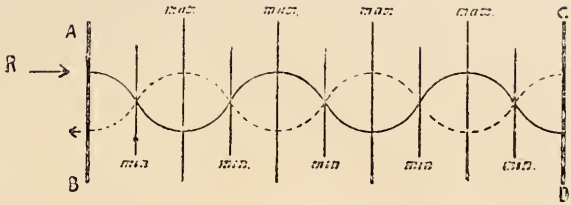
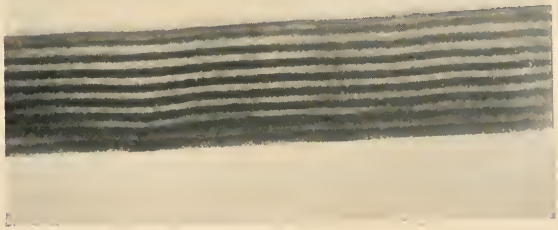


Fig. 33.



Figs. 34, 35. × 1000.

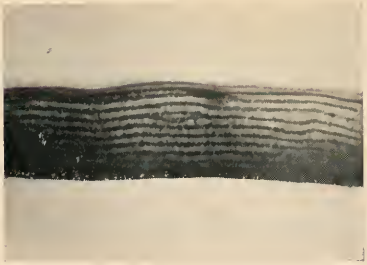


Fig. 36. × 1000.

[To face p. 242.

of course, be acting similarly. The action, moreover, is continuous during exposure, the red waves impressing their forms in the film at the rate of 38,000 to the inch, and the blue at 52,000 to the inch. Prof. Lippmann did not advance beyond the theory, but last year E. Senior photographed a spectrum, and by the aid of collodion stripped the film from the glass support. W. B. Randles imbedded this film in paraffin and after cutting sections mounted them in Canada balsam. Figs. 34 and 35 show the results under high-power magnification, and are photo-micrograms of the red part of the spectrum in which the alternate bands are distinctly visible through the entire thickness of the film. Fig. 36 is a photo-microgram of the blue part of the spectrum under the same magnification. The portion of the film acted on by the blue light was not quite so thick as that of the red owing to the difficulty of making a perfectly plane film. The strata of the blue are, as they should be according to theory, much closer together than the strata in the red. Thus it will be understood that, after development and fixation, each part of the film will reflect only the light whose wave-lengths exactly coincide with the impressions already made in the film.

(6) Miscellaneous.

Ultra-microscopic Objects.*—A. Cotton and H. Mouton, in repeating the experiments of Siedentopf and Zsigmondy on the visibilty of finely-divided particles in certain media, have found the following arrangements very convenient for studying liquids. A very oblique beam of light, diagrammatically represented in fig. 37, is projected on

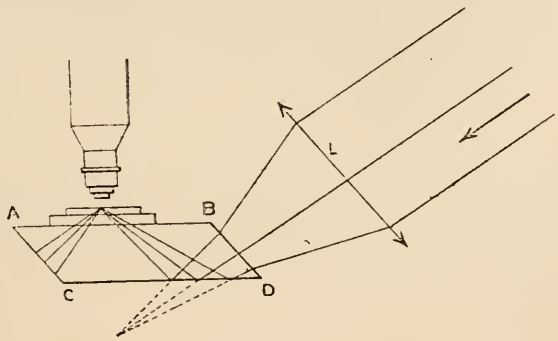


Fig. 37.

to one of the sides of an oblique parallelopiped A B C D with rectangular top and bottom faces, and reflected upwards from the base through the object-slide and cover-slip. A thin layer of the liquid to be examined

* Revue Générale des Sciences, xxiii. (Dec. 15, 1903) pp. 1184–91 (6 figs.).

is placed between the slide and cover-slip, and the under surface of the slide is moistened with a drop of liquid of same refraction-index as the glass. If the angle of incidence of the beam is suitably chosen, the interior beam meets the cover-slip at the angle of total reflexion, and throws no light on to the objective. Any ultra-microscopic particles present in the liquid become, however, diffractive, and therefore self-luminous. The effect on the objective is to render these bodies visible on a dark ground. In the figure the angle of the parallelopiped was about 51°.

The authors consider that their method has the great advantage of using a large percentage of the light emitted from the source. The experiments must be conducted in a darkened room. A view of the actual apparatus is given in fig. 38, where it will be noticed that the light issuing from the condenser of a small inclined lantern is con-

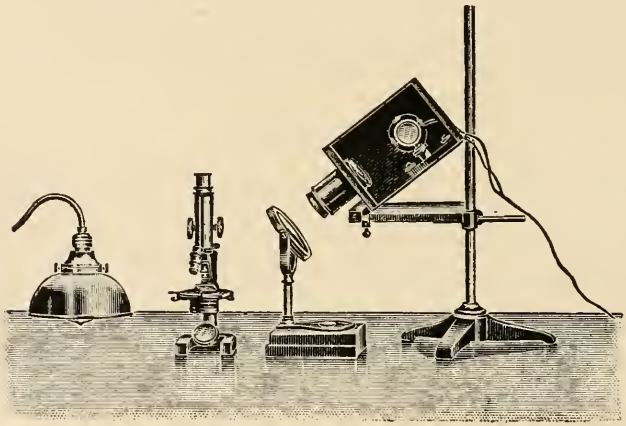


Fig. 38.

centrated by a lens on to the parallelopiped. The lamp on the left is used when it is desired to view the liquid as a transparent object.

The examination of Lippmann's films liquefied showed that the ultra-microscopic particles of silver bromide are in a state of Brownian movement. The authors suggest that this fact may have a bearing on photography in colours. A thin solution of Chinese ink behaved similarly. A preparation of ferrocyanide of copper was examined as a specimen of a colloid, and highly exhibited the Brownian movement; but, when a minute quantity of alum solution was added, the motile particles instantaneously disappeared, and granular masses of ordinary precipitated ferrocyanide of copper were produced. The property possessed by colloids of diffusing light is probably due to the presence of very minute particles, and the authors think that their experiments are very suggestive to biologists who wish to study the action of saline

solutions and diastases on the numerous colloids found in living organisms. It would seem that the minuteness of many bacteria is an insufficient test of their identification, and that more difficult characters, such as peculiar motility, tactism, agglutination, must be looked for: possibly sensitiveness to different kinds of coloured illumination may be found. In the examination of a living culture in bouillon of the microbe of a bovine peripneumonia totally reflected light revealed numerous brilliant corpuscles animated by a movement indistinguishable from Brownian. Great care was taken to ensure that the observations were not tainted by any accidental inequalities or defects in the glass used.

Horder's Clinical Case.—Fig. 39 shows an improved form of the clinical case exhibited at the November meeting.* The modification consists in an alteration in the size of the case, which now measures

Fig. 39

141 mm. by 100 mm. by 31 mm. The increased capacity of the case allows the inclusion of additional requisites such as pipettes, hæmacytometer counting chamber, rack for drying cover-glasses, and some other additional articles.

* See this Journal, 1903, p. 782.

Heele's Miniature Spectroscopes.*—One form of these instruments, catalogued as No. 32, is shown in fig. 40. It has a symmetrical adjust-

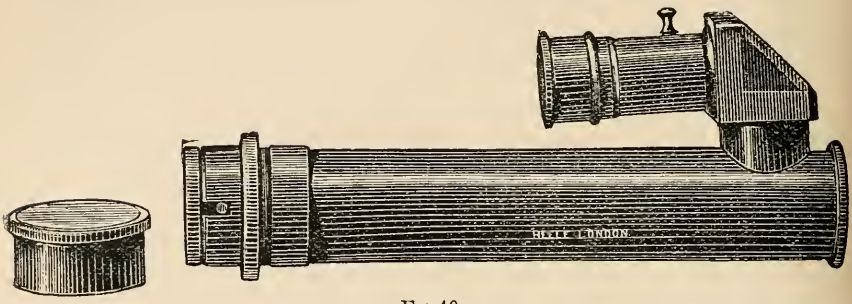


Fig. 40.

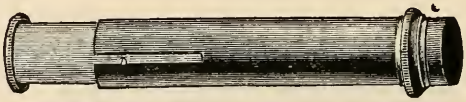


Fig. 41.

able slit, comparison prism, achromatic lens and photographic micrometer scale for determining the position of the lines. The same instrument, in a simpler form, with adjustable slit and achromatic lens, is shown in fig. 41.

B. Technique.†

(1) Collecting Objects, including Culture Processes.

Simple Method for Clearing Nutrient Agar without Filtration.‡ H. Fischer recommends the following plan: A glass funnel of suitable size is plugged with a cork just where the cone joins the tube, and placed in an iron ring. Into this the boiling hot agar solution is poured. It is then covered and placed in the cool. After some hours the mass is found to be hardened, and all the turbidity is quite at the bottom of the glass. The funnel is then inverted, and the agar with a little help falls out. It is caught in the hand or a dish, and the turbid part at the apex of the cone removed with a knife. The rest is then remelted and poured into culture tubes. The method is not suitable for gelatin.

Blood Cultures in Typhoid Fever.§—L. M. Warfield takes 10 to 15 c.cm. of blood in the usual manner from the arm, and distributes it among four or five flasks containing 250 c.cm. of bouillon each, and two or three containing the same quantity of litmus milk. The flasks

* Catalogue (pp. 8–9), Peter Heele, London.

† 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. Bakt., 1te Abt., xxxv. (1904) p. 527.

§ Bull. Ayer. Clin. Lab. Pa. Hosp., 1903, No. 1, pp. 77–80.

are incubated at 37·5° C. If organisms be present, a clouding of the bouillon and blackish discoloration of the blood at the bottom of the flask gives evidence of their growth within 24 to 48 hours. Occasionally the signs of growth do not appear for four or five days. The bacilli are afterwards identified on the ordinary media and by the agglutination test. Cultures made early in the disease give a much higher percentage of positive results than those made during the third or fourth week.

Method of Concentrating Plankton without Net or Filter.*—B. L. Seawell describes the following procedure for concentrating plankton. The samples are collected by dipping or by the use of a plankton pump without the filter. A measured quantity, say 500 c.cm., is placed in a conical flask of, say 750 c.cm. capacity, 5 c.cm. of 40 p.c. formaldehyde added, and the two well mixed at once. The planktonts soon die and settle at the bottom. After about a week the supernatant fluid is siphoned off till only 150 c.cm. remain. The residue is poured into a conical flask of about 150 c.cm. capacity, and allowed to settle for another week. The siphoning is repeated and the residue poured into a 75 c.cm. flask. This flask has a base so small in diameter that all but about 20 c.cm. can be safely siphoned off, and this last sediment filled into two 10 c.cm. phials. If kept for future study it may be advisable to add a small quantity of glycerin.

(2) Preparing Objects.

Bleaching Reagents.†—S. E. Dowdy remarks that hydrogen peroxide when used as a bleaching agent should be employed fresh and of full strength. Chlorinated lime in freshly prepared solution, to which a drop or two of dilute acid is added, makes a much more satisfactory bleacher.

Formol-sublimate Fixing Fluids.‡—R. Pearl recommends the fluids devised by D. C. Worcester for fixing and killing. One of these is a saturated solution of sublimate in 10 p.c. formalin. The other consists of nine parts of the foregoing and one part of glacial acetic acid. The first fluid is especially adapted for fixing and killing Protozoa; the second for fixing teleost eggs, and embryological material in general.

(3) Cutting, including Imbedding and Microtomes.

Pleuel Microtome.§—In this instrument which has been improved by Kaplan, the movement is given to the knife-carrier through the continuous turning of a handle, to the crank of which a connecting rod is attached in the desired degree of eccentricity. This rod is at its other end connected with a sliding block, to which it gives a to-and-fro movement. The sliding block is joined to a metal band, which in its turn is loosely connected to the knife-carrier by means of a double-hinge joint. The extent of the to-and-fro movement of the knife-

* Trans. Amer. Micr. Soc., xxiv. (1903) pp. 17–19.
† English Mechanic, lxxix. (1904) p. 63).
‡ Journ. Applied Micr., vi. (1903) pp. 2451.
§ P. Thate's Catalogue, Berlin, 1903.

carrier thus varies directly with the degree of eccentricity of the attachment of the connecting rod. The working of the micrometer-screw is automatic and can be adjusted by means of a peg on the knife-carrrier. The advantages claimed are :

1. Mechanically ensured movement of the knife-carrier exclusively in the course of the sliding track.
2. Simplicity of construction without cogged wheels.
3. Variability in the extent of the movement of the knife-carrier.
4. Automatic working of the micrometer-screw.
5. Adaptability of the apparatus to other sliding microtomes.

Rotation Microtome.*—P. Krefft has devised a microtome, named by him "Herzberge," of which the knife (fig. 42) is the special feature. This is semicircular in form with an outer cutting edge, and it rotates eccentrically round a selected point lying somewhere in its diameter. During such an eccentric rotation the distance becomes constantly and gradually increased between the rotation point and the cutting point of the advancing edge, which advances to just double the extent of the eccentricity. The knife is fixed to a holder on the top of a vertical axis, on the head of which is a millimeter scale for the setting of the knife to the required eccentricity, which should be equal to half the broadest diameter of the preparation to be cut through. The knife-holder grasps the whole back of the knife, and so any elastic spring is avoided. Across this axis passes a rod which can become fixed in the required position and serves for the regulation of the automatic block-raising apparatus : during the half of the revolution, in which the semicircular knife runs free, i.e. does not cut, a lever fixed to the chief axis pushes the rod to one side, and at the same time by means of a catch takes hold of and moves the toothed micrometer-screw, and so causes the block to be raised. During the second half of the revolution, in which the knife cuts, the lever is out of reach of the rod. The whole is worked by a handle, which by means of a cogged wheel acts on the chief axis.

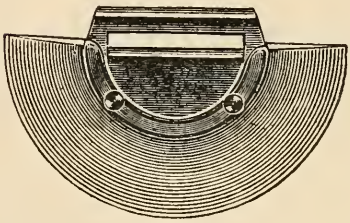


Fig. 42.

For the cutting of paraffin ribbons a straight-edged knife can be substituted for the semicircular one. The advantages claimed for this microtome are :

1. The absence of elastic spring.
2. The course of the knife is uniform and sure.
3. The manipulation is easy.
4. The sections are uniformly regular.

Stebbins, J. H.—**New and cheap Hæmatoxylin Stain.** *Journ. New York Micr. Soc. Annual*, 1902, pp. 1–6.

„ „ **Goldhorne's Double One-dip Bloodstain.** *Tom. cit.*, pp. 6–7.

* Zeitsch. wiss. Mikr., xx. (1903) pp. 7–11 (2 figs.).

(4) Staining and Injecting.

New Modification of the Romanowsky-Ruge Method for Staining Blood-Spores.* Berestneff recommends the following. Stain No. 1 : 0·5 p.c. watery solution methylen-blue (med. puriss.). Stain No. 2 : 1 p.c. watery solution methylen-blue and 0·3 p.c. crystalline soda, heated for three hours in a water bath and then filtered. Stain No. 3 : 0·5 p.c. watery solution eosin (extra B.A.). Four parts of No. 1 are mixed with one part of No. 2, and to 5 c.cm. of this 2·25 c.cm. of No. 3 are added. The preparation is fixed in absolute alcohol, and then stained for 10 to 30 minutes (crescents require at least 35 minutes). The preparation is then dried with filter-paper, or quickly washed with water, differentiated in a mixture of 100 parts alcohol and 2 parts 5 p.c. acetic acid for a few seconds, washed quickly in water and dried.

Demonstrating Presence of Cilia in Bacteria.†—D. Ellis used ordinary agar, "spirillum agar," and peptone-beef broth, and his method was to keep on continually transferring the organism to a fresh medium as soon as growth was perceptible. He was successful in demonstrating cilia in all these species. The following staining method was employed :—Three small drops of water were placed on an absolutely clean slide. A portion of the material was then, with a platinum loop, mixed with the first drop. A loopful of this drop was then mixed with the second, and, lastly, a loopful of the second with the third. From the third drop the cover-glass preparations were made. The smears were then fixed by being kept at 37° C. for 4 minutes, then mordanted for 3½–7 minutes with—

10 c.cm. of a 20 p.c. sol. of Tannin,
8 c.cm. of a cold sat. sol. $FeSO_4$,
1 c.cm. of a sat. sol. of Fuchsin in Abs. Alc. ;

and, lastly, stained for 5 minutes with—

1 grm. Säure violett (Grübler & Co. 6 B),
75 c.cm. Absolute Alcohol,
75 c.cm. water.

Resistance of Tubercle and other Acid-fast Bacilli to Decolorising Agents.‡—C. A. Coles submitted the bacilli of tubercle, smegma, Timothy grass, grass bacillus ii. and mist bacillus to various decolorising agents, after staining with Ziehl-Nielsen for seven minutes. The most important results are that tubercle bacilli can resist 25 p.c. sulphuric acid for 72 hours, while pseudo-tubercle bacilli are decolorised in 16 hours or less. Tubercle bacilli resist Pappenheim's solution [1 part corallin (rosolic acid) in 100 parts of absolute alcohol, to which methylen-blue is added to saturation ; this mixture is further treated with 20 parts of glycerin] for 52 hours, while pseudo-tubercle bacilli are decolorised at the end of four hours.

The author suggests a modification of Pappenheim's solution, finding

* Centralbl. Bakt., 1te Abt. Ref., xxxiv. (1904) p. 296.
† See *ante*, p. 232.
‡ Repr. from Journ. State Med., Feb. and March, 1904, 20 pp.

that the omission of methylen-blue gives better pictures. The films are afterwards contrast stained for a minute or so in weak aqueous solution of methylen-blue.

For differential diagnosis it is advised to immerse the stained slide in the decoloriser for not less than four and not longer than twelve hours. If 25 p.c. sulphuric acid be used, the slides should be left in the acid for at least sixteen and not more than twenty-four hours, and after thoroughly washing with water they are contrast stained with aqueous methylen-blue, dried and mounted.

(5) Mounting, including Slides, Preservative Fluids, etc.

VILLAGIO—**Modern Mounting Methods, continued.**
English Mechanic, lxxix. (1904) pp. 13, 14, 83–4.

(6) Miscellaneous.

Iodine-Calcium Nitrate, a new reagent for Cellulose.* — E. L. Seeliger recommends the following for the recognition of woody material in paper: Iodine 0·1; potassium iodide 0·5; calcium nitrate ($Ca(NO_3)_2 + 4H_2O$) 30·0, and water 50·0. By this, cellulose in its purity is stained light to dark blue, linen dark red, and woody material and woody fibres (as jute) yellow brown. By this reagent, also, can be distinguished the cellulose of conifers from that of other trees—the former staining reddish, and the latter blue. The cellulose of conifers, if bleached, takes on a violet tinge, and if unbleached, a yellowish one.

The Agglutinoscope, an Apparatus for facilitating the Macroscopic observation of Agglutination in the Test-tube.†—H. Jaeger has devised the following apparatus. Three boards of wood are taken, and two of them are joined to the ends of the third by hinges. These two meet in the form of a roof-edge, but one of them is made to overtop the other by a hand's breadth, the latter resting on a ledge on the former. This arrangement screens the daylight from the observer, as he works desk-wise at the lower board. Extending transversely across this, is a slit 3 mm. wide, and about the length of a test-tube. Underneath the slit-opening is fixed an elliptical electric lamp, the long axis of which is parallel with the slit, and through which it sends a very bright beam of light. The test-tube containing the solution to be studied is held by a clamp almost horizontally above the slit, being thereby brightly illumined, and the observer, by means of lens fixed to the board, can readily see even the smallest clumps.

Prevention of Pedetic or Brownian Movements.‡—For the purpose of photography, or for measurement and counting, it is very objectionable to have minute particles in constant motion. For preventing this movement, J. H. Gage uses a 10 p.c. solution of gelatin, filtered through

* Zeitsch. angew. Mikrosk., ix. (1903) pp. 249–50.
† Centralbl. Bakt. 1te Abt. Orig., xxxv. (1904) pp. 521–3.
‡ Trans. Amer. Micr. Soc., xxiv. (1903) p. 21.

filter-paper. A drop of the solution and a drop of milk are placed on a slide and thoroughly mixed. A cover-glass is put on and squeezed down, and then the gelatin is set by putting the slide on ice. This method, which is quite suitable for other liquids containing particles in suspension, gives very satisfactory results.

Cover-glass Cleaner.*—S. E. Dowdy describes an appliance for cleaning cover-glasses as follows. Procure a 1 oz. wooden pill-box, a small piece of thick felt and a strip of chamois leather. Cut or punch out a sufficient number of circular discs of the felt to fill up the bottom part of the box, which should be first smeared inside with seccotine to hold the discs in position. Now line the inner part of the box-lid with a piece of chamois leather in the same way, taking care to get it tightly stretched across, free from creases. The thickness of felt and leather must be so arranged that when the lid is fitted on the box their surfaces just touch. In use, place the cover-glass flat on the felt surface, put on the box-lid, and, holding the box sidewise, rotate its two portions in opposite directions. In this way the thinnest cover-glass may be cleaned without risk of breaking. As a rule, fresh cover-glasses are easily freed from the thin film of adherent grease by soaking them in a little dilute ammonia, afterwards rinsing in distilled water, and either drying at once on a piece of silk or placing them in absolute alcohol, which removes the water and is itself got rid of by evaporation.

Metallography, etc.

Watson and Sons' Metallurgical Auxiliaries.†—1. *Universal Metal-holder* (fig. 43).—This combines in itself a metal-holder with the means of levelling the specimen. Two clamps with rotating jaws grip

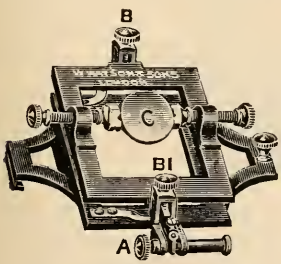


Fig. 43.

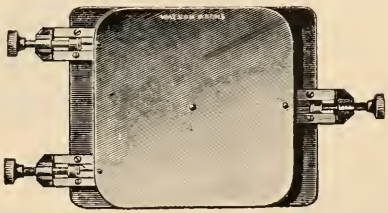


Fig. 44.

the specimen C, and if its plane is not at right angles to the objective, it can be tilted exactly to the desired position by means of the adjusting screws A and B, B′. This fitting is usually made to interchange with the levelling stage plate on the main stage of the Microscope, and for rapid and precise work is of great importance and convenience.

* English Mechanic, lxxix. (1904) p. 14.
† W. Watson & Sons' Catalogue of Micro-Outfits for Metallurgy, pp. 8, 9, 11.

2. *Levelling Superstage* (fig. 44).—It has hitherto been usual for this superstage to be made with levelling screws working from the upper surface, but it will be seen that this new and improved form works from the sides by means of screws operating on wedge-shaped pieces of brass, which, slowly tilting, cause the upper part to tilt, and reaction is obtained by springs attached to the lower plate and grasping the lower one on its upper surface.

3. *Scōp Bullseye Stand Condenser* (fig. 45).—This is fitted with centring adjustments and iris diaphragm. The lens is $2\frac{1}{8}$ in. diameter,

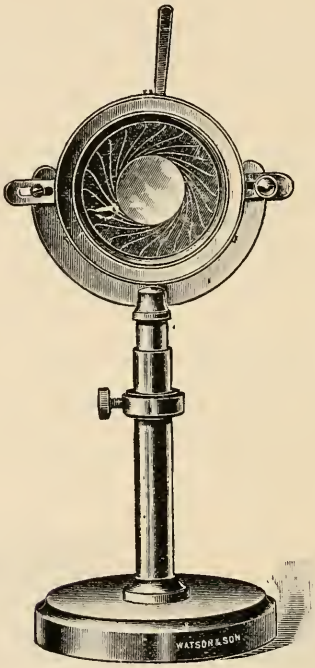


Fig. 45.

and is of a suitable power for work with a vertical illuminator. With it a very small point of light of intense brilliance can be secured.

4. *Scōp Bullseye with Mechanical Adjustments* (fig. 46).—When examining metal specimens, constant necessity arises for the minutest possible alteration of the position of the bullseye lens, sometimes laterally, sometimes vertically. Messrs. Watson have specially constructed this bullseye, which optically is the same as the preceding, to meet this inconvenience. It is mounted upon a pillar, on which is a rackwork, with which adjustments can be made to the finest point by turning the pinion milled head. Laterally, similar slight movements can be effected

by means of a spiral screw. The foot is an exceedingly substantial flat tripod.

Elastic Limit of Metals.*—T. K. R., in an abstract of M. Frémont's carefully-reasoned article, contributed to the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*,† describes the author's chief experiments and results as obtained by microscopic methods. He states that M. Frémont has proved :—

1. That the *theoretical elastic limit* is the mean charge per unit of section on which the real elastic limit is locally attained at a point of the piece tried. It is not the elastic limit of the metal, but of the particular piece of metal under the special conditions employed.

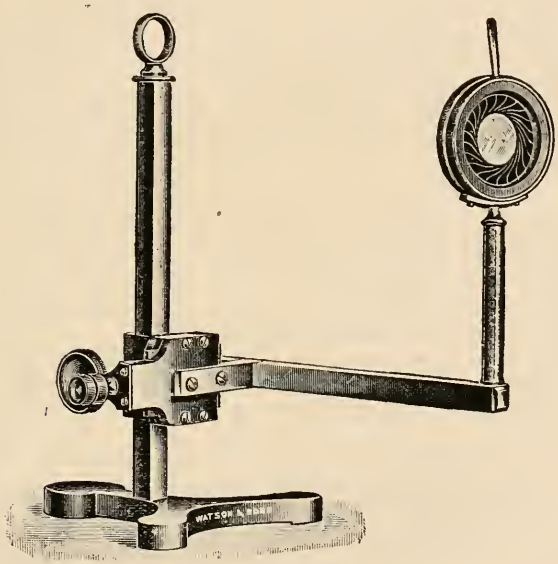


Fig. 46.

2. That the *proportional elastic limit* is still more fortuitous. Owing to compensating error, the line showing the relation between stress and strain may continue to be fairly straight even above the theoretical limit.

3. That the apparent limit is the mean charge per unit of section when the real elastic limit is reached in all regions where it had not previously been reached.

4. Finally, that there is only one elastic limit of a metal, the "real elastic limit," as determined by the method he indicates. The real limit alone has the characters of a physical constant. The other so-called limits depend upon the appearance of discontinuous deformations, the

* Nature, No. 1786 (Jan. 21, 1904) pp. 276–7. † September, 1903

presence of which is almost inevitable in practice, although their cause is purely accidental.

Influence of Sulphur and Manganese on Steel.* — J. O. Arnold and G. P. Waterhouse conclude :—

(1) That sulphide of iron is deadly in its effect upon steel, whilst sulphide of manganese is comparatively harmless.

(2) That the above facts are due to the fusibility, the high contraction coefficient, and the tendency of sulphide of iron to form cell-walls or enveloping membranes surrounding cells of ferrite, whilst sulphide of manganese is much less fusible, segregates whilst the iron is at a high temperature, and so collects into rough globules and very seldom into meshes.

(3) That manganese retards the segregation of iron and hardenite, and that what is called pearlite in a normally cooled manganese steel is really a mixture of granular pearlite and unsegregated ferrite.

(4) That the complete segregation of the ferrite in a manganiferous steel can be brought about by very slow cooling, but that such annealing injures the mechanical properties of the steel by lowering the maximum stress, and the reduction of area per cent. registered by the unannealed steel.

Segregatory and Migratory Habit of Solids in Alloys and in Steel below the critical points.†—J. E. Stead concludes :—

1. That at certain temperatures near to, but below the eutectic point of the iron-phosphorus eutectic, the two constituents when quite solid are capable of migrating from one part to another.

2. That there is evidence that the large crystalline masses in solids have an attractive force for the smaller particles of the same kind, and under suitable conditions draw them to themselves ("crystallic attraction").

3. That in the ordinary or primary eutectic referred to, if the whole mass is of eutectic composition—the constituents being equally distributed and in juxtaposition—the attractions are balanced, and as long as the condition of equilibrium is maintained there is no segregation, at least not during heating for 48 hours to a point just below the eutectic melting point.

4. That active secondary segregation occurs when the eutectic exists in isolated areas, and is surrounded by masses of substance of the same kind as one of its constituents. As there is no equilibrium or balance of the crystallic attractions between the particles of a like kind, both constituents draw together or segregate, and cease to be eutectic in character.

5. That in the secondary eutectic pearlite, at temperatures below the eutectic point, there is the same tendency for the constituents to migrate and segregate.

6. That in annealing steel the main softening effect takes place in the zone 690° C. to 670° C. It is, however, in this zone that the elastic limit of the steel is most rapidly reduced.

* Journ. Iron and Steel Inst., ii. (1901) p. 234 *et seq.* ; Metallographist, vi. (Oct. 1903) pp. 302–13 (9 figs.).

† Iron and Steel Metallurgist, vii. (Feb. 1904) pp. 139–59 (10 figs.).

Recent Investigations in Cast Iron.*—A. E. Outerbridge, jun., has investigated the changes in volume produced by the repeated heating and cooling of cast iron. In some cases the expansion amounted to as much as 40·98 of the original volume. He thinks that these changes must be connected with the mobility of the molecules of the cast iron.

HALL, J. L.—**The Microscope in Engineering: its widening use in studying the Structure of Metals.**

[An interesting, historical and practical paper.]

Iron and Steel Metallurgist, vii. (Jan. 1904), pp. 45–55 (7 figs.).

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* Journ. Franklin. Inst., clvii. (Feb. 1904) pp. 121–40 (3 pls. of six figs.).

PROCEEDINGS OF THE SOCIETY.

MEETING

HELD ON THE 17TH OF FEBRUARY, 1904, AT 20 HANOVER SQUARE, W. DR. HENRY WOODWARD, F.R.S., VICE-PRESIDENT, IN THE CHAIR.

The Minutes of the Anniversary Meeting of the 20th of January, 1904, were read and confirmed, and were signed by the Chairman.

The Chairman said he regretted to have to announce the indisposition of the President, who had written to the Council to explain the cause of his absence, and asked the Fellows present at the Meeting to accept his expression of the great regret he felt at being unable to be with them. Dr. Scott had also written to ask him to act as his substitute on that occasion, and he had much pleasure in complying with this request, although he, of course, greatly regretted the necessity for so doing under the circumstances.

The List of Donations to the Society, exclusive of exchanges and reprints, received since the last Meeting, was read, and the thanks of the Society were voted to the Donors.

	From
Thirty-first Annual Report of the Local Government Board, 1901–2. Supplement in continuation of the Report of the Medical Officer for 1901–2. On Lead Poisoning and Water Supplies. Vol. ii. (8vo. London, 1903)	*The Local Government Board.*
Kitton, F. G., Frederic Kitton, a Memoir. (8vo, London, 1895)	*The Author.*
An Old Microscope by Bate..	*Mr. E. B. Stringer.*

The Secretary read a description of an old Microscope by Bate, which had been presented to the Society by Mr. Stringer. He then called attention to two direct-vision Spectroscopes exhibited in the room, and read a description of these instruments by Mr. Peter Heele to the Meeting.

The thanks of the Society were voted to the authors of these communications.

Mr. C. L. Curties exhibited and described a portable Microscope, which was a modification of one shown some time since, being made with a folding stage of larger dimensions than before, and adapted to carry a full-size $1\frac{1}{2}$-in. condenser, and removable mechanical stage. The leather case into which the instrument was packed also contained space for two eye-pieces, three objectives, one of Dr. Horder's storage boxes, thin glass squares for specimens of blood or sputum collected in making investigations whilst travelling, and his aluminium frame for carrying the same on the Microscope stage.

Mr. Stringer's paper, 'On a new method of reading the lines in the Spectroscope,' was read by the Secretary, and an instrument fitted as described was exhibited.

The Chairman called the attention of the Fellows present to a number of specimens of marine objects mounted by Mr. Waddington, which were exhibited in the room under microscopes by Mr. C. L. Curties, to whom the thanks of the Society were unanimously voted.

Mr. E. M. Nelson's papers, 'On the Vertical Illuminator,' and 'On the influence of the Antipoint on the Microscopic image shown graphically,' were, in the absence of the author, read by the Secretary.

Mr. J. W. Gordon did not suppose he could add anything of interest to Mr. Nelson's paper, because it seemed to him to be completely self-explanatory. The only thing which could possibly add to its clearness would be the figures sent in illustration. (He then drew upon the board the hair in question, as seen upon a black and upon a bright ground, and pointed out the difference in the apparent breadth as seen under these two kinds of illumination.) The peculiar interest in the matter was in the fact that the measurements as given in Mr. Nelson's correction table and those made by observation practically agreed. He did not like to suggest that he could draw these figures accurately enough to serve as the basis for the very refined measurements referred to in Mr. Nelson's paper. It should be understood that Mr. Nelson had himself compared the drawings with the object as seen in the Microscope, and had come to the conclusion that they were accurate enough for the purpose. Mr. Gordon pointed out the interesting circumstance, that in the middle of the dark object they had a bright line, due to the overlapping of the antipoints from either side.

Mr. Rheinberg said he should like to ask Mr. Gordon if he considered that the *relative* results (i.e. the comparative width of the bright image on the dark ground to that of the dark image on the bright ground) were for practical purposes always the same under different intensities of illumination, and whether this had been experimentally tested. It was well known that a bright edge always appeared to encroach more or less on neighbouring dark parts, as exemplified by the experiment of holding a card between the eye and a small bright source of light, when, according to the brightness of the source, the card appears more or less indented at the portion of it just opposite. Having regard to the important results established by the paper which had been read, it would be of considerable interest to know whether the ratio in width between the bright and the dark images held good for every intensity of illumination.

Mr. Beck presumed that this particular hair was of comparatively small size; but he should like to know whether the objective was used with its full aperture, or if it was stopped down to increase the size of the antipoint, so as to get an exaggerated effect.

Mr. Gordon said, with regard to Mr. Rheinberg's point, this was one of extreme interest and of very great importance, and he thought there could be no doubt that the apparent size of the antipoint was very

materially affected by the degree of illumination, varying according as it was high or low. (He then by means of diagrams on the board further discussed the point, and explained that in Mr. Nelson's table, already referred to, the visible antipoint was taken to be rather less than one-fifth of the breadth of the theoretical diameter of the false disc, and that this result had been experimentally reached with illumination of the intensity ordinarily used in high-power microscopy. As regarded the size of the aperture, concerning which Mr. Beck had asked a question, he did not himself inquire of Mr. Nelson what the adjustment was, but he thought that probably Mr. Nelson's paper accompanying the table in the Journal of the R.M.S. contained the data asked for. The two drawings appeared to be made to the same scale, but the black object appeared to be just a little longer than the bright one. This might probably be due to faulty draughtmanship, but, on the other hand, it would naturally happen that intruding antipoints from the bright field would, to a small extent, affect the visible length as well as the visible breadth of a narrow dark object, and so cut it down in one direction as well as in the other.

The thanks of the Meeting were voted to Mr. Nelson for his communications, and to Mr. Gordon for his remarks.

Mr. Keith Lucas read a paper 'On a Microscope with Geometric Slides,' which he illustrated by a wooden model and by numerous photographs shown upon the screen.

The Chairman, in expressing the thanks of the Society to the author of this paper, said that he would no doubt be very glad to hear remarks upon it from any persons present who were so good as to offer any suggestions or criticisms.

Mr. Beck said he should not like to express any opinion as to the merits of this instrument, without first having had an opportunity of carefully examining it. He thought, however, that the writer was probably in error in supposing that the expense of making dovetailed bars was much greater than that of parallel tubes, because with the machinery used for the purpose dovetails could be made absolutely accurate, and at a cost which was not as great as that of parallel tubes, the latter being difficult to make perfectly true. He failed, however, to understand why this arrangement should be called "geometric slides," as mechanical equivalents of the geometric slides were in use in all directions.

Mr. J. E. Barnard thought the subject of this paper opened up a question of great interest, for he felt sure that unless anyone had tried an instrument made on the geometric slide principle, it would be impossible for him to appreciate the great advantage which it offered. He had not himself applied this to the Microscope, but he had done so to a table spectroscope, and he felt sure that if any maker would take up this method of construction for the Microscope, it would be found of very great advantage.

Mr. Gordon said he could understand that Fellows of the Society who were competent to do so would feel a little delicacy in making any critical remarks upon a paper of this kind. There were, however, one or two points which struck him, and upon which he should be glad to have some further information. In the first place, he did not understand how the coarse adjustment was held clamped in the place in which it was put.

The propelling power was obtained by a steel wire passing round a shaft, but he did not know what was the strain upon this, as it appeared to depend upon a spring which kept it taut. If so, he thought it could not sustain any considerable weight of accessory apparatus—such, for example, as polarising and analysing prisms. Another point was as to the arrangement made for the focussing screw of the substage. Mr. Lucas said this was in a very convenient position, and, if regard was had to the substage motion only, that was no doubt so; but it seemed to him that if they wanted to mount either a mechanical stage or a revolving stage upon the fixed stage, the substage screw would be inconveniently in the way. He should like to add his personal tribute to the ingenuity of the design, and to say how much interest he had himself felt in the application of this idea. He thought the supporting pillar looked rather weak, for although the instrument was a very heavy one, the pillar was of a somewhat narrow "scantling," and the rigidity of a Microscope stand was not so much a question of strength against heavy strains, but of strength against vibration, and, judging by the construction, he should think this instrument was likely to prove a little sensitive to such disturbances.

The Chairman was sure that it would be felt by all that Mr. Lucas was a very bold man to have brought a Microscope of his own construction to a meeting at which so many experts were present, and it spoke well for his courage that he was not afraid to submit it for criticism. He begged to thank the author for coming that evening to exhibit this new instrument and to explain its merits so fully, and he felt sure that the remarks made upon it would not be without value, either for the writer of the paper or those who had heard it read.

In reply to the questions which had been raised, Mr. Lucas pointed out that the form of slide adopted in lathes was no guide to the best form for the Microscope, the geometric principle being necessarily sacrificed in the former owing to the need for large surfaces to meet the heavy stresses involved. With regard to the friction between the wire and barrel of the coarse adjustment, the tension on the latter was, in the case of the instrument before them, between 5 lb. and 6 lb., whilst the breaking strain of the wire was 22 lb. It would not, therefore, be possible to further increase the tension of the wire without using one which was thicker, and a thicker wire would pass its elastic limit owing to the small size of the barrel. It was, however, amply sufficient to support any weight which the tube might have to carry. The coarse adjustment tube was extremely light, so that with any ordinary apparatus attached to it the weight would not be great. He had tested it by setting it up upon a table at which he was working, and had focussed it carefully with an immersion objective of 1·4 N.A, and after leaving it for five hours under these conditions, he found that the focus had remained perfectly unaltered. He might also point out, that as regarded the position of the focussing screw of the substage, this was such that no part of it which came down to the level of the stage projected further forward than the front of the limb. The screw could not, therefore, interfere with anything which might be placed on the stage. As to the strength of the pillar, it was made of solid brass, $1\frac{1}{2}$ in. by $\frac{5}{8}$ in., which he thought should be sufficient to prevent vibration.

The Chairman said that the Council had given their consideration to the suggestion made at the last Meeting with regard to giving early notice to the Fellows as to what would take place at the succeeding Meeting, and had decided to accede to the proposal, by arranging that if those Fellows who were desirous of receiving the information monthly would send stamped envelopes to the Assistant Secretary, addressed to themselves, he would send them as much information as he possessed at the time of posting. It was not always possible to say beforehand all that would come before the Meeting, as it often happened that interesting exhibits or short notes were only sent in at the last moment. It was assumed that only a small number of the Fellows would need to have this information sent to them, but in any case the experiment would be tried.

Mr. Vezey said it might be well to remind the Fellows that announcements of the subjects for the Meetings, as far as known, were made in several of the daily and weekly papers.

The following Objects, Instruments, etc., were exhibited :—

Messrs. C. Baker :—A New Portable Microscope.

Mr. C. L. Curties, for Mr. H. J. Waddington :—Protozoa : *Acineta* sp. (Marine), *Noctiluca miliaris*. Cœlenterata : *Cladonema radiatum*, *Gonothyræa* sp., *Turris* sp. Polyzoa : *Bowerbankia* sp., *Pedicellina* sp., *Lophopus crystallinus*. Crustacea : *Caprella erethizon*, *Mysis* sp., showing otocysts and pigment. Tunicata : *Perophera Listeri*.

Dr. R. G. Hebb :—Two woodcuts in illustration of Mr. Nelson's paper 'On the Influence of the Antipoint on the Microscopic Image shown Graphically.'

Mr. Peter Heele :—A Direct-Vision Spectroscope in case, and a larger form on stand.

Mr. Keith Lucas :—Nine Lantern Slides, in illustration of his paper 'On a Microscope with Geometric Slides'; a model illustrating the principle of the geometric slide ; and a Microscope as described in his paper.

Mr. C. F. Rousselet :—Statoblasts of Freshwater Polyzoon, *Pectinatella magnifica* (Leidy).

Mr. E. B. Stringer :—A Direct-vision Spectroscope with an attachment for reading the lines of the Spectrum.

New Fellows.—The following were elected *Ordinary* Fellows :—Messrs W. Griffiths and F. A. Mason.

Prof. J. D. Everett writes us as follows :—

I regret to find that the letter ϵ has been omitted in lines 3 and 5 of page 27 of the February Number, in which my paper appeared. The omission is so obvious that I cannot think how I overlooked it in correcting the proof. The correct formulæ are :

$$\frac{2\pi}{\lambda}\epsilon \sin \alpha \quad \text{and} \quad \frac{2\pi}{\lambda}\epsilon (\sin \alpha + \sin \gamma)$$

MEETING

HELD ON THE 16TH OF MARCH, 1904, AT 20 HANOVER SQUARE, W.
DR. D. H. SCOTT, F.R.S., ETC., PRESIDENT, IN THE CHAIR.

The Minutes of the Meeting of February 17, 1904, were read and confirmed, and were signed by the President.

The following Donation to the Society was announced, and the thanks of the Society voted to the donors.

	From
Hutton, F. W., Index Faunæ Novæ Zealandiæ. (8vo, London, 1904)	*The Publishers.*

Prof. A. E. Wright communicated the purport of his paper, 'On some new methods of measuring the magnifying powers of the Microscope, and of its separate elements,' illustrating his remarks with a lantern diagram of a new piece of apparatus termed the Eikonometer, and by numerous drawings on the board.

Mr. J. W. Gordon said this paper had no doubt conveyed to most of the Fellows present a very comprehensive view of the available methods of ascertaining the magnifying power of the Microscope, and they would certainly have appreciated the extreme simplicity of some of these. But with regard to the point which Prof. Wright had touched upon in discussing the second method described—he adverted to the question as to at what point it was proper to divide up the Microscope into sections for obtaining the separate values of each—Prof. Wright's view seemed to be that there was no need to pay any attention to the view plane of the image itself, and it seemed perfectly clear that for the purpose of arriving at the magnifying power it is unimportant at what stages they made the rests in dividing up the instrument into parts. Prof. Wright said it was convenient to consider the objective by itself, and then the eye-lens and the field-lens, and to estimate their magnifying powers and to put these together. It seemed to him it was convenient also for another reason, that they knew very approximately what was the power of the objective, and they were usually much more at home with this than with the ocular, which was a much stranger portion of the instrument than the objective which they had more frequently to make choice of. On the other hand, it occurred to him that there were certain conveniences in being able to determine the magnifying power in the view plane of the instrument. The reason was, that for some purposes, especially for the purposes of photography, they had to get rid of the magnifying power of the eye-lens altogether, and in that case it was a manifest advantage to be able to tell the magnifying power of the real image formed in the instrument itself.

With regard to the new instrument which had been shown to them

that evening, he had been afforded an opportunity of making a rough experiment with it, and so far as he had tried it the results appeared to be strictly exact. One did not always realise the exactness with which lenses were made, and he had been surprised to find with what precision the result was obtained. He should like to ask with what degree of precision it was capable to obtain results by different methods which Prof. Wright had described to them—how in this respect the various methods compared with one another. He had listened with very great interest to this communication, and was very much obliged to Prof. Wright for bringing it before the Society.

Mr. Beck said he wished to join Mr. Gordon in thanking Prof. Wright for bringing the subject before the Society, and he had no doubt there were many points in it which were entirely new to those present. There was one suggestion he should like to make, and that was that for the most accurate measurement the micrometer might have a ground-glass surface, because a lens of this kind would be found to have a considerable depth of focus. In a somewhat similar apparatus used for another purpose, the micrometer is engraved on a mother-of-pearl surface. They would, of course, naturally appreciate the anatomical simile which had been applied to the Microscope. He dissented, however, from the conclusion drawn, because microscopists had a way of beheading a Microscope, and of putting the head of one on the body of another, and also of extending the trunk ; it was, therefore, essential that they should obtain the magnifying power of the portions into which they divided it, that is to say, the magnifying power of the complete eye-piece and the magnifying power of the object-glass, because if too much power were put into the eye-piece, and too little into the objective, they would get inferior resolution. The greater part of the work should be done by the objective and not by the eye-piece to obtain the best results, and they must have the means of knowing not only the magnifying powers of the two ends of a system, but also the length of the body. There was no difficulty in giving the standard power to the eye-piece, which always gave the same power under all circumstances, but with regard to the object-glass this was not so easy, because it was giving different magnifying powers according to the length of the body. Any method that tried to give fixed magnifying power for an object-glass led one into a hopeless quagmire when different forms of eye-pieces and tube-lengths were employed. With regard to the instrument which had been described, he could not of course judge fairly of its merits without having used it, but it appeared to be most excellent for taking the magnifying power of the complete instrument, though there was likely to be an error in taking the magnifying power of the object-glass separately. It also appeared to have the great merit of being a very rapid and easy means of measuring the actual size of a microscopic object. He felt sure the Fellows present must also have been extremely interested in the diffraction method which had been brought before them by Prof. Wright.

Prof. Wright expressed his thanks to the Society for the very cordial manner in which his remarks had been received. In reply to

Mr. Gordon's question as to what degree of accuracy was obtainable by his arrangement, he was unable to say exactly, not having given special attention to the point. The question was obviously one as to whether any practical difficulty presented itself in connection with the construction of the apparatus proposed, or in connection with the making of the necessary observations. With regard to the latter point, it would, he thought, be clear to everyone who tried the apparatus that there was no difficulty in making the readings with exactness. With regard to the former point, he would only say that, working as he had been doing with diffraction gratings constructed by Messrs. Sanger Shepherd, and with an eikonometer constructed by Messrs. Beck, he had found the error in the measurements he had made was one which might be altogether neglected. He had no doubt that the ground-glass screen which had been suggested by Mr. Conrad Beck would get over any difficulty in the matter of depth of focus, but he had not had practical experience of such a difficulty. He still, after hearing Mr. Beck, was of opinion that the balance of practical convenience was in favour of the method of ascribing a fixed magnifying power to the objective, and a variable magnifying power to the ocular in the case where the tube-length was subject to modification.

The President then proposed a hearty vote of thanks to Prof. Wright for his extremely important and interesting communication, which being put to the Meeting was carried unanimously.

A Note by Mr. E. B. Stringer, 'On the Separation of Ultra-Violet Light,' was read by Dr. Hebb.

On the motion of the President, the thanks of the Society were voted to the author.

Mr. A. Flatters exhibited upon the screen a series of about sixty hand-painted lantern slides illustrating botanical histology. These slides were photomicrographs taken from the actual sections under the Microscope, and coloured to represent the results of staining; the great beauty of many of the sections shown, and the fidelity and accuracy of the colouring, were greatly admired and appreciated by the Meeting.

The President said that anyone who, like himself, had spent a good deal of time over the anatomy of plants, could not fail to be greatly pleased with this extremely interesting exhibition. A number of points of great botanical interest had been brought before them. The sections from which the slides were taken must have been exceedingly good ones, and the manner of showing the effect of double staining was most successful. The accurate colouring of the photographs must require not only great skill, but also considerable botanical knowledge. He noticed one section in which the cambium appeared to have taken up a different stain from the phloëm, and he should like to know how this result was obtained; he should also like to ask under what circumstances the false annual rings shown in a slide of pines were produced. The most beautiful of the whole series was certainly the one showing the pollen-

tube of the wheat on the stigma—he did not think this had been demonstrated before on the screen, so as to show the double staining.

Mr. Flatters thought the reason for the difference in staining was because the phloëm was vascular tissue, which took up the malachite green very readily, whilst the cambium was cellulose. It stained much deeper in some plants than in others, and also in the same plant in different stages of growth. Specimens collected during the next few weeks, when the new tissue was forming, would be found to take up the stain more rapidly than those collected in December, so that to stain properly it was necessary to know the age of a section and the time of year it was taken. Then they could not stain these just what they liked, each would select its own stain and take up what it required, and then the colour had to be reduced in strength until the required tint was obtained. Tissue took up stain much more readily than celloidin.

The thanks of the Society were, on the motion of the President, cordially voted to Mr. Flatters for his exceedingly interesting and beautiful exhibition.

The following Objects, Instruments, etc., were exhibited :—

Mr. Abraham Flatters—

1. Entire plant of Duckweed, *Lemna minor*. Showing root-caps and developing roots from the secondary platelets.

2. Transverse section of root, *Pinus sylvestris*. Cut $\frac{1}{2000}$ Stain, hæmatoxylin and safranin.

3. Transverse section of root of Buttercup, *Ranunculus acris*. Cut $\frac{1}{750}$ Stain, hæmatoxylin and gossypimine (cotton red). The starch grains having taken up the gossimine.

4. Transverse section of root of Yellow Iris, *Iris pseudo-acorus*. Cut $\frac{1}{750}$ Stain, hæmatoxylin and safranin. Secondary rootlet is being developed from three xylem bundles.

5. Transverse section of root of *Zea mays* (Indian Corn). Cut $\frac{1}{60}$ Stain, carmine and malachite green. Throwing off several secondary rootlets.

6. Transverse section through radical end of a grain of Barley. Showing the development of primary and four secondary rootlets, surrounded by nucleated tissue of the endosperm.

7. The primary of tap-root from the last preparation. Enlarged to show the disposition of cells to form vascular system of root.

8. Longitudinal section through apex of aërial root of *Monstera deliciosa*. Cut $\frac{1}{3000}$ by the cold paraffin method. Stained with brazilin, to show nucleated tissue and elongated or needle raphide cells.

9. Enlargement of No. 8 to show the raphides (*in situ*).

10. Transverse section of hypocotyl of Bean, *Faba vulgaris*. Cut $\frac{1}{750}$, immediately below cotyledons. Stain, carmine and malachite green.

11. Transverse section of stem of Clover, *Trifolium repens*. Cut $\frac{1}{600}$ Stain, carmine and malachite green.

12. Transverse section of stem of Bog Bean, *Menyanthes trifoliata*. Aquatic type. Cut $\frac{1}{400}$ Stain, carmine and malachite green.

13. Transverse section of stem of Wound-wort, *Stachys sylvatica.* Cut $\frac{1}{600}$ Stain, carmine and malachite green.

14. Transverse section of stem of Birthwort, *Aristolochia clematilis.* Cut $\frac{1}{600}$ Development of primary and secondary bundles. Stain, carmine and malachite green.

15. Transverse section of stem of Dracæna, *Cordyline rubra.* Cut $\frac{1}{750}$ To illustrate the formation of bundles from Cambium zone. Stain, carmine and malachite green.

16. Portion of a transverse section of stem of Lime-tree, *Tilia europæa.* Cut $\frac{1}{1200}$ Stain, carmine and malachite green.

17. Longitudinal tangential section passing through bast area of last slide. Showing bast fibres and connective tissues. Cut $\frac{1}{1500}$ Stain, hæmatoxylin and safranin.

18. Longitudinal tangential section passing through xylem elements of same. Cut $\frac{1}{1500}$ Stained as last slide.

19. Transverse section of stem of Sunflower, *Helianthus annuus.* Cut $\frac{1}{400}$ Showing primary and secondary bundles. Stain, carmine and green.

20. Longitudinal tangential section of last slide, passing through the inner margin of a primary bundle. Cut $\frac{1}{1200}$ Stained as above.

21. Longitudinal median section through apex of developing pine-stem. Showing meristem tissue in active state of division. Cut $\frac{1}{2000}$ Stain, brazilin.

22. Transverse section of stem of *Pinus*, one inch below growing point. Cut $\frac{1}{1000}$ Stain, aniline blue and gossypimine. Showing formation of xylem plates to primary bark.

23. Transverse section of same stem four inches below growing point. Showing commencement of secondary thickening, and development of a lateral branch. Stained as above.

24. Longitudinal (radial) section of same, throwing off a lateral branch.

25. Transverse section of a resin passage of same. Showing the thickened strengthening band of sclerenchymatous tissue.

26. Transverse section of Old Pine Wood (timber), after completion of secondary thickening.

27. Radial longitudinal section of same.

28. Tangential longitudinal section of same.

29. Transverse section of stem of Indian Corn, *Zea mays.* Cut $\frac{1}{600}$ Stain, carmine and green.

30. Longitudinal section of same. Cut $\frac{1}{600}$ Stained as above. Passing through the annular vessel.

31. Transverse section of a bundle rhizome of Fern, *Pteris aquilina.* Cut $\frac{1}{400}$ Stain, carmine and green.

32. Longitudinal section of same.

33. Transverse section of stem near apex, Horsetail, *Equisetum telmatia.* Cut $\frac{1}{750}$ Stain, carmine and green.

34. The same. Enlarged bundle.

35. Transverse section of vegetative bud of same. Showing development of leaves from the axis.

36. Longitudinal section of apex of stem passing through apical cell. Cut $\frac{1}{1000}$

37. Transverse section of stem of Wheat. Hollow type. Cut $\frac{1}{750}$ Stain, carmine and green.

38. Transverse section of stem of Wheat. Solid type. Cut $\frac{1}{600}$ Stain, carmine and green.

39. Entire flower of Wheat. Stain, carmine. × 10 diam.

40. One shaft of stigma of Wheat, covered with pollen-grains. One pollen-tube penetrating stigma.

41. The same pollen-tube more highly magnified.

42. Longitudinal section of a grain of Wheat (unstained). Cut $\frac{1}{600}$

43. Transverse section of portion of above, more highly magnified.

44. Longitudinal section of embryo of Wheat. Cut $\frac{1}{1200}$ Stain, brazilin.

45. Plumule of last slide, more highly magnified.

46. Radicle of same, ditto.

47. Embryo-sac, with suspensor cells, of Wheat, before fertilisation.

48. The same, after fertilisation. Showing disposition of cells to form new grain.

49. Transverse section of leaf of Orchis, *Cypripedium sp.* Cut $\frac{1}{600}$ Stain, carmine and green.

50. Transverse section of leaf of Pine, *Pinus sp.* Cut $\frac{1}{750}$ Stomata, resin passages, etc.

51. Cuticle of leaf of *Araucaria imbricata.* Stained with brazilin.

52. Sting from midrib of young Nettle. Stain, carmine and green.

53. Transverse section of phylodium of *Acacia decurrens* (Wattle Bark). Cut $\frac{1}{2000}$ Stain, aniline-picrate and gossypimine.

54. Transverse section of leaf-bud of Beech-tree (celloidinised). Cut $\frac{1}{750}$. Showing arrangement of leaves in embryo.

55. Transverse section of leaf-bud of Ash-tree (celloidinised). Cut $\frac{1}{600}$. Showing arrangement of young leaves, leaf-scales, etc.

56. Transverse section of leaf-bud of Sycamore (celloidinised). Cut $\frac{1}{750}$. Showing arrangement of leaves in embryo.

57. Longitudinal section of stem, leaf-stalk, and leaf-bud of Sycamore. Cut $\frac{1}{600}$ Stain, carmine and green. Showing the "absciss layer" of cork-cells, cutting of the leaf-stalk.

58. Transverse section of flower-bud of Poppy, *Papaver rhœas* (celloidinised). Cut $\frac{1}{600}$ Passing through base of stigmatic cap and apex of ovary.

59. Flower of Dandelion. Showing bud in dotted outline,—the stage from which sections are prepared.

60. Transverse section of flower-bud of Dandelion (prepared by the celloidinising method). Cut $\frac{1}{750}$ Stain, carmine. The fine unstained elements surrounding the florets is the pappus. Note the *unlocking* of the surrounding bracts, by the expansion of the bud *x* on slide.

Prof. A. E. Wright.—Diagram: Construction of the Eikonometer.

Exhibit 1.—Arrangement for measuring the magnifying power of the Microscope by means of the eikonometer. A Microscope focussed upon a stage micrometer, and, placed in position on the top of the

ocular, an eikonometer furnishing an image of the stage micrometer focussed upon a measuring scale.

Exhibit 2.—Arrangement for measuring the magnifying power of the ocular. A Microscope with dismounted objective, with a measuring rule placed athwart the open extremity of the barrel; and another measuring rule disposed in the plane of the Ramsden disk of the eye-lens.

Exhibit 3.—Arrangement for measuring the magnifying power of a pocket-lens by the aid of the eikonometer. A Zeiss pocket-lens magnifying 6 diameters is disposed so as to give, at its full focal distance, an image of a millimetre scale disposed upon the table. Arranged above the pocket-lens an eikonometer showing the image of the millimetre scale covering 6 (millimetre) divisions of the measuring scale.

Exhibit 4.—Arrangement for measuring the magnifying power of a lens by means of a median intercostal line developed by the aid of a diffraction grating.

A. A diffraction grating ruled 400 lines to the inch is taken before the eye, and is held with its rulings parallel to the lines inscribed upon a sheet of paper placed at 10 in. from the eye. The lines on the paper being in each case ruled in pairs placed at different distances apart, there is furnished by each of the lines (except in the case presently to be considered) a series of six lines, viz. two principal or dioptric images each flanked on either side by two diffraction images. In the case where the object lines are placed at an appropriate distance apart, the centrally disposed diffraction images are shown to coincide in position, giving origin to a single conspicuous median intercostal line, instead of, as in the case where the lines are placed too near together, or too far apart, two separate and less conspicuous median lines. The distance between the object lines which furnish the conspicuous single median intercostal line is measured off by means of a millimetre rule.

B. Everything is maintained in position except in the following respects. (*a*) A system of more closely interspaced paired lines is substituted for that previously employed. (*b*) The lens whose magnifying power is to be measured is taken in hand, and is so disposed as to yield the largest possible erect image of the object lines. A search is then instituted among these paired lines until a pair is found which yields a single conspicuous median intercostal line.

By the aid of a millimetre scale the interval between the pair of lines which yields the intercostal line in question is now measured.

The quotient obtained by dividing the linear distance measured in *A* into the linear distance measured in *B* corresponds to the magnifying power of the lens. In the case of the Zeiss pocket-lens (× 6 diameters) employed, the quotient is found to be 6.

Exhibit 5.—Arrangement for measuring the magnifying power of the Microscope by means of the median intercostal line.

A Microscope is focussed upon an Abbe diffraction grating, the wider interspaced lines of the central ruling appearing in the field of view.

A diffraction grating ruled 400 lines to the inch is interposed between the eye and the eye-lens of the Microscope, and the grating is rotated until the diffraction images of the object lines fuse together

to make in each case a central intercostal line. The orientation of the grating being maintained unchanged, a series of paired lines is now viewed with the unaided eye, the search being continued until a pair of lines is found which again yields a median intercostal line.

The linear interval between the paired lines in question is measured and is divided by the linear interspace between the lines on the Abbe diffraction grating. The quotient gives the magnifying power of the Microscope.

New Fellows.—The following were elected *Ordinary* Fellows:—Messrs. Frederic John Cheshire, Kenneth Weldon Coadby, Cyril Francis Hill, Dr. John Rennie, and Rev. Carlos Zimmermann.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

JUNE 1904.

TRANSACTIONS OF THE SOCIETY.

VI.—*The Influence of the Antipoint on the Microscopic Image shown Graphically.*

By Edward M. Nelson.

(*Read February 17th*, 1904.)

It was stated in the Journal* that if one of the minute spinous hairs on the delicate membrane of a blow-fly's tongue were examined on a bright ground, the image would present an unreal tenuity and sharpness, whereas if the same hair were viewed with dark-ground illumination, it would have a swollen or thick appearance; also, that the difference between the two images of the same object was caused by antipoints, and that the true image lay between these two pictures; a table was also given showing the amount to be added to the micrometric measurement of an image on a bright ground to bring it up to its true value.

Fig. 47.

Fig. 48.

Mr. Gordon has made a most excellent drawing of these two images (figs. 47 and 48); a careful examination of them will bring the importance of the antipoint effect home to those microscopists who do not care to wade through physical optics and dry mathematical formulæ. These drawings have been most carefully compared with the original, as seen in the Microscope, and were found to be

* Journal R.M.S., 1903, p. 579.

sufficiently exact to be made a basis for measurement (see calculation below *).

It is interesting to note that the breadth of the hairs in these drawings is in the ratio of 65 to 45, and that by equating this ratio to the value given in the table, the true size of the hair agrees with the actual measurement of the apparent size of the hair, viz. ·000033 in., by an oil immersion $\frac{1}{10}$, with a W.A. of ·9 + the correction given in the table.

Thus: ·000033 + ·000004 = ·000037 = $\frac{1}{2702}$ in., this being 12 p.c. greater than its apparent size.

A difference in the apparent size of objects, when viewed on a bright or a dark ground, was recognised many years ago, but neither the absorption nor the diffraction images of the Abbe theory afforded the least clue to an explanation of the phenomenon. But at last the riddle has been unlocked by Mr. Gordon's admirable antipoint theorem, which clears up this, as well as other hitherto unanswered questions, in the interpretation of microscopical images.

Since this paper was read Mr. Merlin has most kindly measured, with his own apparatus, a hair upon another blow-fly's tongue, both on dark and bright grounds, with the following results:—

Dark ground, W.A. ·858 = ·0000418 in.
Bright „ „ ·570 = ·0000287 in.

Equating from these data the size of the antipoint and applying the correction, we find the thickness of the hair to be ·0000366 in.

* Data:—(1) From Mr. Gordon's drawings on bright and dark grounds, with $\frac{1}{2}$-in. objective: W.A. = ·45. The measurements are $4\frac{1}{2}$ and $6\frac{1}{2}$ respectively, by a certain scale which need not be specified.

(2) Measurement of apparent size of hair, dark on bright ground, with oil immersion $\frac{1}{10}$ (W.A. = ·9) = ·000033 in.

Let a = actual size of hair.
b = apparent size at ·45 W.A. } Measured dark on bright ground.
B = „ „ ·9 W.A. }
x = visible antipoint at ·9 W.A.
$2x$ = „ „ ·45 W.A.

Then
$$\left.\begin{aligned} a &= b + 2x \\ a &= \mathrm{B} + x \end{aligned}\right\}$$
$$x = \mathrm{B} - b = \cdot 000033 - b \quad . \quad . \quad . \quad . \quad (i)$$

As the drawings measure $6\frac{1}{2}$ and $4\frac{1}{2}$, the size of the antipoint is half the difference between them, and therefore on this scale

$$2x = \frac{6\frac{1}{2} - 4\frac{1}{2}}{2} = 1,$$

and $x = \frac{1}{2}$,

but $b = 4\frac{1}{2}$, therefore $b = 9x$.

Putting this value in (i) $x = \cdot 000033 - 9x$

$x = \cdot 0000033$,

and $a = \mathrm{B} + x = \cdot 000033 + \cdot 0000033 = \cdot 0000363$.

By table on p. 581 Journal R.M.S. 1903,

$$a = \cdot 000033 + \cdot 000004 = \cdot 000037.$$

The difference being ·0000007.

With my own apparatus the identical hair drawn by Mr. Gordon (figs. 47 and 48) gives these results :—

Dark ground, W.A. ·97 = ·0000394 in.
Bright „ „ ·47 = ·0000275 in.

The thickness of this hair obtained from these data is ·0000356 in.

The antipoint value for W.A. 1·0 derived from Mr. Merlin's measurement of the hair is ·000004486, that from my own measurement is ·000003776, and that published in my "Table" Journ. R.M.S., 1903, p. 581) is ·00000404—this last being obtained from data given by the extinction of a "black dot."

The mean of these three values, viz. ·00000410, may be accepted as being very near a true value for practical use, and the accompanying Table is calculated upon this assumption.

It is remarkable that there should be so close an agreement in the values of antipoints calculated from data obtained from such different sources.

The amplifier described by Mr. Merlin was used in the measurement of the hair.

TABLE SHOWING THE AMOUNT OF CORRECTION TO BE APPLIED TO THE APPARENT MEASUREMENT OF MINUTE MICROSCOPIC OBJECTS.

The correction for objects measured on a bright ground is +
„ „ „ dark „ −

W.A.	White Light, 45,300.*		Screen, 50,000.*		Photography, 63,500.*	
	inches.	μ	inches.	μ	inches.	μ
·1	·0000410	1·041	·0000371	0·942	·0000292	0·741
·2	„ 205	0·521	„ 185	·470	„ 146	·371
·3	„ 137	·348	„ 124	·315	·00000973	·247
·4	„ 103	·262	·00000928	·236	„ 730	·185
·5	·00000820	·208	„ 742	·188	„ 584	·148
·6	„ 683	·173	„ 618	·157	„ 487	·124
·7	„ 586	·149	„ 530	·135	„ 417	·106
·8	„ 513	·130	„ 464	·118	„ 365	·0927
·9	„ 456	·116	„ 412	·105	„ 324	·0823
1·0	„ 410	·104	„ 371	·0942	„ 292	·0741
1·1	„ 373	·0947	„ 337	·0856	„ 265	·0673
1·2	„ 342	·0868	„ 309	·0785	„ 243	·0617
1·3	„ 315	·0800	„ 285	·0724	„ 225	·0571
1·4	„ 293	·0744	„ 265	·0673	„ 209	·0531
1·5	„ 273	·0693	„ 247	·0627	„ 195	·0495

* Number of waves to the inch.

VII.—*On a Microscope with Geometric Slides.*

By Keith Lucas.

(*Read February 17th*, 1904.)

The instrument with which this paper deals represents an attempt to replace the usual planed slides of the Microscope by geometric slides. The application can hardly be considered new, since geometric slides are commonly used on measuring Microscopes, yet I am not aware of the existence of any other Microscope suitable for biological work in which such slides are used.

The arrangement of geometric slide which has been found most suitable for the focussing movements is a tube, concentric with the optic axis of objective and eye-piece, sliding in two V-guides placed near its extreme ends. This arrangement has the advantage of ensuring that rotation of the tube within its V-guides shall not displace the optic axis; consequently the means adopted for preventing this rotation may be of the roughest nature, may, in fact, be only sufficient to prevent such a degree of rotation as would damage the focussing mechanism. Unfortunately the necessity of conforming to the proportions of Microscopes commonly in use has rendered such an arrangement impossible in the case of the slide which carries the condensing lenses. In this case the axis of rotation of the guide-tube has been considerably displaced from the optic axis.

The photograph reproduced in fig. 49 will serve to indicate the general arrangement of the instrument.

The main casting, or limb (A, figs. 49–53), is carried further forward than is usual, so as to partially embrace the large body-tube (B, figs. 49, 50, 51), and carries four projections, two at its upper, and two at its lower end, which form the V-guides, in which that tube slides. This slide forms the coarse adjustment. The means adopted to hold the tube against its four guides, and to prevent it from rotating about the optic axis, will be considered later. The large body-tube carries two rings, one (C, figs. 50, 51) inside its upper, and one (C′, fig. 51) inside its lower end. Each of these rings has two projections upon it, against which the long narrow inner tube (D, figs. 49, 50, 51) is held. Thus are formed the V-guides of the coarse adjustment.

The two upper guides of the fine adjustment, and of the coarse adjustment, and the two concentric tubes which slide in these guides, are shown in fig. 50. The substage is carried by a long stout tube

(E, figs. 49, 52), which passes up inside the limb, and has two guides at the level of the stage, and two, consisting of adjustable screws (F, figs. 49, 52, 53), at a higher level.

The detailed arrangement of the body tubes and focussing mechanism is shown in fig. 51, which is a vertical section passing through the limb and tubes. The long coarse-adjustment tube (D) passes right through the shorter and wider fine-adjustment tube (B). At each end of the latter there is a ring (C, C′), which carries the guides of the coarse-adjustment tube. Between the two tubes there lies a long leaf-spring (G), whose middle point presses back-

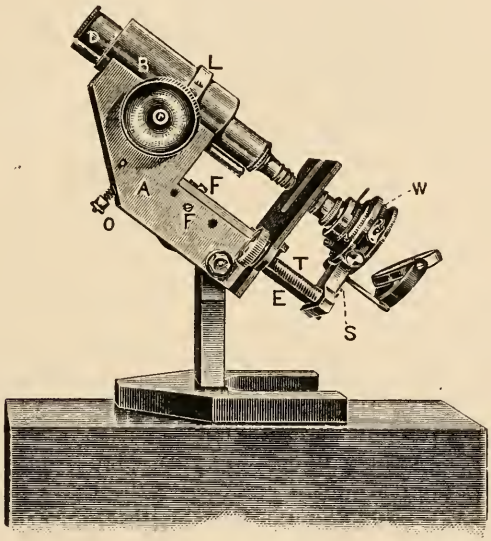


Fig. 49.—Side Elevation of Microscope.

A, limb; B, fine-adjustment tube; D, coarse-adjustment tube; E, guide-tube of substage; F, aligning screws of substage; L, ring carrying bearings of coarse-adjustment barrel; O, nut retaining fine-adjustment tube against guides; S, substage bracket; T, focussing screw of substage; W, spring retaining substage ring against centring screws.

wards upon the coarse-adjustment tube, holding it firmly against its four guides. A piece of smaller tube (H), fixed parallel to the back of the coarse-adjustment tube, and passing through a slot in the upper bearing-ring, prevents the tube from rotating about its long axis.

The next point for consideration is the means adopted for moving the coarse-adjustment tube to obtain focus. This is effected by means of a wire and barrel (J and K, fig. 51). The two ends of the wire are anchored to the extreme ends of the coarse-adjustment

tube, and lie inside the two small tubes which are attached to the back of that tube. The upper one of these small tubes has already been mentioned as the guide which prevents rotation of the coarse-adjustment tube. The lower end of the wire is fixed rigidly, the upper through a spring held in tension. At about its middle point the wire takes one turn round the cylindrical barrel. The barrel has its bearings in a ring (L, fig. 51), which embraces the large fine-adjustment tube. To the outer ends of the barrel are screwed the milled heads of the coarse adjustment. The friction of the wire upon the barrel is sufficient to cause the coarse-adjustment tube to move up or down when the barrel is rotated. The reasons for adopting this device in preference to the usual rack-and-pinion are two: first, the relatively small cost of manufacture, and, secondly, the fact that its action upon the tube is only a direct pull in the direction of the desired movement. It exerts no side thrust, such as is caused by a rack-and-pinion. The absence of teeth causes the motion to be extremely smooth and regular. The wire is made of hardened steel, silver-plated, and is protected, when the instrument is put together, by the small tubes in which it lies.

The four guides in the limb, in which the fine-adjustment tube slides, have been already described. It remains only to deal with the means by which the tube is held against those guides, and prevented from rotating about its long axis. Both these ends are secured by means of a rod (M, fig. 51), hinged to the ring which surrounds the fine-adjustment tube, and passing backwards through a hole in the back part of the limb. A spring (N, fig. 51), held in compression between the limb and a nut (O, figs. 51, 53) screwed on to the end of the rod, pulls the fine-adjustment tube against its four guides. The hinged joint, whose axis is horizontal, allows the fine-adjustment tube to move up and down through a small distance, moving the rod in or out of the hole in the limb as it moves; at the same time it does not allow rotation of the tube against its long axis.

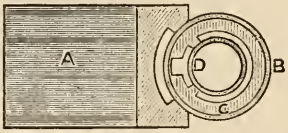


Fig. 50.—Section through Upper Part of Limb and Body Tubes.

C, ring carrying guides of coarse-adjustment tube.
Other letters as in fig. 49.

There is a spring (P, fig. 51) in tension between the upper part of the fine-adjustment tube and the more remote end of the rod. This spring performs two functions. In the first place, it ensures

that the upper part of the tube shall be firmly held against its guides, and, secondly, it pulls the whole tube downwards against the end of the lever by which it is moved.

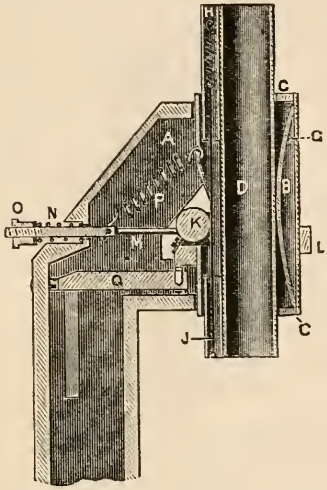


Fig. 51.—Section through Limb and Body Tubes.

C C′, rings carrying guides of coarse-adjustment tubes; G, leaf spring retaining coarse-adjustment tube against guides; H, small tube which prevents tube D from rotating; J, wire of coarse-adjustment; K, barrel; L, ring carrying bearings of K; M, rod, and N, spring retaining tube B against its guides; P, spring forcing tube B downwards against the fine-adjustment lever; Q, fine-adjustment lever. Other letters as in figs. 49, 50.

This lever (Q, figs. 51, 52), which transmits the motion of the fine-adjustment screw to the body-tube, is of the bell-crank type, with its axis of rotation running from back to front of the limb. It is moved by a fine-threaded screw (R, figs. 52, 53), which passes through the left-hand side of the limb, a short distance above the stage. The arrangement of the lever is partially seen in fig. 51 and partially in fig. 52, which is a section passing through the back part of the limb, viewed from the front.

The essential parts of the substage are: a long tube (E, fig. 52), sliding in geometric guides inside the limb, and a bracket (S, fig. 52) attached to this tube, extended laterally to encounter the focussing screw (T, figs. 52, 53), and forwards to carry the centring ring, into which the condenser is fitted. The lateral extension also carries a rod (U, fig. 52), mounted parallel to the tube, and preventing rotation about the long axis of the latter. The whole substage is forced upwards, against its focussing screw, by a long spiral spring (V, fig. 52), anchored to the limb at its upper end, and passing down

inside the tube (E, fig. 52), to which it is attached at its lower end. Since the upward pull of the spring and the downward pressure of the focussing screw are not in the same line, there results a couple, tending to rotate the whole substage and tube in a vertical plane

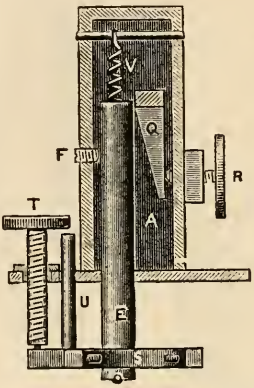


Fig. 52.—Part Section through Lower Part of Limb, showing Substage, viewed from Front.

R, fine-adjustment screw; S, bracket of substage; T, focussing screw of substage; U, rod which prevents rotation of E; V, spring of substage. Other letters as in figs. 49, 50, 51.

about the lower end of the focussing screw. Advantage is taken of this couple to hold the tube against its geometric guides, the upper and lower pairs of guides being placed on opposite sides of the tube. The upper pair of guides is formed by two adjustable screws (one shown at F, figs. 52, 53), which serve to procure perfect alignment of the substage slide with the slides of the body-tube. By this device it is possible to secure the alignment of the body-tube optically instead of mechanically, so that far greater accuracy is obtainable.

As has already been pointed out, rotation of the guide-tube of the substage about its long axis is prevented by means of a rod, which passes through a hole in the stage. This rod makes no attempt to fit in the hole through which it passes, but presses on one side of it only. The rod is prevented from leaving this side of the hole by the device of winding up the long spring (V, fig. 52), which lies inside the guide-tube. This spring has, consequently, a tendency to rotate the substage about the long axis of the tube, in such a direction as to hold the rod against the side of the hole.

The long spiral spring, enclosed within the guide-tube, is thus seen to be the key to the whole substage mechanism. It causes the substage to follow its focussing screw without backlash, holds the tube against its four guides, prevents rotation of the tube about its long axis, and allows of the alignment of the substage slide with the body-tubes.

A few other points about the substage demand attention. The position of the focussing screw (T, fig. 53), above the stage on the right-hand side, is a very convenient one. Moreover, since the nut in which the screw works is fixed to the stage, and the connection between the screw and substage is flexible—being effected by a long pointed pin which passes up inside the screw—alterations of focus can be obtained without fear of any other derangement of the illumination.

The substage bracket is not a complete ring, as is the usual practice, but a fork (S, fig. 52), open at the front. This enables the centring ring to be readily removed. When in place, this ring is held against its two centring screws by a spiral spring (W, fig. 49), stretched between the two prongs of the fork.

The range of the substage movement is amply sufficient to enable it to take condensers of either the substage or understage pattern. The absence of milled heads and slides below the stage renders the condenser accessible from every side.

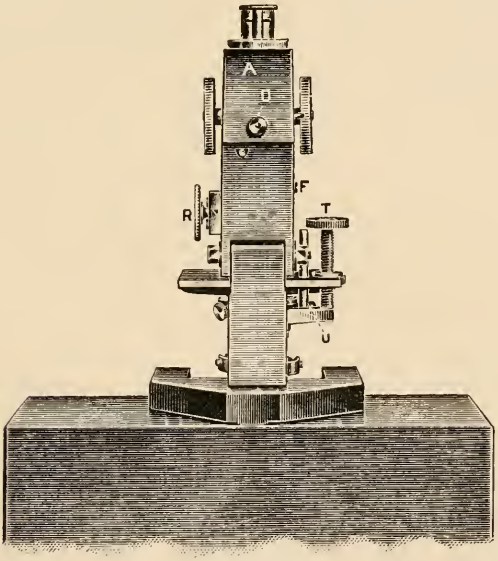


Fig. 53.—Elevation: Microscope in Vertical Position.

Lettering as in figs. 49, 50, 51, 52.

The advantages claimed for the instrument are the following:—(1) Cheapness of manufacture, the turning of the tubes, and the filing of the guides being less expensive work than the planing of dovetailed slides. The alignment of the various slides also involves very little expense, being obtained without careful workmanship.

(2) It is impossible for the movements to become shaky from wear, since every movement is held up by a spring. (3) The alignment of the several slides is obtained optically.

These are the essential advantages. There are also some incidental points, namely, easy removal of the fine-adjustment tube for cleaning; possibility of replacement of any part without the need of special fitting—for example, it would be possible to replace a fine-adjustment tube, which carried a sliding coarse adjustment, by one carrying a mechanical movement, without skilled work; convenient position of the substage focussing screw; accessibility of the condenser; and the shape of the limb, which enables it to be finished entirely by machinery.

Of all these points, those which make for cheapness appear to me to be of the greatest importance. This was the primary object with which the instrument was designed.

The particular instrument from which the photographs reproduced with this paper were taken, was made throughout with the roughest of workmanship. In spite of this, the movements all worked smoothly, and without shake, a result which could certainly not have been obtained with similar workmanship in a Microscope of the usual pattern. This fact affords the strongest proof of the superiority of the geometric slide.

VIII.—*On certain New Methods of Measuring the Magnifying Power of the Microscope and of its Separate Elements.*

By A. E. Wright, M.D.

(LATE PROFESSOR OF PATHOLOGY, ARMY MEDICAL SCHOOL, NETLEY; PATHOLOGIST TO ST. MARY'S HOSPITAL, PADDINGTON, W.)

(*Read March 16th*, 1904.)

The methods of measuring the magnification of the image which are ordinarily in use in connection with the Microscope are the following two.

1. A micrometric scale placed upon the stage of the Microscope is viewed with one eye through the Microscope; an ordinary scale placed at the standard distance of 10 in. is viewed with the other eye; and by an intellectual effort the images in the two eyes are combined into a composite image.

2. By a suitable arrangement of reflectors the system of rays proceeding from a scale placed at 10 in. from the observer is brought across in such a manner as to form an unmagnified image in the eye, which is viewing the magnified image of a micrometric scale furnished by the Microscope.

Both these methods involve the simultaneous observation of two scales, and as a pre-condition of such simultaneous observation a careful balancing of the light which falls into the eye from the two sources.

I do not propose to concern myself with either of these methods to-night. I propose with your permission to consider four other methods of measuring the magnification of the microscopic image. The first and last of these are, so far as I know, novel in principle; and all four have, I think, certain advantages over the methods commonly in use in connection with the Microscope. Before proceeding to the discussion of these methods I may enumerate them.

Method 1.—A lens functioning as the counterpart of the refracting system of the eye is placed above the eye-lens of the Microscope, in such a manner as to bring the image of a micrometrical ruling to focus upon a measuring scale, which occupies a position corresponding to that normally occupied by the retina of the observing eye. The dimensions of the image which is furnished by the Microscope (working in conjunction with the focussing lens) are read off upon this measuring scale by means of an eye-piece.

Method 2.—The magnifying power of the objective and ocular are separately measured, and the magnifying power of the Micro-

scope is arrived at by multiplying together the magnifying powers of these separate components.

Method 3.—The angular aperture of the transmitted beam is measured (*a*) as it enters the aperture of the objective and (*b*) as it leaves the aperture of the eye-lens. The magnification is arrived at by dividing the first measurement by the second.

Method 4.—By the exploitation of a fiduciary phenomenon, which is obtained by the aid of a diffraction grating, an observation is made which furnishes the distance between the lines of a micrometrical ruling as imaged upon the retina by the aid of the Microscope or other magnifying system. This observation made, a series of paired lines is viewed through the grating by the unaided eye from a distance of 10 in. The observer—taking to aid the fiduciary phenomenon before referred to—now seeks out that pair of rulings which furnishes upon his retina an image exactly similar to that obtained with the assistance of the magnifying system employed in the first observation.

The magnification is now obtained by measuring the interval between the pair of object lines which complies with this condition, and by dividing this measurement by the interval between the lines of the micrometrical scale.

Measurement of the Magnification by bringing the Pencils of Parallel Rays which emerge from the Microscope to focus upon a Measuring Scale, and reading off the Dimensions of the Image thus formed by means of an Eye-piece.

The image I now throw on the screen (reproduced in Fig. 54) exhibits the construction of the simple piece of optical apparatus —we may denote it the eikonometer—which allows of the dimensions of the microscopic image being read off at a glance.

At A is disposed a plano-convex lens, which, like the refractive system of the eye, brings to focus the pencils of parallel rays which emerge from the eye-lens of the Microscope.

In the case of the instrument which I have placed upon the table, a focal length of 1 in. has been given to the focussing lens.

Such a lens furnishes upon its principal focal plane an image, whose dimensions are ten-fold smaller than those of the image which is projected outwards from the retina to the conventional distance of 10 in.

In the principal focal plane, just spoken of, is placed a micrometrical scale ruled in tenths of millimetres. These have, for the purpose of the measurement of the image furnished by the focussing lens, the same value as millimetre divisions, applied to the image projected outwards from the eye to a distance of 10 in.

At the back of the micrometrical scale there is mounted a Ramsden eye-piece. This eye-piece serves for reading off the dimensions of the image. It is manifestly open to us to employ in this situation any magnifying power which may happen to be convenient. In the instrument upon the table the eye-piece has a magnifying power of 10—that is to say, a magnifying power which exactly balances the ten-fold minification before spoken of. We obtain by this means, on placing the eye at the eye-lens of the eikonometer, placed in position over the eyepiece of the Microscope, an image of precisely the same dimensions as that obtained on looking into the microscope in the ordinary way. On looking through the eikonometer at a distant object we obtain in like manner an image of the same dimensions as in ordinary unassisted vision.

To complete the description, it may be pointed out that, in addition to the focussing arrangement for the eye-piece, provision

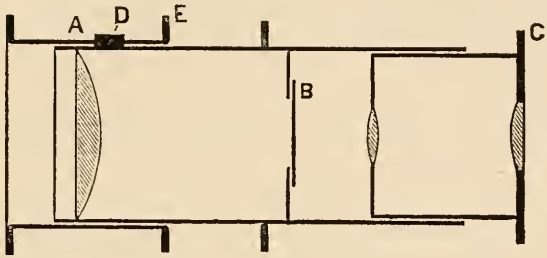


Fig. 54.

A, focussing lens, 1 in. focal length; B, micrometric scale (divided into tenths of a millimetre); C, Ramsden eye-piece, magnifying 10 diameters; D, stud working in spiral groove in E, outer sleeve.

is made for bringing the focussing lens into the plane of the Ramsden disc of the eye-lens. When this is done we obtain in the eikonometer as extensive a field of view as in the Microscope when the Ramsden disc of the eye-lens is, as is normally the case, disposed in the pupil of the observing eye.

In the arrangement adopted, the tube of the eikonometer moves up and down in an outer sleeve—the movement being regulated by a stud fitting into a spiral slot.

In addition to measuring the magnifying power of the Microscope the eikonometer will render services—

(*a*) In the case where we desire directly to measure the magnifying power of the objective, or any other lens or combination of lenses, which furnishes a system of pencils of parallel rays.

(*b*) In the case where we desire to arrive at the magnifying power of an optical element by subtracting from the cumulative

magnifying power of the system the magnifying power of a component optical element.

Example 1.—Where we desire to measure the magnifying power of a pocket lens, we view through the lens in question a millimetre scale, disposing this last at such distance from the lens as to give the largest possible erect image. Holding the lens in position, we now place the eikonometer between the eye and the lens and read off the number of divisions of its scale, which are covered by one millimetre division on the object scale. The number of divisions covered corresponds to the magnifying power.

Example 2.—Where we desire to measure the magnification of an objective, we place a micrometrical ruling upon the stage, remove the ocular from the Microscope tube, and focus down with the objective until we obtain the largest possible erect image of the ruling. We now place a slip of glass over the upper open end of the Microscope tube, and place upon the top of this the eikonometer, and then read off the value of the divisions of the stage micrometer upon the measuring scale.

Example 3.—Where, knowing the magnifying power of the ocular, we desire to measure that of the objective by the indirect method, we measure by means of the eikonometer the total magnifying power of the Microscope, and arrive at the magnifying power of the objective, taken separately, by dividing the total magnification by the magnification which is referable to the eye-piece component.

Measurement of the Magnification of the Microscope by the separate Determination of the Magnifying Power of the Objective and the Ocular.

The possibility of arriving at the magnifying power of the Microscope by the measurement of that of the optical components of the Microscope taken separately, has already been adverted to in the introductory section. In exploiting this principle of measurement, we may leave altogether out of account what I shall venture to call the "optical anatomy" of the Microscope. We may, in other words, ignore the fact that the objective works in combination with the field-lens of the ocular, and that the eye-lens of the ocular works in combination with the optical system of the eye; and we may assume instead that the objective works in conjunction with the optical system of the eye, and that the field lens works in conjunction with the eye-lens. This will, if I may, for the purpose of exposition, resort to a rough analogy from human anatomy, be equivalent to taking together for purposes of measurement, (*a*) the legs and the head and neck, and (*b*) the chest and abdomen, instead of taking together, in the proper anatomical order, (*a*) the legs and lower half of the trunk, and (*b*) the upper half of the trunk and head and neck.

We have in the previous section illustrated the method of measuring the magnifying power of the objective working as a doublet with the optical system of the eye. Here we may deal with the method of measuring the magnifying power of the ocular working as an independent optical element.

Measurement of the Magnifying Power of the Ocular.

The total magnifying power of the Microscope corresponds to the total angle through which the most obliquely incident ray is refracted in its passage from the object plane on the stage of the Microscope to the retina of the observer's eye. The magnifying power of the ocular which we are here concerned to measure corresponds, as reflection will show, to the angle through which the ray in question is refracted while in passage between the aperture of the objective and the aperture of the eye-lens.

In order to obtain our measurement we must be clear, on the one hand, as to the situation of the apertures which are in question, and, further, we must have some means of locating in the respective apertures the points of origin and arrival of the rays from which we have to take off in making our measurements.

Position of the Apertures which come into consideration.—The true aperture of a lens is positioned where the beams which are transmitted through it mutually interfuse and overlap. This *interfusion* disc (variously denoted the "Lagrange disc," the Ramsden disc, and the "pupil of entrance," or, as the case may be, "pupil of exit") is positioned, in the case of the objective, in close proximity to the posterior surface of the back lens of the combination, and in the case of the eye-lens, at a little distance superficial to the upper surface of the eye-lens.

Method by which the Points of Origin and Arrival of the Rays which are transmitted from Aperture to Aperture can be located.—It is manifestly impracticable to identify an isolated ray, or to recognise the point of origin or arrival of such an isolated ray. What is impracticable in the case of the isolated ray is, however, eminently practicable in the case of any beam. We can readily, in case of a beam, identify its point of origin and its point of focal impact. By this means we can, in the case where a particular ray passes through the radiant point (pole of origin) of a beam and again passes through the focal point (terminal pole), identify its position at two points of its course.

Taking this principle as our guide, and bearing in mind that the aperture of the objective is everywhere traversed by rays which intersect with each other to form radiant points; and bearing in mind, further, that the rays diverging from these radiant points will in each case re-intersect in the aperture of the eye-lens, constituting as they do so focal points; we can manifestly re-identify in the image of the objective-aperture, which is formed in the Ramsden disc of the eye-lens, the position of any ray which has emerged from a radiant point in the aperture of the objective.

The position of the rays which pass through the extreme margin of the aperture of the objective can manifestly most readily be

identified for the purposes of measuring the interval which separates them.

Procedure.—Take a low-power lens, preferably one whose back lens is flush with the back of the mount,* measure the diameter of its back lens, and fit it to the Microscope tube. Focussing the objective upon the focal plane of the condenser, and opening up to its fullest extent the iris diaphragm in the substage, project a beam of light upwards through the Microscope. Take in hand now a pocket lens and a millimetre rule. Bringing the former up quite close to the eye, and disposing the latter in the neighbourhood of the bright Ramsden disc, seen on looking down from a distance upon the upper surface of the ocular, bend down over the Microscope, until an image of the illuminated back surface of the objective comes clearly into view. Now readjust the position of the millimetre scale in such a manner as to bring it accurately into the focal plane occupied by the image of the objective aperture. Read off the diameter of the image, and divide this measurement into the measurement previously obtained by the direct application of the rule to the back lens of the objective. The quotient represents the magnifying power of the ocular.

Measurement of the Magnifying Power of the Microscope by the Determination of the Restriction undergone by the Beam in passing through the Microscope.

The magnifying power of an optical system can, as is well known, be determined by measuring the total angle through which the most obliquely incident ray is refracted in its passage through the system. Put otherwise, the magnifying power corresponds to the diminution in the numerical aperture of the beam which is effected in its transmission through the system. A word or two may be in place in connection with the application of this system of procedure to the Microscope.

Determination of the Numerical Aperture of the Beam which enters the Objective.—The determination of the numerical aperture of the beam which enters the objective involves (*a*) the measurement of the linear diameter of the aperture of the objective, or, in the case where the objective is not fully filled, of the linear diameter of the illuminated area of the back surface of the objective, (*b*) the measurement of the focal length of the objective, and (*c*) a know-

* Where a lens of this kind is not available, we may, in conformity with a suggestion made to me by Mr. Gordon, drop upon the back lens of the objective a square or a triangle of paper, whose sides measure, say, exactly 1 mm. By the procedure described above, we now apply our measurements to the image of this triangle or square. An even simpler method of procedure is to dispense with the objective, and to take as our object the vacant lower aperture of the barrel of the Microscope tube, and to apply our measurements to the image of this aperture.

ledge of the refractive index of the medium which bathes the front surface of the objective.

The former measurement (a) may be obtained, where the back lens of the objective is fully filled, and where it is directly accessible to measurement by the application of a millimetre scale to the objective. In the case where the back lens is sunk, or where it is only partially filled by the transmitted beam, we obtain the measurement required by measuring, by the procedure explained in the last section, the Ramsden disc of the eye-lens, and multiplying by the magnifying power of the ocular.

The focal length of the objective is arrived at most simply by measuring its magnifying power by means of the eikonometer, and dividing this magnifying power into 250 mm. or 10 in.

From these measurements and a knowledge of the refractive index of the medium which bathes the front face of the objective, we obtain the numerical aperture of the beam which enters the objective in accordance with the formula

$$\text{N.A.} = \frac{\text{semi-diameter of beam} \times \text{refractive index of the immersion medium}}{\text{focal length of the objective}}.$$

Determination of the Numerical Aperture of the Beam, which is furnished to the Eye by the Eye-lens of the Microscope.—The numerical aperture of the beam, which is furnished to the eye by the eye-lens of the Microscope, is obtained by dividing the semi-diameter of the Ramsden disc of the eye-lens, measured as explained in the last section, into 250 mm. or 10 in.

The magnifying power of the Microscope is obtained from the numerical apertures of the opening and closing beams in accordance with the formula

$$\text{Magnifying power} = \frac{\text{numerical aperture of beam which enters the objective}}{\text{numerical aperture of the beam furnished to the eye by the eye-lens.}}$$

Measurement of the Magnifying Power of the Microscope by the Exploitation of a Fiduciary Phenomenon obtained by the Aid of a Diffraction Grating.

The method of measuring the magnifying power of the Microscope, which I am about to suggest to you, is a direct outcome of Mr. Gordon's critical study of the Abbe theory of microscopic vision, which was laid before this Society some time ago. You will remember that Mr. Gordon's paper dealt with the phenomena of diffraction which come into view when lines and rulings are viewed with the Microscope, or as the case may be, with the unaided eye, through restricted apertures, and in particular through slit apertures and diffraction gratings. Let me recall to your memory the following:—

1. A radiant point is never brought to focus in the image as a point, but always as a diffraction figure—conveniently styled by Mr. Gordon an "antipoint."

2. Where a radiant point is viewed through a circular aperture that antipoint consists of a central false disc, surrounded by a system of alternately dark and bright rings.

We may for our particular purposes leave out of consideration all but the innermost of these rings.

3. When a point is viewed through a slit opening the antipoint obtained corresponds to an optical section of the antipoint referred to in (2). It consists, in other words, of a dash—the optical section of the false disc—flanked on either side by a faintly luminous point, corresponding in each case to the optical section of the first bright ring.

4. Where a diffraction grating takes the place of the simple slit aperture, the outlying elements of the antipoint are emphasized at the expense of the central elements. We obtain, in other words, as the antipoint of a point, a less conspicuous central dash flanked on either side by a brighter point.

5. When a line, or file of points, is viewed through a diffraction grating we obtain a composite antipoint pattern, consisting of a central or principal line furnished on either side by a flanking line.

6. The elongation—meaning thereby the distance between the principal line and flanking line—is determined (*a*) by the periodical interval of the diffraction grating, and (*b*) by the distance between the aperture of the lens and the screen upon which the image is brought to focus.

Having recalled to mind these preliminary points, I am in a position to make my suggestion intelligible. This suggestion is that we should use the elongation of the flanking line as a measuring staff for the determination of the distance at which the principal images of the two lines lie apart in the retinal image. We can use this measuring staff to advantage, in particular, in the case where the elongation of the flanking line corresponds exactly to half the distance between the principal lines. When this condition is fulfilled, the flanking lines which fall into the interspace between the principal lines merge and furnish a single well-marked intercostal line.

Having called your attention to the fiduciary phenomenon which is furnished under these conditions, it will be manifest to you upon consideration that we can exploit this phenomenon in the following manner.

We can place before us at a distance of 10 in. a series of paired lines ruled at progressively increasing intervals, and viewing them through a diffraction grating held, let us say, with its rulings parallel to the object lines, select that particular pair of

lines which furnishes to us a median intercostal line. We can then by the application of a scale measure the linear distance between this pair of lines.

We can now place before us another series of paired lines, lying at distances apart smaller than the paired lines previously considered in the ratio which will, we estimate, correspond to the magnification achieved by the use of lens. We can again select from among this series of paired lines that pair of lines which furnishes as viewed through the diffraction grating, held at the same angle as before, a median intercostal line.

Inasmuch as the pair of lines which is seen by the unaided eye from a distance of 10 in., and the pair of lines which is seen through the magnifying system yield in each case retinal images of precisely the same dimensions, it will be obvious that the magnifying power of the optical system will be arrived at by dividing the interval between the object lines, which have been viewed through the magnifying system, into the interval between the lines which have been viewed by the unaided eye.

While the procedure as described above is admirably adapted to the measurement of the magnifying power of pocket-lenses and such like, it would, if applied without modification to the measurement of the magnifying power of the Microscope, involve the employment of a special stage micrometer with lines ruled at progressively increasing intervals.

The difficulty which has just been adverted to can be evaded. As an alternative to varying the linear distance between the rulings to conform to the elongation of the flanking line, we can accommodate the elongation of the flanking lines to the periodical interval of the rulings of the stage micrometer, and to the magnifying power of the optical system through which we view those rulings.

The required accommodation of the elongation of the flanking lines can be effected by employing, as the case may be, a more finely or more coarsely ruled diffraction grating, or, more simply, by rotating the grating in such a way as to bring—according as we desire to increase or diminish the elongation—the long axis of the slit apertures of the grating into parallelism with the rulings, or, as the case may be, with the normal to the rulings. Having regulated in this way the elongation of the flanking lines until we have achieved the doubling of the ruling by the intercalation of an intercostal line between every two principal lines, we proceed in all essential points as before. In other words—maintaining the orientation of the diffraction grating, which gives a central intercostal line between the ruling of the stage micrometer—we view through this with the unaided eye a series of paired lines placed at a distance of 10 in., and we arrive at the magnifying power of our optical system by dividing the linear distance between the rulings on the stage

micrometer* into the linear distance between the lines which give, as viewed by the unaided eye, a retinal image of similar dimensions.

In conclusion, I desire to express my thanks to Messrs. R. and J. Beck, to Messrs. Swift and Sons, and to Messrs. Sanger Shepherd, for the eikonometers and the diffraction gratings (ruled 400 lines to an inch) which have served for the illustration of the methods I have brought before you.

* The more widely interspaced lines of the central ruling of an Abbe diffraction grating furnish a very convenient stage-micrometer for the procedure here described.

SUMMARY OF CURRENT RESEARCHES

RELATING TO

ZOOLOGY AND BOTANY

(PRINCIPALLY INVERTEBRATA AND CRYPTOGAMIA),

MICROSCOPY, ETC.*

ZOOLOGY.

VERTEBRATA.

a. Embryology.†

Nutrition and Sex Determination in Man.‡—R. C. Punnett finds that if the population of London be divided into three portions exhibiting graduated poverty, the proportion of male to female infants is lowest in the poorest portion, highest in the wealthiest portion, intermediate in the intermediate portion. The proportion of male infants is highest of all in a number of births taken from Burke's *Peerage*.

Alternative conclusions may be drawn: that more favourable conditions of nutrition (1) result in a large proportion of male births, or (2) have no effect on the proportion of the sexes, or (3) may even result in a relative preponderance of female births; but that in the last two cases the effect is masked by other factors which affect different strata unequally. Such factors are shown to exist in a differential infant mortality, a differential birth-rate, and probably also in a differential marriage-age. These factors all tend to diminish the proportion of males in the poorer portions of the population, and thus render the first of the alternative conclusions improbable. Whether the second or third is to be accepted cannot be decided until we are in a position to estimate the quantitative effect of the factors noted above. Punnett's opinion is that their combined effect would not be sufficiently great to mask a preponderance of female births due to better nutrition, and consequently he is inclined to believe that in man at any rate the determination of sex is independent of parental nutrition. In any case its influence can be but small.

* 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, etc., 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, Reproduction, and allied subjects.

‡ Proc. Cambridge Phil. Soc., xii. (1904) pp. 262–76.

Sex of Mice.*—S. M. Copeman and F. G. Parsons publish a record of fifteen months' experimental work, undertaken with a view to determining the extent, if any, to which the relative proportion of the sexes is capable of being influenced by varying conditions of age, nutrition, interbreeding, etc. The work is still in progress, but the results for this period are published with a view to inviting criticism on method and suggestions for the future, and also to indicate to other breeders clues which may appear worth following up. Some interesting conclusions are that there is a hereditary tendency in certain males to beget a markedly large proportion of males, and in others of females. The evidence for a similar tendency in does is not so conclusive. Inbreeding between a male and his offspring is borne for five generations, without loss of fertility or any apparent bodily degeneracy. In large litters the proportion of females is greater than in small ones; more males are produced by does over six months than by does under that age.

Heredity of Pigmentation in Mice.†—L. Cuénot concludes as the result of crossing grey, black, yellow, albino, and other mice, that Mendel's law holds both as regards dominance and disjunction in gametes. In the germ-plasma there must be four sorts of non-correlative determinants completely independent, because they can be inherited separately.

Fertilisation and Hybridisation.‡—Hugo De Vries gives a lucid account of his views as to the material basis of inheritance. He accepts Boveri's conclusions as to the individuality of the chromosomes and Hæcker's hypothesis of the "*Doppelkern*." It is characteristic of his position that he regards the mingling of parental contributions as of subordinate importance as regards the children, but of fundamental importance as regards the grandchildren. The actual mingling takes place immediately before the formation of the sex-cells of the individual in question.

Maturation of Germ-Cells and Mendel's Law.§—E. B. Wilson reports that in his laboratory two independent investigations, one botanical (by Cannon), and another zoological (on spermatogenesis in *Brachystola*, by Sutton), led to the same general conclusion, that in the maturation of the germ-cells there is a segregate transference of paternal and maternal contributions to different cells, which would make Mendel's law more intelligible. To this, Cook objects,‖ on the ground that the small number of chromosomes in the above cases implies that there is not a separation of individual hereditary qualities, but of whole groups of qualities.

Interstitial Testicular Gland and Secondary Sex Characters.¶—P. Ancel and P. Bouin infer from a study of a unilateral cryptorchid pig, in which the testis remained embryonic, while the interstitial gland

* Proc. Roy. Soc., lxxiii. (1904) pp. 32–48.
† Arch. de Zool. Exp., ii. (1904) Notes et Revue, pp. xlv–lv.
‡ See Zool. Centralbl., xi. (1904) p. 161.
§ Science, xvi. (1903) pp. 991–3.
‖ Popular Science Monthly, 1903, p. 88. See Zool. Centralbl., xi. (1904) p. 163.
¶ Comptes Rendus, cxxxviii. (1904) pp. 168–70.

was hypertrophied, and all the external characters of an entire animal were exhibited, that the development of the secondary sex characters is dependent on the condition of the interstitial testicular gland.

Interstitial Testicular Gland.* — P. Bouin and P. Ancel cut the vas deferens between two ligatures in young guinea-pigs and rabbits. In the former the testes developed normally; in the latter, in some cases, the characters of castrated animals were exhibited. This last result was probably due to the destruction of the plexus, whose ramifications accompany the vas deferens. Noteworthy in these rabbits was the degeneration of the interstitial testicular gland, and the authors believe that the inhibition of masculine characters and the production of testicular infantilism is due to the absence or degeneracy of this gland.

Relation of Secondary Sexual Characters to an Internal Secretion by the Testicle.†—S. G. Shattock and C. G. Seligmann record the results of some experiments on Herdwick sheep and common fowls, which were designed to test the suggestion previously made by one of them, that the interstitial cells of the testis yielded an internal secretion, and to discover whether this secretion, absorbed into the circulation, induces the metabolic changes that reveal themselves as secondary sexual characters. The experiments consisted in ligaturing the vasa deferentia in the young, the expectation (not confirmed) being that atrophy due to the pressure of the products would result in the tubuli, while the interstitial cells of the stroma might remain intact. The conclusions arrived at are that occlusion of the vasa does not inhibit the full acquirement of secondary male characters, nor is the discharge of the sperm necessary. It seems clear also that they are not due to metabolic changes set up by a nervous reflex arising out of the mere physical function of the sexual mechanism, for the characters developed in males, partially castrated, whose sole representative of testis consisted of grafts entirely disconnected from their proper nervous relations. The suggestion of an internal secretion of the testis is confirmed, although the authors cannot as yet state what particular cell elements are concerned in its production.

Testicle and Spermatic Ducts of Lemurs in Captivity.‡ — A. Branca states that amongst animals in captivity it is not rare to find a stoppage of spermatogenesis in full-sized testicles. As a result of his investigations on captive lemurs he has found that the seminiferous canaliculi are as wide as usual, the wall shows none of the alterations observed in ectopia, the connective tissue is not hypertrophied, and there are no vascular lesions. The excurrent ducts are normal, but the gland cannot make spermatozoa. He finds four conditions: (1) with epithelial covering represented by cells of Sertoli only; (2) with Sertoli cells and spermatogonia; (3) the elements represented in second type plus spermatocytes of first and second generation; and (4) with the elements present in third type plus spermatids, and with spermatic cord

* Comptes Rendus, cxxxviii. (1904) pp. 231–2.
† Proc. Roy. Soc., lxxiii. (1904) pp. 49–58.
‡ Journ. Anat. Physiol., xl. (1904) pp. 35–72 (2 pls.).

complete. The testicle degenerates without the ejaculatory apparatus apparently exhibiting any appreciable modification; its atrophy seems determined by the time the animal has been in captivity. The elements break down in inverse order of their genesis.

Transmission of Acquired Characters.* — Max Morse discusses afresh this much discussed question, and gives an answer in the negative. He defines an acquired character as a modification of an organism in its ontogeny produced by reactions to external stimuli. Without adding anything new to the discussion he considers the pro's and con's in a fair way, and concludes that it is difficult to imagine how some specific change in a remote part of the body can be registered on the germ-cell, with the result that the offspring has reproduced in it the same specific modification.

Gastrulation in Lizards.†—Karl Peter communicates a sixth paper on the embryology of lizards.

The structure known as the "embryonic shield" is of different morphological value at different times. To begin with, it consists of the two germinal layers,—both uniformly thickened. Afterwards, besides the uniform area, there is a zone in which only the inner layer is thickened. After the retrogression of the endodermic cushion, the ectoderm-plate alone appears on surface view. The mesoderm never coalesces with the endodermic substratum. The notochord is wholly mesodermic in origin, and owes its origin to the mesodermic head-process which proliferates in front of the primitive plate.

It is not easy to summarise an intricate embryological paper like this, but we would give prominence to the author's conclusion that the primordium of the notochord is mesodermic.

Carnivorous Fowls and their Fecundity.‡ — F. Houssay submits the following table of fecundity for the first year of four sets of fowls.

Generation.	Number of Eggs.	Weight of Hen.	Average Weight of Egg.
Graminivorous . .	97	5·360 kgm.	55 grm.
1st carnivorous . .	148	8·674 kgm.	58 grm.
2nd carnivorous . .	167	10·270 kgm.	61 grm.
3rd carnivorous . .	145	8·426 kgm.	58 grm.

In attempting to rear a fourth generation, Houssay obtained from eighty eggs in six sets, fourteen developments, and only seven chicks.

Alimentary intoxication influences the gonads, and tends to sterility and arrested development and premature death of offspring. It is cumulative in its effect and tends to a preponderance of males.

Corpus luteum of Dasyurus viverrinus.§—F. P. Sandes communicates the results of researches on the corpus luteum, with observations on the growth and atrophy of the graafian follicle. His results show

* Ohio Naturalist, iv. (1903) pp. 25-30.
† Arch. Mikr. Anat., lxiii. (1904) pp. 659–700 (2 pls. and 2 figs.).
‡ Comptes Rendus, cxxxvii. (1903) pp. 934–6.
§ Proc. Linn. Soc. N.S. Wales, xxviii. (1903) pp. 364–405 (15 pls.).

that the characteristic cells of the corpus luteum are formed by hypertrophy of the cells of the membrana granulosa. The theca interna folliculi is rudimentary, and forms only the vascular connective tissue of the corpus luteum. The corpus luteum is probably a gland with an internal secretion of use in the organism. It has the function of stopping ovulation during pregnancy, and at the œstral periods.

Problem of Form Regulation.*—S. J. Holmes propounds a theory according to which the process of form regulation does not necessarily involve the preservation of favourable variations among the vital units, although it may involve one factor of that process, viz. the tendency of parts to increase as fast as circumstances permit. He conceives that the checking process by which regulation is effected, is brought about not by the selection of certain vital units, but through the symbiotic relation in which the parts of the organism stand. The whole process of development may occur without the elimination of vital units of any kind, whether they be biophors, determinants, or individualities of a higher order, such as cells or organs. The parts of an organism are engaged in a struggle for existence, but as the parts are mutually dependent, the struggle leads to an adjustment to a norm instead of the elimination of some parts and the survival of others.

Regeneration of Bone and Cartilage.†—Wendelstadt has made numerous experiments on newts and axolotls. When there is regeneration of bony tissue, there must be a return to the primitive cell-forms. The bony tissue itself cannot form new bone nor cartilage. There must be a re-habilitation of those elements which were active in embryonic life, and these are retained in the periosteum. They form, first, cartilage cells, and then these are transformed into osseous elements.

Development of the Sense Organs of the lateral line in Amphibia.‡—R. G. Harrison finds experimentally that the path of the lateral line organs may be varied, and that the path characteristic of a particular species is merely to be considered as the line of least resistance to growth. The stage of development used in the experiments was that when the tail bud just appears, and at this stage the causes conditioning that certain cells belong to the lateral line appear to have been active at an earlier period of development.

Development of Lymph Glands in Man.§—C. A. Kling, in a series of studies of human embryos, has made out, amongst others, the following points. The axillary lymph vessels have developed an abundant plexus before the gland proper arises. In the third fœtal month, in the meshes of the lymph-vessel plexus cellular and vascular tissue is differentiated, showing an irregular trabecular arrangement. Such an area corresponds to each of the gland groups in the axilla, and may be termed lymph-gland centres of origin. Through division of these are formed the single glands. The division appears to be caused by the ingrowth and dilatation of the neighbouring lymph vessels. Lymph sinuses in the

* Arch. Entwickelungsmech., xvii. (1903) pp. 265–305.
† Arch. Mikr. Anat., lxiii. (1904) pp. 766–95 (6 pls.).
‡ Tom. cit., pp. 35–149 (3 pls.).
§ Op. cit., lxiii. (1903) pp. 575–610 (2 pls.).

gland are in the beginning usually lymph vessels. The reticulum cells in their lumen appear only secondarily, and are descendants of the lymph vessel endothelium. The special lymph-gland buds are from the beginning onwards of different size. Some reach during intra-uterine life their definite structure, others remain in a low stage of development. The small, often microscopic glands which one finds in the adult are rudimentary forms, which under special circumstances may develop further, even in the adult. Owing to incomplete separation of the gland centres, twin or other malformations of lymph glands arise.

Origin of the Vitreous Humour.*—A. v. Szily finds in the early stages of development thread-like fibrils, which are extensions of the intercellular bridges of the cells of the adjacent epithelial layers. They are connected with the protoplasm of the cells by means of a "skittle-shaped" structure (*kegelförmigen*), which resembles the "basal-skittles" of the lens cells discovered by v. Lenhossék. If the fibres arise near where mesenchyme cells are abundant, they unite secondarily with these, the mesenchyme dominating the form; in cell-free areas the fibres preponderate during the whole of life. Whether they belong genetically to the retina or to the lens is an unimportant factor. Owing to the independent development and subsequent union of these elements of the vitreous humour, the products of the different germ layers cannot be distinguished, so that no decision as to what is ectoderm and what mesoderm can be arrived at.

b. Histology.

Zoological Distribution, Mitoses, and Transmissibility of Cancer.† E. F. Bashford and J. A. Murray adduce evidence tending to show that the wide zoological distribution, the character of the mitoses, and the transmissibility of cancer, are nearly related phenomena with a common basis.

Malignant new growths have been found in a large and varied series of animals, not only in domestic animals, but also in animals living in a state of nature: wild mouse, codfish and gurnard.

A complicated sequence of cell-changes has been found to be characteristic of carcinoma and sarcoma alike. *This sequence is the same as that which initiates the origin of the sexual generation in plants from the asexual, and is terminal in the history of the sexual cells in animals.* It must be noted, also, that all the cells of the malignant new growths do not undergo the reducing division; a certain number differentiate in the direction of the tissue among which they have arisen, and in the secondary growths when present; somatic mitoses occur in the growing margin, which is also a feature in the growth of cancer when transferred to a new host. Cancer is an irregular and localised manifestation of a process otherwise natural to the life-cycle of all organisms. Successful transplantation experiments have been made, e.g. with mice, in which malignant new growths were transferred from one animal to another of the same species.

* Anat. Anzeig., xxiv. (1903) pp. 417–28.
† Proc. Roy. Soc. London, lxxiii. (1904) pp. 66–76 (1 pl. and 8 figs.).

Conjugation of Resting Nuclei in an Epithelioma of the Mouse.* E. F. Bashford and J. A. Murray draw attention to the fact that the power of cell proliferation, which has been proved to occur in an epithelioma of the mouse (Jensen), is a phenomenon unparalleled in the mammalia. A mass of tumour, 16 lbs. in weight, has been produced by artificially transplanting portions of the original growth and its descendants. When portions of the tissue are transplanted to new sites, the tumours which arise are the genealogical descendants of the cells introduced, and the growth was studied at successive stages of 24 hours. In a tumour removed on the eighth day, and less than half a split pea in size, *conjugation of resting nuclei* has been observed. To take a specific case, the nuclei of two adjacent cells are continuous through the cell-wall by a tube-like bridge, in the middle of which a strand of nucleolar substance, with fusiform swellings, in either cell is visible. The cells of this particular case are adjacent to the stroma, and close to the outer surface of the young tumour.

Behaviour of the Protoplasm in Monocentric Mitoses.†—T. Boveri describes certain peculiarities in the behaviour of the protoplasm of the eggs of sea-urchins which have been shaken after fertilisation. In many cases the effect of this treatment is to inhibit the division of the sperm centrosome, so that the egg contains not an amphiaster with equatorial plate, but a large monaster, to which the chromosomes are joined in a ball-like form. The succeeding behaviour varies, but in the majority he finds that the surface of the egg furthest removed from the sphere shows a very distinct amœboid movement, which is more marked in proportion to the eccentricity of the latter. All the rest of the surface is completely smooth. In the case of eggs deprived of their yolk-membrane, elongation takes place in the direction of the spindle axis, and, without, a narrowing at the equator division occurs with amœboid processes between the blastomeres similar to those of monaster eggs. From a consideration of these and related phenomena, he inclines to the view that the appearance of the equatorial plates in normal cell division is due to the slight influence of the centrosomes in this region—a negative and not a positive effect.

The Morphology of the Glands of Bartholin in Mammals.‡—H. Rautmann has investigated the occurrence and nature of the glands of Bartholin in ox, sheep, horse, cat and dog, as well as the human subject. He failed to find these in both sexes of the Canidæ, a fact not to be explained as due to disappearance during development, for they are absent in the embryo. In the human female, as in the cow, sheep and cat, they occur in pairs, and relatively strongly developed. In the sheep they are poorly developed, and may be absent on one side or altogether. In the mare, ass, mule and sow they are present in all individuals, in numbers subject to great variation, and arranged in rows in a longitudinal direction. The author cannot as yet, owing to the too limited

* Proc. Roy. Soc. London, lxxiii. (1904) p. 77.
† S.B. Phys. med.-Ges. Wurzburg, 1903, pp. 12–21.
‡ Arch. Mikr. Anat., lxiii. (1903) pp. 461–511 (1 pl.).

field of observations, pronounce definitely on their use or exact significance in copulation.

Peptic Glands of the Superior Region of the Œsophagus in Man.* — M. Gliński has studied the occurrence and nature of these glands in man. He asserts that, though existing at least in every second person, they are not present in all cases. In from 3 to 6 p.c. of cases they are macroscopic masses, perfectly visible ; in the rest their presence can only be demonstrated microscopically. They are equally frequent at all ages, and are commoner in males than females. They are usually placed between the level of the cricoid cartilage and the fifth tracheal ring, but occur exceptionally on other parts of the gullet. The large groups may appear lens-like surrounded by a wall, and lying deeply in the gullet, or in round or irregular masses, which may be merged to form larger aggregates, and are slightly raised above the mucous membrane of the gullet. They are usually in two symmetric groups, lying in the side folds ; rarely, in the right side fold a single group occurs. Lying usually on the mucous membrane, they yet sometimes penetrate the muscularis mucosa, never the submucosa. Their stroma is a loose lymphoid tissue, which here and there forms lymph nodules. He discusses their significance from a pathological point of view, and suggests that their lymphoid tissue may form the place of entrance of tubercle bacilli.

Studies in the Retina.† — H. M. Bernard continues these studies, adducing evidence for the continuity of the nerves through the vertebrate retina, through the medium of internuclear connecting filaments between the nuclei of the different retinal layers. This "protomitomic" system has been demonstrated to be continuous with the primitive nerve-fibrillæ of the retinal nerve strands. The outermost fringe of the retinal protomitomic system runs down the rods, which are the end organs of the retina as an organ of vision, while the proximal fringe of the same system is continuous with the nerve fibrils. The paper is a very full one, in which the characters of this system are described, as also its relations to the other retinal constituents and to the chromatin of the nuclei.

Islets of Langerhans of the Pancreas.‡—H. H. Dale has studied the pancreas of dog, cat, rabbit, and toad, with reference to the "islets of Langerhans." Laguesse has described a perpetual change of secretory tissue into "islets" and *vice versâ*, the islets being, in his view, pancreatic tissue in an internally secreting stage, and representing also the stage during which growth takes place. From this view of the normal transformation of the tissues, however, he has resiled, though Dale seems unaware of this. Dale's experiments leave the question of the function of the islets undecided, but the results of occlusion of the duct are in favour of Laguesse's view that they represent an internally secreting stage in the life of pancreatic tissue.

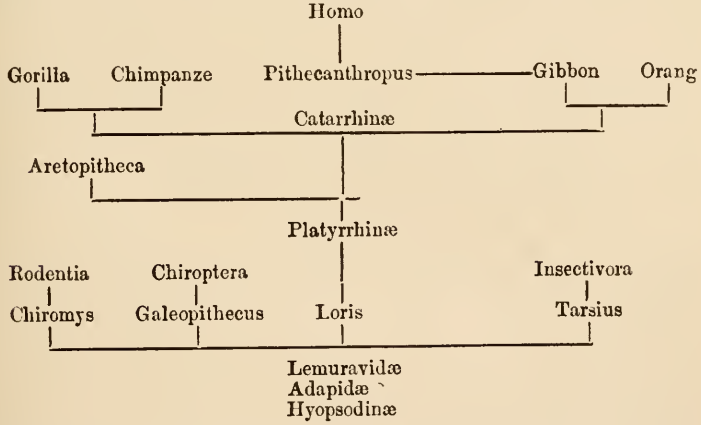
* Bull. Acad. Sci. de Cracovie, 1903, pp. 740–57.
† Quart. Journ. Micr. Sci., xlvii. (1903) pp. 303–62 (3 pls.).
‡ Proc. Roy. Soc., lxxiii. (1904) pp. 84–5.

c. General.

Influence of Light and Darkness.* — Armand Viré has continued his experiments in the subterranean laboratory in the "catacombs" of Paris, under the Jardin des Plantes. In the darkness, *Gammarus fluviatilis* exhibited some marked modifications, e.g. gradual disappearance of pigment and hypertrophy of olfactory and tactile setæ. In an eel, kept in darkness for five years, the eye was almost doubled in volume, though "the optic nervous system" was reduced. Six goldfish assumed a pale whitish rose colour, and were in two years smaller by a half than a similar number, equally fed, but living in the light.

Some subterranean animals were kept in the light, e.g. *Niphargus plateaui*, *Vireia burgunda*, *V. berica*, and *Proteus anguinus*. All showed by their behaviour that the illumination was disagreeable to them, probably through its influence on the pigment-forming cells. After some months, *Proteus* showed much pigmentation, except beneath the head and belly. The Crustaceans have not as yet shown more than slight black patches on the integument.

Origin of Primates.† — H. C. Chapman has been led from an anatomical study of *Tupaia*, in which no cæcum was found either in *T. ferruginea* or in *T. pictum*, to a speculative essay on the origin of the Primates. His views may be inferred from the following scheme.



Tegumentary Colorations.‡ — H. Mandoul has made a very exhaustive analysis of the types of tegumentary coloration in animals. He distinguishes three kinds due to structure: (1) simple reflection, (2) interference, (3) diffraction; and of pigmentary, intrinsic elaborated within the organism, and extrinsic which are of various origins. Reflection may give a white colour, or a satin or velvety aspect, and may be due to air, uncoloured liquids or solid pulverulent matter. For interference effects a very thin lamellar structure is necessary, and they

* Comptes Rendus, cxxxviii. (1904) pp. 706–8.
† Proc. Acad. Nat. Sci. Philadelphia, 1904, pp. 148–56.
‡ Ann. Sci. Nat., xviii. (1903) pp. 225–468 (2 pls.).

are favoured by the presence of a subjacent pigmentary layer. The blue of most vertebrate animals is produced by phenomena identical with those manifested by disturbed media. The physical constitution is the same in both cases. The pigments are bodies varying in properties and composition. Changes of colour are most frequently due to impressions on the retina. The pigmentary granules of the chromoblasts are set in motion by the chromato-motor nerves. The chromatic apparatus shows graded degrees of development in the various forms showing rapid changes of colour. Among the vertebrates having this apparatus in perfection (Batrachians and Reptiles), the blue colour seems connected with the state of dilatation of the black chromoblasts (temporary structural coloration). Bodies showing phenomena of coloration are in final analysis excretory products manifested under different forms (pigment, cuticle, etc.). According to their optical properties, it is determined whether it is to be the play of light (structural colour) or phenomena of absorption (pigment) by which they appear. Thus the aspect of coloration is the direct consequence of the state in which the excretory products present themselves.

Supra-cricoid Cartilage in Man.*—J. Citelli has found in certain subjects a small cartilage above the cricoid, and between the two interarytenoid muscles. This, he states, is not simply an anatomical variation, it is the homologue of the "procricoid" of Dubois, which is present in Amphibians, Reptiles, Monotremes, Marsupials, all Carnivora, except hyæna, some Ungulates, etc. It is rare in higher orders.

Occipital Region of Cerebral Hemisphere in Man and Apes.†—G. E. Smith calls attention to a means not only of checking the evidence of mere surface anatomy, but also of absolutely demonstrating the homology of the sulcus lunatus of the human brain with the *Affenspalte.* This new criterion is afforded by the study of the distribution of the stria Gennari in the occipital cortex. This white line is so sharply defined in part of the occipital cortex in man and the apes, that the stria-bearing region can be mapped out in sections of the fresh brain with absolute exactness. The homology of this area can be assumed in all Primates. The author further emphasises the presence of a definite sulcus præstriatus in most human brains (as well as in all Prosimiæ, Carnivora, Ungulata, and many other mammals); the absence or subsidiary importance of this sulcus præstriatus (vel calcarinus proprius) in all apes—Hapalidæ, Cebidæ, Cercopithecidæ, and Simiidæ; the definite limbic relation of the margins of the occipital operculum (overhanging the sulcus lunatus) and of the inferior occipital operculum (overhanging the sulcus infrastriatus) to the lateral area striata; the presence in most human brains (and occasionally in those of the apes) of superior and inferior limiting sulci of the mesial part of the area striata; and the series of intrastriate sulci, which extend along the axis of the area striata both in its mesial and its lateral parts. The author adopts a new nomenclature in order to emphasise the distinctive relations of the various occipital sulci to the cortical area containing the stria Gennari; and to call attention to the bewildering misuse of terms

* Anat. Anzeig., xxiv. (1903) pp. 289-96. † Tom. cit., pp. 436-51.

in reference to the occipital region of the brain. Certain misleading suggestions of homologies are also treated in the paper.

Mandibulo-auricular Muscle.* — J. Chaine finds in the parotid region in the Badger a small vestige of this muscle, which he regards as homologous with the depressor mandibuli of lower vertebrates. He considers that various muscles described in this region inserted upon the articular bone are nothing but separate fascia of the same muscular formation, and that the mandibulo-auricular is only a representative of some of the fascia of this depressor.

Dentition of the Elephant.†—W. Mitchell has had published a number of fine photographs illustrating the normal dentition of the elephant, injuries resulting in encysted bullets, pathological developments due to injuries to the pulp, and sometimes expressed in fantastic external shapes. He also figures a case believed to be a true necrosis, which is rare.

The Phylogeny of the Boidæ.‡—F. E. Beddard discusses a number of points in the circulatory system of *Python*, *Eryx* and *Boa*, which support the view based upon other evidence that the Boidæ occupy phylogenetically a place at or near the base of the Ophidian series.

Infectious Exophthalmia of Freshwater Fishes.§—J. Audigé describes the course of a peculiar disease observed at the piscicultural station of the University of Toulouse—a unilateral exophthalmia affecting the Californian salmon (*Oncorhynchus quinnat*), and also *Idus orfus* Cuv. and *Squalius cephalus* L., both young and old. The disease is contagious and progresses rapidly, but in darkness no fatal effects result. The eye becomes opaque, but a spontaneous cure is effected. In the warm months the disease was at its height, in autumn it gradually dwindled. We may call attention in passing to the frequent occurrence of a condition approaching exophthalmia in carp kept in slightly abnormal conditions.

Limbs of Holocephali and Dipnoi.‖ — Armand Sabatier continues his study of the paired fins of fishes, developing his theory of the distinctness and independence of what he calls *mains des ceintures*, and *mains terminales des membres*.

Other contributions by the same author ¶ elaborate his own somewhat surprising conclusions as to the comparative morphology of the paired limbs of fishes. We defer further notice until we see an illustrated exposition of Sabatier's interpretations.

Paired Fins of Fishes.**—R. Hamburger gives a detailed anatomical account of the skeleton and musculature of the pectoral and pelvic fins of *Squalus*, *Trigla*, *Periophthalmus* and *Lophius*.

* Proc.-Verb. Soc. Sci. Bordeaux, 1902, pp. 54–5.
† Brit. Dental Journ., xxv. (1904) pp. 284–96 (34 figs.).
‡ Ann. Nat. Hist., xiii. (1904) pp. 233–6.
§ Comptes Rendus, cxxxvii. (1903) pp. 936–8.
‖ Op. cit., cxxxviii. (1904) pp. 249–52.
¶ Op. cit., cxxxvii. (1903) pp. 893–6.
** Revue Suisse Zool., xii. (1904) pp. 71–148 (2 pls.).

Myology of Chondropterygian Fishes.*—J. Chaine calls attention to a muscular layer on the ventral surface of the cephalic and branchial regions, which is remarkable for its many points of insertion in different parts of the skeleton, and for its different arrangements in the various species. He homologises it with the "transverse jugular" of the other vertebrate Classes.

Sub-Orders and Families of Teleostean Fishes.†—G. A. Boulenger gives a very welcome synopsis of these groups, in which his aim has been to build on phylogenetic lines. The most important character distinguishing the Teleostei from the Holostean Ganoids appears to be the presence of an ossified supraoccipital bone. Remnants of primitive characters, such as Ganoid scales, fulcra, rudiments of a splenial bone, spiral valve to the intestine, multivalvular bulbus arteriosus, are still found in some lower Teleosteans, but no longer in that combination which characterises the preceding order. Although *Albula* is exceptional among all Teleosteans in having two transverse series of valves to the bulbus arteriosus instead of one, no Ganoid has fewer than three. The order Teleostei, thus defined, is divided into thirteen sub-orders, whose characters are fully indicated. Brief definitions of the several families are given under their respective sub-orders.

Glands of the Mouth-Cavity of Petromyzon.‡—W. Haack describes the musculature, development, and histological structure of these glands. They are a pair of minute multicellular glands, about 3 mm. long and 0·5 mm. in diameter, having the form of an oval sac, constricted in its hinder third in a dumb-bell like form. They are imbedded in the ventral surface of the basilaris muscle. There is a long slender efferent duct opening in the mouth-cavity. The gland shows a structure quite different from a salivary gland, its secretion has a weakly acid reaction, and no diastatic ferment can be found in its contents.

Japanese Myxinoids.§—Bashford Dean describes *Homea* (= *Bdellostoma*) *burgeri*, *H. okinoseana* sp. n., the largest known Myxinoid, and *Paramyxine atami* g. et sp. n. He throws doubt on the conclusion of Nansen and Cunningham, that *Myxine* exhibits protandric hermaphroditism. It is necessary to collect large numbers throughout the year to reach a well-established conclusion on this point.

Japan seems to be the most favourable region for the study of Myxinoids. "In an especially conservative locality, as at Misaki, we can still catch a glimpse, so to speak, of the better days of the Myxinoids, for here there are living side by side three distinct genera represented by at least four species." The author directs attention to the wide range in the variational characters of species.

Thames Fisheries.‖—James Murie reports on the physical formation, fauna, and fisheries of the Thames estuary, incorporating a wealth

* Proc.-Verb. Soc. Sci. Bordeaux, 1902, pp. 18–19.
† Ann. Nat. Hist., xiii. (1904) pp. 161–90.
‡ Zeitsch. wiss. Zool., lxxv. (1903), pp. 112–46 (2 pls.).
§ Journ. Coll. Sci. Univ. Tōkyo, xix. (1904) art. 2, pp. 1–23 (1 pl. and 4 figs.).
‖ Report on Sea Fisheries and Fishing Industries of the Thames Estuary. Kent and Essex Sea Fisheries Committee, 1903. See Ann. Nat. Hist., 1904, pp. 325–6.

of material largely based on original observation. We select two items: Whitebait, believed to consist mainly of young herrings, is a very mixed collection of small fishes, and Dr. Murie adds 20 to the 11 species which were listed by Frank Buckland in 1879; the White Gaby, *Aphia pellucida*, supposed to be rare in the district, is very abundant in March and April, and Dr. Murie throws doubt on Collett's conclusion that it is an *annual* fish, which dies after breeding.

Adipo-hepatic Function in Invertebrates.* — C. Deflandre gives the results of investigations on a series of types. The leading points seem to be as follow. In Worms the existence of fat-droplets in the cells of the "stomach intestine" indicate the existence of this function in a simple state. In Echinoderms the function is correlated with that of the genital organs. In the Starfish, near the reproductive period, the hepatic cæca diminish in volume and liberate their reserve products, which probably aid in the development of the genital elements. The fat abundance corresponds to these variations. When the genital organs have atrophied, the hepatic tubes are hypertrophied, and occupy the whole of the arm. In Urchins there is a thickening of the walls of the middle intestine, and the cells of this part in containing fat-droplets show an adipo-hepatic function. In Molluscs the hepatic gland appears to possess secretory and digestive functions like that of the pancreas. It stores all the materials of which the organism has need—iron, lime, glycogen, and fat. In this it is like the liver. It also shows seasonal variations in quantity of fat, e.g. *Mytilus*. In the Oyster, from November to March (the reproductive period) there is no fat, while from March to November fat is abundant. In Crustacea the gland possesses digestive, excretory, absorbent, arrestive, and anti-coagulative functions. There is a large supply of fat, of which there is a seasonal variation, which is constant in a species.

Tunicata.

Development of Branchial Apparatus in Tunicata.† — Charles Julin has studied this in numerous types, and has reached a number of important conclusions bearing upon the phylogeny of Tunicates. He finds that *Distaplia* is a Tunicate provided with two pairs of branchial clefts, subdivided secondarily into several (four) transverse rows of branchial stigmata. As in Appendiculariæ, the branchial apparatus of *Salpa* exhibits only one pair of branchial clefts, which remain undivided throughout the whole of life. In *Pyrosoma* we have also to deal with a Tunicate with one pair of clefts subdivided, and the same is probably true of the Doliolidæ. As in *Distaplia*, so in *Clavelina* and *Perophora* there are two pairs of branchial clefts, subsequently subdivided into several rows of branchial stigmata. In all the simple Ascidians whose development has been studied there are three pairs of branchial clefts.

Polymorphism of Dolchinia.‡—A. Korotneff describes a colony of

* Journ. Anat. Physiol., xl. (1904) pp. 73–110.
† Zeitschr. wiss. Zool., lxxvi. (1904) pp. 544–611 (42 figs.).
‡ Biol. Centralbl., xxiv. (1904) pp. 61–5.

Dolchinia which he has found in cylindrical pieces up to 40 cm. in length. On each piece there is a groove in which buds arise, which passing round the cylinder appear on the dorsal side as fully-developed organisms. These represent a second sexless generation, and bear secondary buds of different sizes. There are three generations in the life cycle: (1) a solitary nurse form, with stolon and tail, (2) nurse generation, fixed to the tail, and (3) a free sexual generation. The main difference from *Doliolum* consists in the presence of lateral buds on the cylinder, which the author considers are respiratory animals without nutritive function.

INVERTEBRATA.

Mollusca.

γ. Gastropoda.

New Type of Gastropod.*—Heinrich Simroth describes a peculiar form—*Ostracolethe fruhstorferi* g. et sp. n.—from Tongkin. There is a rudimentary shell with a calcareous plate pressed into the intestinal sac, a large thin conchin membrane, and an apex visible through a cleft in the mantle. The jaw-plate is delicate, the radula has an extraordinarily large number of uniform teeth, with two points and a coiled papilla at each side; the oral disc is circular. The seminal filter is segmented into a number of muscular discs, and there are many other peculiarities.

Simroth discusses the affinities between *Ostracolethe* and the Janellidæ, and the Hedylidæ. Subsequent sections are devoted to the origin of the Æolidiæ, the probable pedigree of the Holohepaticæ, the origin of the Prosobranchs, hermaphroditism in Molluscs, geographical considerations, and a survey of Gastropods from an evolutionist point of view.

Abyssinian Slugs.†—H. Simroth gives a descriptive account of a collection of twenty-one slugs from Abyssinia, including a new genus *Varania*. The slug fauna of this region is extraordinarily rich and peculiar; it includes the phyletic root of *Limax arborum*,—the transition between *Agriolimax* and *Lehmannia*; the Urocyclid fauna of Abyssinia has nothing in common with that of Cameroon: it is rather linked (by *Spirotoxon*) to that of German East Africa. The peculiarities of the Abyssinian slugs, as to coloration, gut-coils, penis, etc., are discussed, and are interpreted in terms of the author's "*Pendulationstheorie*." Interesting notes are made on the coloration. There is a close connection between the pigments and the uric concretions—both nitrogenous excretions of the hæmolymph, which may in diverse ways replace one another both internally and in the skin. The excretion of concretions instead of pigments seems to be prompted by the warm climate, and is predominant in Africa, both on the skin and in the blood-vessels.

* Zeitschr. wiss. Zool., lxxvi. (1904) pp. 612–72 (1 pl.).
† Zool. Jahrb., xix. (1904) pp. 673–726 (4 pls. and 4 figs).

Nepionic Stage in the Gastropods.* — H. L. Kesteven discusses different types of transition from embryonic to neanic shell structure, as seen in *Melo indicus*, *Lotorium abbotti*, and *Triphora*. He arrives at the following definition of the nepionic stage, "That stage during which the velum undergoes degeneration and disappears," and maintains that "where no varix is thrown up at the conclusion of the embryonic shell, no conchylaceous record of the nepionic stage has been left by the mollusc." He admits that the pseudoprotoconch may be the homologue of the embryonic varix, and that it is likely that some pseudoprotoconchs are nepionic.

Inverse Symmetry in Gastropods.† — E. G. Conklin finds that inverse symmetry may be traced from the first cleavage of the egg, which in such cases is found to be inverse, and he considers that this must be preceded by an inverse organisation of the unsegmented egg. No inverse organisation can be detected in the ovarian eggs of sinistral snails, and it is, therefore, probable that it arises about the time of the maturation or fertilisation of the egg.

Maturation and Fertilisation in Cymbulia Peronii.‡—A. Nekrassoff describes the phenomena observed by him in the maturation and fertilisation of this species. In particular his results do not support Boveri's view of the origin of the "segmentation centrosomes." His conclusion is that they arise *de novo*. There is no connection, he thinks, between them and the egg centrosome which has disappeared much earlier, nor can they owe their origin to the sperm. "They originate through the mutual relations of the nucleus and the plasma."

δ. Lamellibranchiata.

Secretion of Pearls.§ — R. Dubois has made for years a study of pearl-formation in *Margaritana*, *Unio*, *Anodonta*, *Pinna*, *Mytilus*, and *Margaritifera*, and formulates four conclusions. The formation of the pearl and of the nacre cannot be compared to an ordinary simple secretion. The organic basis and the carbonate of lime cannot be secreted by the same element. The apparently diverse structures of pearls are readily explicable as due to the passage of migratory calciferous elements through a fenestrated epithelium secreting the conchyolin. The nacre, though the result of rougher work than the fine pearl, is produced by essentially the same mechanism. Some details of the complex secretory process are given.

Detection of Pearls by means of X-Rays.‖—Raphaël Dubois has been successful in detecting the presence of pearls, even of small size, by means of the X-rays. If this method is readily practicable—and it has been used in Ceylon—it will save much useless destruction of pearl-oysters, etc., and will also economise time.

* Proc. Linn. Soc., N.S.Wales, xxviii. (1903) pp. 443–52.
† Proc. Acad. Nat. Sci. Philadelphia, 1903, p. 753.
‡ Anat. Anzeig., xxiv. (1904) pp. 119–27.
§ Comptes Rendus, cxxxviii. (1904) pp. 710–2.
‖ Tom. cit. pp., 301–2.

Development of the Gill in Mytilus.* — E. L. Rice gives a preliminary abstract of inquiries on this subject. He notes specially an interesting parallel in the development of the interlamellar connections. This connection in its finished form is a simple bar containing a blood channel, and connecting the two branches of one and the same filament. In an early stage the two branches are connected by a continuous plate of tissue extending from the bend of the filament upwards for a short distance. This is the adult condition in *Arca* and *Modiola*. Later a perforation appears in the plate, and the portion above the perforation is transformed into the characteristic bar-like connection.

Orientation of Tridachnids within their Shells.† — Anthony corroborates the observations of Lacaze-Duthiers which showed that there is not, as is often asserted, any torsion of *Tridacna* and *Hippopus* within their shells. There has been a remarkable shortening of the antero-posterior axis and an elongation of the dorso-ventral and transverse axes, in adaptation, probably, to the mode of life and the massiveness of the shells.

Arthropoda.

Excretion in Arthropods.‡ — L. Bruntz gives an account of the excretory apparatus in Arthropoda, of which he has examined a very representative series. Of kidneys opening directly to the exterior there exist antennary, maxillary, labial, podal, and coxal forms. These are organs consisting of two essential parts, a sacculus or terminal vesicle with epithelium, whose cells have the property of eliminating ammonium carminate injected into the cœlome, and a labyrinth bringing the sacculus into communication with the exterior. In the majority the labyrinth was proved functional by its elimination of injected indigo-carmine. Excretory organs opening by the intermediary of the digestive tubes are Malphigian tubes, cæca of mid-gut and liver. The liver tubes of all higher crustacea were found to eliminate aniline colours. A third type is the closed organ which accumulates or transforms the waste products. This is represented (1) by the nephrocytes. These are variable in form, groups of cells consisting of fibrillar or vacuolar cytoplasm containing masses of excretory products, upon which carminate may be deposited, or it may appear as granules in the cytoplasm.

Generally in one species, there is one kind of nephrocyte, which may be isolated, or grouped into a dense tissue. They are always on the track of the blood currents, they may be ventral or dorsal, in the head (Amphipods), cephalothorax (Arachnids), thorax (Copepods), or on various situations on the appendages. The third type of excretory organ—the closed organ—is also represented (2) by the uric cells of the fatty bodies. These eliminate vesuvin around the granules of sodium urate.

* Ohio Naturalist, iv. (1904) p. 51.
† Comptes Rendus, cxxxviii. (1904) pp. 296–8 (2 figs.).
‡ Arch. de Biol., xx. (1903) pp. 217–422 (3 pls.).

α. Insecta.

Influence of Environment on Caterpillars.*—A. Pictet has made many experiments showing that changes in the environment (diet and humidity) of caterpillars may result in changes in the adults. An aberrant form of *Abraxas grossulariata*, known in nature, was evoked after two generations of dieting on *Euonymus*; the variety *urticoides* of *Vanessa urticæ* was obtained by feeding the caterpillars on the flowers instead of on the leaves of the nettle. The influence of humidity on coloration seems very marked, especially during the transition period between larval and pupal life.

Influence of Humidity on Caterpillars.†—Arnold Pictet finds that humidity has a marked influence on coloration. When the caterpillars of *Vanessa urticæ* and *Polychloros* are fed for ten days with moist leaves, the resulting butterflies have characteristic black markings on the wings. The same kind of result is obtained when the caterpillars are kept in an atmosphere saturated with moisture: then the nervures in *V. urticæ* are strongly marked in black and the margin of the blue spots is densely black and has invaded the normal area of these spots, which are, therefore, very small, though extraordinarily brilliant. In short, humidity is a factor in inducing partial melanism, and modifications in this direction are common in nature *after rainy periods*. It should be noted that when the larvæ of *V. urticæ* are exposed to humid conditions during the transition moult between the caterpillar and pupa state, there result light coloured butterflies with a broad yellow band, crossing the anterior wing and continued in a triangle on to the posterior wing.

Metamorphosis of Insects.‡—Jules Anglas points out the close relations that obtain between the development of the tracheæ and the phenomena of metamorphosis (histolysis and histogenesis). Active centripetal growth on the part of the tracheæ leads to an insinuation of their terminal cells into the muscle-fibres, for instance, where these tracheal cells play an important rôle in histolysis,—a rôle partly mechanical, probably also chemical, but unaccompanied by phagocytosis.

Digestive Function in Insects.§—A. Porta has examined a number of species of various orders, and concludes that the most important agents in the digestion of insects are the glandular folliculi of the gastric cells, of the villous region, and of the mid-gut folds. These possess both a pancreatic and an hepatic function, and are consequently hepato-pancreatic glands. Their secretion acts by the transformation of albumen into true peptones, by the breaking up of neutral fats into glycerin and fatty acids, by the solution of fatty acids directly broken up by bile, forming an acid liquid capable of emulsifying.

Biology of Stingless Honey-Bees of Brazil.‖—H. v. Ihering com

* Arch. Sci. Phys. Nat., xvi. (1903) pp. 585–8.
† Op. cit., xvii. (1904) pp. 110–2.
‡ Comptes Rendus, cxxxviii. (1904) pp. 300–1.
§ Anat. Anzeig., xxiv. (1904) pp. 97–111.
‖ Zool. Jahrb., xix. (1904) pp. 180–287 (13 pls.).

municates many interesting facts concerning the habits and structure of these bees. A comparison of representatives of the genera *Melipona* and *Trigona* with *Apis mellifica* shows, in addition to the characters common to all Apidæ, such as the existence of drones, queens and workers, swarming, collection of honey and pollen, and the use of wax for building, two important structural differences, viz. the rudimentary nature of the sting, and the formation of the wax-plates on the *dorsal* side of the abdomen. These differences have led the author to constitute the genera in question a separate family from the Apidæ. These bees build their nests mostly in the stems or branches of trees; they choose trees that rot easiest; but some build in the earth, as deep as four metres, with a perpendicular, slanting or spirally twisted tube to the surface. The nests and the structural peculiarities are well illustrated in the plates.

Notes on Ants.* — Adèle M. Fielde gives supplementary notes of experiments designed to ascertain whether any of the rays of light to which the ants are exposed in seeking food, so affect their metabolism as to produce that difference of odour, which, as a result of previous experiments, she believes is the cause of hostility between colonies of the same species and variety, and which is co-incident with difference of age in the individuals composing the colony. Incidentally it was found that while at first they instinctively sought shelter from the ultra-violet rays, after ten months' exposure to these, while still sensitive to them, the ants appeared to have learned that they were innocuous and adjusted their behaviour accordingly. On the main quest, however, the results were negative.

Myrmecological Notes.†—Auguste Forel contributes a miscellaneous series of notes on ants. He submits facts which point to a hitherto unheard-of occurrence,—a spontaneous slave-capturing, pillaging expedition undertaken by *Strongylognathus christophi* v. *rehbinderi*. He reports on ants from Kairouan in Tunisia, from Biskra, from Jerusalem, Cashmir, Brazil, and elsewhere, and on *Camponotus universitatis* sp. n., from near Geneva.

Oviposition in Bombyx mori.‡ — Jules Gal points out that the silk-moth lays eggs whether inseminated or not. But while females which have had complete copulation lay their eggs quickly, those which are virgin or which have had their copulation interrupted retain their ova longer. Moreover, while the inseminated females live on an average 9·3 days after oviposition, the 'virgins' live for 11·3 days thereafter.

Wings of Beetles.§—W. L. Tower has made a careful investigation of the origin and development of the wings of Coleoptera. He describes the wing primordium, the formation of the larval wings and the tracheal system of the wings. The chief conclusion arrived at is, that

* Proc. Acad. Nat. Sci. Philadelphia, lv. (1903) pp. 491–5.
† Revue Suisse Zool., xii. (1904) pp. 1–52 (1 fig.).
‡ Comptes Rendus, cxxxvii. (1903) pp. 932–4.
§ Zool. Jahrb., xvii. (1903) pp. 517–72 (7 pls. and 8 figs.).

the whole of the evidence points to Verson's view that the wings of Coleoptera are derived from the spiracular rudiments of the meso- and meta-thorax. He then states the objections to the Müller-Packard theory of lateral or dorsal prolongations of the tergum, and gives, as two strong objections to the tracheal-gill theory of Gegenbaur, that the ancestry of Pterygota points to a terrestrial, not to an aquatic form; and that tracheal gills are secondary adaptive structures, and so of no phylogenetic significance.

Destruction of Winter Ova of Phylloxera by Lysol.*—G. Cantin gives an account of very successful experiments in which, by using lysol, he destroyed the winter ova of the Phylloxera without in any way hurting the vine.

New Scale-Insect from India.†—E. P. Stebbing describes the life-history of *Monophlebus stebbingi* Green, abundant on the valuable Sâl trees. There are many interesting facts concerning this pest: their sugary exudations can be heard dropping from the tall trees like raindrops after a smart shower; the female has the power of dropping from great heights without harming itself; the female lays between 400 and 500 eggs, and after the egg-laying, which seems to last from a fortnight to three weeks, both the male and female insects disappear from the forest. The author also discusses the life-history of a Coccinellid, *Vedalia guerinii*, predaceous on *M. stebbingi*, and contributes some general remarks on the Monophlebinæ of the Indian region.

Notes on Rhynchota.‡—W. L. Distant gives, in a concluding paper, summaries of the generic characters of the Capsidæ contained in the British Museum.

Luminosity of Lampyridæ.§—J. Bougardt has investigated the structure and relation to the tracheal and nervous systems of the luminous organs in this family of beetles. Their physiology he has studied experimentally by subjecting the insects to a variety of abnormal chemical and physical conditions, such as immersion in carbon monoxide, hydrogen, oxygen, etc., warming, drying, placing in vacuo. It appears that luminosity persists some time after death, although it ceases temporarily under the foregoing conditions. It is not certain whether oxygen is used in the production of light.

Structure of Pediculidæ.‖—N. Cholodkovsky gives some notes on the development of *Pediculus*. In particular he describes at the blunt end of the egg, a spherical body of large cells with a cavity within and surrounded by an amnion-like envelope. It appears to be constricted off from the posterior end of the germ streak. Eventually it is surrounded by yolk and gradually comes to lie on the ventral side of the embryo under the posterior end of the central nervous system. Later, by differential growth, it lies in a hollow on the lower side of

* Comptes Rendus, cxxxviii. (1904) pp. 178–9.
† Journ. Linn. Soc. (Zool.), xxix. (1904) pp. 142–61 (3 pls.).
‡ Ann. Nat. Hist., xiii. (1904) pp. 194–206.
§ Zeitschr. wiss. Zool., lxxv. (1903) pp. 1–45 (3 pls.).
‖ Zool. Anzeig., xxvii. (1904) pp. 120–5.

the alimentary canal. It is the organ described by other authors in adult Pediculi, and peculiar to them, as an abdominal gland of unknown function.

δ. Arachnida.

Development of Scorpions.*—I. Poljansky gives some notes on the yolk and embryonal envelopes, including the relation to the mother during intra-uterine life, in *Scorpio indicus*. At first, while in the uterus, the embryos are semi-transparent, and do not appear to have so much yolk as other scorpions. The embryo after a certain time becomes detached from the mother through the gradual separation of the inner layer of the uterus from its attachment. The passage of the nutritive material continues by osmosis, a process which is aided by the presence of folds upon the dorsal and lateral regions of the body, which increase the absorptive surface.

Two new forms of Trombidium parasitic in Man.†—F. Heim and A. Oudemans have found in several consecutive summers three specifically distinct larval forms of *Trombidium* parasitic in man. One of these larval forms is referable to *T. gymnopterorum*; the others to new species, *T. poriceps* and *T. striaticeps*. Their salient characters are described. The new species have been found also in various mammals, birds and insects. The three species may occur together in the human skin. All the observations relate to the same locality in France (Buré-la-Forge, Meurthe-et-Morelle).

Comparative Anatomy of Mites.‡—Thor completes an elaborate account of the comparative anatomy of prostigmatic Acarina, in which he deals with the skin, the endosternite, the connective tissue, the leucocytes, the respiration, the digestive apparatus, the cutaneous and salivary glands, the excretory organs, the nervous system, the sensory organs, and the gonads.

ε. Crustacea.

Proportion of Sexes in Shore-Crab.§—R. C. Punnett has studied in reference to Mendel's law the proportion of the sexes in *Carcinus mœnas*. From his data, which relate to 3583 crabs—80·6 males to 100 females—Punnett thinks it may be fairly concluded that (1) during the early stages of growth the proportion of the sexes is equal, and that (2) the approach of sexual activity is accompanied by changes of habit and disposition which, by exposing the males to greater risks, lead to an increased mortality during later stages of growth in this sex, as compared with the females.

If we assume that the death rate in the larval and early post-larval stages is equal for the two sexes, then the former of the above two conclusions is in accordance with the view that Mendel's law applies to sex heredity in the crab. The second conclusion suggests the danger of drawing any conclusion as to the relative numbers in which the

* Zool. Anzeig., xxvii. (1904) No. 2, pp. 49–58.
† Comptes Rendus, cxxxviii. (1904) pp. 704–6 (9 figs.).
‡ Ann. Sci. Nat. (Zool.), xix. (1904) pp. 1–190 (9 pls. and 59 figs.).
§ Proc. Cambridge Phil. Soc., xii. (1904) pp. 293–6.

sexes are produced from the proportion of the sexes at later stages of growth. It further points at a possible connection between sexual dimorphism and a different sexual mortality rate. But until more cases of a similar nature have been investigated, it would be unprofitable to dwell on this point.

Sex Recognition among Amphipods.* — S. J. Holmes has determined experimentally that neither sight nor smell are probable factors in enabling the males of *Hyalella* to recognise the females. It appears that accidental contact in their random movements is the initial factor which effects the union of the sexes. The male has a strong instinct to seize and carry other individuals of the same species, while the female tends to lie passive when touched, and especially so if she is seized. Mutilated males, which could not resist, were carried about for hours by other males, but dead specimens of either sex were not so carried.

New Hyperiid Amphipod.†—A. Senna describes a remarkable new genus, *Thaumonectes*, from the Caraibic Sea, which must be placed near *Thaumatops*, among the Hyperiid Amphipods.

Holopedidæ.‡ — Th. Stingelin discusses this divergent family of Cladocera, in which the second antennæ are uniramose. In addition to *Holopedium gibberum* Zaddach, which occurs in North Europe and North America, he describes *H. amazonicum* sp. n., from the mouth of the Amazon. He gives a revised diagnosis of the genus and the family.

Winter Eggs in Copepods.§—E. Wolf has proved the existence of winter eggs in two species of *Diaptomus*, viz. *D. cœruleus* and *D. castor*. He found, e.g. *D. cœruleus* in muddy holes containing stagnant water in August, which remained dry through the winter. In April of the following year he moistened a small part of the mud, and in two days nauplii were to be seen, whose development was followed till their *Diaptomus* nature was quite clear. Subsequently, he found the eggs in the mud, enclosed within a double envelope.

Annulata.

Cephalisation and Metamerism in Annelids.‖ — A. Malaquin has studied this problem with especial reference to *Tomopteris*, and comes to the following conclusions. The cephalic segment of Annelids had primitively a locomotor function, like the trunk segments, but this has given place to more specialised sensorial functions. The cephalic segment may bear true setigerous outgrowths, homologous with parapodia. Cephalisation has been effected in Annelids by the transformation of a single metamere bearing the buccal orifice.

Nematode in Smooth Muscle-Cells of Nephelis.¶ — A. Schuberg

* Biol. Bull., v. (1903) pp. 288–92.
† Bull. Soc. Entomol. Ital., xxxv. (1903) pp. 93–5 (1 fig.).
‡ Revue Suisse Zool., xii. (1904) pp. 53–64 (1 pl.).
§ Zool. Anzeig., xxvii. (1904) pp. 98–108.
‖ Comptes Rendus, cxxxviii. (1904) pp. 821–4.
¶ Zeitschr. wiss. Zool., lxxvi. (1904) pp. 509–21 (1 pl.).

and A. Schröder describe *Myenchus bothryophorus* g. et sp. n., which occurs in *Nephelis vulgaris*, especially within the smooth muscle-cells. It was also found in the connective tissue and in the cocoon of the same leech. There is only one previous record of a Nematode parasitic in leeches (in the body-cavity of *Glossiphonia stagnalis* or *Clepsine oculata*), and the occurrence inside smooth muscle-cells is also remarkable. The new form, which is marked by the possession of a ventral groove, comes nearest to *Tylenchus* and *Aphelenchus*, but neither of these genera has any representative parasitic in animals.

Platyhelminthes.

Development of Planaria simplissima.*—N. M. Stevens finds that in *Planaria simplissima* the division of the chromosomes in both maturation divisions is longitudinal; that the number of chromosomes in the maturation divisions varies from three to six, but is usually three; that there is nothing corresponding to a typical blastula or gastrula; that after several segmentations the blastomeres form an irregular group, embedded in a syncytial yolk-mass which forms a part of the embryo.

Some of the blastomeres form the embryonic pharynx; others wander through the syncytium. The embryonic layer which covers the secondary yolk taken in by the embryonic pharynx, in no way corresponds to the ordinary gastrula-stage. The solid embryo has, by sucking in yolk through its pharynx, become a hollow ball filled with secondary yolk-cells. It consists of a single layer of syncytial yolk-material, containing scattered blastomeres which feed on the primary yolk-material and multiply until they occupy the whole space previously filled by the primary yolk. Then the inner embryonic cells begin to serve as endoderm-cells to absorb the secondary yolk.

The axial gut and its principal branches are formed as ingrowths from the embryonic layer, dividing up the central space which is filled with secondary yolk. Ectoderm, endoderm, permanent pharynx, eyes, nervous system, gonads, glandular cells and muscle-cells, are all formed by direct differentiation of the embryonic cells of the *one* embryonic or germ-layer. There is no formation of two or three distinct germ-layers, nor are any of the organs formed by folding, as in most other forms. Altogether it is a remarkable story.

Early Development of Fresh-water Dendrocœlida.†—E. Mattiesen confirms the results of earlier observers who held that the syncytium surrounding the blastomeres arises by the fusion of the yolk-cells. He observed the process in *Planaria torva*. He further notes that the embryonic mesenchyme contains elements of all the three germ layers, which explains the origin of diverse organs from it. The development has hardly anything in common with that of marine polyclads, which retain primitive characters. The various modifications in the fresh-water forms are mainly due to the development in the centre of a yolk-cell mass.

* Proc. Acad. Sci. Philadelphia, 1904, pp. 208–20 (4 pls. and 5 figs.).
† Zool. Anzeig., xxvii. (1904) pp. 81–87.

Structure and Development of Distomum cirrigerum.*—E. Warren gives an account of this parasite, which appears to have a secondarily acquired monogenetic life-history. The sexual form can develop from the egg within the crayfish host, and a cercaria-cyst stage occurs, generally before any cell differentiation has taken place in the embryo. After the blastomeres have divided into quite small cells it seems to be a matter of indifference how many of them are enclosed in the thick cercaria-cyst; the excluded cells perish, the enclosed mass will develop into the embryo. Hence up to this period there is no sorting out of hereditary tendencies (except that sometimes the primordium of the cirrus-sac appears quite early) into separate cells, but they reside in the mass as a whole. The author is inclined to minimise the importance of the cell as a unit. There are points, too, in the development which tend to weaken the morphological significance of the usual conception of germ layers.

Incertæ Sedis.

Pelmatosphæra.†—Maurice Caullery and Felix Mesnil describe a new organism—which they call *Pelmatosphæra polycirri*—found as a parasite in the body-cavity of an Annelid, *Polycirrus hæmatodes* Clap. It is a spherical, abundantly ciliated organism, apparently allied to Orthonectids, giving rise by endogenous multiplication to asexual progeny.

Echinoderma.

Fertilisation and Parthenogenesis in Echinoderms.‡—A. Schücking has made many experiments bearing on the physiology of fertilisation and development in *Asterias glacialis*, *Strongylocentrotus lividus*, *Arbacia pustulosa*. The mass of ova, with an acid reaction (due to phosphates of potassium and sodium), exerts a fatal, or a paralysing, or an agglutinating, or an exciting and attractive effect on the spermatozoa, according to its amount and duration of influence. The head of the spermatozoon serves for attachment to the ovum, not for boring into it. The spermatozoon is drawn in by a hyaline protuberance of the ovum-protoplasm. The essential event is the union of the two cytoplasms, which seems to be abetted by the centrosomes at the apex of the sperm. In fertilisation an interlamellar splitting of the vitelline membrane allows water to enter, and development then begins.

Schücking was able to induce parthenogenetic development to an abnormal (delaminate) gastrula stage by the most diverse stimuli,—chemical, thermal, electrical, and luminous. The paper is full of interesting experimental data.

New Genus of Spatangoids.§—F. Jeffrey Bell describes a new genus, *Eobrissus*, of Prymnodesmid Spatangoids, with apex almost central and the anterior ambulacrum flush with the test; the antero-

* Quart. Journ. Micr. Soc., xlvii. (1903) pp. 273–301 (3 pls.).

† Comptes Rendus, cxxxviii. (1904) pp. 217–9.

‡ Pflügers Archiv. Ges. Physiol., xcvii. (1903) pp. 58–97 (1 pl.). See Zool. Centralbl., xi. (1904) pp. 161–2.

§ Ann. Nat. Hist., xiii. (1904) pp. 236–7.

lateral ambulacra are directed forwards, and not at right angles to the long axis of the test; there is an open circumanal fasciole as in *Metalia*. This last feature has generally been regarded as a recent acquisition; its co-existence with the archaic position of the apex is of interest.

Regeneration in Starfish.*—Sarah P. Monks, in studying regeneration of *Phataria* (*Linckia*) *fascialis*, cut arms at different distances from the disc, and a number of the single rays produced new bodies, while the rest of the star-fish produced a new ray. There was little difference in the rate of growth of each. The cut edges heal and draw down towards the oral side of the starfish, then small knobs appear at the end, which grow into rays in which the ambulacral furrow soon appears, with the small mouth in the centre of the rays.

Cœlentera.

Devonian Medusa.†—F. Kinkelin gives a description of *Brooksella rhenana* sp. n., closely allied to Walcott's *Brooksella alternata* from the middle Cambrian. Kinkelin's discovery is of special interest because it is the first Medusa found in the Devonian. It was found near Laurenburg on the Lahn, by Ludwig Petry.

New Cerianthid.‡—L. Roule describes *Pachycerianthus benedeni*. The mesenteries are short, only two reaching the base; the directive mesenteries are thick, giving the directive chamber the form of a cylindrical tube; there is an alternation of fertile mesenteries with acontia and sterile mesenteries without acontia, but with mesenteric filaments; the endodermic musculature is scarcely developed; the wall of the column is thick and substantial owing to the development of the longitudinal musculature and the mesoglœa. Apart from the size of the single specimen (British Museum) and the number of mesenteries, there is a suggestion of the characters of the acontiferous larval forms of Cerianthids. It seems, therefore, that there are non-tubicolous Cerianthids, free-living for at least a large part of their life, which retain some of the larval characters of the ordinary tubicolous types. Roule also notes that there is a marked resemblance between *Pachycerianthus* and some Antipatharia, especially *Stichopathes*.

Porifera.

Spermatogenesis in Porifera and Cœlentera.§—W. Görich finds that there is a close correspondence in the spermatogenesis of *Spongilla fluviatilis* and *Aurelia aurita*. In both, the central corpuscles give rise to the intra- and extra-cellular axial filament and to the middle-piece of the ripe spermatozoon. In both, there is a typical apical portion, and the long tail is formed from the protoplasm of the spermatid. The general result is to show that the processes of spermatogenesis in the lowest Metazoa are closely parallel to those in higher forms. Some

* Proc. Acad. Nat. Sci. Philadelphia, lv. (1903) p. 351 (1 fig.).
† Ber. Senckenberg. Nat. Ges., 1903, pp. 89–96 (1 pl.).
‡ Comptes Rendus, cxxxviii. (1904) pp. 708–10.
§ Zeitschr. wiss. Zool., lxxvi. (1904) pp. 522–43 (1 pl. and 4 figs.).

notes on oogenesis in *Sycandra raphanus*, etc., confirm the results of F. E. Schulze. The ova arise from small amœboid cells, and, as in *Tubularia* and *Pennaria*, there is an absorption of adjacent amœboid cells by the growing ova.

Protozoa.

Reproductive Cycle in Protozoa, Volvocineæ, and Dicyemidæ.* M. Hartmann gives a very full comparative account of the life-cycle in these groups, with special reference to the elucidation of the Mesozoa. He concludes that both Dicyemids and Orthonectids can come under the plan of primary metagenesis, such as we are acquainted with in the Protozoa and Volvocineæ. The paper is accompanied by a tabulated comparative statement of the different stages in the life-history of *Coccidium*, *Volvox*, and *Dicyema*.

New Type of Suctoria.† — S. Awerinzew describes *Astrophrya arenaria* g. et sp. n., a suctorial Infusorian from the plankton of the Volga. It is enclosed in a massive shell of fine sandy particles and plant-remains agglutinated with a clear brown substance. There is an irregular central chamber (145–188 μ), with eight lateral processes (86–190 μ), from the ends of which the suckers emerge. Its position is probably near the family Dendrosomina.

New or Little Known Miocene Foraminifera.‡ — A. Silvestri describes from the Miocene of Piedmont a number of new or imperfectly described forms, e.g. *Ellipsopleurostomella schlichti* sp. n., *E. rostrata* sp. n., *E. pleurostomella* sp. n., *Lagena ventricosa* sp. n., *Ellipsobulimina sequenzai* sp. n.

Trypanosoma and Trypanosomiasis.§ — W. E. Musgrave and M. T. Clegg report exhaustively on an inquiry conducted with special reference to Surra in the Philippines. The work discusses fully the geographical distribution, classification, modes of transmission of the parasite, modes of infection, animals infected, treatment, etc. Only a brief indication of some of the points brought out in this important paper can be given. *Trypanosoma* is distributed over large areas of the tropical and subtropical world, corresponding closely to the malarial zones. Its life-cycle is as yet unknown, but is believed to be completed within living animals. Infection with the parasite is through wounded surfaces, in which biting insects, particularly flies and fleas, serve as the principal agents. Statements concerning the infection of pastures and water, and transmission through sound mucous membranes, have nothing to support them. All methods tried for treatment of the disease have been without results of practical importance or significance.

Trypanosoma in Indian Birds.‖ — W. Hanna gives notes of the occurrence of this parasite in the blood of the domestic pigeon and

* Biol. Centralbl., xxiv. (1904) pp. 18–61.
† Zool. Anzeig., xxvii. (1904) pp. 425–6 (1 fig.).
‡ Atti. R. Acad. Sci. Torino, xxxix. (1904) pp. 4–15 (7 figs.).
§ Report Dept. of the Interior U.S.A., 1903, pp. 1–248.
‖ Quart. Journ. Micr. Sci., xlvii. (1903) pp. 433–8 (1 pl.).

Indian crow. They appear to differ from the only Trypanosoma hitherto described as occurring in birds, and from each other.

Coccidia in Lamellibranchs.‖ — L. Léger describes a monozoic parasite which is extremely common in renal epithelium, branchiæ, etc. of mussels at Calvados. It occurs also in *Mactra*, *Donax*, *Tupes*, and *Tellina*. The oyster is not infected by it. The branchiæ may be riddled by the ripe sporocysts, yet apparently without fatal effect. The parasite belongs to the genus *Nematopsis*, and appears to be closely related to the form inhabiting the mantle of *Solen*.

Piroplasma donovani.† — A. Laveran and F. Mesnil give some details in regard to this parasite, found by Leishman and Donovan in the blood of the spleen of individuals from India, suffering from irregular remittent fever.

* Comptes Rendus, cxxxvii. (1903) pp. 1003-6.
† Tom. cit., pp. 187-9.

BOTANY.

GENERAL,

Including the Anatomy and Physiology of Seed Plants.

Cytology,

including Cell-Contents.

Bivalence of the Chromosomes.* — J. P. Lotsy discusses, with the aid of diagrams, the question of the behaviour of the chromosomes in the reducing divisions of animals and plants. He concludes that there is a true qualitative reducing division, since while the somatic cells have bivalent, the sexual cells have only univalent chromosomes.

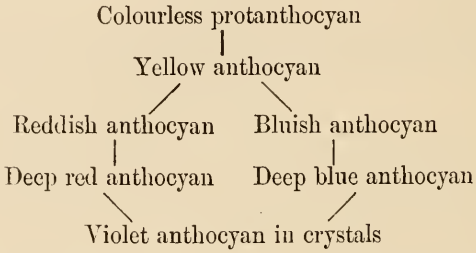
Amitosis in Plants.—W. v. Wasielewski† and B. Nemec‡ have investigated the effects of chloral hydrate in dilute solution upon the division of the nucleus, especially in the roots of seedlings. Both find that treatment with this reagent causes very abnormal nuclear divisions and even multinucleate cells, but that if the treatment is not prolonged, the nuclei and cells return later to their normal state and divide in a typical way. Wasielewski believes, however, that the abnormal divisions are real direct divisions (amitoses), while Nemec is of the opinion that they are merely abnormal mitoses in which, however, the processes of chromosome formation and splitting still occur. Nemec found that by fusion of the abnormally produced nuclei, there were produced nuclei with a double number of chromosomes; presumably a reduction-process occurs later, for such double numbers soon ceased to be seen.

Reduction Division in Ferns.§—R. P. Gregory has examined the early stages in spore-formation in various members of the Polypodiaceæ, and finds that the essential features of the reduction-phenomena recently described by Farmer and Moore are present in ferns. The author describes the details of the reduction division in the spore-mother-cells. The result is a transverse true reduction division of the bivalent chromosomes which characterise the heterotype division. He then proceeds to a discussion of the significance of the reduction division in connection with Mendelian segregation. Viewed from this standpoint the occurrence of a qualitative reduction in plants, as well as in animals, is extremely important as affording a possible provision for that purity of the gametes, in respect of allelomorphic characters, which is demanded by Mendel's hypothesis.

Formation of Anthocyan.‖—T. Ichimura has studied the formation of this pigment to which are due the different shades of red and blue found in plant organs, for instance, in the skin of many ripe fruits, in some young shoots, and in various flowers. The object studied was the

* Flora, xciii. (1904) pp. 65–86 (19 figs.).
† Jahrb. wiss. Bot., xxxix. (1904) pp. 581–606 (figs. in text).
‡ Tom. cit., pp. 645–730 (figs. in text).
§ Proc. Roy. Soc., lxxiii. (1904) pp. 86–92.
‖ Journ. Coll. Sci. Imp. Univ. Tokyo, xviii. (1903) art. 3, pp. 1–18 (1 pl.).

petaloid calyx of *Hydrangea Hortensia* var. *japonica*, which was especially suitable because of the slowness with which anthocyan passes through its different phases of development in this plant, and also because of the long duration of its blossoming period. The different phases are as follows:



When the flowers open the petaloid calyx is yellowish or slightly greenish, the colour being due not to chlorophyll but to the cell-sap. At this stage protanthocyan is already formed, and at a later stage passes into yellow anthocyan which colours the sap of the epidermal cells. Chemical reactions indicate that protanthocyan and yellow anthocyan are allied compounds of tannin or modified phenol compounds. In the second phase (July 1–20) the sepals of the open flowers became coloured red, when exposed to sunlight, by development of red anthocyan, the colour spreading from the apex towards the base. Acids do not produce any marked change in the colour of red anthocyan, but alkalis turn it green. In the third phase (July 20 to August 1) most of the flowers tend to nutate, each sepal becoming turned upside down, when the lower side turns red from the base towards the periphery. The colour is less bright than on the upper face. Microscopical examination shows an increasing number of red epidermal cells on the upper face, while some bluish cells are often met with in the hypodermal layer. On the lower face the red cells occur mainly as irregular idioblasts in the hypoderm. Chlorophyll grains begin to appear at first in the hypodermal cells on both aspects of the leaf, extending later to the middle of the mesophyll. In the last phase (August 1 to September 1) erect flowers can no longer be found. The red colour of the lower face of the sepals becomes darker, chiefly due to the mixing of the epidermal deep red and the hypodermal blue anthocyan. In this phase microscopic examination reveals violet or bluish crystals in the outer layers of the leaf on both faces. Their chemical reactions agree with those of the blue or violet cell-sap, and they must, therefore, be regarded as anthocyan crystals. They dissolve in acids to form a red solution, in potash to form a pale green solution, and in chloral hydrate without any special change of colour. They are doubtless identical with Zimmermann's "pigment secretion" and Kroemer's violet chromatophore. A refractive globule is found in each epidermal cell in this last phase, which closely resembles those described by Kroemer in the coffee-berry; it is probably a proteid combined with fatty bodies.

FARMER, J. B.—**On the interpretation of the Quadripolar Spindle in the Hepaticæ.** *Bot. Gazette*, xxxvii. (1904) pp. 63–5.

Structure and Development.

Vegetative.

Persistence of the Alternate Structure in Cotyledons.* — G. Chauveaud refers to an interpretation of the relation between collateral and radial bundles, which formed the subject of a previous note in the *Comptes Rendus*, 1901. The collateral structure characteristic of the leaf is not primary to the same degree as the alternate arrangement which characterises the root. It represents the last phase of evolution of the conducting apparatus, the alternate arrangement representing the first phase, and the two being connected by an intermediate phase. In all the roots of the higher plants where the conducting apparatus undergoes a complete evolution, there appear (1) the alternate phase, (2) the intermediate, (3) the superposed phase. If instead of following the development in the root we ascend the plant axis, we find a greater or less acceleration of the development, which at a certain level finds expression in the suppression of the two first phases. When development is greatly accelerated, as in the haricot, the suppression occurs suddenly in the neighbourhood of the neck. When on the contrary it is less rapid, as in onion and *Pinus maritima*, the earlier phases persist not only in the tigellum but also in the cotyledons. That is to say there appear in a leaf the same phases already indicated in the root: (1) alternate, (2) intermediate, (3) superposed, a proof that the superposed arrangement in the leaf represents only the last phase of evolution of the conducting apparatus. In a recent note,† the presence of the alternate arrangement has been described in the cotyledons of several Labiatæ. In *Lamium album* and other members of the order, the two primary wood bundles of the radicle pass into the cotyledons, remaining in the same plane, that is, the plane of symmetry of the cotyledons. The bundles do not divide, and no rotation occurs. At a later stage, the first formed elements disappear and only superposed elements are found.

Lignification of Subterranean Organs in Plants of High Regions.‡—A. Dauphiné describes some peculiarities in the structure of the wood of the roots and rhizomes of some herbaceous plants, which when adapted to an alpine climate show a considerable development, living for many years and forming organs of reserve during the period when aërial growth is suspended; successive layers of wood are formed each year. In many families, Ranunculaceæ, Caryophyllaceæ, Rosaceæ, Compositæ, Gentianaceæ and others, the lignification of the secondary wood is irregular. Thus in *Cherleria sedoides* the wood forms a continuous ring surrounding a very reduced pith; the vessels, which are very numerous and of small calibre, are scattered in a cellulose parenchyma, and have but slightly thickened membranes which show no trace of lignification; the medullary rays and the annual layers are not evident. A similar arrangement occurs in the rhizome and root of

* Comptes Rendus, cxxxviii. (1904) pp. 768–72.
† Op. cit., cxxxvii. (1903) p. 804.
‡ Op. cit., cxxxviii. (1904) pp. 592–3.

Silene acaulis and *Gentiana acaulis*, in the root of dandelion, and in numerous rhizomes. Sometimes the pith is more developed, and the vessels do not form a continuous ring. In *Phyteuma hemisphericum* the pith is obsolete, but the medullary rays are very well developed, and the vessels, which alone are lignified, form, in transverse section, narrow radial lines accompanied by a parenchyma with thin cellulose walls. *Trifolium alpinum*, *Lotus corniculatus* and others, show a structure which may be regarded as intermediate between the preceding case and a normal lignification of the secondary wood. The vessels are arranged in radial threads, while the accompanying cellulose parenchyma includes also supporting elements, consisting of elongated fibres of very small diameter and considerably thickened walls, the middle lamella of which shows the lignin reaction, while the internal thickening consists of cellulose, showing sometimes a slight tendency to lignification.

Reproductive.

Morphology of Elodea canadensis.*—R. B. Wylie has studied the morphology of this plant, which is one of the most specialised members of the Helobiales. He describes in detail the development of the pistillate flower; the long floral tube between the ovary and sepals is directed towards the surface of the water by virtue of its low specific gravity brought about by three rows of air spaces. In the male flower, which is much simpler, the receptacle instead of pushing up into a floral tube, becomes merely conical, and gives rise in turn to sepals, outer stamens, inner stamens, and very much later the corolla, which is not prominent and may be quite rudimentary. Four megaspores are usually formed, but in one instance six were observed; the embryo-sac early develops a pouch, in which the antipodal group of nuclei is formed; the polar nuclei approach one another at an early stage, and may remain for a long time side by side; their fusion was not observed before fertilisation. The stamens produce two microsporangia each; the pollen-grains adhere in tetrads, and have a greater specific gravity than that of water. It is of interest that the microspores, though borne by one of the most specialised of submerged aquatics, entirely devoid of cutinised walls in all its vegetative parts, have a strongly cutinised extine and a well-developed intine. In *Najas* and *Zannichellia* on the contrary no extine is developed. The extine in *Elodea* possesses spines which hold back the surface film and imprison sufficient air to keep the spores afloat. The microspore nucleus divides long before the grain has reached its full size; the generative cell is at first crescentic in outline; after its passage into the cytoplasm of the tube-cell it is for a time spherical, but subsequently becomes much elongated, and just before its division into the male cells is curved and may extend nearly across the spore. The tube nucleus shows considerable irregularities in outline during its existence. The formation of male cells occurs long before the pollen-grains are shed; they remain joined together by their elongated ends, while in the pollen-grain they show marked cell-structure; about the nucleus is an extensive mass of cytoplasm differing considerably from the contents of the spore and closely invested by a limiting membrane.

When the staminate flower is mature a bubble of oxygen forms at

* Bot. Gazette, xxxvii. (1904) pp. 1–22 (4 pls.).

the tip, becoming nearly as large as the flower; the buoyancy of the enclosed gas, aided by the low specific gravity of the flower, overcomes the weakened attachment, and the flower darts to the surface. The bubble then disappears, and the sepals snap back quickly, forming three floats, which support the sporangia above the water; the pollen however is nearly all discharged at the moment the flower comes to the surface, the snow-white tetrads being quite conspicuous floating on the water. The pistillate flower is impervious to water and so produces a depression in the surface film. Pollen-grains floating near are brought into contact with the stigmas by means of gravity operating through the declined surface film. The large pollen-tubes penetrate the long floral tube and pass directly through the ovarian cavity to the upturned micropyles. Tubes which have failed to enter ovules often swell up into cyst-like enlargements in the ovary, in which the distinct male cells can be seen. Fertilisation takes place in the usual manner, and the second male cell unites with the endosperm nucleus. The primary endosperm nucleus does not divide until a two-celled embryo has been formed; the pollen-tubes persist until the embryos are well developed. The suspensor cell of the embryo becomes enormously enlarged, and the synergid often increases in size. The primary root is probably functionless, and secondary roots are developed in the seed from the lower parts of the stem.

Pollination of Buckwheat.* — P. P. Richer finds as a result of experiment with *Polygonum Fagopyrum*, a heterostyled dimorphic plant, that the flowers are always quite sterile when self-pollinated, or with pollen from flowers of the same form on the same plant. They are very slightly fertile after illegitimate cross-pollination between flowers of the same form on distinct plants. They are, on the contrary, highly fertile after legitimate cross-pollination between flowers of different form on distinct plants. It seems evident, therefore, that the two forms of flower owe their fertility solely to reciprocal crossing, and consequently that almost all the seeds produced naturally are the result of legitimate union.

Physiology.

Nutrition and Growth.

Nitrogen-assimilation of Fresh-water Algæ.† — J. Reinke describes a symbiosis between *Volvox* and *Azotobacter*, associated with an increase in the amount of combined nitrogen in the solution. He suggests the importance of the latter as a means for obtaining nitrogen from the atmosphere in the case of fresh water as well as of marine organisms. The author adduces in support of his hypothesis the observation of Gerlach and Vogel, that 10 to 12 p.c. of the dry weight of *Azotobacter* consists of nitrogen; it is therefore eminently qualified to act in symbiosis as a nitrogen-assimilator for other plants.

Irritability.

Chemotropism of Roots.‡—F. C. Newcombe and A. L. Rhodes find that the roots of *Lupinus albus* are positively chemotropic towards solu-

* Comptes Rendus, cxxxviii. (1904) pp. 302–4.
† Ber. Deutsch. Bot. Gesell., xxi. (1903) pp. 481–3.
‡ Bot. Gazette, xxxvii. (1904) pp. 23–35.

tions of disodic phosphate, and that no concentration of the solution will produce a negative curve. Stronger solutions (1·5 p.c.) cause first a curving toward the salt and then death. The death of the roots may be due to the osmotic strength of the surrounding medium. The particular attractive component of the salt was not determined; it may be either the sodium or the phosphoric acid ion; the work of Stange and Buller suggests that the PO_4 ion is the active one. Roots of *Cucurbita Pepo* are indifferent towards chemicals, a fact which suggests that sensitiveness to chemicals may vary in the same way as sensitiveness to light; that is to say, roots may be either chemotropic or non-chemotropic. None of the roots tested gave any indication of osmotropism; the experiments suggested that osmotropism and hydrotropism are not identical.

General.

Endophytic Fungus of Orchids.* — Noël Bernard, continuing his investigations on this subject, has endeavoured to cultivate the endophytic organisms of different Orchids. He finds in the case of a hybrid *Cypripedium*, that the fungus, a hyphomycete morphologically identical with that previously isolated from seedlings of *Cattleya*, penetrates the embryo always at the pole turned towards the micropyle. The large fleshy roots of *Spiranthes autumnalis* yielded a hyphomycete indistinguishable from the preceding. The results of experiment suggest that the same endophyte can impregnate different Orchids; that is to say, we are dealing, as in the case of the *Rhizobium* of the Leguminosæ, with a parasite characteristic of the family.

Mechanics of Seed-dispersion in Ricinus communis.† — J. B. Dandeno finds that as the carpels begin to separate in the ripe fruit, one of the three is so placed that the angle of projection of the seed is that which gives theoretically the greatest range; the other two carpels are in a less favourable position. The fruit splits septicidally from the base till a point is reached about 3 mm. from the apex, and meanwhile the carpels also separate from the central column, which bears three projecting processes upon which they are finally suspended. The carpel with its dorsal side uppermost has the most sun exposure and dries most quickly; this is also the one which has the best position for projection. After the carpels are entirely free from the central column, the contraction of the dorsal wall continues until the carpel gives way at its weakest point. This is at the apical end, where are three pairs of tooth-shaped arrangements meeting at a line about 3 or 4 mm. long. Each carpel splits apart at this line with some violence; this acts as a spring suddenly relaxed, and the carpel is projected; the seed, though projected with the carpel, is at this time or soon after, released.

As the result of a calculation the writer finds that the ground covered by the seedlings from a single plant would be approximately 105 acres in 100 years. This calculation is based upon the consideration of the fruit as a projectile alone, and takes no account of other

* Comptes Rendus, cxxxviii. (1904) pp. 828–30.
† Bull. Torrey Bot. Club, xxxi. (1904) pp. 89–92.

means for distributing the seed, such as washing away by water or transportation by wind or animals.

Triadenum virginicum, Rafinesque.*—T. Holm adduces evidence based on morphological and anatomical characters in support of Rafinesque's view of the generic distinction of Linnæus's *Hypericum virginicum*. Rafinesque separated his genus from *Hypericum* solely on the floral glands and reddish flowers, but a study of the plant from the seedling and of the subterranean organs in connection with an anatomical investigation of the vegetative organs compared with those of other species of *Hypericum*, has convinced the writer that *Triadenum* shows sufficient morphological and anatomical characters to entitle it to generic distinction. Its more or less tuberous stolons with scale-like leaves, are not met with among the species of *Hypericum* proper; and the subterranean organs offer several points of interest in which the proposed genus shows a marked deviation from *Hypericum*. The venation of the leaves is also peculiar and characteristic; the veins are very prominent on the lower face of the blade, and the secondaries are more numerous but shorter, and proceeding from the mid-rib under an angle that is much broader than is observable in the leaves of *Hypericum*. In the latter the secondaries proceed, as a rule, from below the middle of the mid-rib, while in *Triadenum* they are noticeable almost to the apex of the blade.

The author gives a somewhat detailed account of the anatomy of the vegetative organs, and points out certain differencies as compared with species of *Hypericum*. The disposition of the ducts seems characteristic of the genus *Triadenum* as compared with the other Hypericaceæ.

Hairs of Aquatic Plants.†—E. Barsali discusses the significance of the hairs of aquatic plants. He cites on the one hand the opinions of Stahl and Schrenk, that muciparous hairs protect the young organs from the attacks of animals, and of colonies of algæ and bacteria; and on the other hand the opinions of Goebel and Schilling, that these hairs remove the young leaves from immediate contact with water. From his own researches, he comes to the conclusion that the sole object of the hairs, whether muciparous or not, is to protect and defend the young organs from external influences.

Development of Stamens in the Interior of the Ovary of Melandryum.‡—F. Buchenau describes some abnormal flowers of *Melandryum rubrum* found near Marburg, which at first sight appeared to be apetalous female flowers. Examination showed them to consist of a single whorl of five leaves, which showed in a manner varying considerably in different specimens the character partly of sepals and partly of carpels. The members were united to form a chamber more or less open at the top; from the lower part of the chamber sprang a whorl of stamens of normal form, generally six to nine in number, sometimes ten. On one occasion a row of ovules was found on the united edges

* Amer. Journ. Sci., xvi. (1903) pp. 369–76 (figs. in text).
† Bull. Soc. Bot. Ital., 1903, pp. 301–7.
‡ Ber. Deutsch. Bot. Gesell. xxi. (1903) pp. 417–24 (1 pl.).

of two adjacent carpel-like members of the outer series. There was never any trace of a central placenta, and the author regards the appearance of the ovules in the unique case as a proof of the origin of the central placenta in normal flowers from the united edges of the carpels.

Monstrosities in Foliage Leaves.*—L. Geisenheyner describes and figures some abnormal leaf-forms. On shoots of *Deutzia crenata* bearing leaves of normal form, other leaves were found showing various stages of union; the author figures a shoot showing a terminal "compound" leaf derived from the union of four displaced simple leaves. He also describes pitcher-formations, involving the whole or part of the leaf in *Magnolia Yulan*, and cases of forking of the mid-rib in leaves of the common Ivy, accompanied with a greater or less indentation or lobing of the central leaf-segment.

MÖBIUS, M.—**History and description of the Botanic Garden at Frankfort-on-the Main.** *Ber. Senckenb. Naturf. Ges. in Frankf.-a.-M.*, 1903, pp. 117–54 (2 pls. and 2 figs. in text).

CRYPTOGAMS.

Pteridophyta.

Development of Vascular Cryptogams.†—G. Chauveaud, as a result of his researches into their embryology, states that the stem of vascular cryptogams is a complex structure. The first divisions in the quadrants of the egg of a fern form a primary meristem, which by differentiation yields a foot, a primary root, a primary leaf, and an undifferentiated portion. The primary root and the primary leaf constitute a primary plantlet, connected with the prothallus by the foot. Between the foot and the primary leaf is the undifferentiated portion, forming a tiny growing point which, when the first leaf has almost reached its complete development, divides actively and forms a second meristem which, on differentiation, gives a continuation of the foot, a second root, a second leaf, and an undifferentiated portion. The second root and leaf form a second plantlet similar to the first, and also connected with the preceding structures by the continuation of the foot. When the second plantlet has reached a certain development, the undifferentiated growing point between the leaf and the foot again divides, and a third plantlet is produced—in short, the fern is built up by a succession of elementary plantlets, consisting of root and leaf, connected by the foot. This mode of formation becomes gradually less evident, owing to rapidity of development resulting in the greater or less fusion of the successive plantlets. The number of cells is also increased in each new generation, and hence these generations, arising at levels less and less distinct, cause a very rapid transverse growth of the structure formed by the fusion of their parts. This body is what we know as the stem, the structure of which becomes increasingly complex with the increasing age of the plant. Thus the stem of ferns represents a fusion of different parts, the number varying according to the level of the section.

* Ber. Deutsch. Bot. Gesell., xxi. (1903) pp. 440–51 (1 pl.).
† Comptes Rendus, cxxxviii. (1904) pp. 511–13.

Antithetic versus Homologous Alternation.* — D. H. Campbell discusses the main arguments put forward in favour of the two rival theories as to the origin of the Bryophyta and Pteridophyta. According to the Antithetic theory, the ferns originated from forms very similar to the simpler existing liverworts, the leafy sporophyte being an elaboration of the non-sexual sporophyte. The Homologous theory maintains that the Bryophytes and Pteridophytes arose quite independently of one another from Algal ancestors—a hypothesis first suggested by the alga-like protonema of the mosses, and the somewhat similar prothallia of certain ferns, especially *Trichomanes*. These filamentous structures the author, a supporter of the Antithetic theory, regards as merely secondary developments. He insists upon the obvious resemblances in the gametophyte of ferns and hepatics, especially the structure and development of the archegonium, and the early stages of the sporophyte and the extraordinarily uniform method of spore-production. The sporophyte of *Anthoceros* in many ways offers the nearest approach to the Pteridophytes, as the author shows. Apogamy is the strongest argument in favour of homologous alternation, but, as it has only been observed in the leptosporangiate ferns (i.e. the most recently evolved and most specialised members of their class), and only in their cultivated forms, apogamy appears to be a pathological phenomenon and not a primitive function. Hence it is difficult to accept the homologous theory that the sporophyte probably arose from the gametophyte as a vegetative outgrowth. The author proceeds to reject this view for other reasons. He gives reasons also for rejecting the view that the sporophyte arose asexually from the gametophyte in response to a call for increased chlorophyll activity. Purely vegetative shoots are of course so produced; but that these gave rise to the leafy sporophyte requires evidence which is not forthcoming. Apospory and apogamy may be compared to adventitious budding. The real explanation of the peculiarities of the leafy sporophyte must be sought in the conditions of water-supply. The bryophytes have never succeeded in emancipating themselves from the aquatic habit. Their rhizoids are inadequate to supply a plant-body of large size. The sporophyte, aërial in habit, by means of its foot draws its water from the gametophyte; and it was not till a root of unlimited growth was evolved, that the sporophyte was enabled to lead an independent existence and attain large dimensions.

Californian Ferns.†—S. B. Parish gives an account of the pteridophyta of California, a State which, stretching 600 miles from north to south, presents great diversity of climatic conditions in latitude, altitude, temperature and rainfall. The latter varies from 60 inches annually in the north to 5 inches or less in the southern deserts. Yet the flora amounts to no more than 76 species. There is a lack of the moist equable warmth which the ferns require for their best development. In the north there is an abundance of a few species, mainly bracken; in the arid south the xerophytic genera—*Pellæa*, *Notholæna* and *Cheilanthes*—exhibit the greatest development. There is a mingling of ferns of a northern and southern type, and it is the latter which are the

* Amer. Naturalist, xxxvii. (1903), pp. 153-69.
† Fern Bulletin, xii. (1904) pp. 1–15.

more interesting and characteristic. The present list is partly a compilation, but is probably correct. Its special interest lies in the records of the distribution of the species within the State.

BAESECKE, P.—**Beiträge zur Pteridophytenflora des Rhein und Nahethales.** (Contributions to the Fern-flora of the Rhine and Nahe Valley.)
[Variations of *Scolopendrium* and *Ceterach*.]
Deutsch. Bot. Monatsschr., xx. (1902) pp. 65–69; xxi. (1903) pp. 54–6, 76–80.

BOLUS, H., & A. H. WOLLEY-DOD—**Ferns of the Cape Peninsula.**
Trans. South African Phil. Soc., xiv. (1903) pp. 363–5.

BORBÁS, V.—**Aspidium Thelipteris var. brachytomum Borb. var. nov.**
Mag. Bot. Lapok., ii. (1903) p. 256.

CHAUVEAUD, G.—**Recherches sur la mode de formation des tubes criblés dans la racine des Cryptogames Vasculaires et des Gymnospermes.** (Researches on the mode of formation of sieve tubes in the root of the Vascular Cryptograms and Gymnosperms.) *Ann. Sci. Nat.*, xviii. (1903) sér. 8, pp. 165–279 (9 pls.).

CHIOVENDA, E.—**Sul nome di alcune felci nostrali.** (On the names of some native Italian ferns.)
[*Phyllitis* is a prior name to *Scolopendrium*, as also is *Polystichum* Roth to *Aspidium* Sw.; and *Cystopteris fragilis* should be corrected to *C. filix-fragilis*, Linnæus having called the plant *Polypodium Filix-fragile*.]
Ann. di Bot. Pirotta, i. (1903) pp. 208–10.

CHRIST, H.—**Can Scolopendrium Lindeni Hook. be separated from S. vulgare Sm.?**
Fern Bull. xi. (1903) pp. 86–7.

" " **Filices Cavalerianæ.**
[List of 48 pteridophyta from Kouy-Tcheou or Kwei-Chou province, in South China, collected by L. Cavalerie, with 13 new species.]
Bull. Acad. Internat. Géogr. Bot., xiii. (1904) pp. 105–20 (9 figs. and 1 pl.).

" " **Les fougères de la Galicia Espagnole.** (The Ferns of Spanish Galicia.)
[Annotated list of ferns collected by Rev. J. B. Merino, including some new varieties.] *Tom. cit.*, pp. 76–81.

CLOS, D.—**Sur une nouvelle localité française de l'Hymenophyllum tunbridgense.** (On a new French station for *H. tunbridgense*.)
Bull. Soc. Bot. France, l. (1903) pp. 592–4.

CLUTE, W. N.—**A new species of Equisetum.**
[*E. Ferrissi*, resembling *E. hyemale*, but differing in measurements of stem and internodes and number of grooves.] *Fern Bulletin*, xii. (1904) pp. 20–3.

" " **The measurement of variation in Equisetum.**
[Comparative measurements of a large number of mature specimens of *E. robustum* and *E. hyemale*, leading to the conclusion that the former is only a stout form of the latter.] *Tom. cit.*, pp. 15–8.

COKER, W. C.—**Equisetum arvense L.**
[Illustrated note on the young prothallia.]
Bot. Gazette, xxxvii. (1904) pp. 60–1 (figs. in text).

EATON, A. A.—**The genus Equisetum in North America. XVI. E. variegatum.**
Fern Bulletin, xii. (1904) pp. 23–5.

FIELD, H. C.—**Note on Hybrid Ferns.** *Trans. Proc. New Zealand Inst.*, xxxv. (1903) pp. 372–3.

GÈZE, J. B.—**Note sur la présence de l'Asplenium viride Huds. dans les environs de Toulouse.** (Note on the presence of *A. viride* in the neighbourhood of Toulouse.
Bull. Soc. Bot. France, l. (1903) pp. 481–2.

GILBERT, B. D.—**A new Fern from Bermuda.**
Amer. Botanist, iv. (1903) pp. 86–7.

GWYNN-VAUGHAN, D. T.—**Observations on the Anatomy of Solenostelic Ferns.**
Ann. Bot., xvii. (1903) pp. 689–743 (3 pls.).

W. H.—**Kew Notes. Rare Ferns.** *Gard. Chron.*, 1904, p. 140 (fig.).

HEY, W. C.—**Asplenium adiantum-nigrum in East Yorkshire.**
Naturalist, 1904, p. 32.

HILL, E. J.—**Remarks on some Fern-worts of Western New York.**
Fern Bulletin, xii. (1904) pp. 18–20.

HIERONYMUS, G.—**Selaginellæ novæ.**
[Descriptions of three new West Indian species.]
Urban's Symbolæ Antillanæ, iii. (1903) pp. 524–7.

,, ,, **Selaginellarum species novæ vel non satis cognitæ. II. Selaginellæ e subgenere (vel sectione) Heterophyllo.** (Species of *Selaginella* which are new or insufficiently known. Part II. Species of the sub-genus or section *Heterophyllum*.)
[A continuation, giving full descriptions of 44 species, with critical notes.
Hedwigia, xliii. (1904) pp. 1–65.

JOHNSON, T.—**Tyloses in the Bracken Fern (Pteris aquilina L.).**
Proc. R. Soc. Dublin, x. (1903) pp. 101–3 (1 pl.).

KRIEGER, W.—**Die Formen und Monstrositäten von Polypodium vulgare L. in der Umgebung von Königstein (Königreich Sachsen).** (The forms and monstrosities of *P. vulgare* in the environs of Königstein, Saxony.)
Hedwigia, xliii. (1904) pp. 74–7.

KUHN, M., & OTHERS—**Flora portoricensis. Pteridophyta.**
[Systematic enumeration of the pteridophytes of Porto Rico, 254 species.]
Urban's Symbolæ Antillanæ, iv. (1903) pp. 1–70.

LÉVEILLÉ, H.—**Quelques fougères anormales du Maine.** (Some abnormal ferns of Maine.) *Bull. Soc. Agric. Sci. Art. Sarthe.*, ser. 2, xxxi. (1903) p. 176.

LUERSSEN, C.—**Botanische Ausbeute einer Reise durch die Sinaihalbinsel von A. Kneucker. Pteridophyta.** (Botanical results of A. Kneucker's journey through the Sinai peninsula. Pteridophytes.)
[Contains a description of a new form of *Equisetum*.]
Allg. Bot. Zeitschr., 1903, pp. 184–5.

MACLOSKIE, G.—**Pteridophyta (collected in Fuego and Patagonia by J. B. Hatcher).**
[Forty-three species determined by L. M. Underwood.]
Princeton University Exped. to Patagonia, viii. (1903) pp. 127–38.

MAXON, W. R.—**A study of certain Mexican and Guatemalan species of Polypodium**
Contr. U.S. Nat. Herb., viii. (1903) pp. 271–89 (2 pls.).

POOLE, H. S.—**On a polished section of Stigmaria, showing an axial cellular structure.** *Proc. Trans. Nov. Scot. Inst. Sci.*, x. (Halifax, 1903) pp. 345–7 (2 pls.).

R[OUY], G.—**Sur l'habitat des Hymenophyllum tunbridgense Smith et unilaterale Bory.**
[The geographical distribution of these two species.]
Rev. Bot. Syst. Geogr. Bot., i. (1904) pp. 186–9.

STOPES, M. C.—**The Epidermoidal layer of Calamite Roots.**
Ann. Bot., xvii. (1903) pp. 792–4 (fig.).

TRABUT, L.—**Sur la présence de l'Isoetes setacea Bosc. en Portugal.** (On the presence of *I. setacea* in Portugal.) *Bull. Soc. Bot. France*, li. (1904) p. 28.

UNDERWOOD, L. M.—**Four recently described Ferns from Jamaica.**
Jamaica Bull. Dept. Agric., 1903, pp. 136–8.

WATERS, C. E.—**Ferns: a Manual for the North-eastern States.**
[A popular work, containing keys based on the fibrovascular bundles of the stipes.]
New York, Holt, 1903, xi. and 302 pp., with over 200 process figs.

WEBER, E. A.—**Der Duwock (Equisetum palustre L.).**
Arb. Deutsch. Landw. Ges., Heft. 72 (1903) 71 pp. (3 pl.).

WITTMACK, L.—**Geschichte und Beschreibung des Adiantum Farleyense Thomas Moore.** (History and description of *A. Farleyense*.)
Gartenflora, lii. (1903) pp. 631–4, 643–4.

ZEILLER, R.—**Hymenophyllum tunbridgense dans la région de Cambo.**
Bull. Soc. Bot. France, l. (1903) pp. 590–2.

Bryophyta.

Origin of Moss-Archegonium.*—G. M. Holferty discusses the development of the archegonium of mosses, and especially of the axial cells, basing his views upon a study of *Mnium cuspidatum*. After a short historical account of previous researches, he describes the early stages of the archegonium, the behaviour of the terminal cell and the canal cells, the division of the central cell, the peripheral cells. He attempts to establish the homology of archegonia and antheridia by showing the homology (1) of the early stages ; (2) of the cells of the axial row ; and (3) of the axial row series and sperm mother-cells. He thinks that both archegonia and antheridia may have had a common origin in the asexual multilocular terminal zoosporangium of some primitive extinct genus of Chlorophyceæ.

Critical Notes on Muscineæ.†—V. Schiffner begins a series of critical notes on new or little known mosses and hepatics, with remarks on their distribution, morphology and biology. He gives a detailed description of *Scapania nepalensis* Nees, and discusses its affinity. He has examined the original specimen of *Gymnoscyphus repens* Corda, and finds it to be parocious and identical in structure with *Aplozia pumila*. Hence the genus *Gymnoscyphus*, a long-standing puzzle, must be suppressed. He discusses *Lepidozia reptans* forma *laxa* Jaap, an interesting plant which must be regarded either as linking *L. reptans* with *L. Pearsoni*, or as a new species, *L. intermedia*. He describes *Cephaloziella Jackii* var. *Jaapiana*, an interesting instance of modifications caused by change of environment. He gives the chief characteristics of *C. byssacea* var. *verrucosa* Jens., and is inclined to regard the plant as a mere form.

Rhynchostegium litoreum.‡—H. N. Dixon discusses the systematic position of this moss, which occurs along the Mediterranean coast and also in the south of England. He has received specimens from Algiers, the first record for Africa. Its affinity he considers to be with *R. tenellum* rather than with *R. curvisetum*, for reasons which he states in detail. As an alternative, he raises the question whether *R. litoreum* may not be a hybrid of the other two species.

Tyrolean Muscineæ.§—K. W. v. Dalla Torre and Ludwig Graf von Sarnthein have issued the fifth volume of their flora of Tyrol, Vorarlberg and Liechtenstein, containing a list of 182 hepatics and 731 mosses, with numerous varieties. A complete account of the distribution in the several botanical provinces is given, with the collector's name, substratum, altitude, and references to the literature where the record is to be found. Limpricht's classification has been employed for the mosses, and assistance has been obtained from Matouschek, Schiffner and Stephani. A chapter on the history of bryological research in Tyrol and a copious index are added.

* Bot. Gazette, xxxvii. (1904) pp. 106–126 (2 pls.).
† Oesterr. Bot. Zeitschr., liv. (1904) pp. 52–8, 102–4.
‡ Rev. Bryol., xxxi. (1904) pp. 21–3.
§ Flora von Tyrol, Vorarlberg, Liechtenstein. V. Die Moose. Innsbruck, 1904, liv. and 671 pp. (1 portrait).

North American Mosses.*—J. M. Holzinger discusses the external structure of *Anacolia*, and amends Schimper's description of the genus by the admission of a rudimentary peristome in certain cases, thus bringing within the generic limits two North American species previously placed in *Bartramia* and *Glyphocarpus*. J. Cardot † publishes notes on eight North American mosses. J. F. Collins ‡ corrects some erroneous citations made by Limpricht, Schimper and others, from Nees and Hornschuch's *Bryologia Germanica*, concerning *Weisia* and *Hymenostomum*. P. M. Towle and A. E. Gilbert § give some notes on the fertilisation of *Polytrichum* at Vermont. The antheridia and archegonia reach maturity in April; and fifteen months later the spores in the sporophyte are ripe for dispersal.

Patagonian and Fuegian Mosses.‖—P. Dusén gives an account of the 71 mosses collected by J. B. Hatcher in 1896–7, near Rio Chico, etc., including 24 new species. The latter are fully described and figured. Two long lists follow: consisting of (1) described species; (2) species named, but not yet described in print. The same writer also gives an account of the leading features of the vegetation of western Patagonia from his own experience, and conveys therein much information about the habitats and distribution of the Muscineæ.

Hawaiian Mosses.¶—E. Levier gives an historical account of the collections of mosses which have been made in the Sandwich Islands, and of papers published upon them. Having submitted to V. F. Brotherus a set of specimens gathered by D. D. Baldwin, he gives a list of the determinations, comprising 163, of which 74 are new species, 14 are new to the archipelago, and 75 had been previously recorded. The total number of species recorded for the islands is now 254, and that of the genera is 86. The island of Maui yields the richest moss-flora.

Morphology and Biology of Ricciocarpus natans.**—J. F. Garber describes the life-history of *Ricciocarpus natans* under the headings: material and methods; the thallus; the sex-organs; fertilisation; the sporophyte; biology. When fruiting (in spring) the plant floats on the surface. The plant is monœcious and bears the sex-organs in definite groups, the antheridia preceding the archegonia. The earliest division of the sporophyte is transverse or oblique; and the early subsequent divisions are irregular. Much nutritive material is excreted into the capsule. There is no indication of elaters or of a sporophyte foot; but a structure, which is the physiological equivalent of a foot, is developed from the basal cell of the archegonium. The gametophyte number of chromosomes is four; that of the sporophyte is eight. Plants stranded on wet soil take root and lose their ventral plates, but if inundated again are unable to resume the floating condition unless

* Bryologist, vii. (1904) pp. 23–9.
† Tom. cit., pp. 30–1.
‡ Tom. cit., pp. 32–3.
§ Tom. cit. pp. 35–6.
‖ Princeton Univ. Exped. Patagonia, viii. (1903) pp. 1–33; 63–125 (7 pls.; figs. in text).
¶ Bull. Soc. Bot. Ital., 1904. pp. 7–25.
** Bot. Gazette, xxxvii. (1904) pp. 161–77 (2 pls. and figs.).

the young apices manage to break away to the surface of the water. The apices have great plastic capacity. The sporophyte is liable to attack by an Ustilagineous fungus.

Mycorrhiza of Liver-worts.—Anton J. M. Garjeanne* has examined the mycorrhiza found in the rhizoids of a great many hepatics, and concludes that they are more of the nature of parasites than of symbionts. The fungus penetrates the rhizoid from the soil, and the invaded cells become more or less disorganised. Many examples were found to be entirely free from hyphæ and yet growing vigorously. The author thinks that in these lower plants mycorrhiza is of less importance than in the higher forms.

B. Nemec † discusses the relation of the mycorrhiza to its host in *Calypogeia trichomanis*. He points out that it is found only in the short-lived rhizoids, that it enters them from the outside and never from the hepatic thallus, that it forms pseudoparenchymatous swellings in the rhizoid initials, and may throw out haustoria into neighbouring cells but spreads no further, being kept at bay by the vitality of the host. Its presence in, or absence from, the hepatic appears to depend upon the habitat of the latter. While the mycorrhiza benefits by the symbiosis, the hepatic appears neither to benefit nor to suffer by its presence, so far as the author can determine.

Patagonian Hepatics.‡—A. W. Evans gives an account of the 53 hepatics gathered by J. B. Hatcher on the south coast of Tierra del Fuego, and in Patagonia by J. B. Hatcher in 1896–7. Two new species and some rare and incompletely known forms are described and commented upon. A supplementary list of all known hepatics from the region of the Magellan Straits is added.

BARKER, T.—**Note on Tortula rigida Schrad. and Tortula brevirostris Hook. and Grev.**
[A doubt as to whether these are really distinct species.]
Rev. Bryol., xxxi. (1904) p. 23.

BAUER, E.—**Musci Europæi exsiccati, series I.** Prague, 1903, 16 pp.

BENA, M.—**Die Laubmoosflora des Ostrawitzathales.** (Moss-flora of the Ostrawitzathal.)
[An annotated list of 240 species, 10 of which are new to Moravia and Silesia.]
Verh. naturf. Ver. Brünn, xli. (1903) pp. 3–27.

BLIND, C.—**Note complémentaire sur les Sphaignes de la région jurassienne.** (Supplementary note on the sphagna of the Jura.)
Bull. Soc. Nat. Ain, 1903, pp. 16–18.

BOTTINI, A.—**I primi Muschi delle isole Eolie.** (The first Mosses of the Æolian islands.)
[Fifty-eight species.] *Bull. Soc. Bot. Ital.*, 1903, pp. 294–9.

BROTHERUS, V. F.—**Musci Hawaiici, quos legit D. D. Baldwin.** (Mosses of the Sandwich Islands, collected by D. D. Baldwin.)
[List of 163 species, of which 74 species and 5 varieties are new.]
Op. cit., 1904, pp. 14–25.

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* Beih. Bot. Centralbl., xv. (1903) pp. 471–82 (10 figs.).
† Op. cit., xvi. (1904) pp. 253–68 (1 pl.).
‡ Princeton Univ. Exped. Patagonia, viii. (1903) pp. 35–62 (3 pls.).

BROTHERUS, V. F.—**Musci novi Dussiani.** (New mosses collected by Duss.)
[Descriptions of 20 new species from Martinique and Guadeloupe.]
Urban's Symbolæ Antillanæ, iii. (1903) pp. 421–9

BROWN, R.—**On the Musci of the Calcareous Districts of New Zealand, with descriptions of 35 new species.**
Trans. Proc. N. Zeal. Inst., xxxv. (1903) pp. 323–42 (6 pls.)

BRUCKNER, FAMILLER, AND OTHERS—**Flora exsiccata Bavarica. Bryophyta. Lf. 9–12, Nos. 201–300.**
Mitt. Bayer. Bot. Ges. Erf. Heim. Flor., 1904, pp. 348–9.

BRUNNTHALER, J.—**Ueber die Wachsausscheidung von Ditrichum glaucescens.** (On the secretion of wax in *D. glaucescens.*)
Oesterr. Bot. Zeitschr., liv. (1904) pp. 94–6.

CAMUS, F.—**Muscinées recueillies en Corse en mai et juin 1901.** (Muscineæ gathered in Corsica in May and June 1901.)
Bull. Soc. Bot. France, l. (1903) pp. cli–clxxv.

CARDOT, J., ET I. THÉRIOT—**Mousses de Kouy-Tcheou (Chine).** (Mosses of the Chinese province Kwei-Chau.)
[Contains 16 species, collected by E. Bodinier, two of which are new.]
Bull. Acad. Internat. Géogr. Bot., xiii. (1904) pp. 81–4 (1 pl.).

CORBIÈRE, L.—**Contribution á la flore bryologique de l'Algérie.** (Contribution to the moss-flora of Algeria.)
[A list of 104 mosses and 34 hepatics, of which 11 mosses and 24 hepatics are additions to the flora.] *Rev. Bryol.*, xxxi. (1904) pp. 31–42.

CUFINI, L.—**Contributo alla Flora Briologica del Canadà.** (Contribution to the moss-flora of Canada.)
[List of 33 British Columbian mosses.]
Bull. Soc. Bot. Ital., 1903, pp. 287–90.

CULMAN, P., UND J. WEBER—**Verzeichnis der Laubmoose des Kantons Zürich.** (List of the mosses of Canton Zürich.)
Mitt. Nat. Ges. Winterthur, 1903, pp. 3–80.

DAVIES, J. H.—**Moss notes from North Ireland.**
[List of 47 species, 6 new to Ireland.] *Irish Naturalist*, 1904, pp. 15–21.

DIECKHOFF, H.—**Beiträge zu einer Mossflora von Geestemünde.** (Contributions towards a moss-flora of Geestemünde.)
Aus. d. Heimat f. d. Heimat, 1903, pp. 3–16.

DIXON, H. N.—**Discelium nudum Brid. in Northants.**
[A new, and the southernmost British record for the species.]
Journ. Bot., xlii. (1904) p. 55.

" " **Pottia Heimii Fürnr. inland.**
[Records the occurrence of this distinctly maritime moss in Northamptonshire. It has also been recorded from other inland districts in Kent, Yorkshire, Somerset, and Hereford.] *Tom. cit.*, pp. 55, 89.

" " & W. E. NICHOLSON—**Bryological notes on a trip in Norway.**
Nyt Mag. Naturv., xlii. (1904) pp. 91–6.

GEHEEB, A.—**Botanische Ausbeute einer Reiser durch die Sinaihalbinsel von A. Kneucker. Bryophyta.** (Botanical results of A. Kneucker's journey through the Sinai peninsula. Bryophytes.)
[Includes 20 species, 14 of which are new to Sinai, among them being two new to science, two hitherto known only from Kurdistan, and one recorded only from New Zealand.] *Allg. Bot. Zeitschr.* 1903, pp. 185–9, 203–4; 1904, pp. 4–5.

HAGEN, J.—**A propos de l'inflorescence du Bryum pallescens.** (The inflorescence of *Bryum pallescens.*) *Rev. Bryol.*, xxxi. (1904) p. 30.

" " **Sur la position systématique du Dicranum molle.**
[A claim that this moss should be put into the *Scoparia* group, and not into *Arctoa.*] *Tom. cit.*, pp. 28–9.

HANDEL-MAZZETTI, H. VON—**Beitrag zur Kenntnis der Moosflora von Tirol.** (Contribution to our knowledge of the moss-flora of the Tyrol.)
Verh. K. K. Zool. Bot. Ges. Wien, 1904, pp. 58–77.

HERZOG, T.—**Die Laubmoose Badens. Eine bryogeographische Skizze.** (The mosses of Baden. A bryogeographical sketch.)
[Continuation. Distribution and main characteristics of 51 species.]
Bull. Herb. Boissier, iv. (1904) pp. 241–56.

JENSEN, C.—**Cephalozia striatula, nova sp.**
[Description of a new Danish hepatic.]
Rev. Bryol., xxxi. (1904) pp. 25–7 (figs.).

„ „ **Hypnum (Brachythecium) validum, nova sp.**
[Description of a new Danish moss.] *Tom. cit.*, p. 24 (fig.).

LANGERON—**Les Mousses sociales du Palatinat.** (Moss associations of the Palatinate.)
[A study of the Harpidia and other social groups of mosses.]
Bull. Soc. Bot. France, l. (1903) pp. 430–58.

LAUBINGER, C.—**Laubmoose von Niederhessen (Cassel) und Münden.** (Mosses of Lower Hesse (Cassel) and Münden.)
Abh. Ver. f. Nat. Cassel, xlviii. (1903) pp. 1–80.

„ „ **Lebermoose in nördlichen Reg.-Bezirke Kassel und Münden.** (Liverworts in the northern parts of the Kassel and Münden district.)
Abh. Ber. Ver. Naturk. Kassel, 1903, pp. 88–96.

LITSCHAUER, V.—**Beitrag zur Kenntniss der Moosflora Algiers.** (Contribution to a knowledge of the moss-flora of Algiers.)
[A résumé of previous publications on the subject, together with the beginning of a revised list of the species.]
Oesterr. Bot. Zeitschr., liv. (1904) pp. 104–12.

„ „ **Beitrag zur Kentnis der Moosflora Tirols.** (Contribution to our knowledge of the moss-flora of Tyrol.) *Op. cit.*, liii. (1903) pp. 370–6.

MACVICAR, S. M.—**New British Hepaticæ.**
[Records the occurrence of *Lophozia guttulata* and *Odontoschisma Macounii* in the Highlands, and adds some brief notes.]
Journ. Bot., xlii. (1904) p. 88.

MATOUSCHEK, F.—**Additamenta ad Floram bryologicam Hungariæ.** (Additions to the Hungarian moss flora.) *Mag. Bot. Lapok.*, ii. (1903) pp. 205–8.

„ „ **Aeltere und neuere Moosfunde aus Niederösterreich.** (Old and new records of Muscineæ in Lower Austria.)
Deutsch. Bot. Monatsschr., xx. (1902) pp. 110–14.

„ „ **Beiträge zur bryologischen Floristik von Rajnochowitz und dessen weiterer Umgebung.** (Contributions to the bryological flora of Rajnochowitz and its more extended environs.)
Zeitschr. Mähr. Landesmus, iii. (1903) pp. 113–22.

„ „ **Beiträge zur Moosflora von Kärnthen. II.** (Contributions to the moss-flora of Carinthia. Part II.) *Carinthia*, 1903, pp. 93–100.

„ „ **Bryologische-floristische Mittheilungen aus Böhmen.** (Communications regarding the bryological flora of Bohemia.)
Mitt. Ver. Naturfreunde, Reichenbach, 1902, pp. 44–8; 1903, pp. 60–74.

„ „ **Das Bryologische Nachlassherbar des Friedrich Stolz. Ein Beitrag z. bryolog. Floristik von Tirol und dem angrenz, Italien, v. Bayern, Krain u. d. Küstenländern.** (The moss-herbarium of the late F. Stolz. A contribution to the moss-flora of Tyrol and the adjoining parts of Italy, Bavaria, Carniola, and the maritime provinces.)
Ber. Naturw. Med. Ver. Innsbruck, 1903, 184 pp.

MIGULA, W.—**Thome's Flora von Deutschland, Oesterreich und der Schweiz.**
[Finishes the mosses, 916 of which have been described, and begins the hepatics.] Bd. v. Lief. 16 (Gera, 1904) pp. 401–48 (6 pl.).

PARIS, E. G.—**Index Bryologicus. Ed. II. Fasc. 1–5.**
Paris: Hermann, 1903–4, pp. 1–320.

PARIS, E. G.—**Muscinées de l'Afrique Occidentale française.** (Muscineæ of French West Africa.)
[A list of 32 mosses and 2 hepatics; 19 of the mosses are new, and are described.] *Rev. Bryol.*, xxxi. (1904) pp. 42–9.

PEKLO, J.—**Einiges über die Mycorrhiza bei den Muscineen.** (Concerning the occurrence of Mycorrhiza in Muscineæ.)
Rozpranz Abh. d. Böhm. Akad., xii. (1903) No. 58, 22 pp., 1 tab.

PÉTERFI, M.—**A Catherinea undulata rokonsagá.** (Catherinea undulata and its relationship.) *Magyar Bot. Lap.*, ii. (1903) pp. 46–55.

" " **Az erdélyi Fissedensekröl.** (On the species of Fissidens of Siebenbürge.) *Tom. cit.*, pp. 64–89.

" " **Adatok Erdély lombos Mohflésájához.** (Contributions to the moss-flora of Siebenbürge [Transsylvania].) *Tom. cit.*, pp. 288–98.

" " **Bryologiai Közlemények.** (Bryological communications.)
[Contains two mosses and a variety new to Hungary.]
Növénytani Közlemények, ii. (1903) pp. 173–6.

" " **Ueber die ungarischen Weissia-Arten.** (On the Hungarian species of *Weissia*.) *Növ. Közl.*, 1903, pp. 24–5.

QUELLE, F.—**Göttingens Moosvegetation.** (Moss-vegetation of Göttingen.)
Inaug. Diss., 1902, 163 pp.

RÖLL, J.—**Beiträge zur Laubmoss- und Torfmoos-Flora der Hohen Tatra.** (Contributions to the moss- and sphagnum-flora of the Tatra Mountains.)
[A list of 114 mosses and of 45 varieties of *Sphagnum*.]
Hedwigia, xliii. (1904) pp. 132–9.

ROTH, G.—**Die europäischen Laubmoose.** (The mosses of Europe.)
[Completion of first vol. of the flora.]
Bd. i. Lief. 5 (Leipzig, 1904) pp. i–xiii., 513–98 (14 pls.).

SCHIFFNER, V.—**Kritische Bemerkungen über die Europäischen Lebermoose mit Bezug auf die Exemplare des Exsiccatenwerkes Hepaticæ europææ exsiccatæ. Series III.** (Critical remarks on the European liverworts, with reference to the specimens of the author's *Hepaticæ europææ exsiccatæ*).
Sitz. ber. Deutsch. Naturw. Med. Ver. "Lotos." Prag., xxiii. (1903) pp. 215–77.

" " **Ueber Riccia Baumgartneri n. sp. und die mit dieser Nächstverwandten Formen.** (On a new species, *R. Baumgartneri*, and its nearest allies.)
Oesterr. Bot. Zeitschr. liv. (1904) pp. 88–94 (8 figs.).

STEPHANI, F.—**Marsupella olivacea.** *Op. cit.*, liii. (1903) pp. 340, 341.

THÉRIOT, I.—**Mousses de la Nouvelle-Calédonie.** (Mosses of New Caledonia.)
[Contains nine species, collected by Dr. De la Combe; three are new.]
Bull. Akad. Internat. Géogr. Bot., xiii. (1904) pp. 85–6 (1 pl.).

VALENOVSKI, J.—**Iatrovky ceske.** (Hepaticæ of Bohemia.)
Rozpr. Akad. Prague, 1902, 24 pp. 4 pls.

WADDELL, C. H.—**Jungermannia capitata Hook. in Co. Down.**
Irish Naturalist, xii. (1903) p. 219.

" " **Thuidium delicatulum in Co. Down.** *Loc. cit.*

WARNSTORF, C.—**Neue europäische und exotische Moose.** (New European and exotic mosses.)
[Descriptions of 12 mosses and 5 exotic sphagna.]
Beih. Bot. Centralbl., xvi. (1904) pp. 237–52 (2 pls.).

WINKLEMANN, J.—**Ein Beitrag zur Moosflora Ober-Baierns und Tirols.** (Contribution to the moss-flora of Upper Bavaria and Tyrol.)
[List of 35 hepatics and 58 mosses of Alpine type.]
Deutsch. Bot. Monatsschr., xxi. (1903) pp. 106–10.

WOLLNY, E.—**Eine für Deutschland neues Lebermoos.** (A new German liverwort.)
Mitt. Bayer. Bot. Ges. Erf. Heim. Flor., 1904, pp. 341–2.

ZSCHACKE, W.—**Weitere neue Moosfunde aus Anhalt.** (Further new moss-records for Anhalt.)
[Contains three corrections of records in a former paper, with several additions.] *Deutsch. Bot. Monatsschr.*, xxii. (1904) pp. 3–6.

Thallophyta.

Algæ.

Points of Algological Nomenclature.*—R. Chodat publishes notes on the nomenclature of certain genera, as to which he differs from other authors. He first deals with the question as to whether Wille is right in considering *Sphærocystis* Chod. a synonym of *Glœococcus* A. Braun. The author considers there is no justification for this course, since *Glœococcus* is a palmelloid condition of some alga unknown, while *Sphærocystis* is characterised by its colonies of microscopical, free-swimming cells, which are quite spherical. The latter plant has been often found, while no one but Wille has ever been able to recognise *Glœococcus*. In the second note, the author discusses *Sphærella* and *Chlamydomonas*, and shows that though *Sphærella nivalis* scarcely differs from a *Chlamydomonas*, still the name *Sphærella* should be maintained. *S. lacustris* should be *S. Wrangelii* Sommerfelt. In the next note, the differences between *Pteromonas nivalis* Chod. and *Astasia nivalis* Shuttlew. are pointed out. Finally, the new genus *Chionaster* Wille is stated to be a synonym of the fungus *Cerasterias nivalis* Bohlin, which is the same as *Tetracladium* De Wildemann.

Colour of Algæ and of Water.†—N. Gaidukov summarises the work of former writers on the relation between the colour of algæ and the rays of light which reach them at their various depths. He has himself experimented on *Oscillatoria sancta* and *O. caldariorum*, and finds that the colour of these species alters under the influence of differently coloured lights, and he compares his results and conclusions with those of other writers on the subject. The depth of the water through which the sun's rays have to pass affects the quality of the light which reaches the plants, and the colour of the alga accommodates itself accordingly. Water, however, varies in colour according to the season, the condition of the sky, etc.; and irrespective of these variations there are many other influences which affect the distribution in depth, and the colour of the algæ. But, speaking generally, the most important factor in the distribution in depth, and the colour of algæ, is the quality of the sunlight—the source of energy. In fact, the author sums up the whole question as follows: In the process of photosynthesis, the relations between certain rays and the work performed by them can only be quantitative. The view concerning the harmful or beneficial effect of this or that ray of light on the processes of photosynthesis is without justification, as is also the view that chlorophyll is the only assimilative colouring matter in those chromophyll-containing algæ growing in deep water; and both these views are contrary to the great natural law—the conservation of energy.

Sexual Reproduction in Ceratium.‡—E. Zederbauer has observed for the first time sexual reproduction in the Peridineæ. In *Ceratium hirundinella*, a fresh-water form, two individuals become fixed together by a mass of slime; from each there then grows out of the longitudinal

* Bull. Herb. Boiss., iv. (1904) pp. 233–40.
† Hedwigia, xliii. (1904) pp. 96–118.
‡ Ber. Deutsch. Bot. Ges., xxii. (1904) pp. 1–8 (1 pl.).

furrow a conjugation-tube. The two tubes unite and the cell-contents pass into the tubes and there become fused and form a zygospore. Such a method of sexual reproduction strongly supports the view of the relationship of the Peridineæ with the Conjugatæ and Diatoms.

Siphoneæ Studies. *—A. Ernst publishes a continuation of these studies, of which No. II. is entitled "Contributions to a knowledge of Codiaceæ." He begins by describing a plant from Posilipo as a new species of *Udotea*, and calls it *U. minima*, comparing it with *U. Desfontainii*, the well-known Mediterranean species. It is characterised by the absence of the peripheral filaments, which occur as a rule in *U. Desfontainii*. A section of this paper is devoted to a consideration of this latter species, and another to its regenerative power in connection with external injury. This power it possesses to a considerable degree. The "Phylogeny and System of Codiaceæ" forms the next subject, and is followed by remarks on the genus *Codium*, which is placed by the author with *Pseudocodium* in sub-family Codieæ, as distinct from sub-family Udoteæ, in the family Codiaceæ. The nine families of Siphoneæ are enumerated, as also the four of Siphonocladeæ, and the question of reproduction in this group is discussed. The author is strongly of opinion that the so-called zoosporangia of *Udotea*, figured in certain works, are merely foreign bodies, and have no connection with the plant. He has often searched for sporangia on specimens of *Udotea*, and has tried to grow plants of his new species with a view to the development of fruit, but without success. He thinks it, however, premature to assume that although in the past many of the genera of Siphoneæ may have had sexual reproductive organs, they are now reduced to methods of vegetative propagation only. This conclusion can only be reached after years of growth under inspection in native habitats. The paper is illustrated by three plates.

The third of the Siphoneæ studies is devoted to the morphology and physiology of the reproductive cells of the genus *Vaucheria*. The author begins by a chapter on the formation of sporangia and aplanospores in *Vaucheria piloboloides* Thur., in which he gives a short *résumé* of work done on the zoospores of *Vaucheria*, and then goes on to describe the asexual spores of *V. piloboloides*, which he considers occupy an intermediate position between the zoospore of *V. sessilis* and the aplanospore of *V. geminata*. The formation of both sporangium and spore in *V. piloboloides* occupies only a few hours, and the process is described in detail, as well as the subsequent escape of the spores. The free spores of *V. piloboloides* are distinguished from those of any other species of *Vaucheria* by their elongated club-shaped form, which is preserved even after germination. This process is also described. The conditions of spore-formation in *V. piloboloides* are then discussed. In contrast to the fresh-water species of *Vaucheria*, *V. piloboloides* develops under conditions more or less stable, and the period of its vegetation lasts at Naples about two months. Successful attempts were made to grow it under observation, and the best methods are given for arousing the formation of zoospores. Various experiments were tried in con-

* Beih. Bot. Centralbl., xvi. (1904) pp. 199–236 (3 pls.); pp. 367–82 (1 pl.).

nection with the formation of aplanospores, and the details with the respective results are here set forth.

Genus Spirotænia.*—J. Lütkemüller continues his studies on *Spirotænia*, begun in 1895, describing new species and giving observations on others already known. For the limitation of species he considers that the form of the cells and the form and arrangement of the chlorophores are of importance. The chlorophores are either parietal or axile; in the latter case the pyrenoids are always found lying along the longitudinal axis of the cells. In parietal chlorophores the breadth of the band, the number and narrowness of its windings, and the angle of the spiral curve are to be noted. The author gives indications as to what constitutes a broad or a narrow band, as well as a gentle or sharp angle in the spiral curve; and alludes to further details of importance in species having axile chlorophores. Diagnoses and notes are given of thirteen species, of which three are new.

New Species of Ecballocystis.†—K. Yendo describes three new marine species of this genus, which has till now only been recorded from fresh water. Two of the new species are from the coasts of Japan and one from Port Renfrew, B.C. Zoosporangia have been observed in two of the new species. All three are minutely described, and their relationship with *Euglenopsis*, *Prasinocladus*, *Chlorangium*, and *Collinsiella* is discussed.

Transmutation of various Stages in Diatomaceæ.‡—C. Meresch-kowsky formulates a law to explain the variation in diatoms and their genealogy. In a previous paper § he enunciates what he calls the Law of the endochrome, the principle of which is that the endochrome of immobile diatoms has a tendency to cover the surface of the frustule in such a way as to leave uncovered so far as possible the raphe and other openings in the walls, in order that the protoplasm may come into contact with exterior objects, and thus aid the movement of the diatom. This law does not, however, provide an explanation for many of the phenomena connected with the endochrome, and the author, therefore, bases a second law on the results of his wide study of the subject. This he terms the law of transmutation of the stages in diatoms, and briefly stated explains it thus: the passing and temporary stages of development of an organism may gradually become permanent, and thus cause an accelerated evolution by producing sudden and considerable changes in the structure of an adult organism. He explains this law by giving first a theoretical illustration, and then one taken from the genus *Surirella*. He figures and describes the various stages which lead to the division of *S. Capronii*, and he shows that each of the various forms through which this species passes corresponds with the permanent form of some other species of the genus *Surirella*, as known and described. He believes that the species of diatoms may have been developed from some one form, in which various temporary stages have by degrees

* Oesterr. Bot. Zeitschr., liii. (1903) pp. 396–405, 483–8 (1 pl.).
† Bot. Mag. Tokyo, xvii. (1903) pp. 199–206 (1 pl.).
‡ Journ. de Bot., xviii. (1904) pp. 17–29.
§ Script. Bot. St. Petersb., xix.

become of longer and longer duration, till they became the permanent stages; and he is inclined to think that the whole genus *Surirella* may have had its origin from some species of *Auricula*—following the law of transmutation which is here for the first time formulated. The paper is illustrated by text figures, and is to be continued.

Pure Cultures of Diatoms.*—O. Richter has succeeded in isolating and studying two species of diatoms, *Nitzschia Palea* W. Sm., and *Navicula minuscula* Grün. He grew them in gelatin and in agar, and gives the details of his results. He finds that diatoms, like *Scenedesmes acutus*, have the effect of liquefying gelatin, and that both his species dissolve agar, forming deep grooves into which they sink. The rate of multiplication depends on the species and the medium employed for cultivation. Strong sunlight injures the cultures, bleaching them and sometimes destroying them. Agar has a marked effect on the form of the diatom, altering according to the strength of the medium. The diatoms showed themselves to be phototactic. As regards nutrition, it was seen that magnesium is absolutely necessary for the diatoms, but it is probable that *Nitzschia Palea* does not require calcium.

Sphacelariaceæ.†—C. Sauvageau has issued a reprint of his 'Remarks on the Sphacelariaceæ,' so far as they have already been published in the *Journal de Botanique*. The remainder of his work will continue to appear in parts in the same Journal. After a short introduction, the author gives an interesting chapter on what he terms Generalities. The general structure of the plants of the order is described, and references are made to the work of Geyler and Magnus; the conclusions of the latter with regard to the sympodial branching of Sphacelariaceæ, though ignored or disbelieved for so long, are shown by Sauvageau to be correct. As regards the relationship between Sphacelariaceæ and Ectocarpaceæ, the author recognises, of course, that such exists, but he points out certain characteristics peculiar to Sphacelariaceæ only. One of these is the black or black-green coloration of the thallus by eau-de-Javelle. The reacting substance in the cells is as yet unknown. Other characters not shared by Ectocarpaceæ are the presence of chromatophores in discs or in grains, never in plates or in ribbons; the almost constant presence of tannin; and the endogenous growth of the hairs, solitary, in pairs, or in a tuft. The plurilocular sporangia of Sphacelariaceæ show an independent dehiscence for each loculus, but the dehiscence is generally simultaneous. It takes place by means of a dissolution of the wall, and not by tearing. A possible exception to this mode of procedure is *Sphacelaria olivacea*. A description is given of the antheridia of the order, about which bodies there had been much doubt and discussion. The author has not yet, however, seen copulation nor a fixed zoospore with two red spots. The male nature of the plurilocular sporangia with small loculi is established, but the nature of the other plurilocular sporangia still remains doubtful; and the author is inclined to think that a study of those genera usually supposed to have no propagula,

* Ber. Deutsch. Bot. Ges., xxi. (1903) pp. 493–506 (1 double pl.).

† Journ. de Bot., xiv., xv., xvi., xvii., 1900, 1901, 1902, 1903, sep. copy, 320 pp., 62 figs. in text.

i.e. *Halopteris* and *Cladostephus*, might produce satisfactory results. Comparisons are drawn between Sphacelariaceæ and neighbouring genera. The division of the genus *Sphacelaria* into autonomous and parasitic species is pronounced artificial, and it is shown that one and the same species may be parasitic, or may penetrate merely, or live epiphytically on animal, vegetable, or mineral substrata. In the case of parasitism, the use of eau-de-Javelle is recommended as a rough guide to the extent of the host-plant which is attacked. The remainder of the book deals with various genera and species, new and old. The illustrations are many and most instructive.

Corallineæ of Japan.*—K. Yendo gives a list of the Corallinaceæ hitherto recorded from Japan, which number 68, and include species of *Choreonemua*, *Melobesia*, *Mastophora*, *Lithothamnion*, *Lithophyllum*, *Goniolithon*, *Amphiroa*, *Cheilosporum* and *Corallina*.

Bangia atropurpurea.†—G. B. De Toni has compared authentic specimens of certain species of *Bangia*, and finds that *B. sericea* Bory. is identical with *B. atropurpurea* Ag., and that *B. fuscopurpurea* Lyngb. is the marine form of that species. Synonyms of *B. atropurpurea* Ag. forma *fuscopurpurea* are *B. condensata* Zan., *B. ocellata* Zan., and *B. dura* Zan. Other species are mentioned as being closely allied to *B. atropurpurea*.

Byssus purpurea.‡—G. B. De Toni and A. Forti have succeeded in establishing the identity, synonomy and relationship of *Byssus purpurea* Lightfoot, which they found themselves in Iona last year, and have compared with types and authentic specimens of other species. They find that *B. purpurea* is a good species of *Rhodocorton*, and has for synonyms *Byssus rubra* Huds., *Callithamnion purpureum* Harv., and *Chantransia coccinea* Kütz. A diagnosis is given of the species, and a list of known habitats. No fruit has ever been recorded, and the authors think this may be attributed to the aerobic habit of the plant.

Phytoplankton of Fresh Water.§—H. Bachmann publishes a *résumé* of our knowledge of fresh-water plankton under the following headings: (1) Definition, in which the various terms regarding habitat and depth are defined. (2) Methods of investigation. (3) Constituents of phytoplankton. (4) Quantity of plankton. (5) Periodicity. (6) Statistics of variation. (7) The flowering of water. (8) Horizontal distribution. (9) Vertical distribution. (10) Conditions of life in the lakes. (11) Floating capability of phytoplankton. (12) Classification of waters according to their phytoplankton. (13) Origin of plankton. (14) The importance of plankton to the animal world. The paper closes with a fairly long list of the literature on the subject.

A Fountain Alga.‖—L. Beesley describes his successful cultivation of a new fresh-water alga, which resembles certain species of *Gongrosira*

* Bot. Mag. Tokyo, xvi. (1902) 12 pp.
† Att. Pontif. Accad. Rom. Nuov. Linc., lvii. (1904) 4 pp.
‡ Att. R. Ist. Veneto., lxiii. (1904) pp. 205–10.
§ Bot. Zeit, lxii. (1904) pp. 82–106.
‖ New Phytolog., iii. (1904) pp. 74–82 (1 pl. and 2 figs. in text).

in the general shape of the thallus, and the form of the chloroplast as a parietal plate. It differs, however, from that genus in having no encrustation of lime—indeed, the natural substratum is a siliceous one. The zoospores also are not formed in terminal and swollen zoosporangia, as in the Gongrosireæ. The author describes and figures his apparatus for cultivation of the alga, and gives an account of the life-history which he was able to watch in every detail. Neither the formal diagnosis nor the name is given to this new alga. Its chief characteristics are as follows: It is silicicolous in habit and grows in running water of low temperature, forming an irregularly-branched, star-shaped or circular thallus, the cells of which are longer than broad, containing a parietal chloroplast and no pyrenoids. By continuous division, beginning always at the centre of the thallus, the cells break up into zoosporangia, from which issue four zoospores. The thallus may pass into a palmelloid condition, and in this condition the cells divide at once to form (*a*) zoospores, or (*b*) daughter-cells which repeat the process. The zoospores are bi-ciliate and pear-shaped, with basin-shaped chloroplasts, red eye-spot and colourless anterior portion. They germinate, without any period of rest, to form a new plant. No sexual stage is known. It is subject to attack by a Chytridiaceous fungus.

German Fresh-water Algæ.* — A. A. Pascher gives a list of the algæ from the forest-land of South Bohemia. This first part of his work includes the Florideæ, Phæophyceæ, Chlorophyceæ, and Schizophyceæ. Diatoms and plankton will follow later. The number of species determined is 476, of which 54 are new to Bohemia. The localities are carefully recorded and critical remarks are often appended.

M. Schmidt † publishes a dissertation on the algal flora of the Lüneberg heath, which does not claim to enumerate all the species, but is nevertheless a useful addition to the botanical flora of the district. Seventeen new species, forms and varieties are described; and remarks are made on topographical distribution, on the morphology and biology of Desmidiaceæ, and on the system of the Conjugatæ. Plates of desmids are given.

Algæ of the Gulf of Spezia.‡—A. Preda proposes to publish a list of the marine algæ of this gulf from Capo Corvo to Portovenere, including the records of past collectors as well as those of his own gathering. He divides the area into four zones of depth, defining the limits of each. The names of the few botanists are given who have worked at the algæ of this district, with the titles of their works. The present paper deals only with the Florideæ, of which 73 species are recorded. Topographical notes are added to each record.

Bahaman Algæ.§—M. A. Howe describes a new species of *Neomeris*, *N. Cokeri*, from Eleuthera, as well as a new variety, var. *laxus*, of *Coccocladus occidentalis* from Nassau. Seven other species of algæ are recorded, which are either rare or of special interest, and critical notes

* SB. Deutsch. Nat.-wiss.-med. Ver. Böhmen. "Lotos," xxiii. (1903) pp. 161–211.
† Grundlagen e. Algenflora d. Lüneberger Heide, Hildesheim, 1903, 98 pp., 2 pls.
‡ Malphigia, xviii. (1903) pp. 76–93.
§ Bull. Torrey Bot. Club, xxxi. (1904) pp. 93–100 (1 pl.).

are appended to each species-name. A useful key to the three species of *Neomeris* is given.

ADAMS, J.—**Distribution of Vaucheria in Ireland.**
[A note recording *Vaucheria sessilis* from Antrim. The author remarks that seven freshwater species of this genus are recorded from Co. Dublin and Co. Wicklow in the *Guide to the County of Dublin*, published for the British Association Meeting in 1878.] *Irish Naturalist*, xii. (1903) p. 218.

ARTARI, A.—**Zur Frage über die Wirkung der Mediums auf die Form und Entwickelung der Algen.** (Concerning the influence of media in the form and development of algæ.) *Sep. Mitteil. Moskau Techn. Schule* (1903). 93 pp., 5 photos.

ATKINSON, G. F.—**A new Lemanea from Newfoundland.** *Torreya*, iv. (1904) p. 26.

CHALON, J.—**Projet de Liste des Algues marines comprises entre l'embouchure de l'Escart et La Corogne (incl. îles Anglo-Normandes).** (Sketch-list of marine algæ occurring between the mouth of the Escart and La Corogne.) *Namur*, 1904, 19 pp.

CUSHMAN, J. A.—**Desmids from South-western Colorado.**
[Seventeen species and varieties, of which four varieties are new.] *Bull. Torr. Bot. Club*, xxxi. (1904) pp. 161–4.

FOURNIER.—**Phycologie française. Chlorophyceæ. Catalogue des algues vertes d'eau douce observées en France.** (Catalogue of green freshwater algæ observed in France.) *La Feuille des Jeunes Naturalistes*, 1903, pp. 4–10.

GOMONT, M.—**Sur la végétation de quelques sources d'eau douce sous-marines de la Seine-Inférieure.** (On the vegetation of several freshwater submarine springs in Seine-Inférieure.)
[A note on the marine flora in the neighbourhood of seven springs situated between Saint-Valéry-en-Caux and Etretat. Fucaceæ and Corallineæ are entirely absent, and the species found are mainly estuarine; but certain Floridæ attain unusual development.] *Comptes Rendus*, cxxxviii. (1904) pp. 221–3.

KREISSLER, K. VON—**Einige Planktonfänge aus dem Brenn-See bei Feld in Kärnten.** (Some plankton hauls from the Brenn Lake near Feld, in Carinthia.)
[A short list of 12 species, with remarks.] *Oesterr. Bot. Zeitschr.*, liv. (1904) pp. 58–60.

LAUBY, A.—**Rapport sur les dépôts diatomifères de Neussargues.** (Report on the diatomaceous deposits of Neussargues.) *Bull. Acad. Int. Géog. Bot.*, xiii. (1904) pp. 62–3.

MACMILLAN, C.—**Cumaphytism in Alaria.**
[Note on the adaptation of *Alaria nana* Schrad. to existence in sea-surf, and the marked resemblance which it assumes to *Postelsia*.] *Bot. Gazette*, xxxvii. (1904) pp. 147–9 (2 figs.).

SCHMIDLE, W.—**Botanische Ausbeute einer Reiser durch die Sinaihalbinsel von A. Kneucker. Algæ.** (Botanical results of A. Kneucker's journey through the Sinai peninsula. Algæ.)
[List of 29 freshwater algæ, including a new variety and a new form.] *Allg. Bot. Zeitschr.*, x. (1904) pp. 6–8 (fig.).

SCHMIDLE, W., & A. KNEUCKER—**Algen von Aegypten, Frankreich und Oberitalien.** (Algæ from Egypt, France and Upper Italy.)
[A list of 12 species of freshwater algæ, with the localities.] *Tom. cit.*, p. 3.

TOBLER, FR.—**Eigenwachstum der Zelle und Pflanzenform. Vorläufige Mittheilung über fortgesetzte Studien an Meeresalgen.** (Special growth of the cell and plantform. Preliminary communication of further studies in marine algæ.) *Bergens Museums Aarbog*, 1903, No. 11 (6 pp.).

Fungi.

Cytology of Araiospora pulchra.*—C. A. King gives an historical *résumé* of the species of *Araiospora*, with a more particular description of *A. pulchra*. The main part of the work is devoted to the account of the development of the sexual organs of this species. The oogonia arise singly or in umbels at the distal ends of certain segments, which in turn produce special segments on which the antheridia are borne. The oogonium contains thirty-five to fifty-five nuclei, which migrate to the periphery, where cells are formed each with one or more nuclei. The further changes in the protoplasmic structure are followed in detail; when mature there is a deeply staining fine-meshed mass of protoplasm in the centre, and one nucleus. No antheridial tube is formed. The passage between the two organs is oogonial in structure. After the male nucleus has entered the oosphere, the central mass radiates out into the peripheral ooplasm. The two nuclei put out beaks toward each other, which in some cases come in contact. The nuclei may remain pointed until the oospore wall is partly formed. The later stages of fertilisation were not seen; fusion probably takes place at a later stage. King concludes from his studies that *Araiospora* should be placed between *Pythium* and the Saprolegniaceæ.

Peronosporeæ.†—A monograph of these fungi was prepared by A. N. Berlese before his death, and has now been issued. He divides the species of *Peronospora* into three groups distinguished by the form of the branchlets of the conidiophores. A short historical account of the genus is given, and full descriptions of each species. The monotypic genus *Bremia* is also included in the monograph; and a bibliography of the literature on the subject is given, with an index of the species.

Spinellus chalybeus and the Spinellus Group.‡—Paul Vuillemin has found that a fungus growing on a decaying agaric is identical with a species described in 1845 as *Ascophora chalybea*, and which has not been encountered since that date. It is characterised by the aerial filaments which gradually become brown, by the swollen base of the sporangiophore and the dilated apophysis, and by the evanescent wall of the sporangium. Vuillemin finds that the spinous mycelium which gave the name to the genus is not a generic character. He connects the three genera *Spinellus*, *Dicranophora* and *Sporodinia* closely together; they form a *phylum* in the genealogical sense.

Sexual Reproduction of Basidiobolus.§—Z. Woycicki has reinvestigated the development of the zygospore in *B. ranarum*. He finds that the nuclei which enter the zygospore do not fuse directly, but each undergoes an amitotic division. Two of the four nuclei so produced become disorganised, while the other two fuse in course of time to form the single nucleus of the zygospore. He compares this with the process

* Proc. Bost. Soc. Nat. Hist., xxxi. (1903) pp. 211–45 (5 pls.).
† Revista Patol. Veg., x. (1904) pp. 185–298 (69 figs.).
‡ Ann. Mycol., ii. (1904) pp. 61–69 (1 pl.).
§ Flora, xciii. (1904) pp. 87–97 (1 pl.).

described by Chmielevsky for *Spirogyra*, and considers that *Basidiobolus* must be related to that alga.

Conidial Stage of Morchella.*—Gaston Bonnier gives the results of his experimental cultures of various species of *Morchella*. The ascospores were easily made to germinate, and formed a sterile mycelium very similar in the different species tested. No conidial formation could be induced in the artificial cultures, but when the spores were sown on suitable soil a further growth was induced, and a conidial form closely similar for several species of *Morchella* was grown, and was found to be identical with a Hyphomycete discovered and described by Matruchot as *Costantinella cristata*.

Development of the Perithecium.†—P. A. Dangeard contributes some observations made on *Saccobolus violaceus*, *Ascophanus ochraceus*, and *Aspergillus glaucus*. In all of these he finds both an ascogonium and pollinodium, but there is no fusion between the two. He finds also that the development of *Ascophanus* more nearly resembles that of *Pyronema* than of *Saccobolus*, and he thinks that such facts might be useful in tracing the affinities of these fungi, and in following the development of the aerial Ascomycetes from the aquatic Siphomycetes.

Notes on Ceratostoma juniperinum.‡—P. Baccarini has examined the tubercles that occur on the branches of the juniper, and on which *Ceratostoma* has been constantly found growing. The perithecia are always on dead tissue, but the mycelium of the fungus penetrates to the living cells and causes the distortion of the branch. He did not find bacteria in the tubercles, as did Cavara. He considers the injury to be due to *Ceratostoma* alone.

Specialisation of Parasitism in the Erysiphaceæ.§—E. S. Salmon publishes a preliminary paper on this subject. He had already published his experiments proving the existence of "biologic" forms in the Erysiphaceæ. He has now carried his research further and finds that there are bridging host species that enable the parasite to pass from one to another. For instance, the mildew on *Bromus racemosus* is incapable of infecting *B. commutatus*, but it never fails to infect *B. hordeaceus*, and the fungus after growing on *B. hordeaceus* infects *B. commutatus*. There is no morphological difference to be detected in the fungus on these various grasses. He finds further that there are biologic species or races in the host-plant also without any morphological distinction. The spores of *Oidium* from several species of *Bromus* infected *B. hordeaceus*, a Russian form of *B. mollis*; the two grasses being morphologically identical, while they would not infect the native *B. mollis*, proving some physiological distinction between the forms.

The same‖ writer records still another discovery made by him during his investigation of this subject; that "under certain methods of culture in which the vitality of the host-leaf is interfered with, the restricted powers of infection, characteristic of 'biologic forms,' break

* Comptes Rendus, cxxxviii. (1904) pp. 416–17.
† Tom. cit., pp. 642–3.
‡ Nuovo Giorn. Bot. Ital. xi. (1904) pp. 49–52.
§ New Phytolog., iii. (1904) pp. 55–60 (3 figs.).
‖ Proc. Roy. Soc., lxxiii. (1904) pp. 116–18.

down." The conidia of the *Erysiphe* fungus were induced to grow on plants otherwise immune to their attacks by previously injuring the leaves. The fungus growth thus produced could then readily infect an uninjured surface of the same host. Plants are subject to many accidents, and Salmon holds that by the aid of such injury, a fungus may get hold of a host otherwise safe from attack, and this may account for sudden outbreaks of disease. It may also explain the nature of wound fungi, such as *Nectria*, etc., which infect the host only through wounds.

Cultural Experiments with the Barley Mildew, Erysiphe graminis D.C.*—E. S. Salmon had already demonstrated the existence of biologic forms of this fungus with species of *Bromus* as host-plants. He has made a further series of cultures on *Hordeum*, to find whether any species or variety of barley of economic importance would show a difference as regards susceptibility to the attacks of the parasite. He chronicles in several instances cases of what he terms sub-infection, when one out of many inoculation experiments would alone be successful, and cases where a very modified infection took place. The latter instance he explains by the fact that several haustoria have penetrated one epidermal host-cell, and the enzyme present in the cell failed to kill them all, so that the fungus succeeded in producing a modified growth. As a result of his observations he judges "that immunity and susceptibility are due to constitutional (physiological) peculiarities and not to any structural ones." He concludes that some varieties are, under natural conditions, more resistant to attacks of the disease than others. Detailed tables are given of the various experiments. He also tried the effect of copper sulphate as a fungicide when applied to the roots of the cereals. He found that even when solutions strong enough to distort the plants were applied to the soil, the leaf-cells still remained susceptible to the fungus. When he grew the seedlings in a water solution with the same strength of copper introduced as that with which he had watered the soil, they all died off. The control cultures in pots of soil watered by a copper solution grew into robust plants, each with a powdery patch of mildew.

Forms of Saccharomyces.†—Alb. Klocker publishes a new species, *Sacch. Saturnus*, the spores of which are distinguished by a distinct band round the centre, and by a somewhat citron shape. He was able to grow them on plaster blocks and by various other methods. The new yeast ferments dextrose, levulose and raffinose; it inverts saccharose and then ferments the inverted sugar. Along with the fermentation an ether is produced. The species was found on soil from the Himalayas. One somewhat similar has been noted in Danish and Italian soil.

Saccharomycopsis.‡—This new genus of Yeasts was isolated from soil collected near the St. Gothard Pass by H. Schiönning. It is

* Ann. Mycol. ii. (1904) pp. 70–99.
† Comptes Rendus, Lab. Carlsberg, 1903, pp. 84–91 (6 pls.).
‡ Tom. cit., pp. 101–25 (5 figs.).

characterised by the massive vegetative development composed of mycelium and spores—the mycelial growth being much more pronounced than in any known form of *Saccharomyces*. The form of the spore is also very characteristic: it possesses an exosporium which divides into valves on germination, something like a capsule, hence the specific name *capsularis*. The new yeast causes the fermentation of maltose, dextrose, etc. The writer describes at length the different cultures and experiments he made. He has placed another species, *guttulatus*, also in the genus. It has endospores of a similar character.

Classification of Penicillium.*—In several species of this genus, the ascomycetous form has been found. Alb. Klocker has discovered a new species which he names *P. Wortmanni*, and he suggests a new classification for the forms of which the full fructification is known. The familiar *P. glaucum* forms sclerotia in the interior of which the ascospores are produced; he would therefore place it in a genus by itself in the Perisporiaceæ near to the Tuberaceæ. The other forms that have a fructification similar to *Gymnoascus* should form a new genus, or be included in *Gymnoascus* itself. The new species is described as a *Penicillium*, although the ascus fruit bears a strong resemblance to *Gymnoascus flavus*. The conidial form marks the difference between the two fungi. The author describes his methods of culture and the means whereby he induced a growth of the higher fruit form.

Trichothecium roseum.†—K. S. Iwanoff found this fungus to be the cause of bitterness in fruit. He found it first on plums, which were red in colour and had a very bitter taste; the exterior was beset with small wart-like prominences. Examination showed the presence of mycelium, and by suitable cultures the Hyphomycete *Trichothecium* was developed, an upright conidiophore bearing a succession of two-celled pear-shaped spores at the tip.

Botrytis Disease of Tulips.‡—H. Klebahn has made a prolonged study of this disease caused by *Botrytis parasitica*, an account of which has already been published by Ritzema Bos. He does not agree with the latter in attributing the outbreak of the disease in new localities to infected soil; but considers from the history of various cases that it has been conveyed with the bulbs. He made many culture experiments, all tending to prove that the *Botrytis* was a specialised form and would not cause disease on any other plants. He also tried to infect tulips with several other forms of the fungus collected from various sources, but without result. The results of the experiments are described in detail, and advice is given as to methods of preventing disease.

Wintering of Oidium Tuckeri.§—There have been many theories as to the means whereby this fungus is perpetuated in the absence of perithecial fruits. Gy de Istvanfi finds that the mycelium lives on the twigs during the winter and gives rise to the new fungus growth. He recommends treatment of the plants during the winter with fungicides.

* Comptes Rendus, Lab. Carlsberg, 1903, pp. 92–102 (1 fig.).
† Zeitschr. Pflanzenkr., xiv. (1904) pp. 36–40 (7 figs.).
‡ Tom. cit., pp. 18–36 (1 pl.).
§ Comptes Rendus, cxxxviii. (1904) pp. 596–7.

In a further note he repeats and emphasises his observations, that the perpetuation of mildew of the vine is due to mycelium in a resting condition rather than to spores. He gives an account of the observations that have led him to this conclusion.

Parasite of Stigmarian Rootlets.* — F. E. Weiss found in the section of a rootlet from the Halifax hard bed, a condition of tissue that he thinks can only be explained by the supposition that the rootlet had been invaded by a parasitic fungus. In the middle cortex there occurs a mass of more or less regular secondary cells, and towards the outside there is a patch of compressed disorganised tissue which cannot be identified, but which may be fungal. A large cylindrical cell arises from the outer secondary tissue and passes outwards, and in this cell there is a fairly large spore-like body with indications of other similar bodies. Weiss concludes that these are the spores of a *Urophlyctis*, and should his surmise prove correct he would suggest the name of *Urophlyctites Stigmariæ*.

Uredinopsis.† — P. Magnus contributes a paper on this genus originally founded by himself. He gives a history of the different species, all of which grow on ferns. There are two forms of Uredospore enclosed by a peridium, the teleutospores are two- to four-celled, and the intercellular mycelium does not form haustoria. Four species of this genus come from America; only two have been found in Europe.

Notes on Uredineæ.‡—P. Dietel describes two members of Melampsoraceæ. The first, *Pucciniostele mandschurica*, grows on *Astilbe chinensis* in Manchuria. It has two forms of teleutospore. The second of these develops in autumn in spore-chains. He found a second fungus on the same host, which he makes the type of a new genus *Klastospora*. The teleutospores are one-celled and are also produced in chains. In both these genera the teleutospores fall to the ground leaving an empty, hollow, crater-like bed.

Phthiriosis of the Vine.§—This fungoid disease due to a symbiotic association between the cochineal insect and the mycelium of a fungus had hitherto been found underground on the roots of the vine, where the cochineal had burrowed for the sake of moisture. A very wet season in Syria has induced an aerial growth of the mycelial masses, which enveloped the branches of the vine; and L. Mangin and P. Viala record their observations on the new development of *Bornetina corium*. The change in form and structure resembles the effects already obtained by them in artificial cultures.

Eriksson's Mycoplasma Hypothesis.‖ — G. B. Traverso gives an account of Eriksson's theories as to the propagation of rust in cereals and the objections that have been raised against it. He thinks that the controversy remains undecided, and that more research and more

* New Phytolog., iii. (1904) pp. 63–8.
† Hedwigia, xliii. (1904) pp. 119–25 (2 pls.).
‡ Ann. Mycol., ii. (1904) pp. 20–6.
§ Comptes Rendus, cxxxviii. (1904) pp. 529–31.
‖ Bull. Soc. Bot. Ital., 1903, pp. 311–18.

workers are needed. He desires especially that agriculturists should everywhere take note of the existence of alternative hosts, such as the Barberry, etc., and of their influence on the propagation of rusts.

Taxonomic Importance of the Spermogonium.* — J. C. Arthur disclaims any intention of deciding as to the true nature of the spermogonium in Uredineæ. He considers it a "problematical organ *sui generis*, and that all the other rust spores are of a conidial or asexual character." He traces the life-cycle of the Uredineæ as worked out by certain writers, beginning with the teleutospore in which the fusion of the two mycelial nuclei has taken place. The bi-nucleate character, he states, is again established in the sporidium to continue through all the forms onward to the teleutospore. Arthur describes the various spore forms and notes that the spermogonium, which always appears at the beginning of the life-cycle, never repeats itself. In reference to its taxonomic value he insists that it should always be described by collectors, and the spore-generation with which it is associated; if, for instance, it is accompanied by uredospores, it can at once be concluded that there is no æcidium in the life-cycle. Position, form, colour and size are also characters worth recording, though of minor importance. They have all more or less specific value and aid in identification.

On the Origin of Parasitism in Fungi.†—George Massee claims to have proved that parasitism in fungi is an acquired habit. Though the spores of the parasite germinate on any moist surface, they do not continue to grow unless on the particular species of plant of which they are known to be the parasite. This selective power of the fungus is due, Massee says, to chemotaxis; and he made a large number of experiments to find the substances that were favourable to the development of the parasite. Fungi that are saprophytic can be induced to penetrate the host-plant, by injecting into it a substance that is positively chemotactic to the germ tube of the fungus. He found that infection took place more readily during the night when the cells were more turgid, and more sugar and other chemotactic substances were present in the cell-sap.

New and Interesting Californian Fungi.‡—Edwin Bingham Copeland describes new species of *Coprinus*, *Battarrea* and *Podaxon*, and gives careful notes of some Californian Morels. A large number of these were gathered, and he found that they all had transition forms from one to the other. They fell into three groups referable to *M. conica*, *M. esculenta* and *M. hybrida*. Copeland does not consider, however, that these represent but one species. He agrees with European mycologists that some parent type has given rise to several distinct lines of descendants, and the differences are now constant.

He gives notes on the function of *Coprinus* cystidia, which in *C. fuscosporus* sp. n., certainly act as props and braces to hold the moist gills apart and allow the spores to fall out.

* Bull. Torr. Bot. Club., xxxi. (1904) pp. 113–25.
† Proc. Roy. Soc., lxxiii. (1904) pp. 118–19.
‡ Ann. Mycol., ii. (1904) pp. 1–8 (2 pls.).

Coffee Disease.*—F. G. Kohl traces the disease to the attack of a Hyphomycete, *Stilbella flavida*, which is not confined to the coffee-plant but grows on several other hosts. The writer does not think that the fungus in question has any connection with other fungi recorded on coffee; and he thinks that the *Stilbella* has not yet entirely adapted itself to its new host. The conidia alone failed to infect, and growth was only obtained when the whole head of the *Stilbella* was inserted in the host-plant. He recommends various methods of combating the disease.

Parasitic Fungi.†—A. Volkart describes a new species of Exoascaceæ on the leaves of a composite. Although the mycelium is subepidermal, the author includes it in the genus *Taphrina*, placing it alongside another species of the genus in which the mycelium pierces the epidermal cells. He found a Pyrenomycete, *Mycosphærella Aronici*, associated with *Fusicladium* and *Phyllosticta* on the leaves of *Aronicum*, and considers them to be stages of one life-history. He found another Hyphomycete, *Cercosporella*, and still another *Phyllosticta* on the same host, but he has not identified them with any Ascomycetous forms.

Occurrence of Fungus Spores in the Atmosphere.‡—K. Saito has undertaken a research on this subject to determine the number of spores present in the air and variations due to the time of year. He wished also to determine the genera and species of the spores and to find how these varied in space and time. He omitted bacteria and yeasts from his work. Soya gelatin was employed as the basis of the culture media and a week was allowed for incubation. He tested the spore contents of the air for several different localities in or near Tokyo, and for all the months of the year. In the air of the garden the maximum of spores was in July, the minimum in March. The same result was found in the air of the streets. In a high wind the number was greatly increased; after rain or snow, fewer of these organisms were present in the air. The author gives a list of all the species that he found, forty-six in all, *Cladosporium herbarum*, *Penicillium glaucum* and *Epicoccum purpurascens* being the most frequent.

Mycorrhiza.§—G. F. L. Sarauw has published a long dissertation on the symbiosis of fungi with the roots of the higher plants. He criticises the deductions made by Frank from his experiments with forest trees, and inclines to the belief that the mycorrhiza is not so essential to the health of the higher plants as Frank considered it to be. The vigour of the fungus is determined by the presence of humus in the soil, and is therefore more largely developed in woods than in carefully cultivated ground. As to the species of fungus that enter into symbiotic relations with the roots, he considers *Cladosporium* and *Helminthosporium* to be the most usual forms, and he rather throws doubt on the idea that

* Beih. zum Tropenflanzer, iv. (1903) pp. 61–77. See also Ann. Mycol. ii. (1904) pp. 120–3.

† Ber. Deutsch. Bot. Ges., xxi. (1903) pp. 477–81 (1 pl.). See also Ann. Mycol., ii. (1904) p. 115.

‡ Journ. Coll. Sci. Imp. Univ. Tokyo, xviii. (1904) 58 pp. (5 pls.).

§ Rev. Mycol., xxvi. (1904) pp. 1–19.

truffles, agarics or puff-balls take any share in forming the mycelial sheaths round the young roots. He concludes that though the mycorrhiza is harmless it is of no positive advantage to the host-plant.

Nemec * has studied the same question as regards the hepatics.

British Mycology.†—An account of the autumn fungus foray of the British Mycological Society is given by Carleton Rea, with a list of the fungi collected during the foray week in Savernake Forest. W. L. W. Eyre gave the presidential address on "Mycology as an instrument of recreation." Arthur Lister contributes an account of the mycetozoon *Echinostelium minutum* which was collected by a member of the Society at Hereford, the first record for Britain.

A. Lorrain Smith describes two new forms of disease caused by fungi: *Glœosporium Tiliæ*, which attacked the petioles of the leaves of the lime, causing them to fall in the early summer, and *Septoria fragariæ*, which had passed from the strawberry leaves to the fruit, and spoiled a whole crop. She also publishes notes on imperfectly described microfungi. Carleton Rea chronicles the finding of two new Phalloideæ in Europe, *Lysurus australiensis*, found in Worcestershire near a mill where refuse and dirt from Australian wheat-bags had been thrown, and *Anthurus borealis*, which was found in a field of asparagus at Mecklenburg, in Germany. The same author, with A. Lorrain Smith, publishes the list of fungi added to the British flora during the preceding year. Diagnoses are given of species not previously published, or that have been only imperfectly described.

French Mycology.‡—Em. Boudier describes a new genus of Myriangiaceæ, *Guillermondia*, a minute fungus measuring about ½ mm. in diameter, occurring as little black points on horse-dung. The spores become dark coloured when mature, and remain in groups of eight after the ascus has disappeared.

The same writer § describes a sterile form of *Hydnum erinaceum*. No hymenium was formed on the teeth. Sporules, or conidia, were found, but they were not borne on basidia.

Paul Vuillemin ‖ describes a new genus *Spinella*, which he places among the Mucorineæ near to *Dispira*. The fungus, which seemed to be parasitic on *Mucor*, forms a swollen head at the top of an upright sporophore from which arise elongate spore-like projections, each bearing a spore of similar appearance. The whole plant is colourless or yellowish.

M. Prillieux¶ describes the dehiscence of the perithecia of *Rosellinia necatrix*, a dangerous parasite of the roots of the vine. The paraphyses and asci become mucilaginous, and the spores escape in drops of mucilage by the splitting of the perithecial walls at various points.

B. Souché ** has observed a new form of *Cantharellus cibarius*. It is paler in colour than the well-known species, the cap is thinner, the

* See ante, p. 328.
† Trans. Brit. Myc. Soc. for season 1903 (1904) 67 pp., 3 col. pls.
‡ Bull. Soc. Mycol. France, xx. (1904) pp. 19–22 (1 pl.)
§ Tom. cit. pp. 23–5.
‖ Tom. cit., pp. 26–33 (1 pl.).
¶ Tom. cit., pp. 34–8 (2 pls.).
** Tom. cit., 39–49.

gills less decurrent, and the stalk more slender. The writer also gives details of various fatal cases of poisoning due to eating fungi. He has been careful to describe the symptoms and the remedies applied to the patients. Several species of *Amanita* had been eaten.

American Mycology.*—A. P. Morgan describes a new species of *Sirothecium* found growing on wood. G. G. Hedgcock † has proved by repeated culture experiments that the *Phyllosticta* found on the leaves of the beet, and the *Phoma* found on the root of the beet are the same fungus. The name *Phoma* has the priority. J. C. Arthur ‡ gives the fourth of his reports on the cultures of plant-rusts during the preceding year. He has succeeded in tracing the life-history of a number of species. W. A. Kellerman § continues his index of Uredinous culture experiments, with lists of species and hosts for North America.

APPEL, OTTO & STRUNK, H. F.—**Ueber einige in Kamerun auf Theobroma cacao beobachtete Pilze.**
[The completion of a descriptive list of new fungi found growing on Cacao. New genus *Corymbomyces* (Verticillieæ).]
Centralbl. Bakt., xi. (1904) pp. 632–7 (4 figs.).

BAUDISCH, F.—**Notizen über Septoria parasitica, Fusoma Pini und Allescheria Laricis.**
[A description of fungi dangerous to young forest trees.]
Centralbl. Forstwesen, xxix. (1903) p. 461.
See also *Ann. Mycol.*, ii. (1904) p. 123.

BUBAK, FR., & J. E. KABAT—**Mycologische Beiträge.**
[Diagnosis of 12 new species of microfungi found in Bohemia.]
SB. K. Böhm. Gess. Wiss., No. xi. (1903) 7 pp.

BUBAK, FR.—**Ein Beitrag zur Pilzflora von Montenegro.**
[A record of the fungi of Montenegro. Many of the species of microfungi are new to science. *Op. cit.*, No. xii. 22 pp.

DEUNHARDT, RUD.—**Ueber eine neue Pestalozzia-art (verwandt mit P. Hartigii) und Künstliche Züchtung ihrer Konidien auf Getreidearten. P. hordeidestrua.**
[The author made artificial cultures of the *Pestalozzia*, and reinfected young plants of barley with fatal results.]
Ber. Deutsch. Bot. Ges., xxii. (1904) pp. 175–6.

GRIFFITHS, DAVID.—**Concerning some West African smuts.**
[Diagnoses and descriptive notes of new species of *Sorosporium*, *Ustilago*, *Tilletia* and *Thecaphora*. *Bull. Torrey Bot. Club*, xxxi. (1904) pp. 83–8 (10 figs.).

HECKE, L.—**Beizversuche gegen Hirsebrand.**
[An account of methods employed to destroy the Rust of Millet.]
Zeitschr. landw. Versuchswesen Oesterr., ii. (1903) pp. 765–75.
See also *Ann. Mycol.*, ii. (1904) p. 125.

HENNINGS, P.—**Zweites Beitrag zur Pilzflora des Gouvernments Moskau.**
[The list includes several new species of fungi.]
Hedwigia, xliii. (1904) pp. 66–73.

„ „ **Fungi fluminenses a. cl. E. Ule collecti.**
[The fungi were collected in the neighbourhood of Rio de Janeiro; there are a considerable number of new species.] *Tom. cit.*, pp. 77–95.

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* Journ. Mycol., x. (1904) p. 1.
‡ Tom. cit., pp. 8–21.
† Tom. cit., pp. 2–3.
§ Tom. cit., pp. 26–45.

HÖHNEL, FRANZ v.—**Mycologische Fragmente. Fortsetzung.**
[Descriptions of new species and notes on previously recorded forms. The new genera are *Sirozythia* (Nectrioideæ) and *Conioscypha* (Dematieæ).
Ann. Mycol., ii. (1904) pp. 38–60.

LISTER, A.—**Notes on Mycetozoa from Japan.**
[A description of 18 species of already known forms.]
Journ. Bot., xlii. (1904) pp. 97–9 (1 pl.).

MAIRE, R., DUMÉE, P., & LUTZ, L.—**Prodrome d'une flore mycologique de la Corse.**
[The list includes a number of new species, mainly of microfungi.]
Bull. Soc. Bot. France, pp. 179–297, pl. 48 (1901), and pls. 13–14 (1903).
See also *Ann. Mycol.*, ii. (1904) p. 112.

PECK, CH. H.—**Report of the State Botanist, New York State Museum.**
[The report includes the diagnoses of a considerable number of new species of fungi.] *Bull.*, No. 67 (1903) 194 pp., 5 pls.
See also *Ann. Mycol.*, ii. (1904) p. 113.

PENZIG, O., UND SACCARDO, P. A.—**Icones Fungorum Javanicorum, Text.**
[Diagnoses of genera and species from Java already published in *Malpighia*.]
E. J. Brill, Leiden, 1904, 124 pp.
" " " **Icones Fungorum Javanicum, Tafeln.**
[Contains 80 plates, each with four drawings of fungi, natural habit and microscopic details.] E. J. Brill, Leiden, 1904.

PETRI, L.—**Osservazioni sul genere Tylostoma Pers.**
[A general account of the genus, and diagnoses of all the different species.]
Nuovo Giorno Bot. Ital, xi. (1904) pp. 53–69 (12 figs.).
" " **Naucoria nana sp. n.**
[Diagnosis and complete description of a minute agaric.
Ann. Mycol, ii. (1904) pp. 9–11 (2 figs.).

REHM, H.—**Ascomycetes Americæ borealis.**
[An account of 16 new species, most of them described for the first time.]
Tom. cit., pp. 32–37.

SACCARDO, P. A.—**Notæ Mycologicæ.**
[Notes on a large number of species, a few of them new to science. There is only one new genus, *Oncopodium*, akin to the genus *Sporodesmium* among the Dematieæ.] *Tom. cit.*, pp. 12–19 (1 pl.).

SYDOW, H. UND P.—**Neue und kritische Uredineen.**
[Nine new species of Uredineæ are described from Africa and from California.]
Tom. cit., pp. 27–31.

Lichens.

Growth-Forms of Lichens.*—Max Britzelmayer has made a study of several forms of *Cladonia*. He finds that in many cases varieties that have been described as such are merely due to accidents of habitat. He traces the different growths of *C. furcata*, which grows best on chalk or loamy sandy soil. In less favourable localities it is found as vars. *subulata* and *tenella* with a much more slender growth; in damp woods the form *regalis* is found with well-developed podetia and no thallus. He notes also changes of colour due to locality in this and other *Cladoniæ*: brown moor-inhabiting forms change to light green in damp shady woods.

Development of Lichen Fruits.†—Otto Metzger selects several types of Lichens that have not yet been properly worked out in order to further our knowledge of this subject. In all the cases examined he

* Hedwigia, xliii. (1904) pp. 126–31.
† Beitr. Wiss. Bot., v. (1903) pp. 108–44 (7 figs.).

found the ascogonial initial cells, such as have been described by Stahl and others, in the very early stages of growth, and his aim has been to determine their significance. He found that the young apothecium in *Solorina saccata* took rise in the lower part of the algal layer, and that there was no trace of fertilisation, nor formation of trichogynes. The ascogonial cells were not multinucleate; they gave rise by branching to a complex growth of hyphæ from which the asci were developed. The paraphyses had a different origin and were formed before the asci. There are no spermogonia developed in *Solorina*. Very similar results were found in *Acarospora glaucocarpa*. No trichogynes are formed, and no spermogonia are present. The apothecium arises more in the middle of the algal layer. In *Verrucaria calciseda* it took origin underneath this layer; here also there were ascogonia formed, but no trichogynes, though spermogonia and spermatia were present. The development of the fruit was entirely non-sexual. In *Imbricaria physodes* the ascogonium was composed of three initial cells produced by branching from the ordinary hyphæ, on the upper side of the green layer. No previous copulation of the initial cells could be detected and no trichogynes were formed, though spermogonia are present. The many black points so characteristic of this Lichen were found to be apothecia degenerated at an early stage. Metzger examined *Peltigera canina*, and found here also vegetative or non-sexual development only; spermogonia are rarely developed. He gives an account of the best methods of treating the thallus to ensure the detection of the early stages of the apothecium. He found benzine derivatives especially useful, as they possess the property of reacting with oxidising agents, to form coloured substances, and thus marking off the tissue surrounding the ascogonium, which contained some oxidising agent that was absent in the ascogonium itself.

Erwin Baur * has also published the results of his researches on this subject. He begins by reviewing the work that has been already done, and emphasises its importance from a systematic point of view. He gives details as to his methods of examination, and then gives the results of his work on the different forms. In *Parmelia Acetabulum* he finds that an immense number of carpogonia and spermogonia are formed similar to those of *Collema*, but very few apothecia are matured; cross fertilisation may be necessary to ensure further growth or the carpogonium may develop apogamously. He thinks that probably more than one series of initial ascogonial cells is included in each apothecium. He found the same type of carpogonium in *Anaptychia*, *Endocarpon*, *Gyrophora*, *Lecanora* and *Cladonia*, all of which he considers to be sexual in their mode of development. In *Anaptychia* and *Endocarpon* especially, he observed spermatia at the apex of the trichogyne, though the further stages of fertilisation have not been followed. In *Cladonia* the carpogonium arises at the base of the fruit, the podetium is therefore not a modified apothecium, as Krabbe supposed it was. Several other genera, *Solorina*, *Peltigera*, *Peltidea* and *Nephromium* are probably non-sexual; the carpogonia have become non-sexual, no trichogynes are formed, and the spermogonia are absent or poorly developed.

* Bot. Zeit., lxii. (1904) pp. 21–44 (2 pls.).

Anatomy of Crustaceous Lichens.* — Eugen Lang contributes a series of studies on the nature of the seemingly insignificant thallus growth of some Lichens. *Sarcogyne simplex*, which grows on granite, has been repeatedly described as almost or entirely wanting in thallus. The specimen examined by Lang grew on dolomite, and nothing was visible except the fruits, but after decalcifying the substratum a quite substantial endolithic thallus was laid bare; cortex, gonidial layer and hyphæ, which, in the lower parts of the stone, contain oil, and, mixed with them, abundant spheroid cells. A specimen that grew on silicate of lime showed no spheroid cells, but bundles of "oil" hyphæ with rather deficient oil-contents were present. The presence of "oil" in the hyphæ depends on the presence of carbonates in the substratum. An examination of *S. pruinosa* yielded the same results: an abundant thallus imbedded in the stone, and, after decalcification, the "oil" hyphæ and spheroid cells were found in the deepest rhizoid layers. In both these species he found the gonidial layer thinner when the lichen had penetrated deeply into the stone. The growth of *S. latericola* was entirely superficial, the gonidial layer was well developed, and no trace was found either of "oil" hyphæ or of spheroid cells. Several other crustaceous lichens examined afforded the same results, proving the influence of the substratum on the development of the gonidia and of the specialised hyphæ. Thus a different habitat entirely altered the characters of the thallus. The writer notes the presence of fungi and of their tendency to invade the lichen fruits, where there is evidently more abundant nourishment to be had.

Schizophyta.

Schizomycetes.

Production of Acetylmethylcarbinol by Bacteria of the Bacillus mesentericus Group.†—H. Desmots grew *Bacillus mesentericus vulgatus*, *B. fuscus*, *B. flavus*, *B. niger* and *B. ruber* in media containing 2 p.c. of peptone and of calcium carbonate, and with an addition of glycerin, mannite, glucose, dextrin or inulin, etc. The action is slow, but the sugar disappears altogether. The formation of acetic and valerianic acids can be demonstrated, and also of ethylic alcohol in small quantities. The distillate has besides special properties: it reduces Fehling's solution in the cold; it rotates the plane of polarised light to the left; it does not restore the colour of fuchsin treated with bisulphite; iodoform is not formed if it is treated with iodo-potassic-iodide solution and ammonia; it is not precipitated by mercuric sulphate with heat. With phenylhydrazine, crystals of osazone are formed, having a melting point of 243° C. If this osazone is treated with oxidising agents, e.g. potassium bichromate and acetic acid, long needle-shaped crystals are obtained soluble in alcohol and ether, and having a melting point of 151° C. These can be reconverted into osazone by the addition of phenylhydrazine. The substance responsible for these reactions is acetyl-

* Beit. Wiss. Bot., v. (1903) pp. 162–88 (13 figs).
† Comptes Rendus, cxxxviii. (1904) pp. 581–3.

methylcarbinol, $CH_3-CO-CHOH-CH_3$. The author has found this substance produced also by certain other bacteria, e.g. *B. subtilis* and *Tyrothrix tenuis*.

Reduction of Sulphates by Bacteria.*— A. van Delden, working with *Microspira desulfuricans*, found that it grew best at 25° C. to 30° C. The organic matters usually present in polluted waters are suitable for the reducing organism. Lactates, malates and succinates are the most suitable organic salts, whilst nitrogen is assimilated in the form of asparagin, peptone and ammonium salts. Nitrates hinder the reduction. Sulphate reduction takes place in canal and river water after a little potassium phosphate, sodium lactate and asparagin have been added; it is suggested that the reduction might be utilised, in conjunction with an iodometric titration, for estimating the amount of sulphate present in water. Cultivations in gelatin containing hydrogen sulphide produced sulphur at the surface to a depth of about 1·5 cm. A bacterium was isolated which does not reduce sulphates, but reduces sulphites and thiosulphates, and, with limited access of oxygen, oxidises the hydrogen sulphide to sulphur. The bacterium resembles *Microspira desulfuricans*, and differs from *Bacterium hydrosulphureum pontican* in not growing in air. The author experimented also with *Microspira æstuarii*, cultivating it in various solutions containing magnesium sulphate and suitable nutrient material, and estimating the amount of hydrogen sulphide produced. The effect obtained was similar to that with *Microspira desulfuricans*. The reduction of sulphates by *Microspira desulfuricans* and *Microspira æstuarii* is a process which is possible, under anaerobic conditions, only in a medium which contains, in addition to sulphates, some suitable organic nutrient material. Sulphate reduction, like denitrification, can be effected in the absence of free oxygen.

Microbe Pathogenic to Rats (mus decumanus and mus ratus).† J. Danysz, during an outbreak of spontaneous disease in field mice, isolated a cocco-bacillus pathogenic to rats. Difficulty was experienced in maintaining the virulence of the organism, as by passing the microbe a certain number of times from rat to rat its pathogenicity was much weakened. This difficulty, however, was got over by making experiments on series of twenty or thirty rats at a time, when it was always found that from the bodies of one or two of these animals a sufficiently virulent culture could be obtained, and that the virulence of this culture might be maintained for two or three months. Such cultures have been used successfully in the destruction of rats on farms, warehouses, etc., and even in a large town like Odessa. The cultures were made in bouillon, and crusts of bread were dipped in it as a bait. In the author's opinion there is in these procedures no risk to human beings or to other animals.

Bacteriology and Histology of Mud obtained at a depth of 10 m. from a Roman Funereal Pit at the Necropolis of Bernard (Vendée).‡—M. Baudouin, who conducted this investigation, regarded

* Centralbl. Bakt., 2te Abt., xi. (1903) pp. 81–94, 113–9. See also Journ. Chem. Soc., ccccxcv. (1904) ii. pp. 67–8. † Brit. Med. Journ., (1904) i. p. 947–9.
‡ Comptes Rendus, cxxxvii. (1904) pp. 1001–3.

the pit as dating back to the second century. It was about 10·4 m. deep, and from about 3·5 m. from the surface downwards was filled with calcined earth, along with divers objects which had been placed in the pit. This calcined earth had been converted into mud by water filtering either from the surface or laterally. Some of this mud was obtained at a depth of 10·1 m. with aseptic precautions. It was found to be destitute of diatoms, and therefore not comparable to the mud of the neighbouring marshes. There were present in it, however, certain animal spicules, which were attributed to *Acarina* parasitic on the fleeces of domestic animals thrown into the pit. A bacteriological examination of the mud demonstrated the presence of numerous micro-organisms. The majority of these were found to be *Bac. coli*. There were besides strepto-, staphylo-, and diplococci, as well as tetragenous forms. Anaerobes were also present.

The author is of opinion that these organisms were introduced with the bodies of animals into the pit, and had been preserved there as in a closed vessel during eighteen centuries.

Hæmorrhagic Septicæmia in Animals.* — P. G. Woolley and J. W. Jobling have issued a report on an outbreak of hæmorrhagic septicæmia occurring in a herd of cattle (Caraboas) arriving in Manila from Shanghai. In the cases observed they found three pathological types: the pulmonary type, in which the lesions resemble those of broncho-pneumonia; the rapidly fatal septicæmic type, with few macroscopic changes; and the glandular and suppurative type, which terminates in general infection. In all types there were more or less wide-spread hæmorrhagic lesions. From all similar organisms have been isolated, of which the characters are as follows: short bacilli, with rounded ends, polar staining, occasionally encapsulated and non-motile, non-liquefying, non-Gram-staining, growing invisibly on potato, not producing gas, not coagulating milk or reducing litmus, producing indol and nitrites, and not forming spores.

Some Pulmonary Lesions Produced by the Bacillus of Hæmorrhagic Septicæmia of Caraboas.†—P. G. Woolley describes three cases, two in Caraboas and one in a native horse, of invasion of the lungs by the bacillus of hæmorrhagic septicæmia. One of the two former he regards as a pure case of the infectious type of pleuro-pneumonia; the other two presented appearances similar to those of broncho-pneumonia in the stages of red and grey hepatisation and suppuration. The author suspects that the pulmonary invasion was subsequent to a bronchitis in all three cases, and that the bacilli gained access to the lungs from the upper air passages. He regards it also as certain that in all of the cases death was the result of a terminal septicæmia, incident to the entrance into the blood-stream of the organisms which were present in the lesions of the lungs.

Bacterial origin of the forms of the Arabin Group: the Pararabin form of Sterculia (Bact. pararabinum, sp. n.).‡—R. Greig Smith

* Report, 1903, No. 12, Dept. Interior Bureau Govt. Lab. Manila, 1904.
† Op. cit., No. 9. ‡ Proc. Linn. Soc. N.S.W., xxviii. (1903) pp. 541–52.

found that gum drops oozing from the seed capsules and twigs of *Sterculia diversifolia* consisted of a mixture of arabin and pararabin. The arabin is produced by *Bact. acaciæ*. Another organism—*Bact. pararabinum*, sp. n.—was isolated from the gummed fruits, etc. Upon solid media and in solutions containing saccharose, dextrose, levulose, galactose, mannite or glycerin, a slime is formed. By appropriate treatment this yields a soluble pararabin gum, which upon dehydration becomes insoluble, and this modification is soluble in dilute acid and insoluble in dilute alkali. It is not hydrolysed by dilute acid, but strong acid converts it into arabinose and galactose. The bacterium does not secrete invertase, and in solution of saccharose it forms gum, ethyl-alcohol, carbon dioxide, succinic, lauric, acetic, butyric and formic acids.

MICROSCOPY.

A. Instruments, Accessories, &c.*

(1) Stands.

Old Microscope by Bate.—This Microscope (fig. 55) by Bate, kindly presented to the Society by Mr. Stringer, was exhibited at the February Meeting of the present year. It is apparently a late form of

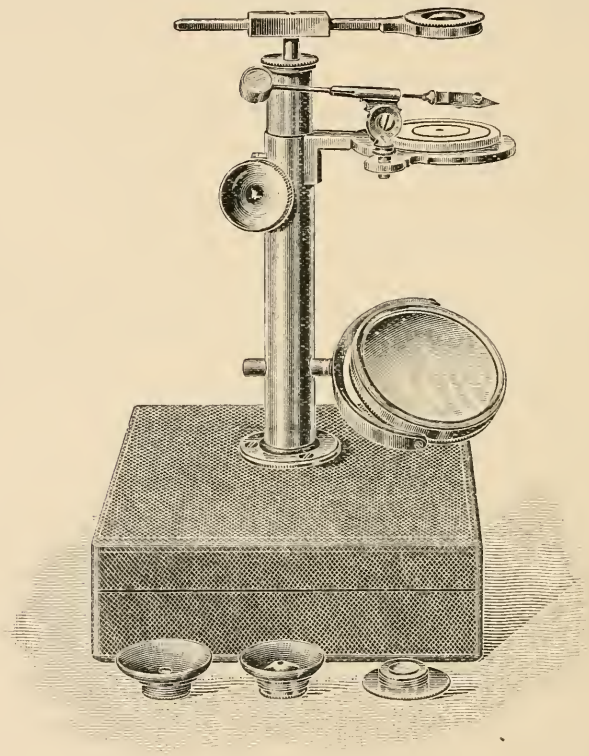

Fig. 55.

Ellis's Aquatic Microscope, described by Adams in his *Essays on the Microscope*, published in 1787.

Adams says, "In the representation of this Microscope the pin D is delineated as passing through a socket at one side (really the back) of the pillar A, whereas it is usual at present to make it pass down a hole bored through the middle of the pillar."

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

Further on he says, "These Microscopes are sometimes fitted up with a toothed rack and pinion for the more ready adjustment of the glasses to their proper focus."

These two modifications constitute the principal differences between the Bate Microscope and the one named after John Ellis, and used by him in 1752–4 when preparing his work, *An Essay towards a Natural History of Corralines.* Ellis there says the Microscope was made by Cuff, and he gives a figure and description. The figure was used by Adams in his Essays, and on a reduced scale may be found in Dallinger's edition of *Carpenter on the Microscope.*

Cuff's Microscope is evidently the forerunner of many modern dissecting Microscopes.

The date of this (Bate) Microscope is doubtful, but there is reason to believe that Bate's instruments were produced somewhere about the early part of the last century.

It scarcely requires any further description, beyond mentioning that there are four lenses, the two higher powers being provided with Lieberkühns.

Old Microscope by Plössl, of Vienna.—This Microscope, which was exhibited at the Society's Meeting on January 20, and is represented in fig. 56, resembles in general character the old Microscope by Schiek, figured by Quekett in his *Practical Treatise on the Use of the Microscope*, 2nd ed. 1852, fig. 50, p. 102.

It is an early example of a Continental Achromatic Microscope, and its date may be given approximately as 1845.

The brass body, 10½ in. long, is supported on a short curved piece, which slides on a triangular steel bar by rack-and-pinion movement. The teeth of the rack are let in on the under surface of the steel bar, and the latter is fixed by a compass joint to a solid, upright brass pillar, which stands on a folding tripod with levelling screws at each end. Three brass discs are provided, on which the sharp points of the levelling screws rest.

The stage is movable, for fine adjustment focussing, on the same triangular bar by means of a fine screw fixed at the end of the bar. Another screw at the back serves to clamp the stage in any position.

The stage has mechanical motion in two directions; a fine screw on the right gives lateral motion to the extent of about ⅜ in. On the left lower side a screw, acting on a lever, and with the stage plate pressing against a spring at the top of the stage, gives up-and-down motion. A horse-shoe shaped piece on the stage holds the object slide, and can be lifted by pressing against a spring below the stage.

In addition to these movements there is on the right side a large drum micrometer screw, with divisions reading to 0·00001 of a Vienna inch, and also some divisions on silver at the bottom of the stage. The screw works against a spiral spring enclosed in a small brass cylinder on the other side of the stage.

The single mirror on a swivel, fixed to the steel bar, is concave, and provided with blackened brass diaphragms to partly cover the mirror when less light is desired.

There are four Huyghenian eye-pieces and one large positive eye-piece, having two large plano-convex lenses, the convex sides turned

towards each other. The six object glasses all screw together, one on the top of the other; they are intended to be used singly or in combinations of two or three, as indicated by the table of magnifications.

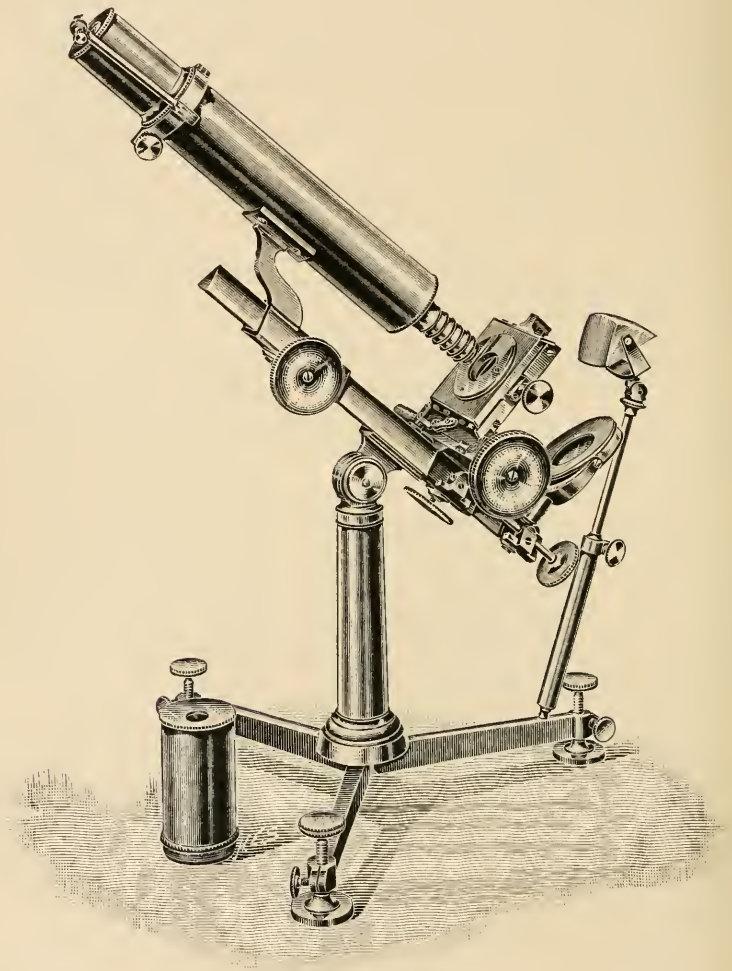

Fig 56.

A bull's-eye condenser is provided, and also a rectangular condensing prism with two convex surfaces, mounted on an extending rod with compass joint, to be fixed on the front leg for illumination above the stage.

The following table of magnifications, compiled by the makers, accompanies the instrument :—

Objectives.	Eye-pieces.				
	Apl.	I.	II.	III.	IV.
No. 1	11	24	36	..	..
1 + 2	26	54	89	..	..
1 + 2 + 3	41	84	126	..	..
2 + 3 + 4	51	108	160	..	..
3 + 4 + 5	68	134	205	450	..
4 + 5 + 6	103	206	300	720	1080

Baker's Diagnostic Microscope No. 1.*—This instrument (fig. 57) is a modification of the one designed at the suggestion of Major Ronald

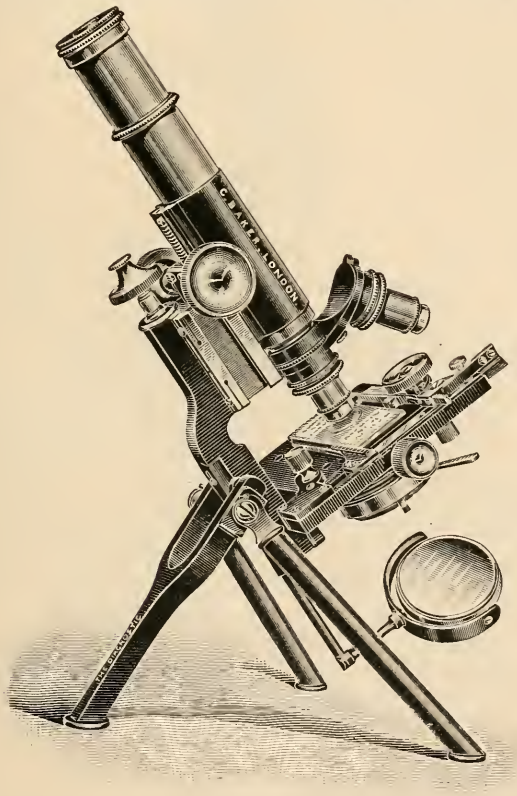

Fig. 57.

Ross, F.R.S., for the special use of officers of the Indian Army Medical Department for the diagnosis of malarial fever, etc.

* See this Journal, 1902, p. 98.

It has diagonal rack-and-pinion coarse movement, micrometer screw fine adjustment and draw tube, as in the original instrument, but a larger stage, $3\frac{1}{4}$ in. by $2\frac{3}{4}$ in., which folds to facilitate packing, and is held in position by a strong clamp screw, a substage fitting of $1\frac{1}{2}$ in. diameter carrying a full size Abbe condenser and iris diaphragm, and larger plane and concave mirrors, viz. $1\frac{1}{2}$ in. diameter, have been added.

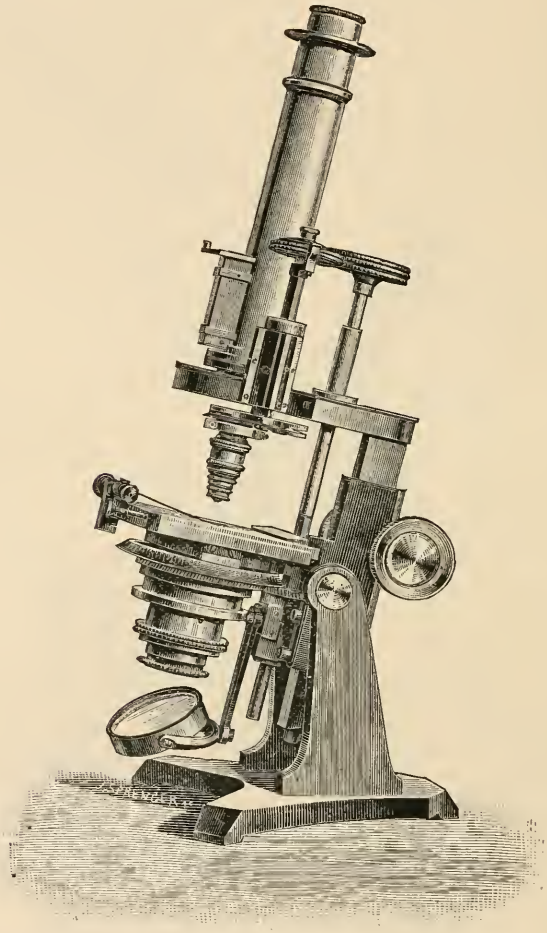

Fig. 58.

A removable mechanical stage with 1 in. movement in both directions has also been fitted, as this greatly facilitates the examination of blood spreads, etc.

It is mounted on a folding tripod foot, and is supplied in a solid leather case. The size of case is $10\frac{1}{2}$ in. by $5\frac{1}{2}$ in. by 3 in., and it will carry the following apparatus :—Microscope stand, two eye-pieces, three

objectives, bottles for stains, Horder's storage box for cover-glass preparations, and the special aluminium frame to carry the latter.

Mineralogical Microscope.* — This is shown in fig. 58, and is a strongly constructed model, inclinable, with a stage 85 mm. square. The Nicol's prisms have rectangular surfaces; the polariser can be removed, and the analyser behind the objective inside the tube can be easily slipped to one side. The object under examination does not turn: the Nicol's prisms being turned together by means of cog-wheels worked by a screw-button; this arrangement is something like the Allan-Dick model made by Swift. A graduated circle, with a vernier reading to one minute, indicates the position of the polariser with regard to the object. Rapid change of parallel light into converging light is effected by lenses mounted on a slide. The variation of the focus produced by the Nicol's prism is corrected by a lens. There is an opening behind the objective for the introduction of mica or quartz lamellæ, etc.

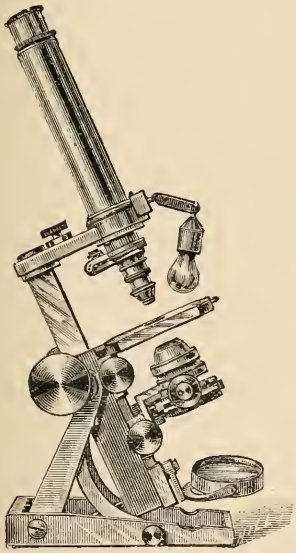

Fig. 59.

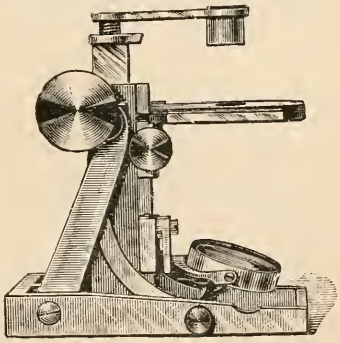

Fig. 59a.

The instrument has the quick-changing nose-pieces. The position of the oculars with respect to the Nicols is determined by shades.

The lenses for this series of Microscopes are all supplied by Messrs. Seibert and Kraft, of Wetzlar.

Travelling Microscope.†—This is shown in fig. 59. It is described as "large size," but is reduced to a small bulk by the easy dismounting of its component parts. The instrument can also be used as a simple Microscope for dissection (fig. 59a). The present form seems an improvement on the earlier model, which was described in this Journal.‡

* Catalogue Soc. Génévoise pour la construction d'instruments, de physique et de mécanique, No. 2485 (1900) p. 102.

† Op. cit., No. 2430 (1900) p. 101. ‡ Journal R.M.S., 1884, p. 437.

Leitz' New Binocular Loup.*—This instrument, which was exhibited at the December meeting (1898) of the Royal Microscopical Society, is shown in fig. 60. The usual principle of the ordinary binocular Microscope is not adopted, inasmuch as that principle involves a partition of the beam of light proceeding from an object, and a consequent diminution of the brightness of the image. But this instrument consists of two independent Microscopes, just as an opera-glass is formed of two separate telescopes, and the two images are combined by a mental process. The arrangement allows a greater freedom in the choice of objectives than in the ordinary binocular Microscope. The instrument contains two of Brücke's loups, whose fields of view accurately superpose. The eye-distance from the preparation-plane is about 250 mm., the field is large and flat, and the magnification about four diameters. The binocular loup admits of horizontal and vertical adjustment, and can be secured in any position by clamping-screws. The fine adjustment is by rack-and-pinion.

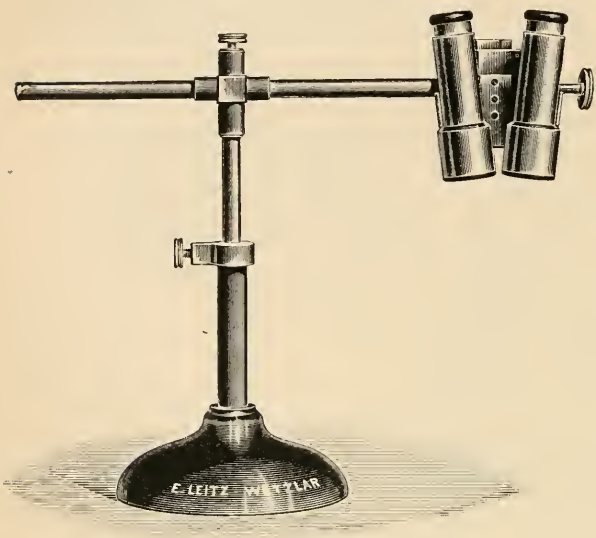

Fig. 60.

Dowdy, S. E.—**Sliding Stage for the Microscope.**
English Mechanic, lxxix. (1904) p. 218 (1 fig.).

(4) Photomicrography.

Dowdy, S. E.—**Amateur Photomicrography.**
English Mechanic, lxxix. (1904) p. 172–4 (5 figs.).

(5) Microscopical Optics and Manipulation.

Absorption and Emission of Air and its Ingredients for Light of Wave-lengths from 250 μ to 100 μ.†—After describing a photographic vacuum Spectroscope designed and made by himself, with lenses and prism of fluor-spar, and with arrangements for maintaining the same pressure throughout the body of the instrument, as in the Geissler tube (used end on), V. Schaudinn states his results.

* Zeitsch. f. Ang. Mikr., ix. (Feb. 1904) pp. 291–2 (1 fig.).
† Smithsonian Contributions to Knowledge, xxxix. (1903) No. 1413, 30 pp., 4 pls. and 10 figs. in text.

Photographs of the ultra-violet spectra, beyond 185 μ, of the following substances were made :—Nitrogen ; Oxygen ; Water ; Carbon monoxide ; Carbon dioxide ; Hydrogen.

Nitrogen.—Emission spectrum : beyond 185 μ no bands. Absorption spectrum : very transparent, even beyond 162 μ, but absorbed particular wave-lengths energetically.

Oxygen.—Emission spectrum : three continuous maxima at about 185 μ. Absorption spectrum : rays absorbed in the neighbourhood of 185 μ in a series of well-defined groups, fourteen in number.

Hydrogen.—The author states that none of the spectra beyond 185 μ with which he is acquainted emits such a wealth of lines or extends so far as this. Hydrogen reaches its highest photographic efficiency at 162 μ, and extends to approximately 120 μ ; but as such wave-lengths have not yet been measured, it is impossible to give the exact limit. A single plate of fluor-spar at the lower limit reduced the photographic effect to one-half. Hydrogen is extremely transparent.

Air.—The absorption effect of strata of the following thicknesses was tried : 15, 14, 4, 3, 2, 1, 0·5, 0·25, 0·1 mm. With the same time of exposure and same width of slit, the greater thicknesses stopped the spectrum entirely at 178 μ, but a stratum of 4 mm. allowed the first band at 170 μ to appear. With a stratum of 0·5 mm. the spectrum runs to the end of the plate, corresponding to 163 μ, and with the lesser thicknesses of air still further. Attention is drawn to the profound effect caused by introducing such a thin layer of air at atmospheric pressure into the path of the rays.

The paper is throughout illustrated by photographs of spectra.

In connection with V. Schaudinn's interesting experiments, J. W. Gifford observes that, with fluor-spar and the melted quartz now available, there is no doubt that object-glasses could be made, and a vacuum Microscope constructed for use with these very remote rays. In which case, the present resolving power of the Microscope (other things being equal) would be increased, roughly speaking, sevenfold. This means that objects could be separated when the interval between them was no greater than one nine-hundred-thousandth of an inch = ·0282 μ.

Note on the Diffraction Theory of the Microscope as applied to the Case when the Object is in Motion.* — According to the Abbe theory of microscopic vision, says R. T. Glazebrook, when a grating is placed on the stage of a Microscope and illuminated by plane-waves, diffraction images are formed in the focal-plane of the object-glass, and the images in the view-plane result from these—and this is undoubtedly true. The following difficulty has, however, been raised : if the grating be moved in its own plane in a direction perpendicular to the ruling, the diffraction images do not change ; those seen in the view-plane move : how then can the latter images be due to the former ? The answer lies in the fact that in the above argument the effect of the differences of phase among the diffracted images has been neglected. The diffracted images are not all in the same phase, their

* Proc. Physical Soc., 1904, p. 162.

relative phases are altered by shifting the grating, and the image pattern in the view-field is altered in consequence. A simple case is considered in the paper, and it is proved that the image in the view-plane may change without an alteration in the *position* of the diffracted images.

Light Waves and their Uses.* — Although this work is of little assistance to us in solving those intricate microscopical problems which depend on the wave theory of light, it is nevertheless a most fascinating book. More than this, it will be useful to those of our Fellows, who, not having studied physical optics, are desirous to understand something about the fundamental principles by which the Microscope image is formed.

The drawback to all books on this subject is, that if they are worth anything at all, they are crammed full of mathematics, and, therefore, intelligible only to those acquainted with that form of hieroglyphic writing; if, on the other hand, the treatment is popular, they are generally so inaccurate as to be valueless.

Here we have a book by one of the highest authorities, written with hardly a mathematical symbol, and in a peculiarly pleasant style.

The author, A. A. Michelson, speaking of wave-motion, says that it "is one of the most fascinating, not only of the department of science, but of human knowledge. If a poet could at the same time be a physicist, he might convey to others the pleasure, the satisfaction, almost the reverence, which the subject inspires."

The chapter succeeding that upon Wave Motion and Interference, deals with the Resolving Limits for the eye, the Telescope and the Microscope. It is shown that the resolving power of the eye is about $\frac{1}{250}$ in. at 10 in., and that this amount is augmented five-hundredfold by a 5 in. telescope and four-hundredfold by a Microscope.

The larger part of the book is occupied by showing how quantities (linear and angular), far smaller than any that can be dealt with either by the telescope or Microscope, can be measured by means of the Interferometer—an instrument, as its name suggests, for measuring interference phenomena.

Those who have studied mathematical instruments will be much interested in the description of the *harmonic analyser*, as well as in the woodcut showing some of the wonderful curves it has drawn.

Some idea of the accuracy gained in measurements made by the Interferometer may be obtained from the following example.

A standard metre, measured by three different observers at different times, separated by whole months, was found to be equal in length to 310678·48 red waves of light. The greatest difference between the three measurements was only one-fifth of a single wave-length.

There are three plates giving excellent coloured representations of spectra, and the book is well illustrated by woodcuts throughout.

Simple Method for the Observation of Ultra-Microscopic Particles.†—E. S. London demonstrated to the Microbiological Society of Petersburg (November 8, 1903) a new apparatus of Siedentopf and

* Decennial Publications of the University of Chicago. University of Chicago Press, 1903, 8vo, 166 pp, 3 pls. and 108 figs.

† Centralbl. Bakt., Ref., xxxiv. (1904) pp. 433-4.

Zsigmondy for ultra-microscopic observations. Its constituent parts were (1) a carbon arc light, (2) a condenser, (3) a vessel filled with alum solution for the absorption of the heat rays, (4) a diaphragm, (5) a Microscope, and (6) a specially constructed camera. The first four were taken from the large microphotographic apparatus of Zeiss. The Microscope was also by Zeiss. The special camera was a four-sided metal receptacle, 2 cm. by 0·8 cm. by 1·8 cm., in which there were five round openings 0·3 cm. in diameter. The opening in each of the smaller surfaces was prolonged into a metal tube. The openings in the narrow surfaces were placed opposite each other. The fifth opening occupied the middle of the broad upper surface. The middle point of the three last lay in one plane. The light passing through the condenser, the alum-containing vessel and the diaphragm, entered the anterior opening of the camera, which latter was placed on the Microscope object-wise. The illuminated contents of the camera can then be studied through the upper opening. By means of this apparatus various objects were demonstrated, and among them the *Bacillus dysenteriæ* (Shiga) in normal saline solution, with a magnification of only 31 diameters.

Filtration of Ultra-Violet Rays through a Selection of Jena Optical Glasses.*—H. A. Krüss has investigated this subject in connection with samples of glass supplied him by Schott and Co. These samples represented the kinds of glass most frequently used in optical instruments, and comprised the catalogue numbers 3094, 2900, 2990, 3046, 1800, 2572, 3111, 3013, 2563, 2625. Each sample was, moreover, supplied in the three thicknesses. The results are tabulated in the following manner: for glass of 1 mm., $\lambda = 309$ to 384 $\mu\mu$; for glass of 10 mm., $\lambda = 309$ to 434 $\mu\mu$; for glass of 100 mm., $\lambda = 309$ to 480 $\mu\mu$. A full account of the method, apparatus and theory is given, as well as an introductory bibliography.

Optical Properties of Vitreous Silica.†—J. W. Gifford and W. A. Shenstone point out that the properties of vitreous silica suggest that it is not unlikely to play an important part in optical work. Its composition is definite, that is to say, it is not liable to those minute variations which make it impossible to produce with certainty two meltings of glass, which exhibit no sensible difference in their optical properties when tested by a first-rate spectrometer. Hardly any corrosive fumes, except those of fluorine and hydrogen fluoride, attack silica, and it is indifferent to most ordinary solvents. It is as transparent to ultra-violet radiations as quartz, but is not doubly refracting like that substance. Although it is a little difficult to prepare vitreous silica in large masses, this difficulty can be surmounted, and the supply of the substance is not limited like that of fluorite. In short, vitreous silica places at our disposal a really standard glass. Its refractive index is low, and its dispersive power is sensibly greater than that of quartz.

The authors describe the method of manufacture, which involved a

* Zeit. f. Instrumentenkunde, xxiii., July 1903, pp. 197 207; August 1903 pp. 229–39 (7 figs.).

† Proc. Roy. Soc., lxxiii., No. 491, pp. 201–8 (3 figs.).

prolonged use of the oxy-hydrogen gas furnace, and the satisfactory results from the testing of a series of prisms. They give tables of :

1. The refractive indices of vitreous silica.
2. The focal lengths in metres of a compound lens of fluorite and vitreous silica, achromatised for wave-lengths 7950 and 1852.
3. Partial and proportional dispersions of fluorite and vitreous silica.

The second of these is quoted below *in extenso*.

Radii :—R = 0·38733; S = 0·20351; R′ = S; S′ = ∞.
R, S, R′, S′ refer to the surfaces of the two lenses.

Wave-length.	Focal Length.	Wave-length.	Focal Length.	Wave-length.	Focal Length.
7950	1·00000	3962 H′	0·99743	2194	0·99120
7682 A′	1·00010	3611	0·99653	2144	0·99151
7066 B′	1·00045	3303	0·99558	2099	0·99174
6563 C	1·00070	3034	0·99409	2062	0·99205
5893 D	1·00086	2749	0·99250	2024	0·99258
5607	1·00059	2573	0·99143	1988	0·99360
5270 E	1·00017	2446	0 99054	1933	0·99490
4861 F	0·99983	2313	0·99055	1852	1·00000
4341 G′	0·99874	2265	0·99078		

Theories of the Resolving Power of a Microscope.*—Geometrical optics in its relation to instruments has, says R. T. G.,† been studied to great advantage abroad ; we in England have of recent years somewhat neglected the subject, with the result that only a small share in the recent advance in lens construction has been ours. The books and papers under review tell us of the advance.

It was in 1878, in his report on the London International Exhibition of Scientific Apparatus, that Prof. Abbe first directed attention to the fact that the further perfection of the Microscope as an optical instrument depended on the advance of the art of glass making. With the glasses then at their disposal it was not possible for opticians to get rid of the secondary spectrum of their object glasses ; while a glass could be made achromatic for two wave-lengths, the differences in the relative dispersion of the two ends of the spectrum were such that there was an outstanding amount of colour which prevented the attainment of the highest perfection of the image. It was to this fact that the establishment of the now celebrated firm of Schott and Company was due, and the results of Abbe's own work on Microscope lenses are summed up in the first volume of his collected papers, which has recently appeared.

* 'Gesammelte Abhandlungen.' Von Ernst Abbe.
'Das Zeisswerk und die Karl Zeiss-Stiftung in Jena.'
'Zur Theorie der Mikroskopischen Bild-erzeugung.' By Victor Grunberg.
'The Helmholtz Theory of the Microscope.' By J. W. Gordon.
'The Theory of Optical Images.' By Lord Rayleigh (Journ. R.M.S., 1903).

† Nature, lxix. (1904) pp. 497–8.

The well-known paper, *Contributions to the Theory of the Microscope and of Microscopic Perception*, which forms the basis of his work, is here reprinted, and it will be interesting to consider some of the points it raises.

But first let us contrast what is now possible so far as achromatic correction is concerned with what was possible, say twenty years ago. In those days the ordinary flint and crown glasses only were available. In the case of a telescope object glass with a focal length of one metre for the D line, the variation in focal length will, with such glasses, amount to 1·4 mm. for A′ and 2·2 mm. for G′. In an object glass using modern glass, such as that designed by Mr. H. D. Taylor, these errors are reduced respectively to −0·1 mm. and +0·3 mm.

These figures are enough to show how much the optician owes to the art of the glass maker.

Turning now to some theoretical matters connected with the microscope which are dealt with by Abbe in his papers, let us consider first the term "numerical aperture" in its relation to the resolving power of the instrument. We owe to Abbe the introduction of this term, and the realisation of its importance as defining, in certain circumstances, the resolving power of the instrument. By numerical aperture is meant the value of the quantity $\mu \sin \alpha$, where μ is the refractive index of the medium in which the object is placed, 2α the vertical angle of the cone subtended at the object glass by the point in which the axis of the instrument meets the object. Let us suppose, then, that an object is on the stage viewed by transmitted light, and to simplify matters let us suppose the source of light at some distance.

Then, according to Abbe* and his followers, in considering the image formed in the focal plane of the eye-piece, we are not to start from the object as a self-luminous source and consider where the image of such a source would be if formed by the laws of geometrical optics; we are to start from the source itself, to consider its image formed in the focal plane of the object-glass, and to treat this image as a self-luminous source of light in the microscope tube from which arises the image we see.

If the object be small, the focal image will be modified by diffraction due to the object, and according to the views enunciated in the paper before us, it is on the nature of the diffraction images and the number of them which are formed that the definition depends.

We will return later to the question whether it is necessary thus to consider our problem.

At present let us develop it and examine whether it affords us a satisfactory solution of the problem of resolving power.

Suppose, now, the Microscope has been focussed on some object on the stage and then this object has been removed; the parallel rays from the source are brought to a focus in the focal plane of the object glass, forming there a circular patch of light; rays diverge from each point of this, and reaching the eye produce the sensation of a uniform luminous field.

Now let the field in the focal plane be limited by diaphragms

* It was stated recently by Dr. Czapski (Proc. R.M.S. August, 1903, p. 569) that it would be a mistake to suppose that Prof. Abbe had merely given a grating theory of the Microscope; he has treated the matter more fully.

pierced with a series of small apertures. The distribution of light in the focal plane of the eye lens, the view plane, will no longer be uniform; we shall see the diffraction pattern formed there by the apertures.

If, for example, there be but one aperture, a single narrow slit, the field will still be uniform; light diverges from the slit uniformly in all directions, and no structure is seen.

If we have a number of equidistant slits the view plane will be crossed by a series of equidistant dark and light bars. The distance between these bars and the distribution of light between them will depend on the distance between the slits of the diaphragm and the distribution of luminosity among the slits. If this be known, the distribution of light in the view plane can be calculated. If, for example, the distance between the slits be doubled, the distance between the maxima in the view plane will be halved, that is to say, the number of bright bars in a given interval will be doubled. The distribution in the view plane depends on that in the focal plane, and can be calculated from it; this is quite certain.

But now, instead of producing a variable distribution in the focal plane of the object glass by means of diaphragms, we can do it by means of the diffraction effects of small objects on the stage.

Thus, if we put on the stage a grating consisting of a series of equidistant spaces, and if e be the grating distance, then, taking homogeneous light, a series of narrow bands of light, the diffraction images of the source, will be produced in the focal plane with darkness between them; the central image will be on the axis, and if θ_1 θ_2 . . . be the angular distances between the images, then $\sin \theta_1 = \lambda/e$, $\sin \theta_2 = 2\lambda/e$, etc.

It may be shown that the image in the view plane produced by this series of diffracted images is the ordinary geometrical image of the grating. It should be observed that in this proof there is no discussion of the distribution of light in the interspaces between the maxima, and it is on this distribution that the question of resolving power depends. It is clear, of course, that if we modify the number of spectra in the focal plane we modify the image, and this is done in an ingenious way in some of the experiments arranged by Prof. Abbe's pupils to illustrate the theory.

If we cut out all but the central image the view field is uniform, no structure is visible; if we allow the first image on either side of the central one to become effective, the bands appear in the field in their proper positions, and so on. It is said to be the fundamental result of Abbe's theory that the object, the grating, can be fully resolved if one diffraction image is formed on either side of the central one. It is clear that in this case there will be variations of intensity in the view plane; we shall see later what they amount to.

Now the number of spectra is limited by the fact that some of the diffracted light may be so obliquely diffracted as not to enter the object glass. If $2a$ be the angular aperture of the object glass measured from the axial point of the stage, then the nth diffracted image will not appear if $\sin \theta_n$ is $> \sin a$, but $\sin \theta_n = n\lambda/e$.

Hence, for the nth image to be excluded, $n\lambda/e$ must be greater than $\sin \alpha$, but according to Abbe, for resolution the first diffracted image must appear, and hence resolution is just possible if λ/e is equal to $\sin \theta$.

It has been assumed that air is the medium on either side of the object glass; if on the object side we have a medium of refractive index μ, then it is easy to show that we must replace $\sin \theta$ by $\mu \sin \theta$, and the condition of resolution is that e should be equal to $\lambda/\mu \sin \theta$, or introducing the term numerical aperture for the quantity $\mu \sin \theta$, we have the result that a grating is resolvable if the space between the lines is not less than the result found by dividing the wave-length of light by the numerical aperature.

Now, while the truth of this result can in certain cases be established, the reasoning given in the books under consideration is insufficient to prove it.

In order to decide if the grating can be resolved we must establish the law of variation of intensity in the view plane, and then consider whether these variations are such that they can be detected by the eye. This has been done by Lord Rayleigh. The images formed in a Microscope are, like all other images, produced by interference; in considering resolving power we have to consider diffraction effects, it is true, but the diffraction which concerns us mainly is that due to the aperture of the object glass, and only indirectly that due to the object viewed.

Neither is it necessary, if we know completely the distribution of the light over the stage, to go back to the source in our consideration of the problem; having given the distribution over the stage both in amplitude and phase, we are potentially able to determine that in the view plane without reference to the source. Difficulties of calculation may stop us, it is true, but that is another matter.

Let us take, again, the case of a grating illuminated by plane waves, their plane being parallel to that of the grating; we have to consider the effect due to a series of equidistant lines of light; these differ, however, from a series of independent equidistant linear sources in that, with the grating, the phases of the various sources are the same; we have therefore to remember that interference will take place between the light from the different lines, while with a series of independent lines there is no relation between the phases; we can calculate the intensity due to each source separately, and superpose the whole.

Lord Rayleigh's solution of the problem, which is presented when a narrow double line in a spectrum is viewed through a telescope, or when the attempt is made to resolve two close double stars, is better known than his equally valid solution of the grating problem, and as it is simpler it will be useful to indicate it first.

The intensity in the view plane for a single linear source, assuming for the moment that we are dealing with a telescope with a rectangular aperture, is given by a certain curve. If we assume a second independent source parallel to the first we get a similar curve alongside the first. The resultant intensity is found by adding the corresponding ordinates of the two curves, and the lines will appear as double when the drop in the resultant intensity curve is sufficient to be detected by the eye.

Lord Rayleigh suggested that in his case the drop would be just distinguishable when the maximum of intensity due to the second curve was superposed on the first minimum due to the first, and experiment has borne this out. In this case the two halves of the aperture send light in opposite phases to the first minimum, and the angular deflection of the minimum is the angle subtended by the wave-length of light at the distance of the breadth of the aperture. Two lines which subtend a greater angle than this can be resolved.

Similar methods were applied by Lord Rayleigh in 1896 to the Microscope, and additional results have been given in his recent communication to the Royal Microscopical Society, which follows Mr. Gordon's interesting paper on Helmholtz's theory of resolving power in the *Journal* of the Society. In his paper Mr. Gordon discusses in detail Helmholtz's theory, and points out how far it is from fully explaining all the difficulties of Microscopic vision.

In Lord Rayleigh's earlier paper he deals with (1) two independent linear sources viewed through a Microscope, and shows that they can be resolved if the distance between them is half that given by Abbe's theory; (2) two sources which are always in the same phase; in this case resolution is impossible if the distance is that given by the theory.

If, instead of having *two* sources, either cophasal or independent, we have a long series, the problem is more complex, but the method is the same. An expression is found for the variations of intensity in the view plane, and the question is considered whether or no these variations are sufficient to be noticed by the eye.

In the paper the question of the visibility of a dark bar on a uniform field is dealt with, and here again a distinction must be drawn between the case in which the field is self-luminous and that in which it is due to a distant source. In the latter case it appears that the image of the bar would be marked by a perceptible darkening across the field, even when the breadth of the bar was but $\frac{1}{32}$ of that given by Abbe's theory, though the breadth of this shadow would not be a measure of that of the bar; in the former case the fall in intensity over the geometrical image is only one-half of what it is in the latter. Moreover, we are certain to arrive at erroneous consequences if we apply results obtained from the case of a grating of a large number of parallel slits to a case such as that of a single small aperture through which light is coming or a single small obstacle obstructing the light; the diffraction pattern due to such an obstacle is entirely different from that due to a grating, and the conditions of resolution will be different also.

It appears, then, that while Abbe's theory of Microscopic vision is undoubtedly correct in that a small object or objects on the stage produce diffraction patterns in the focal plane of the object glass, and the illumination in the view plane can be inferred from these diffraction images, still this method of regarding the question is not the only possible one, neither is it necessary to go back to the original source if we know the distribution in the object plane. By proceeding, however, in the way indicated by Lord Rayleigh, we can evaluate the distribution of intensity in the view plane, at any rate in certain cases, and obtain thus a numerical estimate of the resolvability.

(6) Miscellaneous.

Gage's Microscopy.*—S. H. Gage's *The Microscope: an Introduction to Microscopic Methods and to Histology* has recently passed into the ninth edition, and while retaining all its previous excellent features and well-known characteristics it has been revised throughout, and important changes have been effected in certain parts, e.g. those relating to serial sections and to micro-chemistry. The chapter on the Projection Microscope has been entirely re-written and much more fully illustrated.

B. Technique.†

(1) Collecting Objects, including Culture Processes.

New Culture Medium made with Helix Pomatia.‡—Della Rovere has employed the following culture medium for the purpose of determining whether certain micro-organisms retained longer on it their virulence and reproductive power, than when grown on horse-liver or horse-flesh bouillon, a medium considered the best for their growth. 300 grm. snails, freed from their shells and finely minced, are set in 1000 c.cm. of water, and to this are added 10 grm. Witte's peptone and 5 grm. sodium chloride. From this bouillon or agar is prepared. The author concludes that such bouillon is the most suitable for *B. coli*, *B. icteroides* and *B. murisepticus*. He found that the virulence of *B. coli* remained for a long time, and that the reproductive power of *B. coli*, *B. icteroides*, *B. murisepticus* and *B. anthracis* remained for a longer time than in cultures in horse-flesh bouillon. He holds that the characteristic of his bouillon is due to the fact that it contains an important quantity of grape sugar developed through a natural reduction of glycogen.

Bacterial Diagnosis of Typhoid by means of the v. Drigalski-Conradi Medium and Agglutination.§—B. Lipschütz, from the results of an experimental research on this subject, comes to the following conclusions:

1. The v. Drigalski-Conradi medium simplifies the cultivation of typhoid bacilli from fæces, urine, etc., but the characteristic behaviour of the typhoid bacillus on this medium, and the identification of the suspected colonies by means of agglutination, do not furnish a certain guarantee for the accuracy of the bacterial diagnosis, and therefore a wider cultural investigation is advisable.

2. It is desirable in the investigation of suspected colonies by means of agglutination to employ the so-called 'end-dilution' (*Wassermann*). If there is suspicion of para-typhoid (or dysentery) the

* Comstock Publishing Company, Ithaca, New York, 1904, vi. and 299 pp., 230 figs.

† 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.

‡ Gazetta degli Ospedali e della Cliniche, 1904, No. 139. See also Centralbl. Bakt., Orig., xxxiv. (1904) p. 562.

§ Centralbl. Bakt., 1te Abt., xxxv. (1904) pp. 798–811.

agglutination of the colonies in question must be investigated with the specific serum of this disease.

3. Agglutinin and agglutinating substances are not bodies of constant composition and nature; they appear rather as biological products to differ within certain limits, and this renders desirable the special judging of agglutination results in each case.

4. The immobilising in the agglutination of typhoid or coli bacilli, depends on the nature of the specific serum as well as on that of the employed bacteria.

Capsule Formation by Diplococcus Pneumoniæ in Culture.* — M. H. Gordon demonstrates the capsules by the following procedure:

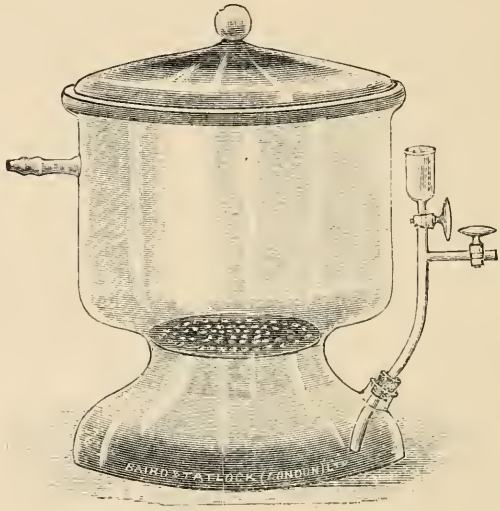

Fig. 61.

Boil for 30 minutes, 1 lb. of minced beef in 1 litre of distilled water. Filter and add 12 p.c. of *yellow gold table* gelatin, 1 p.c. pepton and ½ p.c. salt. Make faintly alkaline to litmus paper with liquor potassæ (B.P.). Add white of egg, and steam for 30 minutes. Filter, pour into tubes, and sterilise in the steamer for 30 minutes on two successive days.

A drop of the fluid gelatin culture, after incubation at 37°, is removed with a loop and spread over a cover-glass, dried over the flame, allowed to stand in alcohol for a minute, and then without drying transferred, film downwards, to a watch-glass containing Ziehl-Neelsen's carbol-fuchsin. After staining for 1 to 3 minutes the cover-glass is dipped lightly in water. The moisture is then removed from the upper side, and the preparation is then examined in water.

Permanent specimens showing the capsules are difficult to obtain by

* Brit. Med. Journ. (1904) i. p. 659 (1 fig.).

this method, unless the film be deeply stained and washed very slightly in water.

New Anærobic Apparatus.*—A. R. Laing has devised an apparatus which consists of a glass jar (fig. 61) with a constriction near the base, and surmounted with a closely fitting lid. Near the top is a short tube for connection with an exhaust pump. Below the constriction is another opening, through which passes a glass tube kept tight by means of a rubber cork. The upper end of the tube has two arms, one having a reservoir for caustic potash, the other leading to the hydrogen supply. Both arms are furnished with stop-cocks.

To work the apparatus, a sufficiency of pyrogallic acid is first put into the reservoir below the constriction; upon the latter is placed a perforated porcelain plate, on which the cultivation vessels rest. The glass lid is smeared with vaselin and pressed firmly down, and the gap between the lid and the jar filled with paraffin soap. The air is then exhausted and the apparatus filled with hydrogen, this process being repeated six times to ensure a complete hydrogen atmosphere. A little of the hydrogen is removed by means of the exhaust, in order to have slight negative pressure within the vessel. Potash solution is then run in.

W.J.S.—**Collecting and preparing Diatoms.** *English Mechanic*, lxxix. (1904) p. 84.

(2) Preparing Objects.

Preparing Small Dried Insects for Microscopical Examination.† G. Enderlein claims good results from the following treatment of such dried material. The insect is placed carefully in a mixture of 1 part moderately strong caustic potash solution and 8 to 10 parts water. If winged, these appendages are best first removed. If, however, the insect is a very delicate one, the wings may be left on, and a weaker solution of the alkali employed. According to the size and delicacy of the object, it remains in this solution from 10 minutes to 1 hour, until indeed the natural form has been regained. It is then placed in water, being carefully watched the while, lest undue swelling take place. The larger air-bubbles are now removed with a fine brush, and the object again placed for a short time in dilute caustic potash, transferred to water, and then taken gradually into 96 p.c. alcohol, when the remaining air-bubbles are removed as before. In 96 p.c. alcohol it can be kept. If a microscopic preparation is desired, as much as possible of the body contents are removed by pressure with a fine brush. The object is then arranged suitably, passed through absolute alcohol and cedar oil, and mounted in Canada balsam. If one is dealing with very thin chitinous structures, e.g. delicate abdominal walls, it is well to mount the specimen in glycerin directly after water.

The author makes permanent glycerin preparations by fixing the cover-glass, on which no glycerin should be allowed to flow over, to the slide by means of a ring of wax. This being done, Canada balsam or

* Lancet, i. (1904) p. 515 (1 fig.).
† Zool. Anz., xxvii. (1904) pp 479–80.

other cement is applied to the edges. In many cases it is worth while to preserve a dry wing between cover and slide, a simple ring of wax being sufficient. Except with larger and more markedly chitinous insects, such as beetles, heating of the caustic potash solution is not advised.

Demonstrating the Structure of Corpus luteum of Sheep.*—F. H. A. Marshall placed freshly excised uterus and ovaries in 10 p.c. formalin, and after six days at least pieces of the uterine wall were excised. These were then washed in water for about twelve hours, and afterwards passed through alcohols of increasing strength. Sections, made by the paraffin method, were stained with hæmatoxylin and iron-alum, hæmatoxylin and eosin, anilin-blue and borax-carmin. The ovaries were generally treated in the same way, but sometimes were fixed with sublimate.

Demonstrating Presence of Seed-Fungus in Darnel.†—E. M. Freeman placed the grains in a germinating chamber, and dissected out the embryos or seedlings at various stages. The fixatives used were Flemming's fluid and chromic acid (1 p.c. and ½ p.c.). Anilin-water safranin and Heidenhain's hæmatoxylin were found to be the most effective stains. In some cases chloral hydrate, potassium hydrate, and lactic acid were used. For demonstrating the starchy endosperm the sections were made with an ether-freezing microtome.

Fixation of Infusoria.‡—P. de Beauchamp recommends the following procedure for fixing in the extended condition contractile animalcules, especially Vorticellæ. The principal feature of the method consists in slowly anæsthetising the animals, placed between a slide and cover-glass. The use of the cover-glass prevents a too hasty action of the reagent and avoids diffusion currents. The preparation is supported on a couple of wedges placed inside a glass vessel containing a little alcohol. The duration of the anæsthesia varies from ¼ to ¾ of an hour, according to circumstances. The animals are then fixed by running a drop of the fixative under the cover-glass. The author used only saturated solution of sublimate for fixing, which requires copious and prolonged washing in order to get rid of it, but suggests that osmic acid would act equally well. The preparations may now be stained say with picrocarmin, and afterwards mounted in glycerin.

Demonstrating the Tubular Reticulum in the Cytoplasm of nervous and epithelial Cells of the Earthworm.§—S. Ramón y Cajal, after calling attention to the existence of a tubuliform apparatus in the cytoplasm of the nervous and epithelial cells of the earthworm, gives the following method for demonstrating the reticulum. The pieces of earthworm, which should not exceed 3 to 4 mm. in thickness, are incubated for two to five days at 35° to 40°C. in 1·5 p.c. solution of silver nitrate in distilled water. In certain cases stronger or weaker solutions may be used with advantage, but it is always advisable to employ a large quantity. When removed from the silver solution, the pieces should

* Phil. Trans., cxcvi. (1904) p. 55. † Tom. cit., pp. 3–4.
‡ Bull. Soc. Zool. de France, xxix. (1904) pp. 26–7.
§ Bol. Soc. Española Hist. Nat. iii. (1903) pp. 395–8 (2 figs.).

be washed for a few seconds in distilled water, and then transferred to the following reducing medium :—Pyrogallic acid 1 grm. ; formalin 5 to 10 grm ; distilled water 100 grm., for 24 hours. After a rapid wash the pieces are placed at first in 36 p.c. alcohol and then in absolute, previous to imbedding in celloidin or paraffin.

The author * adopts the same procedure for staining nerve-fibrils.

Preparing Planarian Worms.†—G. Marpmann places the worm on a slide by means of a pipette, and then narcotises it with 0·5 p.c. eucain. When it no longer responds to the stimulus of a needle, it is killed by pouring over it the following solution :—Sublimate 1 ; salt 1 ; glacial acetic acid 5 ; water 100. The specimen may be stained with picro-carmin and then cleaned up in pure carbolic acid, the latter being removed by means of xylol previous to mounting in balsam. These worms are well adapted for showing nerve ramifications when stained by appropriate methods.

Demonstrating the Structure of Cardiac Fibres.‡—In his researches on the structure and development of the cardiac fibres in the Vertebrata, F. Marceau fixed the tissue in acetic acid sublimate, using chiefly Zenker's fluid. After from 4 to 24 hours, according to the size of the heart or of the pieces taken, the tissue was transferred to alcohols (30, 50, 70, 80 p.c.) for 2 to 6 hours, and then paraffin sections made. The sections were usually stained with iron hæmatoxylin, and afterwards contrast-stained with eosin or Bordeaux red. It was found advisable to mordant the sections for 12 to 24 hours in iron alum. In reference to the after-staining with eosin, the writer notes that it is better to use a weak solution and employ it when the iron staining is halfway through, and finish off the iron staining afterwards.

Heidenhain's hæmatoxylin and vanadate of ammonia method was also used, but only in a few instances, as there are many difficulties connected with it. The hæmatoxylin and chloride of vanadium method recommended by Wolters was found to be far more easy ; the results were good, but did not differ materially from those of iron hæmatoxylin.

In order to obtain good preparations of heart-muscle of birds and mammals, it was found better not to fix the material until three-quarters of an hour had elapsed after the animal was killed.

For teasing out the fibres 20 p.c. nitric acid was far superior to caustic potash or chromic acid ; the fibres were easily dissociated, and when washed in water, alcohol and glycerin would make excellent permanent preparations.

(3) Cutting, including Imbedding and Microtomes.

New Method for Sticking Celloidin Sections to the Slide.§—R. Fischel recommends linimentum exsiccans for sticking celloidin sections to the slide. This adhesive is composed of 5 parts tragacanth, 2 parts glycerin, to 100 parts distilled water, and is put up in collapsible tubes.

* C. R. Soc. Biol. de Paris, lv. (1903) pp. 1565–8.
† Zeitschr. angew. Mikrosk., ix. (1903) pp. 328–9.
‡ Ann. Sci. Nat. Zool., xix. (1904) pp. 235–9.
§ Zeitsch. wiss. Mikr., xx. (1904) pp. 288–91.

A piece about the size of a pea is placed between two slides ; by squeezing these together two thin even films are produced. Upon the films are arranged the celloidin sections. Upon these are placed several folds of blotting paper, and firm but gentle pressure applied.

Instead of the foregoing procedure, some of the liniment may be mixed with distilled water to a syrupy consistence, and a film made on the slide with a camel's-hair brush. In any case, it is always necessary to make the smears immediately before arranging the sections, as the linimentum dries very quickly.

The slides covered with sections are then placed in a vessel containing 96 p.c. alcohol for a quarter to half an hour before they are exposed to any after-treatment, such as staining or mounting.

If it be desired to remove the celloidin, the slides are immersed in a solution of equal parts of alcohol and ether for half an hour or more, and then transferred to 96 p.c. alcohol.

Method for Sticking Paraffin Sections to the Slide.*—H. Michaelis places the section in warm water (45°) and removes it thereform on a slide. After removing the superfluous water with blotting-paper, a piece of smooth writing-paper is pressed firmly on the section. On carefully lifting the paper the section is removed along with it. The paper is then cut off all round the section, care being taken not to have any piece projecting beyond the edge of the section. A slide is now covered with a layer of glycerin albumen, and upon this the section is laid, paper side uppermost. After pressing the section firmly down, the albumen is coagulated in the flame. When the paraffin is dissolved out in xylol the paper falls off.

(4) Staining and Injecting.

New Method of Staining with Iron Hæmatoxylin.†—A. Paine, in a communication made to the Pathological Society of London, recommended the use of iron and hæmatoxylin in *one* solution, not in separate and consecutive solutions as in the methods of Heidenhain and Benda, and without subsequent decolorisation. Such a solution he prepares by adding in certain proportions a 5 p.c. solution of hæmatoxylin (Grübler) in absolute alcohol, to a weak solution of perchloride of iron, e.g. 1 to 1000 of the B.P. liq. ferri perchlor. fort. Convenient proportions were found to be 5 to 10 drops of the former to 10 c.cm. of the latter solution. This stain can be used after alcohol, mercury or bichromate fixation, but the best results followed fixation in 3 p.c. potassium bichromate and 5 p.c. glacial acetic acid added at the time of using.

Staining of Bacteria difficult to Stain (Glanders and Typhoid Bacilli, Gonococci, etc.) in Sections of Skin and other Organs.‡—K. Zieler recommends for sections, to be stained with polychrome methylen-blue, a preliminary staining with acid orcëin solution. By

* Centralbl. allgem. Pathol. au. pathol. Anat., xiv. (1903) pp. 264–5.

† Lancet, i. (1904) pp. 435–6.

‡ Centralb. allg. Path., xiv. (1903) p. 561. See also Centralbl. Bakt., xxxiv. (1904) p. 462.

this a considerable alcoholic firmness is obtained, and also a differentiation of the nuclear and protoplasmic structure, and a staining of the elastic fibres. Glanders bacilli appear dark on an unstained ground, and typhoid bacilli intensely red-violet. The proceeding is as follows: (1) Fixing and hardening, best in Müller-formalin, and embedding in paraffin or celloidin. (2) Sections are stained overnight in orcëin D (Grübler), 0·1; officinal nitric acid, 2·0; 70 p.c. alcohol, 100·0. (3) A short washing in 70 p.c. alcohol. (4) Water. (5) Staining in polychrome methylen-blue for 10 minutes to 2 hours. (6) Distilled water. (7) Differentiation in glycerin-ether mixture, 1; water, 2 to 5, until the sections appear bright blue. (8) Distilled water, 70 p.c. alcohol, absolute alcohol, xylol, balsam.

Is there a "Vital" Staining?—Under this heading R. Krause* discusses the question as to whether vital staining is really possible, meaning thereby a staining of the cell organs while the cells themselves suffer no loss of function, or whether such staining is not merely staining *intra vitam*, and associated with loss of function and approaching death of the stained tissue elements. The author inclines to the former supposition from the results of observations on the ciliated cells lining the vestibule of the labyrinth in *Petromyzon*, their function being of course observable microscopically. He injected into the heart or posterior cardinal vein of the living animal a few cubic centimetres of a 2 p.c. solution of crystallised, chemically pure methylen-blue (Höchst) in normal saline solution. At the end of the injection the auditory capsule was laid bare, and then by means of a good knife horizontal or vertical sections were cut. These were studied in normal saline solution. The cells at first appeared unaffected, but soon their constituent parts underwent a differential staining, the continued unchanged movement of the cilia contra-indicating any impairment in the functional activity of the cells.

Staining Trypanosoma.†—W. E. Musgrave and M. T. Clegg approve of Woolley's method of staining Trypanosoma. The blood films are fixed for 10 minutes in absolute alcohol, and then stained with the following solution:—(A) Eosin, 1 grm.; distilled water, 1000 c.cm. (B) Polychrome methylen-blue, Unna's formula. (C) Methylen-blue, 1 grm.; distilled water, 100 c.cm. (D) Solution B, 2 parts; solution C, 1 part. 1 c.cm. of A is mixed with 4·5 c.cm. of D. The preparations are stained for 20 to 40 minutes, are then washed, and afterwards stained with solution A for 2 to 5 seconds.

Method for Intra-vitam Staining of the Protoplasmic Granules of the Cornea.‡—G. Colombo makes a saturated solution of Bismarck brown in 92 p.c. sodium chloride. This is filtered while hot and afterwards when cold. The solution is sterilised in a water bath and then dropped into the conjunctival sac of a frog. About 5 drops are instilled four times a day. In 3 or 4 days the cornea becomes yellowish brown. A piece of the excised membrane may now be examined in physiological salt solution.

* Anat. Anzeig., xxiv. (1904) pp. 400–3.
† Publications of Dep. Int. Bur. Govt. Lab., Manila, 1903.
‡ Zeitschr. wiss. Mikrosk., xx. (1904) pp. 282–8 (1 pl.).

In order to fix the pigment granules *in situ* the whole eye should be immersed for about eight hours in the following solution. Saturated solution of sublimate in 1 p.c. sodium chloride, 2 c.cm.; 1 p.c. solution of osmic acid, 2 c.cm.; 1 p.c. acetic acid, 1 c.cm. The eye is then transferred to Müller's fluid for 16 hours, after which the cornea is excised and washed in running water for 1 or 2 days. The material may then be dehydrated in absolute alcohol, and, having been cleared in origanum oil, examined on the flat, or sections may be made by the paraffin or celloidin methods.

Triple Staining of Vegetable Tissue.* — L. Petit stains sections of vegetable tissue with iron chloride and ferrocyanide of potash, whereby the cellulose and collenchyme are coloured blue. The cork and cuticula are stained with alkanna and woody tissue by means of an aqueous or alcoholic solution of iodine green. In this way a triple staining is obtained.

Vital Staining of Corethra plumicornis.†—W. Kolmer, after trying to stain the larvæ of *Corethra plumicornis* with methylen-blue but without success, hit on the following ingenious device. In the fluid containing the larvæ and the methylen-blue he placed a colony of *Stentor cæruleus*. The infusoria soon perished, and methylen-blue granules were freely deposited on their bodies. These were greedily eaten by the larvæ, the stain passing from the alimentary canal to other parts of their anatomy, so that the structure of the animals was easily observed.

New form of Section-Lifter.‡—S. E. Dowdy bends a piece of wire gauze to the shape of a funnel. A circular cover-glass is placed inside the hopper. After the funnel is immersed in the fluid the section is washed off into it. On raising the funnel, the section is left stranded on the cover-glass. The latter is then easily removed. By this procedure thin and delicate sections may be secured and mounted without risk of injury.

DOWDY, S. E.—**Thickness of cover-glasses.**
English Mechanic, lxxix. (1904) p. 81.
" " Ditto. *Tom. cit.*, p. 123.
F.R.M.S.—Ditto. *Tom. cit.*, p. 104.
GRIBBON, W.—Ditto. *Tom. cit.*, p. 194.
HOLMES, EDWIN—Ditto. *Tom. cit.*, p. 104.
MIETER, MILLIE—Ditto. *Tom. cit.*, p. 123.
TREADLE—Ditto. *Tom. cit.*, p. 240.
VERINDER, A.—**Mechanical finger.**
English Mechanic, lxxix. (1904) pp. 88, 153 (1 fig.).
(See this Journal, 1879, pp. 951–3.)
VILLAGIO—**Modern Mounting Methods—continued.**
English Mechanic, lxxix. (1904) pp. 13, 83, 149, 240; lxxviii. (1904) p. 534.

* Proc. Soc. Amis Sci. Nat. de Rouen, 1903.
† Biol. Centralbl., xxiv. (1904) pp. 221–3.
‡ Pharmaceut. Journ., lxxii. (1904) p. 263 (1 fig.).

(6) Miscellaneous.

Mounting Diatoms.*—J. G. R. Powell gives the following method for mounting filamentous diatoms so as to display them in that beauty of pattern which they lose by boiling. They are mounted between two thin covers, so that they can be examined either as transparent or opaque objects. The slips for this purpose are made of card, wood slips being more costly.

Cut 3 in. by 1 in. blanks, in one set punch $\frac{5}{8}$ in., in the other about $\frac{1}{2}$ in., and gum together. When thoroughly dry ring the hole with black sealing-wax varnish, and cement in a $\frac{5}{8}$ cover, ringing on a varnish cell of about $\frac{1}{2}$ in. These slips, with their cells, are best prepared at odd moments in advance. The filamentous diatoms are found as waving chocolate-coloured wisps in running streams, ditches, drains, and springs. They should be lifted carefully out into a small, wide-mouthed bottle with distilled water, and brought home with as little skake as possible. Transfer them gently to a saucer of distilled water, have ready some clean covers (say $\frac{9}{16}$ No. 2), each cover with a drop of distilled water on it. Cut off a tiny portion of the filament, and let it settle on a cover in the drop, removing the superfluous water when it has settled. Dry the covers thoroughly, and then burn them. Place these diatoms upward on a flat slip of platinum or a bit of very thin tin, and gently lower them into the flame of a Bunsen burner till all vegetable matter is destroyed. Now very lightly retouch one of the prepared cells with cement, and lay on the cover diatoms downward, sealing down after a few hours. This last is a ticklish job, as the cement has a tendency to run in and spoil the mount. The cement should be thick, and only just touched. Brown's cement is good for the first layers. Slides so mounted are glorious objects under incident light, one side being best for this purpose ; and the other, on which the diatoms are in optical contact with the cover, is better for transmitted light. But this method obstructs the light for Lieberkuhn and paraboloid. The burnt cover may be mounted on a ring of Canada balsam or dammar in chloroform. These gums, separate or mixed, dry quickly, are not so liable to run in, and do not obstruct the light. If the diatoms on the cover are rather crowded, the cover may be fastened to a slip, diatoms upward, with a tiny drop of ordinary balsam, heated till not quite hard, and then the cover gently melted down. Then a tin ring of proper size can be cemented just outside it, and a $\frac{5}{8}$ or $\frac{3}{4}$ cover put on, One or two mounts of the burnt covers should be put up in the ordinary balsam method. Run a drop of spirit of turpentine on to the diatoms, followed by a tiny drop of ordinary balsam, and give them time to mix. Then lay the cover on the thin slip, balsam upwards, heat gently over say a benzoline lamp till the balsam when cool is not hard. Care is needed to avoid bubbles. Centre a glass slip with an ink dot, touch the other side with a very little fresh balsam, lay the cover balsam downward, and warm gently till the two balsams mix, and run under the whole cover. If the mounter has been successful, the cover when cool will stand rubbing, and no finishing is required. Label with plain inch

* English Mechanic, lxxix. (1904) p. 123.

squares of note paper, letting the writing run the long way of the slide. Card shoes require no labels, and can be stacked one on the other. Suitable cells may be cut of any depth from compo gas piping, and fastened with marine glue.

Beck's Safety Cedar Wood Oil-Bottle.—In shape this bottle (fig. 62) resembles a cone. The metal cap is fitted with a flexible wire looped at the end for holding a drop of the oil. The central tube is ground into the main bottle to form a good joint. The bottle is filled by removing the tube.

Fig. 62.

New Method for neutralising Carmin Injection-Masses.*—P. Konaschko states that he is able to get good injection masses by the following method. Ammonia carmin is added to gelatin solution in the ordinary way. The neutral reaction is determined, as usual, by the disappearance of the odour of ammonia, and then any trace of ammonia is detected by means of dialysing the mass through animal membrane. If the carmin mass will not diffuse through such a membrane, it will not permeate blood vessels. The membrane used is the septum cisternæ of the Frog. The membrane is taken up with a forceps, the blades of which are flat and perforated. On one side of the membrane is placed a drop of the warm mass, on the other side a piece of writing paper moistened with physiological salt solution. If the mass is sufficiently neutralised the paper remains unstained after one to two minutes. As it is possible to oversaturate the mass with acetic acid, which would precipitate the carmin, it is advisable after each addition of acid to examine the injection-mass under the Microscope.

Metallography, etc.

Microscopic Analysis of Metals.†—The metallographic work of Floris Osmond is so well known and so universally appreciated, that the appearance of a text-book by him on the microscopic analysis of metals will be welcomed by all who are interested in this aspect of the subject. The volume is edited, and presumably englished, by J. E. Stead, a fact which affords an additional recommendation. The style is most lucid, and the illustrations copious and excellent.

In the first part metallography is considered as a method of assay. Under this heading the author deals with the subject in three subdivisions: the anatomical, or the identification of individual constituents; the biological, or the transformations which occur in the life of metals and alloys under the influence of heat and pressure; the pathological, or

* Zeitschr. wiss. Mikrosk., xx. (1904) pp. 280–1.

† London, Charles Griffin & Co., Ltd., 1904, x. and 178 pp., with diagrams and 90 photographic illustrations.

the diseases of metals, represented by incipient fractures, slag inclusions, planes of weakness, and metals in which weakness has been produced by improper treatment.

The second part contains the general methods for the micrographic analysis of carbon steels. The first two chapters are devoted to the technique for obtaining suitable surfaces for microscopical examination. The next chapter describes the primary constituents of carbon steels, and the fourth is occupied with the micrographic identification of the various constituents. Then follows a detailed examination of selected steels, and the influence of annealing and quenching. The last chapter gives the author's theoretical and practical conclusions.

To this English edition are added two special appendices, one on the apparatus and the method for photographing the metallic surfaces, the other on the relative softness of austenite.

The volume is well got up, and the index sufficient.

Influence of Structure upon Strength under Sudden Stresses.§—R. Job gives an interesting instance of a driving-wheel tyre which fractured in service, while in apparent good condition as to size and extent of wear, and without any indications of internal flaws. Neither analysis nor tensile tests suggested any faults, but microscopic examination of an etched surface from a central section revealed that the structure was excessively coarse and open, thus proving that thorough working of the steel had ceased while the metal was at a high temperature. The material was therefore capable of but relatively small resistance under sudden stress.

Notes on the Structure of an Alloy which on Freezing Separates into Solid Solutions and a Eutectic.‖—J. E. Stead reproduces a large scale photograph used by Sir William Roberts-Austen in his "James Forrest" lecture, before the Institution of Civil Engineers, April 23, 1902, on the structure of phosphorus and iron compounds. Dark octahedral spines represent the unsaturated portions which first solidified and merged into the saturated or white parts surrounding the "land-locked" eutectic itself.

* Iron and Steel Metallurgist, vii., March 1904, pp. 324–5 (1 fig.).
† Tom. cit. pp. 258–9 (1 fig.).

PROCEEDINGS OF THE SOCIETY.

MEETING

HELD ON THE 20TH OF APRIL, 1904, AT 20 HANOVER SQUARE, W. DR. HENRY WOODWARD, F.R.S., VICE-PRESIDENT, IN THE CHAIR.

The Minutes of the Meeting of the 16th of March, 1904, were read and confirmed, and were signed by the Chairman.

The List of Donations to the Society, exclusive of exchanges and reprints, was read, and the thanks of the Society were voted to the Donors.

	From
Cowan, T. W. The Honey Bee. 2nd edition. (8vo, London, 1904)	*The Author.*
Gage, Simon H. The Microscope. 9th edition. (8vo, Ithaca, 1904)	*The Author.*
Tank Microscope, by Thos. Ross	*The Committee of the Quekett Microscopical Club.*

The Secretary called attention to a copy of the ninth edition of Gage's *Work on the Microscope*, which he considered to be one of the most useful treatises dealing with the subject. It was a work which should be in the hands of anyone desirous of becoming thoroughly acquainted with the manipulation of the Microscope and with microscopical technique. He then referred to a book on the Honey-bee, presented by T. W. Cowan, a Fellow of the Society.

A Tank Microscope, by Ross, presented to the Society by the Quekett Microscopical Club, was exhibited in the room, and the thanks of the Society were unanimously voted to the club for this interesting donation.

Mr. Karop said that the instrument had been presented to the Quekett Microscopical Club, by Mr. Thos. Ross, as far back as 1870. What may have been the circumstances of the gift he could not say, but years before (1870), the keeping of marine aquaria had been a popular mania, and one knew that Microscopes had been devised for use in connection with them, such as, for instance, Warington's, described in the first edition of *Carpenter*, p. 91. In any case this particular instrument was a beautifully made and highly finished piece of work, having nearly every conceivable adjustment; and although it did not possess much scientific or any value at the present time, and was useless except, perhaps, for exhibiting such objects as small flowers and so forth at soirées, yet it was certainly a beautiful specimen of the optician's art, and, therefore, worthy of a place in the Society's collection.

The Chairman said that a very excellent exhibition of living aquatic objects had been arranged for that evening, and he would ask those Fellows who were not exhibitors themselves, to pass a special vote of thanks to those who were. Their thanks were also due to Members of the Quekett Club who had kindly brought their Microscopes, and were exhibiting examples of pond life.

The vote of thanks having been put from the Chair, was carried unanimously.

The Chairman said that they had no formal papers to be read at the Meeting, and he, therefore, now had only to invite those present to examine the objects exhibited, which he was sure would prove to be of very much interest to all.

The proceedings were then adjourned to May 18th.

The following Objects, Instruments, etc., were exhibited :—

The Society :—Large Tank Microscope, by Thos. Ross.

Mr. F. W. Chipps :—*Floscularia ornata.*

Mr. J. D. Ersser :—*Hydra vulgaris.*

Mr. A. E. Hilton :—*Fredericella sultana* × 40.

Mr. E. Hinton :—*Lophopus crystallinus.*

Mr. K. I. Marks :—*Anuræa brevispina* ; *Melicerta ringens* ; *Synchæta pectinata* ; *S. oblonga* ; *S. tremula.*

Mr. W. J. Marshall :—Larva of *Ephemera.*

Mr. J. Milton Offord :—Vorticella and Hydra.

Mr. D. Powell :—Tadpole, ventral aspect, showing the heart and circulatory system.

Mr. T. H. Powell :—*Volvox globator.*

Mr. H. T. Rogers :—*Volvox globator.*

Mr. C. F. Rousselet :—*Floscularia ornata* ; *Melicerta ringens* ; Rotifera, various ; *Stephanoceros Eichhorni.*

Mr. D. J. Scourfield :—*Alona quadrangularis.*

Mr. C. J. H. Sidwell :—*Alona quadrangularis* ♀, showing olfactory setæ, heart in motion, and mandibles.

Mr. C. D. Soar :—*Limnesia histrionica.*

Mr. H. Taverner :—*Brachypoda versicolor*, and various nymphs, Hydryphantes sp.

Mr. Geo. Tilling :—*Lophopus crystallinus.*

Messrs. W. Watson and Sons :—Rotifera.

New Fellows.—The following were elected *Ordinary* Fellows :—Messrs. Morgan Isaac Jones and Joseph Parrott.

MEETING

HELD ON THE 18TH OF MAY, 1904, AT 20 HANOVER SQUARE, W.
DR. D. H. SCOTT, F.R.S., ETC., PRESIDENT, IN THE CHAIR.

The Minutes of the Meeting of April 20, 1904, were read and confirmed, and were signed by the President.

The List of Donations to the Society, exclusive of exchanges and reprints, received since the last Meeting, was read.

	From
Osmond and Stead, Microscopic Analysis of Metals. (8vo, London, 1904)	*The Publishers.*
Harriman Alaska Expedition. Vols. VIII., IX., Insects; Vol. X., Crustacea. (8vo, New York, 1904)	*The Publishers.*
A Ladd's Student's Microscope	*Mr. Wynne E. Baxter.*
An old portable Microscope	*Dr. C. St. Aubyn Farrer.*

Descriptions of the Microscopes presented to the Society by Mr. W. E. Baxter and Dr. Farrer, contributed by Mr. Rousselet, were read to the Meeting.

The thanks of the Society were voted to the donors, and to Mr. Rousselet for his communication.

Mr. F. W. Watson Baker exhibited and described three new devices which had recently been brought out by Messrs. Watson & Sons. The first of these was a new objective changer, consisting of two rollers linked together, and having a jaw on each The rotation of these rollers by means of a handle caused the inversion of the jaws, leaving a clear opening for the insertion of the objective. On releasing the handle, the rollers and jaws were carried back to their previous position by the action of a coil-spring, in doing which the objective threads were gripped and the shoulders brought together. In consequence of the variations in the pitch of the screw-thread used by different makers, it was found necessary, in order to secure accurate working, to supply small rings to fit on the objectives for use in this changer. Two special features were claimed for the changer: one was its thinness, the increase in the length of the body by its use being only ½ in.; the other its light weight, it being constructed of magnalium.

The second item exhibited was a mounting device, designed by Mr. W. Rosenhain, for microscopic specimens of irregular shape, such as metal sections. The description read to the Meeting was, that for microscopical examination it was necessary to mount metal specimens in such a way as to ensure that the polished face was accurately adapted for the optic axis of the Microscope. This was sometimes secured by the use of a levelling stage, but the device shown consisted of two

horizontal plates, the upper one capable of vertical movement, though always remaining parallel to the lower one. The specimen to be mounted was placed face downwards on the lower plate; a glass slip was carried by the upper plate, which had a large hole in it through which the back of the specimen could be seen. Having obtained the proper position the irregular back surface of the specimen was filled up with some suitable mounting medium, the upper plate being then lowered until the glass plate pressed firmly upon it. The two plates were then clamped together until the medium had set. In this way the specimen was attached to the glass in a position which ensured that the polished surface was exactly parallel to the surface of the slip. A piece of washleather tightly stretched upon the lower plate avoided all risk of the polished metal face getting scratched during the process.

The third exhibit consisted of glass troughs designed by Mr. Kingsford for use as aquaria for infusoria, or for containing coloured fluids to act as light filters. They were formed of two circular plates of glass held firmly by a metal band lined with india-rubber, and kept in position by binding screws. A sufficient opening at the top was provided for the introduction of liquids. The great advantage of this form of apparatus is that it can be taken to pieces with facility for the purpose of cleaning or for replacing the glass if broken.

Mr. Kingsford said that another merit of these troughs was that they would stand any variations of temperature without becoming leaky. To test this he had repeatedly boiled water in one, and after pouring this out had immediately filled up the cell with cold water, and found that it showed no signs of leakage afterwards, neither was the glass cracked.

Mr. A. A. C. E. Merlin's note on Mr. Nelson's new formula Amplifier was read by the Secretary.

Mr. Karop said that, so far as he understood from the paper, the method appeared to be the principle of the Barlow lens applied to the Microscope, viz. a negative lens interposed between objective and ocular to increase the magnification. This device was not, he believed, a success in the telescope, but of course might very well be so for the purpose intended here.

The thanks of the Society were voted to Mr. Merlin for his communication.

Mr. E. M. Nelson's paper upon the visibility of Mr. Grayson's rulings of 120,000 lines to the inch was read by the Secretary.

The President thought this was a very interesting communication.

Dr. Hebb remarked that he saw this plate exhibited at the recent conversazione of the Royal Society, and though it was easily resolved, his impression was that some of the lines were more strongly marked than others.

Mr. E. E. Hill pointed out that the ruling shown at the Royal Society was only under an objective of 1·1 numerical aperture.

The thanks of the Society were voted to Mr. Nelson for his paper.

The Secretary read a list of persons who had been nominated by the Council for election as Honorary Fellows of the Society, and who would be submitted for ballot at the ensuing Meeting.

Notice was also given on behalf of the Council, that at the close of the next ordinary Meeting of the Society it would be made special for the purpose of altering Bye-law No. 25, by omitting the word "future."

A letter was read from the Selborne Society, inviting the assistance of the Fellows of the R.M.S. as exhibitors at the conversazione to be held at Burlington Gardens on May 27.

Attention was called to an exhibition of flower seeds under a number of Microscopes in the room, provided by Mr. C. Beck.

New Fellow.—The following was elected an *Ordinary* Fellow:—Mr. John Stevens.

The following Objects, Instruments, etc., were exhibited:—

The Society:—A Student's Microscope by Ladd, date about 1864; an old portable Microscope (possibly by Cary).

Mr. F. W. Watson Baker:—A New Objective Changer; a Mounting Device for specimens of irregular shape; Glass troughs for use as aquaria or as light filters.

Mr. Conrad Beck:—Flower Seeds: Amaranthus, Calampelis, Digitalis, Linaria, *Loasa aurantiaca*, *Oxalis rosea*, Petunia, Rhododendron, Salpiglossis, *Silene pendula*, Whitlaiva, and Fern Spores.

Mr. C. F. Rousselet:—Statoblasts of *Cristatella mucedo* and *Pectinatella magnifica*.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

AUGUST 1904.

TRANSACTIONS OF THE SOCIETY.

IX.—*A Direct Proof of Abbe's Theorems on the Microscopic Resolution of Gratings.*

By Prof. J. D. Everett, F.R.S.

(*Read June 15th*, 1904.)

Suppose the Microscope to be adjusted for viewing a transmission grating laid on its stage, illuminated by a source so placed that the incident light may be regarded as consisting of a single train of plane waves travelling in a direction perpendicular to the rulings. Diffraction spectra will be formed in the focal plane of the objective, and will consist, for light of given wave-length λ, of bright points, all of them lying in the plane drawn through the axis perpendicular to the rulings. The optical paths which we shall have to discuss lie in this plane.

Let the spectrum of zero order be called C, the two spectra of the first order A_1 B_1, the two of the second order A_2 B_2, and so on. It will be necessary for us to consider the optical paths from an incident wave-front (in a fixed position) to points midway between successive bars of the grating and thence to the spectra. These paths increase or diminish in arithmetical progression as we pass from each middle point to the next, increasing for the spectra on one side of C, and diminishing for those on the other side. The common difference of the progression is zero for C, $\pm \lambda$ for A_1 and B_1, $\pm 2\lambda$ for A_2 and B_2, and $\pm n\lambda$ for the two spectra of order n.

The optical disturbance at a fixed point P, in the image-plane conjugate to the plane of the grating with respect to the objective, is the sum of the disturbances due to the different spectra. All these disturbances have the periodic time T characteristic of light

of wave-length λ; and the disturbances due to C, A_1, B_1, A_2, B_2, are represented by the expressions

$$c \cos 2\pi \frac{t}{T};$$

$$a_1 \cos 2\pi\left(\frac{t}{T} + \alpha_1\right); \qquad a_2 \cos 2\pi\left(\frac{2t}{T} + \alpha_2\right);$$

$$b_1 \cos 2\pi\left(\frac{t}{T} - \beta_1\right); \qquad b_2 \cos 2\pi\left(\frac{2t}{T} - \beta_2\right);$$

c, a_1, b_1, a_2, b_2 being constant coefficients; and α_1, β_1, α_2, β_2 constants depending on the position of the grating.

Now consider the effect of a small displacement x of the grating in its own plane, perpendicular to the bars. As all the points P, C, A_1, B_1, A_2, B_2 are fixed, there will be no changes in the distances of the spectra from P. Let s denote the grating-interval, and let M be the middle point between a selected pair of consecutive bars. If the grating were displaced through the distance s, the optical path through M from the incident wave-front to A_1 would be increased or diminished by λ, and an equal and opposite change would be made in the path to B_1. For A_2 and B_2 the changes would be $\pm 2\lambda$. The change of path for A_1 and B_1 due to displacement x is, therefore, $\lambda x/s$, giving $2\pi x/s$ as the difference in phase; with twice this difference for A_2 and B_2. The expressions for the five disturbances are thus altered to

$$c \cos 2\pi \frac{t}{T};$$

$$a_1 \cos 2\pi\left(\frac{t}{T} + \frac{x}{s} + \alpha_1\right); \qquad a_2 \cos 2\pi\left(\frac{t}{T} + \frac{2x}{s} + \alpha_2\right);$$

$$b_1 \cos 2\pi\left(\frac{t}{T} - \frac{x}{s} - \beta_1\right); \qquad b_2 \cos 2\pi\left(\frac{t}{T} - \frac{2x}{s} - \beta_2\right);$$

the signs being chosen on the convention that a positive value of x increases the path to A_1.

Writing ϕ for $2\pi t/T$, all these expressions are of the form $F \cos(\phi + \epsilon)$; and to find their sum we may use the well-known formula (applicable to finding the resultant of coplanar forces at a point):

$$F_0 \cos(\phi + \epsilon_0) + F_1 \cos(\phi + \epsilon_1) + F_2 \cos(\phi + \epsilon_2) + \ldots\ldots$$
$$= R \cos(\phi + E),$$

with

$$R^2 = F_0^2 + F_1^2 + F_2^2 + \ldots\ldots + 2 F_0 F_1 \cos(\epsilon_0 - \epsilon_1)$$
$$+ 2 F_0 F_2 \cos(\epsilon_0 - \epsilon_2) + 2 F_1 F_2 \cos(\epsilon_1 - \epsilon_2) + \ldots\ldots$$

In the present case R^2 measures the luminous intensity at P; and the expression for it, as due to the five spectra above included, will consist of five constant terms, together with ten terms which are simple-harmonic functions of x.

If we include only one of the five spectra, R^2 is constant, and the intensity at P does not vary as the grating moves. The field is therefore uniform, with no trace of lines.

If we include only C and A_1, we have

$$R^2 = c^2 + a_1^2 + 2\,c\,a_1 \cos 2\,\pi\left(\frac{x}{s} + \alpha_1\right);$$

showing that the intensity goes through one complete cycle of values as x increases from 0 to s. There is therefore one line in the image for one line in the grating.

If we include only A_1 and B_1, we have

$$R^2 = a_1^2 + b_1^2 + 2\,a_1\,b_1 \cos 2\,\pi\left(\frac{2\,x}{s} + \alpha_1 + \beta_1\right);$$

showing that the intensity goes through its cycle while x increases from 0 to $\frac{1}{2}\,s$, and goes through two cycles while x increases from 0 to s. There are therefore two lines in the image for one line in the grating.

If we include only A_1 and B_2 (the two intervening spectra C and B_1 being stopped out), we get

$$R^2 = a_1^2 + b_2^2 + 2\,a_1\,b_2 \cos 2\,\pi\left(\frac{3\,x}{s} + \alpha_1 + \beta_2\right);$$

showing that there are three lines in the image for one in the grating.

With any five consecutive spectra included, we shall have x/s, $2\,x/s$, $3\,x/s$ and $4\,x/s$ in the arguments of the cosines; and the expression for the intensity will be reducible to a Fourier series containing four periodic terms, of periods s, $\frac{1}{2}\,s$, $\frac{1}{3}\,s$, $\frac{1}{4}\,s$.

NOTES.

On the Influence on Images of Gratings of Phase Difference amongst their Spectra.

By Julius Rheinberg.

It is my privilege to bring an experiment to your notice this evening * which illustrates very well the effect on the image of a grating which is produced by alterations of phase between the spectra which it forms in the back focal plane of the objective.

In Prof. Everett's interesting paper we have heard how it occurs, that when a grating is moved in its own plane at right angles to the lines, a change of phase is brought about amongst these spectra, and that this change of phase accounts for the lines shifting in the image, although the spectra in the focal plane do not shift their position. Similar results have, I think, recently been arrived at by Dr. R. T. Glazebrook.

Now it occurred to me, that if the shifting of the lines in the images were caused by change of phase amongst the spectra, we ought to be able to make the lines in the image of the grating move without moving the grating on the stage at all, by the expedient of introducing a difference of phases amongst the spectra in the back focal plane.

This is the experiment I have to show you. The arrangements are as follows. The Microscope used is one of the so-called "Demonstration" microscopes specially designed by Prof. Abbe many years ago for his experiments showing the relation between diffraction effects and image formation. I am indebted for the loan of this apparatus to the firm of Carl Zeiss. Without entering into details about the many ingenious arrangements in this instrument, it suffices our purpose that the back focal plane of the objective is readily accessible, and that the spectra formed there and the resulting image in the view-plane can be alternately examined with rapidity and ease.

The grating is placed on the stage of the Microscope. In the substage condenser we use a narrow slot, and in the back focus of the objective, where the grating forms the spectral images of this slot, we introduce an Abbe Glass Wedge Compensator.† We

* See account of the Proceedings of the June Meeting at end of this Number.

† To understand the action of the compensator, think of a square slab of glass, the faces of which, instead of being accurately plane parallel, are very slightly wedge-shaped. Imagine the square of glass cut in half, and that we have two similar

arrange this so that the contact edges of the two halves of the compensator just come between the zero maximum (or dioptric beam) and the maximum of the first order (or first spectrum) on the one side. We next cover up all the maxima except these two. Then, looking through the Microscope, the image of the grating is seen, and as we turn the micrometer-head of the compensator, thereby altering the phase of the one maximum, the lines in the image travel across the field.

It is rather important that, under the conditions of this experiment, with the admission of two contiguous spectra only, the actual *practical* extent of the movement of any individual line is confined to about twice its own width. This can be shown by studying the effect of an isolated bright line, and it is desirable to bring the fact out, because apparently any particular line of the grating moves right across the field.

But in this effect we have nothing more than a rather remarkable optical illusion, by which the analogy between the shifting of the lines when the grating is moved bodily, and the shifting when the phase-difference is introduced by a compensator, becomes greater than is actually the case.

We can best understand this by regarding the image of any line as the bright visible portion of a diffraction pattern. The pattern may be represented by an intensity curve, and this curve would show that besides the chief bright line there is a narrow bright line on either side—almost unobservable under ordinary circumstances.

Now when the grating is shifted on the stage, this intensity curve representing the image is shifted about bodily in the view plane, i.e. the region in the view plane where the maximum occurs may move from one portion of the field to another, whilst the configuration of the diffraction pattern remains unaltered. When, however, a phase difference is introduced by the compensator, there is no change of region in the view plane where the visible portion of the diffraction pattern is produced, but the configuration of the intensity curve itself undergoes alteration. The narrow faint line shifts along, becoming broader and brighter; the central bright line shifts along, becoming narrower and less bright, and a certain position is arrived at where both lines are equally bright and equally broad. This is the state of things when half a phase difference is

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wedges. Now think of these two halves being laid alongside of one another again, with their edges in contact, so that the square slab is re-formed. It is evident that the glass is of equal thickness in the two halves in any diameter drawn at right angles to their contact edge. But if the one glass be slid against the other, then in all such diameters the glass on one side will be slightly thicker or thinner than the glass on the other.

In the compensator the one glass wedge is therefore made immovable, whilst to the other a movement is imparted by a micrometer-screw sufficiently gradually that we can readily alter the relative thickness of the two halves by fractions of a wave-length of light, thereby obtaining our difference of phases.

reached. If continued further, a new line makes its appearance on the one side just as the line on the other is going to disappear. Now when we have a grating on the stage, it can be shown that in the image the diffraction patterns, due to neighbouring lines in the object, overlap, and interference occurs in such a way that as any image line loses in brightness from one object line, it gains in brightness in just the same proportion from the neighbouring object line. Thus the brightness as seen remains constant, and so far as appearance goes it is the same line which travels right across the field.

My intention this evening was only to bring some visual evidence in connection with the interesting matter which Prof. Everett has brought to our notice. I fear I have been explaining my experiment at too great length; if so, my excuse is that I was desirous to bring out not only the points of similarity, but also the points of dissimilarity which may result from creating difference of phase amongst the spectra by different means.

When the above note was written, I thought the experiment was an entirely new one, but I have since found that a somewhat similar one was made by Abbe, and referred to in a catalogue of optical measuring instruments issued by the firm of Carl Zeiss in 1893.

In Abbe's experiment the chief maximum is blocked out, and a phase difference created between the two maxima of the first order, and it is pointed out that, under these circumstances, the number of lines in the image is doubled, and that the striæ wander.

An Attachment for reading the lines in a direct-vision Spectroscope.

By E. B. Stringer, B.A., F.R.M.S.

This attachment (fig. 63) may, perhaps, be of interest to the Society, since an arrangement of the same kind might easily be made for a micro-spectroscope. It affords a more accurate means of reading the lines than the reflected scale which is generally used, whilst it is even more convenient, as the scale does not require independent illumination.

It consists of a light and rigid arc of phosphor bronze, of about 40 degrees, and $6\frac{1}{4}$ in. radius, cast in one piece with the broad ring by which it is firmly clamped to the body of the instrument. The arc carries a millimetre scale, which is divided in white upon a

black ground, so that it may easily be read in a dim light. A vernier reading to tenths is carried above the scale by the telescope itself, and immediately beneath the eye-piece is a magnifying lens, which follows the vernier in its movement, and through which the scale and vernier may be read with the greatest ease, without any change of the observer's position. The eye-piece has cross wires of the usual kind.

It will be seen that the radius of the arc is much greater than that of the table in most table spectroscopes, so that much finer readings are possible; also, that as the vernier is carried by the telescope itself instead of by a separate arm, there is less chance of inaccuracy.

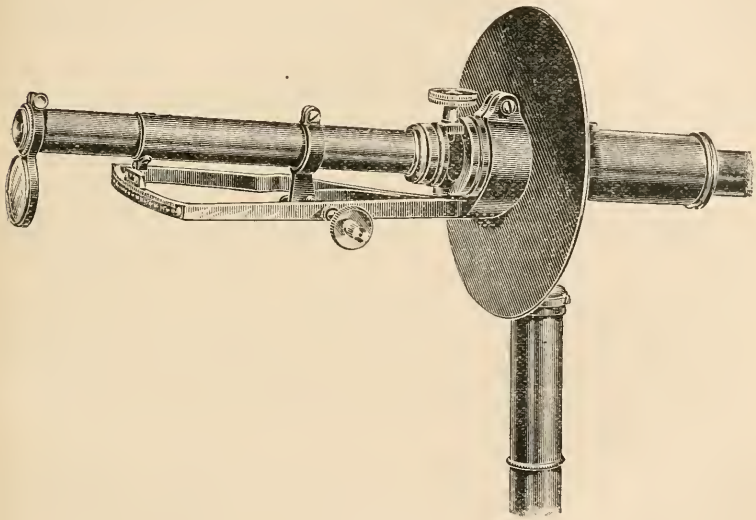


Fig. 63.

The telescope is carried round by means of a screw, which bears against a lug clipped upon the tube, and works through a small boss cast on one arm of the arc, the opposing spring being attached to the opposite arm and bearing on the opposite side of the lug, an arrangement which altogether relieves the telescope from any lateral strain. The screw has two milled heads; the smaller is rapidly rotated between the finger and thumb in order to move the telescope quickly through a large distance to another part of the spectrum, whilst the larger is for exact adjustment upon any line it may be desired to read. A blackened screen of sheet metal protects the eyes from direct light.

The instrument itself was made by Browning.

On a Method of Obtaining Monochromatic Ultra-violet Light.

By E. B. Stringer, B.A., F.R.M.S.

In a paper read before the Society at the April meeting last year,* I pointed out the advantage of using the electric arc itself as a source of light in photomicrography, and showed how a monochromatic violet light might be obtained, by isolating the violet band of the arc spectrum by the use of solutions of ammonia sulphate of copper and quinine. I have since found a means of separating the two ultra-violet bands from the visible rays; and also of isolating one of them so as to obtain monochromatic ultra-violet light.

A solution of uranic sulphate is completely opaque to the visible violet band of the arc spectrum, whilst freely transmitting the two ultra-violet bands; so that if this be used with the ammonia copper solution instead of the quinine, we get the ultra-violet rays alone. A solution of uranic acetate, on the other hand, transmits only the first or less refrangible ultra-violet band; this, therefore, gives monochromatic ultra-violet light—as one may be allowed to call it, though of course it has no colour, appearing on the screen of a pale grey or neutral tint.

Lenses corrected so as to work with it would be a considerable gain, and might easily be used; the focal adjustment being made by the visible violet rays, before the introduction of the uranium solution. Its mean wave-length is about 3760, that of the visible violet band being 4190.

Of course the prism is not used when actually working with the Microscope, the troughs of solution being placed in the path of the direct beam from the arc. Such a comparatively weak source of light as the arc itself cannot be used well, without the concentration afforded by the condensing system which I described in a previous paper.

In order to get both bands with the uranic sulphate it is better to use a solution of methylen-blue to which copper sulphate has been added, instead of the ammonia copper solution. The object of the copper sulphate is to cut off the extreme red which the methylen-blue transmits. This solution may also be used with the acetate, and is better than the ammonia copper for both purposes.

Using a quartz prism and lenses, a trough having quartz sides, and a fluorescent screen of uranic phosphate, both the uranium solutions are found to cut off all the rest of the ultra-violet

* See this Journal, 1902, p. 276.

spectrum beyond the bands above mentioned. This is still the case when this part of the spectrum is rendered much more intense by the use of iron, instead of carbon poles.

The ultra-violet carbon spectrum falls off very much in intensity beyond the second band, there being only one other band (at about its middle) at all comparing in brightness with the first two. These two bands, however, reach the limit transmitted by most glasses.

On Grayson's 120,000 *Band-Plate.*

By Edward M. Nelson.

Through the kindness of Mr. Beck I have been enabled to examine a Grayson Test-Plate, which contains a band ruled at the rate of 120,000 lines to the inch (= ·21 μ). This band was strongly resolved by an apochromatic oil-immersion $\frac{1}{8}$ 1·43 N.A. (for the long tube) and a 5 eye-piece. With 12 and 24 eye-pieces the resolution was quite as strong as the transverse striæ of the *Amphipleura pellucida* appear in good photomicrographs.

This band was also resolved by a semi-apochromatic $\frac{1}{10}$ 1·3 N.A. (for the long tube) with a 5 eye-piece. A friend even saw the lines with a 4 eye-piece, though I could not do so myself.

It was also resolved by an old achromatic water-immersion $\frac{1}{12}$ 1·2 N.A. by Powell and Lealand; but in this case the lines appeared to have irregularities in their ruling. A long tube apochromatic dry 4 mm. ($\frac{1}{6}$) ·97 N.A. resolved the 90,000 band (= ·28 μ) quite easily; the same band was also resolved by a long tube dry apochromatic $\frac{1}{4}$ ·96 N.A. with some difficulty.

It may be remarked, in passing, that the latest books on Physical Optics, used by our Universities and schools, state that $\frac{1}{90,000}$ in. (or ·28 μ) is the theoretical limit for microscopic vision!

A Zeiss apochromatic 12 mm. ($\frac{1}{2}$) for the long tube ·66 N.A. resolved the 60,000 band (= ·42 μ) quite strongly, but there was not the slightest appearance of its resolving the 70,000 band. The resolving limit of this very fine lens is probably about 65,000 (= ·39 μ). A short tube semi-apochromatic $\frac{1}{6}$ ·84 N.A. resolved the 80,000 band (= ·32 μ), and a short tube semi-apochromatic $\frac{1}{4}$ ·76 N.A. resolved the 70,000 band (= ·36 μ). The bands were examined with many other lenses, but nothing worthy of note was observed.

Ruled lines are more difficult to resolve than diatoms of equal fineness; we may go further, and say that ruled lines mounted in a

dense medium, such as realgar, are more difficult to resolve than diatoms of equal fineness mounted in quinidine, and much more difficult than diatoms mounted dry on cover.

Before a lens fails to resolve a band, the next lower band appears to be irregularly ruled, but these apparent irregularities of ruling disappear when the band is examined by a lens of greater aperture. When, therefore, some lines in a band appear strongly ruled, and others faint or missing, the observer knows that the limit has been reached. He may, by improving his illuminating conditions, or by altering his lens-adjustment, remove all appearance of these irregularities of ruling, but then they are sure to reassert themselves in some higher band. The best screen for microscopical work of this kind is made by dissolving acetate of copper crystals in *distilled* water, until a saturated solution has been obtained. This solution must be filtered many times, then to it should be added a very small quantity of *methyl* blue. It appears that acetate of copper will hold only a certain amount of blue, the surplus, therefore, will be thrown down. Sunlight with a heliostat was used, and the light made oblique, in one azimuth, by an achromatic oil-immersion condenser N.A. 1·4.

The theoretical resolving limit for oblique light may roughly be taken to be 100,000 times the N.A. of the objective, and the practical at something a trifle short of this; but 100,000 N.A. is a convenient form for a "memoria technica."

In conclusion, might I be allowed to suggest that the labour of ruling these bands would be considerably lightened if fewer lines were ruled in each band?

It is, perhaps, a mistake to have all the bands ruled upon one plate; for a complete set of test bands four plates would be preferable. The first might contain bands from 1000 to 10,000 per inch; the second, 12, 14, 16, 18, 20, 25, 30, 35, 40, 45 thousand per inch; the third, 50 to 100 thousand; and the fourth, 90, 110, 120, 130, 140, 150, 160 thousand per inch.

The first plate would be suitable for loups and very low-power lenses, the second for lenses up to $\frac{2}{3}$, the third would carry us on from that point up to a dry lens of maximum aperture, and the fourth from thence to the limiting power of the Microscope, as at present constituted.

In the fourth plate, the 90,000 band is inserted as a strong band to adjust the lens upon.

This band-plate is a beautiful specimen of Mr. Grayson's unrivalled rulings.

Since the above Note was written, I have received from Mr. Grayson two more examples of his rulings. The lines in these plates are ruled with marvellous accuracy. Just at this time a new screen was obtained, giving results superior to any as yet

tried, and the sun having obligingly shown himself steadily for a few hours, I am able to give some fresh details, which may be of interest.

On one of these plates, under these new conditions, I saw the 120,000 (·21 μ) band clearly resolved, with the cheap oil-immersion $\frac{1}{10}$ (long tube) of 1·3 N.A., and the 4 eye-piece. Previously I had failed to see this, although a friend had done so. This band was also resolved by a Powell and Lealand water-immersion $\frac{1}{12}$ N.A. 1·2, and a 5 eye-piece.

The semi-apochromatic $\frac{1}{4}$ N.A. ·76 resolved the 80,000 (·32 μ) band; some years ago attention was directed to the remarkable resolving power of this objective.

The 90,000 (·28 μ) band was resolved by a Powell and Lealand apochromatic dry $\frac{1}{4}$, with the 12 eye-piece.

While the instrument and heliostat were in position, it occurred to me to try the dry front of the Powell and Lealand water-immersion $\frac{1}{12}$, when, to my astonishment, the 100,000 (·25 μ) band was plainly and well resolved.

This lens is one of the series that used to be known as Powell's new formula water immersions. It was introduced by that firm in December 1874; the $\frac{1}{8}$ appeared first, and became very celebrated; afterwards a $\frac{1}{16}$ was produced, the $\frac{1}{12}$ came later, probably about 1877. These lenses were the finest extant before the advent of the oil immersions.

Being so successful with this dry $\frac{1}{12}$th, I next tried two old $\frac{1}{12}$ths, one by A. Ross, N.A. ·81, and the other by Powell, N.A. ·93, both being constructed upon Lister's formula, with triple fronts and backs, and doublet middles.

The A. Ross showed the 80,000 (·32 μ) band very strongly, and the 90,000 (·28 μ) as an exceedingly difficult image.

The Powell did the 90,000 band quite easily, and, strange as it may appear, the 100,000 band (·25 μ) was certainly resolved, although the image was a difficult one.

It was a great surprise to find a Microscope objective, made more than half-a-century ago, resolving a 100,000 (·25 μ) band.

In all cases oblique light in one azimuth was used from an achromatic oil-immersion condenser.

It is clear, therefore, that with this new screen the limit of 100,000 times the N.A. of the objective (mentioned in my previous Note) is fully established for practical work.

Mr. Grayson having placed test band-plates, properly ruled and properly mounted, within our reach, it remains for microscopists to make the best use they can of them, and to endeavour that their practical work shall lag behind the theoretical limit as little as possible.

On Nelson's New Formula Amplifier.

By A. A. C. Eliot Merlin.

A few months ago, when endeavouring to effect some delicate microscopical measurements, it was found that the magnification afforded by even $\frac{1}{12}$ and $\frac{1}{16}$ in. objectives used in conjunction with the low-power eye-piece of Powell's screw micrometer, was insufficient always to insure the greatest possible accuracy. It is obvious that for such work a very high magnification is advantageous, as then an entire revolution of the divided drum, and consequent considerable movement of the spider line, represents a very minute real interval, and therefore small errors in bringing the "wires" into exact contact with the margins of the object to be measured are reduced to a minimum. In ordinary cases, for visual purposes, it is an easy matter to obtain any useful amount of enlargement that may be required with a given objective by the simple expedient of employing an ocular of suitable power; but with the screw micrometer any great augmentation of power at the eye end of the instrument must inevitably cause the spider-lines themselves to appear coarse and thick, a consequence which certainly would not tend to increase the accuracy of results obtained under such conditions.

In the circumstances I appealed to my friend, Mr. E. M. Nelson, asking him whether it would not be feasible to employ some suitable kind of amplifier over the back combination of the objective, thus insuring a sufficient increase of power with various lenses without affecting the apparent fineness of the micrometer spider-lines. In response, Mr. Nelson most kindly computed for me a simple form of amplifying lens, which has proved so satisfactory in practice that I venture to draw the attention of Fellows of the Society to its capabilities.

The lens is negative, plano-concave, and in use is placed in my instrument (Powell's No. 1) on the top of the fine-adjustment tube, at a distance of about three inches above the back combination of the objective, and in that position increases its initial magnifying power 2·52 times. The effect of the amplifier is also to increase the working distance of the objective and thus disturbs its corrections for critical work; but this disturbance can be compensated by means of the correction collar, and therefore adjustable objectives are preferable for use with the amplifier in order to obtain the best possible definition. When, however, the objective is in a fixed mount, the necessary correction may be effected by lengthening the tube as for decrease in thickness of cover-glass.

Personally, I have found that the new amplifier yields especially good results when employed in conjunction with a Powell $\frac{1}{12}$ in. oil immersion of measured N.A. 1·27, this lens being provided with collar adjustment. With the combination specified, 13·18 revolutions of the micrometer drum equal $\frac{1}{1000}$ in., and the definition proves remarkably sharp, both with a large solid axial illuminating cone and also with oblique light from a wide-angled oil immersion condenser. By the latter arrangement I have been enabled not only easily to "step" and count the tranverse striæ on *A. pellucida* running at 94,000 to the inch, but have also succeeded in "stepping" those of an extremely finely marked small species of *Nitzschia* (mounted in realgar), which count 112,000 to the inch. The last proved a very delicate and difficult task, owing to the faint resolution obtainable by lamplight.

Although primarily intended for micrometrical purposes, the new amplifier would doubtless prove most useful for students' stands, if mounted on an arm so as to allow it to be brought into working position through a slot cut in the body of the instrument. In this manner a great increase of magnifying power could be quickly and easily obtained, and the resultant slight disturbance of the objective correction would be quite negligible, and indeed not discoverable, when the Microscope is set up in the ordinary rough-and-ready fashion inculcated in the medical schools, while more careful manipulators could readily obtain really critical images with a little skill in the adjustment and choice of the objectives employed. To many workers also who prefer shallow eye-pieces, yet do not possess objectives of very high initial magnifying power, the new arrangement would probably be welcome.

Through Mr. Nelson's kind permission I am enabled to annex hereto the formula of the new amplifier.

Formula of Amplifier.

Plano-concave Borosilicate glass $\nu = 64·0$ (0·144 No. 5, Jena Catalogue).
Radius of concave = 1·0.
Diameter = 0·7.
Focus = 2·0.
Thickness at centre = 0·05.
Measurement is in inches.
Flat side of lens to face objective.

SUMMARY OF CURRENT RESEARCHES

RELATING TO

ZOOLOGY AND BOTANY

(PRINCIPALLY INVERTEBRATA AND CRYPTOGAMIA),

MICROSCOPY, ETC.*

ZOOLOGY.

VERTEBRATA.

a. Embryology.†

Occurrence of Parthenogenesis.‡—Everett F. Phillips gives a useful summary of the most important work done on this subject. The case of the honey-bee is fully discussed, not because the author considers it of most importance, but simply as a basis for the subsequent treatment, which covers the whole field of doubtful as well as undoubted instances, from Trematodes to Mammals. Some of the facts made clear in this review may be briefly stated. It is evident that parthenogenesis has had a separate origin in many places in the animal scale. All that is necessary in the maturation of a parthenogenetic egg is that the normal number of chromosomes shall be retained, and this may be brought about by the retention of the second polar body, by fertilisation by the second polar body, or perhaps by the division of the chromosomes without the corresponding cell-division. Parthenogenesis is generally associated with, and probably caused by the necessity of the appearance of a great many individuals suddenly at a certain period of the year or of the life-cycle. There may be a need for females, e.g. *Aphis*, or for males, e.g. Honey-bee, or it may be that the habits of the animal make the chance of the occurrence of a sexual union too small, and in consequence the females have acquired the agamic method of reproduction. *Cercaria* offers a good example of this. The relation of the problem of the determination of sex to that of parthenogenesis is dealt with in the paper. The views put forward by various writers that the sex is determined before the ova leave the ovary appear to receive support from the facts of parthenogenesis.

* 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, etc., 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, Reproduction, and allied subjects.

‡ Proc. Amer. Phil. Soc., xlii. (1904) pp. 275–345.

Development of Veins of the Liver in the Rabbit and Sheep.* C. Bonne has studied these in a series of embryos from 6 mm. in length to full term. His main results are: (1) In man, rabbit and cat the right umbilical vein ceases early to share in the hepatic circulation, and serves exclusively for circulation in the right abdominal wall, leading down to the left umbilical vein, where it joins the blood from the allantois. In sheep both veins are equal in size, and unite beneath the liver into a common median trunk, which lasts till the pulmonary circulation is established. At the 7 mm. stage this trunk gives off numerous branches to the abdominal wall: these disappear later. The fusion of the two veins takes place first in the interior of the liver, or at its level, and progresses downward. The canal of Arantius is continuous at the lower extremity with the common trunk of the two umbilicals. (2) The common vitelline trunk is for a long time much smaller than that of the hepatic veins; at 14 mm., as the intestinal develops, it becomes larger. The vein of Spiegel's lobe first ends in the vitelline, later in the sinus of the portal vein or in a vein of the right lobe. Some veins from the right and Spiegel's lobes go direct to the vena cava. (3) In man, rabbit and cat the canal of Arantius is early distinct from the sur-annular segments of the two vitellines; it exists before they have lost their connection with the proximal ring. It is separated from them by a thickness of hepatic tissue traversed by capillaries. This occurs later in the sheep, viz. after the proximal ring has disappeared. Then the canal of Arantius gets smaller, to the advantage of the inferior vena cava, which collects the sur-hepatic veins. (4) The efferent veins are at first represented by the terminal trunks of the two vitelline veins. The left vitelline has a communicating orifice with the right efferent vein, which also communicates with the sinus. All this is transitory; at 8 mm. the two sur-hepatics connect with the great trans-hepatic, not the sinus. Physiological considerations are also discussed in the paper.

Nephridial Canals in Guinea-Pig.†—R. Meyer finds that the primitive nephridial canals in the guinea-pig have a communication with the cœlome, but this seems rather a re-opening of a previous connection between the median and lateral plate than a fresh invagination. The openings seem comparable to the secondary nephrostomata in Amphibians, except that those of the guinea-pig are transient.

Lens Development under Abnormal Conditions.‡—A. Schaper has studied the development of the lens in the embryo of *Rana* after extirpation of the central nervous system. The new lens rudiment he finds grows downwards from its point of origin in such a way as to suggest an "attempt" to get into a normal place with reference to the eye vesicle, which may be, the writer thinks, due to some sort of tropism between eye and lens rudiment.

Structure and Development of the Middle Ear in Man and Mouse.§—L. Drüner discusses in this paper the question of the homo-

* Journ. Anat. et Physiol., xl. (1904) pp. 225–67 (3 pls.).
† Anat. Anzeig., xxiv. (1904) pp. 25–30 (4 figs.).
‡ Tom. cit., pp. 305–26. § Tom. cit., pp. 257–86.

logy of the malleus-incus articulation in mammals with the quadrato-articular of other vertebrates. He holds that there are insuperable morphological and physiological difficulties in accepting such homology, and proves the homology of the lower jaw articulation in mammals with that of the lower vertebrates. As an illustration of the evidence adduced may be taken the relations of the trigeminus to the lower jaw in Urodeles, which have no parallel in the malleus-incus articulation of mammals.

Early Development of Desmognathus fusca.*—H. H. Wilder supplements an earlier paper on this subject by an account of the development during the first three days. The segmentation is at first almost typically holoblastic, although in the later relation of embryo to yolk it greatly resembles that of meroblastic embryos.

b. Histology.

Ciliary Movement.†—E. A. Schäfer refers to the theory of ciliary movement which he stated in 1891. If cilia are hollow extensions of the cell, occupied by hyaloplasm and invested by a delicate membrane, thickened (or at any rate less extensible) either along one side or in a spiral line, any tendency of the hyaloplasm of the cell to flow into or out of such a hollow process—in other words, to increase or diminish the tension within it—must result in a bending movement if the line of less extensibility were a straight one, or in a circular or corkscrew movement if the line were a spiral one. And since the amœboid movements of cell protoplasm are in all probability due to local changes in tension at the surface of the cell, this assumption regarding the structure of cilia would at once bring their action into line with that of other more general contractile manifestations of protoplasm.

Prof. Schäfer defends this theory against the interpretations recently put forward by Dr. Pütter.‡

Structure of Mammalian Blood-vessels.§ — Baum and Thienel point out the lack of definite knowledge which exists on the subject of the microscopic structure of different types of blood-vessels. They have made a comparative study of the arteries and veins in the region of the axilla in horse, ass, ox, calf, sheep, pig and dog, the results of which are detailed in the present paper.

Nerve-endings of Human Skin.‖ — A. S. Dogiel in a very full paper confirms and extends the work of Ruffini on this subject. Some new facts of interest are brought out. The nerve apparatus *minus* capsule can be divided into two groups, that enclosed in connective tissue and that in epithelium. To the apparatus of the first kind belong the Ruffini corpuscles, the tree-shaped end branchings, the unencapsuled end ganglion, intra-papillary endings, ribbon-form bundles, and nerve-fibre network (vaso-motor nerves in papillæ-Ruffini, and the

* Amer. Naturalist, xxxviii. pp. 117–25.
† Anat. Anzeig., xxiv. (1904) pp. 497–511.
‡ Asher and Spiro. Ergebnisse der Physiologie, ii. Abth. 2.
§ Arch. Mikr. Anat., lxiii. (1903) pp. 10–34 (1 pl.).
‖ Zeitschr. wiss. Zool., lxxv. (1903) pp. 46–111 (10 pls.).

papillary fasciale of Ruffini). The sub-papillary nerve-web composed of medulla-less branches and threads, the unencapsuled ganglion, the ribbon-form bundles and the intra-papillary network have one and the same source. They represent the end-branchings of the axis-cylinder of those relatively thick medulla-containing fibres which separate themselves from the bundle of nerve-fibres of the superficial network. The fibres mentioned, after losing the medulla-sheath, break into smaller branches passing not only to one but to several papillæ. A certain number of branches and fibres penetrate the typical (possibly also the modified) Meissner's bodies, and form in the same a more or less close network. Finally, fibres which penetrate the epithelium and end in the same, arise from the aforesaid network and also from the unencapsuled ganglion, from the bundles, and the inter-papillary network.

Olfactory Organ of the Lamprey.* — E. Ballowitz has made a precise study of this interesting organ in *Petromyzon fluviatilis*, which includes an entrant duct, a complex nasal sac, and a naso-palatal canal which ends just above the œsophagus. He gives an account of the histological peculiarities of the different regions, and corroborates Johannes Müller's observation that the most posterior part acts like an aspiration bladder in a spray-syrinx, being rhythmically compressed and enlarged in association with the respiratory movements.

Histological Studies on Cerebral Localisation.†—A. W. Campbell seeks to further the establishment of a correlation between function and histological structure, and gives his results on the central gyri, the occipital, temporal, and limbic lobes. The normally existent topographic variations in arrangement of cortical nerve-cells and medullated nerve-fibres have been adopted as a standard criterion in forming judgment on points bearing on localisation. The examination of the disposition of these elements over the entire cortex of human and anthropoid apes' brains, both normal and pathological, constitutes the groundwork of this research, of which the present paper is an abstract.

Histology of the Light Organs of Photinus marginellus.‡—A. B. Townsend finds that the light organs are composed of two distinct layers, lying above the ventral body-wall of the fifth and sixth abdominal segments. The dorsal layer consists of polygonal cells with large nuclei, and with cytoplasm almost entirely replaced by a granular secretion. A similar secretion occurs in the fat-cells of the same region of the body. The ventral layer is composed of two elements, parenchyma cells and cylinders. The former are irregular in shape and size, and their granular secretion is finer than that of the dorsal layer cells, and appears to be different chemically. The cylinders are masses of tissue surrounding the vertical tracheal stems and their branches. There is no change in the structure of the tracheæ until near the periphery of the cylinder, where each fine tracheal twig breaks up into tracheoles. These have no spiral thickening. Photogeny occurs in that portion of the tissue where

* SB. K. Preuss. Akad. (1904) pp. 671–6.
† Proc. Roy. Soc., lxxii. (1903) pp. 488–92.
‡ Amer. Naturalist, xxxviii. (1904) pp. 127–51.

the tracheolar network is found, and where there is consequently the most abundant supply of oxygen.

c. General.

Arboreal Adaptations.*—L. I. Dublin reviews these in Mammalia. He distinguishes (1) partially arboreal—including the majority of the carnivores, insectivores, and rodents and *Dendrohyrax*; (2) strictly arboreal, subdivided into (*a*) modified for running on branches—arboreal marsupials and lemurs; (*b*) modified for suspension from branches—sloths and bats; (*c*) modified for swinging by fore limbs, hind limbs on the marsupial type—remaining arboreal primates. The special features characteristic of each type are briefly described.

Seventy New Malayan Mammals.†—Gerrit S. Miller, junior, reports on four large collections of Malayan Mammals made by Dr. W. L. Abbott—rich in slightly differentiated insular forms of rats and squirrels, and including peculiar insular species of porcupine and flying lemur, a dwarf siamang, a member of a new monkey genus, *Simias*, and so on. The title of the paper, "Seventy new Malayan Mammals," indicates how far we are from having exhausted even the mammalian fauna.

Seventh and Eighth Sternal Ribs in Man.‡—J. D. Lickley discusses the significance of the occasional presence of an eighth true rib in man, and of variations in the mode of sternal attachment of the seventh. He considers that the caudal end of the thorax is degenerating, as is shown by the diminution in the number of ribs which unite with the sternum in man and the higher primates as compared with the lower monkeys. The eighth rib has undergone so much degeneration that it rarely joins in the sternum, and falls short of the middle line. When degeneration has been partly arrested, it reaches the middle line without becoming incorporated in or joining with the sternum. A similar degeneration is affecting the seventh rib, which may not join or be incorporated in the mesosternum, but meet its fellow of the opposite side. A further change brings the seventh in a few cases into the same position as the eighth normally occupies, viz. it fails to reach the middle line, and terminates by a secondary connection with the sixth.

Asymmetry of Skull in Toothed Whales.§—O. Abel finds that this is greatest where the nostrils are most highly elevated upon the head, e.g. *Platanista* and Xiphinæ, whilst in forms with the nostrils nearer the front there is either no deviation from bilateral symmetry (*Zeuglodon*), or only a trifling one (*Phocæna*).

Ear of Toothed Whales.‖—G. Boenninghaus has made an exhaustive study of the ear and related structures in *Phocæna* and other Cetacea. From the great similarity of the rudimentary external ear to that of the seal he assumes that when functional it acted similarly. In the

* Amer. Naturalist, xxxvii. (1903) pp. 731–6.
† Smithsonian Miscell. Collections, xlv. (1903) pp. 1–73 (19 pls. and 1 fig.).
‡ Anat. Anzeig., xxiv. (1904) pp. 326–32.
§ SB. Akad. Wiss. Wien, cxi. (1902) pp. 510–26 (1 pl.).
‖ Zool. Jahrb., xix. (1904) pp. 189–360 (2 pls.).

water the ear of the seal is closed by the external pressure, and opened by muscular action in air. When the whale remained always in the water, and its body had undergone such transformation that in the usual position of repose on the surface its external ear lay below the water line, the necessity for opening the ear to receive sound waves through the air ceased, with the result that the ear muscles have become rudimentary. In the toothed whales there occurred a twisting and elongation of the anterior sphenoid, with the result that the external nasal opening lies on the upper surface of the forehead. Through this modification of the fore-part of the skull the eustachian tube has been shifted towards the roof, and the tubo-palatal muscles have disappeared. Other modifications have also taken place here, with the result that, except when the act of swallowing takes place, the tube is closed, but the conduction of sound is not impeded. These and other peculiarities are all referable to the alteration in structure of the whole skull adapted to secure the possibility of breathing in the horizontal position of repose at the surface of the water.

Photographs of Living Finback Whales from Newfoundland.*—F. W. True publishes the first photographs of living whales in American waters. They all represent the common finback, *Balænoptera physalus* (L.). Under ordinary circumstances the finback rises and sounds obliquely, the flukes are not thrown out, and the spout is vertical. The actions of the animal as regards the length of time it remains below the surface, the distance it travels while submerged, and the number of times it spouts in succession, are irregular. The spout is shown to be single in the finbacks, for the two columns of vapour-laden breath unite so close to the head that they appear as one.

Affinities of the Pygopodes.†—R. W. Shufeldt gives a detailed statement of the affinities between the grebes (super-family Podicipoidea) and the loons (super-family Urinatoroidea). He adheres to the conclusion which he maintained in 1884, that our existing grebes and loons are derived from, or are the descendants of the great toothed divers (Hesperornithidæ) long since extinct. The grebe-stock was an earlier offshoot than the loon-stock from the great toothed diver stock.

Comparative Osteology and Phylogeny of the Columbiformes.‡—Rudolf Martin makes an important contribution to the taxonomy of the pigeon-like birds. He gives a comparative account of the skeletal structure of pigeons, noting the main lines of evolution and the secondary changes. He pays particular attention to *Didunculus strigirostris*. The order Columbiformes includes two sub-orders: Didi, with the families Dididæ and Pezophabidæ; and Columbæ, with the families Columbidæ, Peristeridæ, Treronidæ, Carpophagidæ, and Didunculidæ.

Reclassification of the Reptilia.§—H. F. Osborn, as the result of a searching study of the problem of the diphyletic origin of the reptiles,

* Smithsonian Miscell. Collections, xlv. (1903) pp. 91–4 (3 pls.).
† Amer. Naturalist, xxxviii. (1904) pp. 13–49 (1 pl.).
‡ Zool. Jahrb., xx. (1904) pp. 167–352 (2 pls. and 96 figs.).
§ Amer. Naturalist, xxxviii. (1904) pp. 93–115.

designates the two groups as the sub-class Synapsida, or primitively single-arched reptiles, and Diapsida, or primitively two-arched. All the most primitive Diapsida are placed in the super-order Diaptosauria, a group equivalent in taxonomic rank to the Squamata or Dinosauria. He describes the reptiles falling within these two groups. He concludes that the birds probably originated from a group of Diaptosauria, identical with or closely related to that which gave rise to the Dinosauria. It is not true that birds have descended from Dinosaurs, but there is very strong evidence that birds and Dinosaurs are descended from a common stock. There is no question that the mammals are affiliated with the sub-class Synapsida, as is seen in their skull and shoulder-girdle structure, and in phalangeal formula. As to their nearer relationships, they appear to be with the super-order Anomodontia. The divergence of the mammal stem from these typical reptiles will probably be found to have occurred in the Permian or Lower Trias of South Africa. In fact, Broom has recently described what he believes to be a mammal jaw (Karoomys) from the Karoo Beds of South Africa.

New European Lizard.*—M. G. Paracca describes from Sardinia what seems to be a distinct species (*L. sardou* sp. n.), allied to *L. oxycephala*, but yet quite separate from it and allied species.

Notes on Reptiles.†—Franz Werner has made a careful comparison of the scales in two young Boids (*Epicrates angulifer*) and in their mother. In regard to twenty-five points there was a lack of complete hereditary resemblance, and in some cases the variation was very marked.

In a second note he discusses the symptoms of approaching natural death as exhibited in peculiar attitudes, in colour-change, in the look of the eye, etc., in snakes, lizards, and other reptiles.

Vegetarian habits are exhibited by more reptiles than is usually supposed, e.g. by many Chelonians and lizards. There is perhaps no single reptile which altogether rejects animal food, and, with the exception of the land tortoises and the leguans, most of the vegetarian forms are so only occasionally. In all the families of lizards the largest and most massive species are vegetarian.

The author also discusses variability in reptiles, with especial reference to scales and coloration, e.g. in *Zamenis gemonensis* and *Lacerta muralis*.

An Abnormal Tortoise.‡—B. Wandolleck describes in detail a monstrosity of a tortoise, which had been called *Testudo marginata*, but turned out to be *T. græca*, with a hump on its back and all sorts of abnormalities in the vertebral column, ribs, carapace, and scales. There must have been some remarkable inhibition of the normal growth: that is all that can be said.

Existing Genera of Trionychidæ.§—O. P. Hay reviews critically the genera of the Trionychidæ as founded by various authors. He

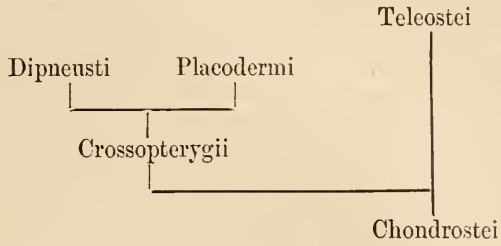
* Bull. Mus. Torino, xviii. (1903) 3 pp., 1 fig. See Zool. Centralbl. xi. (1904) p. 156. † Biol. Centralbl., xxiv. (1904) pp. 332–48 (1 fig.).

‡ Zool. Jahrb., xx. (1904) pp. 151–66 (4 figs.).

§ Proc. Amer. Phil. Soc., xlii. (1903) pp. 268–74.

disagrees with Baur regarding the types of some of the genera of that author, and particularly on the value of some of these genera.

Phylogeny of the Teleostomi.*—C. T. Regan gives the following classification of the Teleostomi, the relations of the different orders being indicated thus :—



The Chondrostei and Crossopterygii correspond to the groups usually so named ; the Dipneusti comprise the Sirenoidei only ; the Placodermi include the Arthrodira, Antiarcha, and Osteostraci ; and to the Teleostei the Ganoidei Holostei are added.

Oral Breathing-Valves of Teleostei.†—E. G. Mitchell has studied these in a large number of species. They are sheets of membrane composed of elastic connective tissue, covered with a mucous membrane continuous with that lining the mouth. They are situated in the mouth-cavity behind the maxillary and mandibular teeth, and their function is to prevent regurgitation of the water through the mouth in the act of breathing. Their size and shape are dependent on the size and shape of the mouth. In fishes with inferior mouths the upper valve is well developed, while the lower is reduced or absent ; terminal-mouthed fishes have upper and lower valves nearly equal, while in upwardly directed mouths, e.g. *Echeneis naucrates*, the maxillary valve is the smaller.

Gill-Arches of Murænidæ.‡—Canna M. L. Poppa gives a careful account of the structural characters of the branchial arches in *Anguilla*, *Conger*, *Ophicthys*, *Muræna*, and other eel-fishes, and shows that the peculiarities are specifically diagnostic. This is of value, but, as the author points out, the study is incomplete without an interpretation of the structural peculiarities in reference to the peculiarities in mode of life, especially as regards diet.

Fresh-water Fishes of Mexico.§—S. E. Meek notes that in Mexico there are four quite distinct fish faunas, and though they overlap at the borders, the region of each may be fairly indicated on the map. The origin of the fish is given, approximately, as from the Colorado river, from the Rio Grande, from the Lerma, and from Central America. The paper contains interesting notes on viviparity, which seems to be the rule amongst the tropical Pœciliidæ. It appears that in the tropical

* Ann. Nat. Hist., lxxvii. (1904) pp. 329-49.
† Amer. Naturalist, xxxviii. (1904) pp. 153-64.
‡ Ann. Sci. Nat., xix. (1904) pp. 367-90 (20 figs.).
§ Amer. Naturalist, xxxvii. (1903) pp. 771-84.

fresh-waters of America there is much more provision made for the care of the young than in the cooler waters of the northern continent.

Sub-Species of Mustelidæ.*—G. E. H. Barrett-Hamilton describes a number of examples of various species so differentiated as to merit ranking as sub-species. In the pine-marten he finds a tendency to deeper coloration, and a brighter throat-patch in the southern representatives of the species. Among the polecats in the south the tendency is to assume yellow under-fur and face markings, while in Central Europe the face markings are more extensive, and both they and the under-fur are whiter.

Fauna of New Zealand.†—F. W. Hutton has edited a valuable 'Index Faunæ Novæ Zealandiæ,' in which, with the help of numerous collaborateurs, he has furnished a list of the animals inhabiting New Zealand and the neighbouring seas. It has been a labour of love for all concerned, and will doubtless have its reward in an increased knowledge of the fauna of New Zealand. These balance-sheets are of the greatest value, and the editor deserves congratulations. In the introduction there is a discussion of the elements of the fauna, and sufficient evidence is adduced to show, if that were necessary, that New Zealand is not an oceanic island.

Plankton of Gulf of Trieste.‡—A. Steuer notes the following as distinctive features:—larval stages of worms and crabs, plankton forms limited to coast regions; medusa swarms in more or less abundance; absent or sporadic in appearance:—*Noctiluca*, *Thalassicola*, colonial Radiolaria, Sapphirinæ, Ostracoda, Hyperiæ, Pteropoda, Salpidæ, which are common or more frequent in the South Adriatic. The presence of Pteropoda and Salpæ is due to periodical swarms in the South Adriatic or to the perennial plankton of the south.

Tunicata.

Self-Fertilisation and Cross-Fertilisation in Solitary Ascidians.§ S. Gutherz has made experiments with *Phallusia mammillata* and *Ciona intestinalis*, and finds that in the former artificial autogamy is successful in all or almost all eggs, while in the latter it succeeds in only a small percentage of cases. In both cases cross-fertilisation was almost invariably successful. In natural conditions cross-fertilisation must be the rule in *Ciona*, and autogamy exceptional; in *Phallusia* the opportunities for natural autogamy seem to be much greater.

INVERTEBRATA.

Mollusca.

Egg-Envelopes of Cephalopods and Chitonidæ.‖—A. Schweikart finds that in five species of Chitonidæ the ovum is first surrounded by

* Ann. Nat. Hist., lxxvii. (1904) pp. 388–95.

† Index Faunæ Novæ Zealandiæ. Published for the Philosophical Institute of Canterbury, New Zealand. London (1904) 372 pp.

‡ Zool. Anzeig., xxvii. (1903) pp. 145–8.

§ Arch. Mikr. Anat., lxiv. (1904) pp. 111–20.

‖ Zool. Jahrb., 1904, Supplement, Band iii. Heft 2, pp. 353–406 (4 pls. and 2 figs.).

a chorion membrane, which is a secretion of the pellicular epithelium, and secondly by the vitelline membrane, which is formed by a hardening of a peripheral zone of the egg-cytoplasm. In *Sepiola* and *Loligo* the chorion is also secreted by the follicular epithelium. Particular attention is paid to the formation of the micropyle.

γ. Gastropoda.

Natural History of Haminea solitaria Say.*—W. M. Smallwood has studied this Tectibranch mollusc with especial reference to its life-history. The egg-laying period extends from the middle of June to the end of August, during which time the adults migrate from the deep water at Wood's Hole into shallow ponds and lagoons. The eggs are laid in a gelatinous mass, spherical in form, attached to eel-grass, algæ, stones and sticks. The eggs pass from the one-celled stage to the free-swimming embryo in seven days. In its method of segmentation, *Haminea solitaria* is in close agreement with other molluscs. No positive results were obtained from attempts to produce abnormal segmentation.

Nematocysts of Æolids.†—G. H. Grosvenor brings forward as evidence that the nematocysts of Æolids are derived from their prey, the following: Not only are nematocysts of Æolids and Cœlenterates identical in plan of construction and mode of discharge, but each of several distinct types occurs in both groups. A single type of nematocyst does not occur uniformly throughout a species, but different individuals of the same species may have quite different nematocysts; moreover, a single individual may have nematocysts of several different types, found in as many distinct species or groups of Cœlenterates. When it is known on what Cœlenterate an Æolid has recently been feeding, the nematocysts of the two are found to be identical. Also the nematocysts from the fæces of an Æolid, which are generally admitted to be derived from their food, are always identical with at least some of the nematocysts from the cnidosacs. Those Æolids (Janidæ, Fionidæ, and *Calma glaucoides*) which habitually feed on animals other than Cœlenterates, have no nematocysts. No plausible account of the development of nematocysts in Æolids has been given, though several attempts have been made. This view affords a satisfactory explanation of the function of the ciliated canal through which nematocysts and other indigestible bodies have been observed to pass from the gastric diverticulum to the cnidosac. Strethill Wright's experiments have been confirmed. In one case three *Rizzolia peregrina*, having only small pip-shaped nematocysts in their cnidosacs, were fed on *Pennaria cavolinii*, the nematocysts of which, after a month, had almost entirely replaced the original pip-shaped ones.

Palæozoic Pteropoda.‡—F. Chapman describes a number of fossils of genera *Styliola*, *Tentaculites*, *Hyolithes*, etc., from Palæozoic formations in Victoria. Their characters as Pteropoda are considered, the author classing them in this group with a certain amount of reserve.

* Amer. Naturalist, xxxviii. (1904) pp. 207–25 (16 figs.).
† Proc. Roy. Soc., lxxii. (1903) pp. 462–86.
‡ Proc. Roy. Soc. Victoria, xvi. (1904) pp. 336–42 (1 pl.).

Larval Eye of Chitons.*—Harold Heath has studied the ocelli in *Ischnochiton magdalensis*, *Trachydermon raymondi*, *Nuttalina thomasi*, etc. As Kowalewsky stated, the eyes of the larvæ become clearly defined about the time of the first appearance of the shell; they are situated immediately behind the velum half-way up the sides of the body; they are characterised by the pigment deposited about a clear central body. Under no circumstances does the eye of the forms mentioned become sub-epithelial. In at least eight species they persist as long as the shell and mantle are sufficiently transparent to allow light to penetrate. Histologically they resemble Annelid-trochosphere eyes, and their early development is almost identical.

Heart of Solenogastres.†—H. F. Nierstrasz finds that the Solenogastres have a spacious pericardium which may be prolonged distally; that the heart is well-developed, except in *Myzomenia* and *Dondersia*, and consists of an auricle and a ventricle; that the auricle arises by invagination of the dorsal and ventral walls of the pericardium, or of the dorsal wall only; that the ventricle is always a dorsal invagination. There are almost always two auriculo-ventricular openings with sphincters. The heart is open dorsally and distally, as follows from its mode of origin, but there is a more or less complete closing in by a connective-tissue sheath. Ciliated bands, Pruvot's "bourrelets ciliés" occur on the walls of the pericardium. Except in *Myzomenia* and *Dondersia*, the heart of Solenogastres, e.g. *Neomenia*, *Proneomenia*, etc., is by no means a rudimentary organ. Full details of many forms are given.

δ. Lamellibranchiata.

Origin of Fine Pearls.‡—L. Boutan has made a study of this subject, and criticises the views of Jamieson and others as to the place of origin of pearls. He is emphatically of opinion that fine pearls are secreted by the external epithelium of the mantle. They have fundamentally the same origin as the so-called "nacreous pearl" and nacre itself.

Arthropoda.

α. Insecta.

Gall-Formation.§—H. Rössig has made many observations and experiments in order to determine what organs in Cynipid larvæ stimulate the formation of galls. He deals at length with the salivary glands, the œnocyte groups of cells, the Malpighian tubules, and the epithelium of the hind-gut. It seems certain that the gall is induced by a chemical stimulus, by a fluid, by a product of the larval metabolism which is exuded very early. It seems clear that the stimulus is not in the vascular fluid, nor in the salivary secretion. Rössig believes that the evidence points to the secretion of the Malpighian tubules, probably with co-operation from the œnocytes. But his results are more conclusive as to what does not cause the stimulus, than as to the actual cause.

* Proc. Acad. Nat. Sci. Philadelphia, 1904, pp. 257–9 (1 fig.).
† Verh. K. Akad. Wetenschappen Amsterdam, x. (1903) No. 2, pp. 1–52 (3 pls.).
‡ Arch. Zool. Exp., ii. (1904) pp. 47–90 (1 pl.).
§ Zool. Jahrb. xx. (1904) pp. 19–90 (4 pls.).

Male Terminal Segments and Armatures in the Hymenopterous Genus Colletes.*—F. D. Morice, with a view to rendering the recognition of species of this genus easier, has constructed a table of the copulatory armatures which yield remarkable specific characters. Notes are given on thirty-five species, and their armatures figured.

Natural History, Anatomy, and Physiology of the Honey-Bee.† T. W. Cowan, in response to a call for a new edition of his hand-book on the Honey-bee, has issued one revised and corrected, upon which "no expense has been spared to make it the most perfect on the subject of which it treats." The work contains chapters on parthenogenesis, metamorphosis, and hermaphrodite bees, in addition to those on anatomy and physiology, of which there are twenty-one.

Australian Lepidoptera.‡—A. J. Turner, in a much-needed revision of the Geometridæ, sub-family Hydriomeninæ, has increased the number of recognised species by one-half. The work is so tabulated that by means of it species can be worked out, and is of value on this account.

The Endoderm of Lepidoptera.§—F. Schwangart has investigated a number of developmental points in connection with the endoderm, and has made out, *inter alia*, that the gland structures of the gut arise out of parts of the lower layer of the fore- and hind-gut, which are pushed downwards with the blind ends of the stomo- and proctodæum. In *Endromis* early separation of endoderm and mesoderm does not take place.

Aberrations of Lepidoptera.‖—Under this title P. I. Lathy describes and figures forty-five notable variations. Two examples may be given. (1) A specimen of *Melinæa mauensis* from Demerara, which is gynandromorphous, the left side being female and the right male. It is not definitely stated whether the note refers to external features only or not. (2) A male of *Amathusia andamanensis*, with three ocelli on the hind wings below.

Mosquitoes of Para.¶—Emilio A. Goeldi has made a number of experiments on the mosquitoes of this region, with especial reference to *Stegomyia fasciata* and *Culex fatigans*, which appear to have considerable hygienic importance.

Reduction of the Head in Dipterous larvæ.**—N. Holmgren gives comparative notes, with homologies, on the head-parts of the larvæ of *Chironomus*, *Phalacrocera*, *Microdon*, and *Musca*. One point dwelt upon is the relation of the T columns seen in a cross-section of the mouth-cavity of *Musca*, with cavities in the two-layered cuticula of the mouth of *Phalacrocera*, which are lined with a chitinous layer, and which though different in appearance are shown to be the same structure.

* Trans. Entom. Soc. London (1904) pp. 25–63 (4 pls.).
† Houlston & Sons, London, 2nd ed. (1904) 220 pp.
‡ Proc. Roy. Soc. Victoria, xvi. (1904) pp. 218–84.
§ Zeitschr. wiss. Zool., lxxvi. (1904) pp. 167–212 (2 pls.).
‖ Trans. Entom. Soc. London, 1904, pp. 65–70 (1 pl.).
¶ Bol. Mus. Goeldi, iv. (1904) pp. 1–69.
** Zool. Anzeig., xxvii. (1904) pp. 343–55.

Anal Gills in larva of Glossoma boltoni and some Hydropsychidæ.* A. Thienemann describes in the larva of *Glossoma boltoni* small, white finger-like prolongations, similar to the anal sac of certain *Tipula* larvæ, which contained tracheal branches, and which he regards as tracheal gills. Similar appendages in the Hydropsychidæ, he finds, are blood-gills; he thinks it probable that the anal sacs of the Rhyacophilidæ are tracheal gills also.

Mealy-Winged Flies of California.†—Florence E. Bemis describes the characters of the Aleyrodidæ—small or minute insects infesting plants, oviparous, with incomplete (?) metamorphosis, with immature stages, quiescent, attached by sucking mouth-parts to the leaves, with adults free and active, covered with granules of white wax. A table is given of all the known American species of *Aleyrodes*, and the systematic descriptive catalogue of the Californian forms includes no fewer than sixty-six species.

Oriental Aleurodidæ.‡—H. W. Peal makes contributions towards a monograph of the Oriental Aleurodidæ—a family of Homoptera, which are allied to the scale-insects. He describes eight new species from Calcutta and Behar, and discusses preventive measures.

Egg-Cases and Early Stages of some Cassididæ.§— F. Muir and D. Sharp describe these in certain South African species. The eggs are placed in a case built of membranes formed of a peculiar substance. In *Cassida muriana* and allied forms there is an extremely small and imperfect ootheca covered with excrement. The ootheca is of various degrees of perfection, in accordance with the species that forms it; and in the ootheca of *Aspidomorpha puncticosta* the structure is so elaborate and perfect that it surpasses even the combs of bees and wasps. The paper records new observations on the extraordinary nature and habits of Cassidid larvæ.

Life-History of Gongylus gongyloides.‖ — C. E. Williams gives a number of interesting notes on the structure and habits of this Mantis of the tribe Empusides. It is a floral simulator, in which the ventral aspect is modified in form and colour, chiefly with a view to the attraction of prey, while the dorsal surface and wings are free of conspicuous colours and markings. As in *Idolum*, there is a peculiar purple pigment for the production of petaloid colouring in various parts of the body. This insect, which is found in many parts of India, Ceylon, etc., feeds on various Lepidoptera. These frequent the creepers and flowering shrubs, upon which it displays its whole body and limbs at the end of a twig or spray, or on a spike of flowers, maintaining this inverted position exposed to the full sunlight without any serious risk from its enemies.

Phagocytic Organs in Gryllidæ.¶—C. Dawydoff describes as phagocytic organs certain paired structures of triangular form which occur

* Zool. Anzeig., xxvii. (1903) pp. 125–9.
† Proc. U.S. Nat. Mus., xxvii. (1904) pp. 471–537 (11 pls.).
‡ Journ. Asiatic. Soc. Bengal, lxxii. (1903) pp. 61–98 (5 pls.).
§ Trans. Entom. Soc. London (1904) pp. 1–23 (5 pls.).
‖ Tom. cit., pp. 125–37.
¶ Zool. Anzeig., xxvii. (1904) pp. 589–93 (3 figs.).

in the abdominal region in close association with the heart in various Orthoptera (*Gryllus*, *Nemobius*, *Gryllotalpa*, *Brachytrypus*, *Gymnogrillus*). He believes that these organs—two pairs in *Gryllus* and *Nemobius*, four pairs in *Gryllotalpa*, and so on—are homologous structures in Orthoptera.

New Copeognatha.*—Günther Enderlein reports on some forms of these remarkable insects, collected by Fr. Dahl in the Bismarck Archipelago, e.g. the new genus *Soa*, in the family Lepidopsochidæ. He also notes that the function of the so-called "stigma-sac" on the under side of the anterior wing of all Copeognatha is to hold the wings together in the resting position.

New Mallophaga.†—Vernon L. Kellogg gives an analytical key to the two sub-orders and the genera of this interesting but little studied order of parasitic insects. In the order, as at present known, there are about 1500 species, comprising 23 genera. The small number of genera is striking in itself, but it is made more amazing when it is remembered that eleven of the genera comprise but thirty of the species, leaving nearly the whole bulk of the species in the twelve remaining genera. The addition of two new genera—*Philoceanus* from *Procellaria tethys*, and *Nesiotinus* from *Aptenodytes longirostris*, is therefore rather notable in the development of our knowledge of this order.

Mallophaga from Hawaiian Islands.‡—V. L. Kellogg and B. L. Chapman report on a collection of twenty species of biting lice obtained by R. C. MacGregor, from twelve species of birds shot in the Hawaiian islands. We note the paper because it reports on the first collection of Mallophaga from this area. Of the twenty species fourteen are named and described as new, four are named and described as varieties of previously known species, while but two can be considered typical representatives of already known species. Of the twelve hosts, four are peculiar to the Hawaiian islands, and the parasites of these birds are all new species, except the two taken from the Hawaiian coot, *Fulica alai*.

Thanasimus in the Himalayas.§—E. P. Stebbing reports the discovery of *Thanasimus* (near *T. nigricollis*) in the north-west Himalayas, a beetle belonging to the family Cleridæ, which is of great importance because it is predaceous upon several wood-boring and bark-boring Scolytidæ, detrimental to the coniferous forests of the north-west Himalayan area.

β. Myriopoda.

Sense of Smell in Myriopods.‖—C. Hennings finds that the antennæ, and these alone, function as organs of smell. The strength of this sense varies noticeably in different forms; it stands in no visible connection with the length of the animals, but more probably has

* Zool. Jahrb., xx. (1904) pp. 105–12 (1 pl.).
† Biol. Bulletin, v. (1903) pp. 85–91 (3 figs.).
‡ Journ. New York Entomol. Soc., x. (1902) pp. 155–70 (3 pls.).
§ Journ. Asiatic Soc. Bengal, lxxii. (1903) pp. 104–10.
‖ Biol. Centralbl., xxiv. (1904) pp. 274–83.

œcological significance. The most sensitive olfactory organs are found in two representatives of the Diplopoda, viz. *Glomeris* and *Polyzonium*.

New Genera of Scutigeridæ.* — F. Silvestri describes *Scutigerides* g. n., and *Scutigerina* g. n., both allied to *Scutigera*, and each represented by a species from the Transvaal and Cape Colony respectively. He also describes three new species of *Paralamyctes* from the same region.

δ. Arachnida.

Structure of Heart and Origin of Blood-Cells in Spiders.† — V. Franz states that the ring musculature of the spider's heart consists, as in other Arthropods, of semicircular constituent parts, touching each other at their ends above and below. It lies outside a delicate layer of longitudinal fibres, upon which, in many forms, lie isolated longitudinal fibres, and over these an adventitia. The wall of the heart breaks up interiorly into blood-cells. An intima, such as was earlier supposed to exist, is not present in spiders.

Wing-like Lateral Organs of Solifugæ.‡—R. Heymons makes a careful study of these peculiar structures, discovered by Croneberg in 1887, and comes to the conclusion that they belong to the category of embryonic lateral organs, arising from the embryonic lateral plates, as in other types of Chelicerata. They have nothing to do with wings, and instead of pointing to any affinity with insects, they corroborate the Arachnoid character of the Solifugæ.

Spiders of the Sub-Family Erigoninæ.§ — F. P. Smith proposes a classification of the family Linyphiidæ. He establishes two subfamilies, the Linyphiinæ and the Erigoninæ, and in an introductory communication gives the distinctive characters of the latter division. It contains three natural groups: (1) the *Nercene*, comprising a number of genera with the sternum at least as broad as long, and the elevation of the male caput, when present, so placed as to have practically no effect upon the position of the eyes; (2) the *Diplocephali*, with caput elevation of male, such that position of eyes is affected; (3) the *Walckenæra*, with sternum considerably longer than broad, the cephalothorax somewhat elongate, and the tibia of the male palpus furnished with prominent apophyses.

ε. Crustacea.

Modification of Eye-Peduncles in Cymonomus.‖—E. Ray Lankester has examined the material of the "Porcupine" collection of the genus *Cymonomus*, a species of which *C.* (*Ethusa*) *granulata*, has hitherto been reputed to exhibit a series of types, from forms with well-developed eyes and living at the surface, through others with eye-stalks but apparently blind, from deeper water, to a third form not only blind

* Redia, i. (1903) pp. 253–8.
† Zool. Anzeig., xxvii. (1904) pp. 192–204.
‡ SB. K. Preuss. Akad. Berlin (1904), pp. 282–94 (2 pls.).
§ Journ. Quekett Micr. Club., 1904, pp. 9–20 (1 pl.).
‖ Quart. Journ. Micr. Sci., xlvii. (1903) pp. 439–63 (2 pls.).

but with eye-stalks modified as sharply pointed rostra. Examples of the first type were not found in the collection, but Lankester believes that "there is no doubt that such a shallow water form has existed, and very possibly still exists." He further quotes evidence for believing that the form with rostriform eye-peduncles has a geographical and not merely a bathymetrical correlation, and ranks it as a distinct species, naming it *C. normani.*

Breeding Habits of American Crayfish.* — E. A. Andrews gives an interesting account of the breeding habits of *Cambarus affinis.* Though his observations were made upon individuals kept in confinement in the biological laboratory at Baltimore, they probably indicate in some measure what occurs in nature. Field observations remain "much to be desired."

In two lots the females were decidedly in the majority, 26 : 14—39 : 14. In a third lot they were 41 to 39 males. Even when the females are more abundant than the males, there is no probability of the eggs going without fertilisation, since one male may unite with several females.

Sexual union was observed in February, March and April, but there is an autumnal pairing, in place of or in addition to the spring pairing.

The spermatozoa are transferred from the male to an external seminal receptacle upon the female, where they are stored till the time that the eggs are laid. There is no copulation or use of intromittent organs as in crabs, nor any such vague attachment of spermatophores as has been described in the European crayfish, *Astacus*; in captivity the union lasts from two to ten hours, and either the male or the female may repeat the process with other individuals.

The somewhat intricate sexual union is described in detail; the result is the storing up of spermatozoa within the annulus or sperm receptacle in the female. The annulus in *Cambarus affinis* may be described as a calcified region on the ventral side of the thorax, between the sterna of the somites bearing the fourth and fifth legs. The evidence strongly favours the view that the seminal matter received into the annulus is that which subsequently fertilises the eggs. Perhaps spermatozoa received in autumn may be used to fertilise ova laid in spring.

After sexual union many of the crayfishes died, and it was found that the males died in larger numbers than did the females. In several cases the males died within a few hours after union.

After union there is quite a long period before the eggs are laid,—often some weeks. In preparation for laying the females tend to hide in dark corners and are very excitable. These days are taken up with great and peculiar activity, resulting in a thorough cleaning of the ventral side of the abdomen. This is also described in detail. The eggs are usually deposited at night, and the liberation is preceded by the exudation of the secretion of the "cement glands." Thus the eggs pass from the oviducts into a basket formed by the bent-up abdomen and full of glairy secretion which protects them from contact with the water.

* Amer. Naturalist., xxxviii. (1904) pp. 165–206 (10 figs.).

By turning about from side to side the female gives the eggs every opportunity to become fastened to the pleopods. The mode of fertilisation has not been made out, but probably the sperm passes out from the annulus after laying.

A short account is given of the development. The young continue to crawl about upon the pleopods for about a week after hatching, and the liberated larvæ return again and again to the mother.

Sexual instincts and organs mature long before the maximum size is reached. Little specimens were seen uniting in pairs when but four months old and 50 to 60 mm. in length, but as yet it is not known that they lay before they are twenty-three months old and 75 mm. long.

Mutations of Certain Atyids.* — E. L. Bouvier asserts that the new species of *Ortmannia*,—*O. henshawi* recently established by M. Rathbun, is a form of *Atya bisulcata*, which has the curious character of recalling the immediate ancestral form of *Atya*. It is not a case of ordinary dimorphism, sexual, or produced by season or locality; in both forms there are the same variations of size and sex. He considers that the *Atya* is the direct descendant of *Ortmannia*, and that in the case of certain species, this derivation is not yet a definitely accomplished fact. *Atya bisulcata* and *Atya serrata* are in a condition of unstable equilibrium, where the same creature may indifferently present the form of the past or of the future. In *Ortmannia americana*, the primitive form alone exists; in *Atya brevifrons* de Man, the primitive form seems to have disappeared, bequeathing a very marked stamp to its descendant, which, like *Ortmannia*, is small and provided with locomotor feet of feeble power.

British Fresh-water Entomostraca.†—D. J. Scourfield concludes, in a third paper, his synopsis of these Entomostraca. The paper deals with the Ostracoda, Phyllopoda, and Branchiura, including new records of rare species of Cladocera and Copepoda. A tabular statement showing the distribution of the Ostracoda is given.

Annulata.

Regeneration of Trunk and Head Segments in Lumbricus variegatus.‡—P. Iwanow finds that the intestine in regeneration is formed in the new segments of the trunk and head in a similar way through the outward growth of the old intestine. In most cases the growing part breaks outward through a small proctodæal, or stomodæal fold. The new growing epithelium is early differentiated, and along with it there are large epithelial "germ-cells," which take up a place in the ventral half of the body-wall, and later on the dorsal side also. The nerves and ectodermal muscles, as well as gut, are formed in essentially the same way in both regions, but important differences are met with in the formation of the elements of the cœlomic mesoderm. In the head segments a great part of the longitudinal muscles is formed through direct growing in of the muscle fibres of the old trunk musculature lying near, the other longitudinal muscles of the head segments along with all other mesodermal

* Ann. and Mag. Nat. Hist., lxxvii. ser. 7 (1904) No. 77, pp. 377–81.
† Journ. Quekett Micr. Club, 1904, pp. 29–44 (1 pl.).
‡ Zeitschr. wiss. Zool., lxxv. (1903) pp. 327–390 (2 pls.).

tissues arise from the cell elements of the old cœlomic mesoderm. The greatest part of these wandering mesodermal elements is formed by cells of the longitudinal musculature which have separated off from their contractile substance, and have at the same time undergone certain alterations in the structure and size of the nucleus. The mesoderm of the trunk segments arises from certain indifferent "germ-cells," which give origin to various tissues and organs. The special way in which the mesodermic structures of the head segments arise, the author notes, is paralleled in the cœlomic mesoderm of the head vesicle of *Polygordius*, which according to Hatschek is an outgrowth of the part of the trunk mesoderm adjacent to it.

Digestive Apparatus in Polychæta.*—L. Brasil has made an exhaustive study of this subject, the leading results of which may be stated. At the entrance to the digestive tubes in many Polychetes there are claviform glandular cells, which arise by degenerative changes of the superficial cells of the epithelium. In the intestine of *Lagis koreni* there are formations analogous to those described by Eisig in the Capitellidæ under the name of "lymphatic cell diverticula." These are the seat of intense and continuous renovation. The ferment cells may contain fat. The secretion of ferments begins with nuclear expulsions, to which the nucleolus contributes. Nuclear degenerations may occur by pycnosis, karyorhexis, or chromatolysis. The old cell may be totally expelled (nucleus in chromatolysis), or it may atrophy (nucleus in pycnosis or karyorhexis). The epithelium is the seat of a continual renovation whose intensity is in relation to the secretory activity of the region in question. The renovation goes on by mitosis, which gives rise to elements some of which become digestive cells (trophocytes), while others retain the embryonic character. These alone retain the power of mitotic division, and from their subsequent divisions result trophocytes and "multiplying cells" as before. The amitoses observed in the intestine give rise to pluri-nucleate cells, whose nuclei all degenerate. The mid-gut of *Lagis* secretes amylase, trypsine, and probably lipase. The oily-looking corpuscles so often described in the middle intestine of Polychæts are not a digestive secretion, but nutritive reserves—fat, localised in the intestinal epithelium; glycogen is absent. Intestinal excretion does not occur in *Lagis*. The differentiation of specialised diverticula for a single secretion (*Arenicola*), for secretion and excretion (*Aphrodite*), marks progress towards the "liver" of molluscs.

Revision of Annelid Genera.†—Albert Soulier continues his careful revision of the genera of Annelids from the region of Cette, discussing *Potamilla*, *Sabella*, *Branchiomma*, *Myxicolla* and *Polydora*. His results, if made available to other workers on marine Annelids, will be of much value.

Minute Structure of Nerve-cells and Epithelial Cells in Earthworms.‡—Santiago Ramón y Cajal describes in these elements of *Lumbricus* a tubuliform structure in the cytoplasm.

* Arch. Zool. Exp., ii. (1904) pp. 91–255 (5 pls).
† Mem. Acad. Sci. Montpellier, iii. (1903) pp. 193–278 (12 figs.).
‡ Bol. Soc. Española Hist. Nat. iii. (1903) pp. 395–8 (2 figs.).

Splanchnic Musculature in Oligochæta and Hirudinea.*—N. Livanow notes that the general statement in regard to the musculature of the intestine is, that the internal layer consists of circular fibres and the outer of longitudinal fibres. In *Branchiobdella varians* and *Haplotaxis gordioides* (syn. *Phreoryctes menkeanus*) the arrangement is the reverse. The same is true of *Acanthobdella*, but in Lumbriculidæ, Enchytræidæ, and terricolous Oligochæta, the circular muscles are internal and the longitudinal external. Livanow comments on the possible theoretical import of the two types of muscle-arrangement.

Nematohelminthes.

Cerebral Ganglion and Body-Cavity of Gordiidæ.†—Max Runther finds that in architectural plan and in the minute structure of the various systems, the genus *Gordius* betrays remarkable affinities with the Archiannelida, especially as regards cuticular structure, nervous system, musculature, parenchyma, and gonads. He deals especially with the cerebral ganglion and the body-cavity, and the general result is that *Gordius* is nearer to *Polygordius* than to typical Nematodes.

Radially Striated Ganglion Cells in Ascaris.‡—R. Goldschmidt describes these remarkable and characteristic cells, which occur throughout the nervous system of *Ascaris*. The ganglion cell is surrounded by a glia-capsule, externally bounded by a firm lamella, and consisting of numerous extremely fine concentrically-disposed membranes traversed by equally fine radial lamellæ, like an intricate spider's-web. From the capsular wall numerous radial processes penetrate into the cytoplasm in the direction of the nucleus, and end in the internal finely vacuolar plasma. In the cytoplasm the processes run in fine tubes.

As to the physiological meaning of this intricate structure, Goldschmidt thinks that a trophic function is improbable, and inclines to attribute to it a mechanical rôle. It makes the cell more sensitive to the vibrations and oscillations which affect the body generally.

Platyhelminthes.

Development of Turbellarians.§—E. Bresslau gives a large number of facts regarding the development of the Winter and Summer eggs of *Mesostomum ehrenbergi*, *M. lingua*, etc. The Winter eggs of all the forms are very numerous: they have abundant yolk-cells, and are enclosed in a thick brown-coloured shell. The yolk-cells blend into a thick yolk-mass, in the midst of which the germinal material lies. The epiderm has a paired origin; the gut and schizocœle arise by indifferent cells of the embryo laying themselves around cavities which have previously appeared in the yolk-mass. The Summer eggs of *M. ehrenbergi* have a very small number of yolk-cells, which contain only minimal yolk-masses. The egg-membrane is thin, transparent and colourless. The yolk-cells differentiate into enveloping and vacuole cells, while the germinal substance

* Zool. Anzeig., xxvii. (1904) pp. 585-9.
† Tom. cit., pp. 606-14 (4 figs.).
‡ Biol. Centralbl., xxiv. (1904) p. 173-82.
§ Zeitschr. wiss. Zool., lxxvi. (1904) pp. 213-332 (7 pls.).

lies ventrally close to the egg-membrane. The gut and schizocœle arise as a result of the melting in of the vacuole cells through cells of the still undifferentiated embryo.

Trematodes from Canadian Fishes.*—J. Stafford gives an account of fifty-eight of these, a number of which are new genera or species. Of these, the fresh-water fishes yield such a large proportion as to suggest an unworked fauna.

Cestode with Separate Sexes.†—O. Fuhrmann describes the male and the female of a remarkable cestode, *Dioicocestus acotylus*, which was found in Ardeiform and Colymbiform birds, *Plegadis guarauna*, *Podiceps griseigena*, and *P. dominicus*. The male, which differs externally from the female, has double copulatory organs, while the genitalia of the female are single and have no vaginal aperture. In the case of each of the three known species of *Dioicocestus*, only one male and one female occurred in each host. Perhaps, as the author suggests, one pro-scolex gives rise to two scolices, male and female. But the intermediate hosts are unknown. The peculiar musculature and the absence of a female aperture, force Fuhrmann to refer these remarkable forms to a special family, Acoleinæ—short-jointed, thick cestodes with two longitudinal and three alternating tranverse layers of muscles in the parenchyma of the strobila. In *D. acotylus* there are no suckers, and the rostellum is degenerate.

Fresh-water Representative of a Marine Genus of Turbellaria.‡ O. Fuhrmann describes from deep water in the Neuenburger-See an almost colourless Turbellarian, a millimetre in length, with a remarkable chitinous copulatory apparatus. He calls it *Hyporhynchus neocomensis* sp. n., and its special interest is, that it seems to be a representative of the marine genus *Hyporhynchus*, differing only in the strong development of the proboscis and in the absence of chitinous parts in the bursa seminalis.

Polyzoa.

Fresh-water Polyzoon from Rhodesia.§—C. F. Rousselet describes a new form, *Lophopodella thomasi* g. et sp. n., whose special character appears to be the structure of the statoblasts. These differ distinctly from those of *Pectinatella*, the only form having features approaching the new type. The statoblasts are elliptical in shape with truncated ends, each bearing normally five spines beset with numerous minute closely set curved hooks.

Tertiary Polyzoa of Victoria.‖—C. M. Maplestone gives a descriptive list with synonyms of the species of family Selenariidæ, a work which appears to have been much needed owing to the confusion existing in the naming of the members of this group. The paper includes an account of new species, both fossil and recent.

* Zool. Anzeig., xxvii. (1904) pp. 481–95.
† Zool. Jahrb., xx. (1904) pp. 131–50 (8 pls.).
‡ Zool. Anzeig., xxvii. (1904) pp. 381–4 (3 figs.).
§ Journ. Quekett Micr. Club., 1904, No. 54, pp. 45–56 (1 pl.).
‖ Proc. Roy. Soc. Victoria, xvi. (1904) pp. 207–17 (2 pls.).

Incertæ Sedis.

Body Cavities and Nephridia of Actinotrocha.* — R. P. Cowles has found in two Actinotrochæ from Beaufort, North Carolina, that there is an incomplete mesentery between the preoral lobe and the collar cavities, and a complete one between the collar and trunk cavities. The trunk cavity contains a ventral mesentery, and in one species, indications of a dorsal mesentery; but there is no sign of a dorsal mesentery, such as Masterman describes for the collar cavity. The mesoderm was not found to arise from archenteric diverticula. The anterior and lateral borders of the blastopore are most active in giving rise to mesoderm cells, which in the gastrula stage form a definite sac. This sac anteriorly becomes the lining of the preoral lobe, while its posterior wall becomes the lobe collar mesentery. The preoral lobe and the lobe collar mesentery are lost during metamorphosis; the collar cavity and its lining become the ring vessel of the adult; the cavity of the mesodermal sac between the mesodermal lining of the collar cavity and the ventral ectoderm becomes the supra-septal cavity of the adult; the trunk cavity, including the cavity of the ventral pouch, is transformed into the infra-septal body cavity, and the mesentery between the collar and trunk cavities becomes the transverse septum of the adult. The author's observations on the nephridia confirm the work of Goodrich in nearly every detail.

Regeneration in Phoronis Mülleri.† — E. Schultz discusses in a third paper on regeneration phenomena the results of his experiments on *Phoronis*. The animals were cut by means of scissors at various levels,—through the tube, and above it with head expanded. In every case, whether severed only through the tentacles, through the first part of the œsophagus, at a point where spontaneous breaking away of head goes on, or still lower down, normal animals resulted. The notable fact here brought out, that the most protected parts within the tube,—not likely in the ordinary course to suffer injury,—regenerated as well as the exposed portions, suggests that regeneration has not arisen through natural selection, but is a primary peculiarity of living substance.

Ptychodera flava funafutica.‡—J. W. Spengel gives an account of a form of *Ptychodera flava* from Funafuti (Ellice group), and emphasises especially the differences between it and *Pt. fl. caledoniensis* of Willey and *Pt. fl. laysanica*.

Development of Blood-Vessels and Blood-Corpuscles in the Actinotrocha Larva.§—R. P. Cowles discusses this difficult question. The Actinotrocha, which has just completed its metamorphosis, has only one ring-vessel (larval collar-cavity), but the young *Phoronis*, when it is twelve hours old, possesses both the recipient and distributing vessels. These, the author believes, arise by the fusion of the walls of the single ring-vessel in the metamorphosing Actinotrocha, and by the subsequent

* Johns Hopkins University Circular, 1904, No. 2, pp. 28–37.
† Zeitschr. wiss. Zool., lxxv. (1903) pp. 391–420 (2 pls.).
‡ Zool. Jahrb., xx. (1904) pp. 1–18 (2 pls.).
§ Zool. Anzeig., xxvii. (1904) pp. 598–906 (7 figs.).

separation of the two parts along the line of fusion. The red blood-corpuscles of the adult *Phoronis* make their appearance in the young Actinotrocha; and when the latter become fully developed, they are usually present as one or two pairs (according to the species) of conspicuous red masses in the larval collar-cavity. But this only indicates the general tenor of the author's observations.

Lohmanella catenata.* — E. Neresheimer describes this mesozoon parasite from the body of species of *Fritillaria*. The two-layered young form possesses a marked resemblance to a gastrula. But here the cell-complex which would correspond to the inner layer shows nothing comparable to a true endoderm, since almost the whole material is used up for the formation of (probably asexual) reproductive bodies, whilst the material corresponding to the ectoderm takes on the function of digestion. He believes that this formation arises, not by invagination, but by overgrowth. From a study of stages in the life-history of *Amœbophrya*, which are analogous to those seen in *Lohmanella*, the author proposes to group these genera together under the name Blastuiloidea, placing this division in the same rank as those of the Planuloidea and Mesenchymia.

Rotatoria.

Rotatoria and Gastrotricha of Ploen.†—In this work of 178 pages Max Voigt gives the results of his investigation of these animals, which he has prosecuted for about twenty months in the lake region of Ploen in Holstein. Altogether 217 species of Rotifers were observed, of which the following four are new species: *Cordylosoma perlucidum*, *Cœlopus uncinatus*, *Cœlopus rousseleti*, *Distyla ploenensis*; and one, *Anuræa aculeata* var. *cochlearis*, a new variety, though all these have already been mentioned by the author in a short descriptive account, without figures, in the *Zool. Anzeiger* in 1902. The most interesting new species is undoubtedly *Cordylosoma perlucidum*, for which a new genus had to be created, intermediate between the Floscules and the Philodinæa, with a strange combination of characters.

The author gives an exhaustive account of the occurrence of the various species in the different large and small lakes and pools of the region, as well as of the appearance of the males and the production of resting eggs.

In a second division an account of twenty-three Gastrotricha found in the region is given, of which ten are described as new.

A third division enumerates five parasites found in the body-cavity of various Rotifers. Seven plates, with thirty-nine figures of Rotifers and seventeen figures of Gastrotricha, accompany this memoir.

A Monograph of the Rattulidæ.‡ — H. S. Jennings has rendered a great service to all students of the Rotifera in producing this excellent monograph, which is a thorough revision up to date of the Rotatorian family Rattulidæ. The author has very carefully sifted the

* Zeitschr. wiss. Zool., lxxvi. (1904) pp. 136–63 (2 pls.).

† Stuttgart (1904) 178 pp. and 7 pls. Will appear also in vol. xi. of Forsch. Ber. biol. Stat. Plön.

‡ Bull. U.S. Fish Com. for 1902, pp. 273–352 (15 pls.).

synonymy, and has taken pains to give an accurate description and good figure of each species, so that it ought not to be difficult in future to determine the animals of this family met with in lakes and ponds. This revision has necessitated a number of changes in classification in order to bring the generic and specific names into consonance with the recognised rules of nomenclature. In accordance with these rules the family is divided into the two genera, *Diurella* and *Rattulus*, as having historical precedence over the names of *Cœlopus*, *Rattulus* and *Mastigocerca*, which they replace. The genus *Diurella* comprises those Rattulidæ having two equal, or nearly equal toes which were formerly called *Rattulus* and *Cœlopus*, whilst the genus *Rattulus* contains those animals having a single long toe with usually some small sub-styles, and formerly called *Mastigocerca*. Though these changes in names are troublesome, and may at first produce a little confusion, they are historically correct and must be accepted. One can only regret that the late C. T. Hudson did not avail himself of the unique opportunity of putting the nomenclature right when writing his great work, *The Rotifera*. In the present monograph thirty-six species are recognised as good, of which two are described as new, and a list of seventeen doubtful or insufficiently described species is added at the end. The two new species are named: *Diurella weberi* and *D. dixon-nuttalli*.

Echinoderma.

Parthenogenetic Larvæ of Asterias glacialis.* — Yves Delage obtained parthenogenetic larvæ experimentally by the action of carbon dioxide on unfertilised eggs. They attain a stage approaching metamorphosis, exhibiting rosette and apical disc, and having five lobes representing the five arms, containing terminal plates having the form of broad fenestrate laminæ. Their development was very slow—it lasted for more than three months. The few survivors which reached this stage were lost by accident when they were full of life, and there was no reason to suppose they were not in a state to reach complete development. Artificial feeding with a pure culture of Chlorellæ, enabled the author to attain the success he reached.

Parental Care in Echinoderms.†—H. Ludwig recalls attention to a case described by Th. Mortensen.‡ In *Hypsiechinus coronatus*, a deep-water North Atlantic Echinoid, the eggs and embryos are sheltered by spines around the apical disc of the female.

Cœlentera.

Medusæ from Maldive Islands.§ — H. B. Bigelow concludes, from the results of a collecting trip to these islands, that the fauna as represented in the Medusæ, though showing a general resemblance to that of the Tortugas in the Atlantic and Fiji in the Pacific, has no recent relationship to either of these. The general resemblance of the three

* Arch. Zool. Exp., ii. (1904) pp. 27–42 (1 pl.).
† Zool. Anzeig., xxvii. (1904) p. 423.
‡ Danish Ingolf Exp., iv. (1903).
§ Bull. Mus. Compar. Zool. Harvard, xxxix. (1904) pp. 245–69 (9 pls.).

is to be explained on the ground that they are all of the "coral-reef" type. The striking thing in the Maldives is that of forms known to be "local" in their distribution, nearly all found were new, and not only so, but they are separated from their nearest allies by divergences, which amount often nearly to generic importance. The writer concludes that the Maldives are an area of geographic isolation which has lasted for a considerable period.

Porifera.

Spermatogenesis in Porifera and Cœlentera.* — W. Görich finds that division goes on within the spermatocyst of *Spongilla* so actively that nuclei can hardly be found in a state of repose—even when the nucleus of the spermatid has not reached this state, the centrosomes, one larger than the other, may be seen beside it. A further stage is: both centrosomes move toward the periphery—the smaller one nearer the inside. The latter next moves towards the nucleus, and in doing so forms a delicate thread extending towards the larger body. Almost at the same time the tail is formed. On the opposite side of the nucleus a minute highly refractive granule appears at this stage, whose origin was not traced, though the author believes that it arises from the centrosome. Somewhat similar phenomena were observed in the sperm-development of *Aurelia aurita.*

Protozoa.

Demonstrating Discharge of Contractile Vacuoles.† — H. S. Jennings points out that it is possible with the greatest ease to demonstrate that, in *Paramœcium* and similar forms, the contents of the contractile vacuoles are discharged to the outside. The method consists in mingling a large quantity of finely ground Indian ink, or Chinese ink, with the water containing the animals. The clear fluid from within the vacuoles passes into the black and opaque surrounding water, where it is absolutely conspicuous, as a white and shining spot.

Using this method, Jennings has observed the discharge of the contractile vacuoles in *Paramœcium*, *Nassula* and *Oxytricha*, and also in various Rotifers.

Trypanoplasma of the Minnow.*—Louis Léger gives a description of *Trypanoplasma borreli*—a Flagellate from the blood of the minnow (*Phoxinus lævis*). It is also known in the Red-Eye, and is adjacent to *T. cyprini* Plehn from the carp.

* Zool. Anzeig., xxvii. (1903) pp. 64–70.
† Tom. cit. pp., 656–8 (1 fig.).
‡ Comptes Rendus, cxxxviii. (1904) pp. 824–5.

BOTANY.

GENERAL,

Including the Anatomy and Physiology of Seed Plants.

Structure and Development.

Vegetative.

General View of the Genus Pinus.*—M. T. Masters adds another useful memoir to those which he has previously published on the Conifers. He draws special attention in the present instance to histological characters, especially those of the leaf, and their values for systematic purposes. The integrity or subdivision of the fibrovascular bundle affords an excellent character. The position of the resin-canals is more variable; they are not always present, and in some cases vary in position on the same branch. The difference in general form of the leaf section is well known, but Dr. Masters points out that the shape of the meristele does not always correspond with the general leaf-shape, though it nevertheless affords a good means of distinguishing certain species. The number and size of the endoderm-cells were also found to afford good characters. The thickness of the hypoderm or stereome layers varies in different species, and even in the same species under varying conditions. When the tree is much exposed to wind, the hypoderm-cells are likely to become thicker if not more numerous than in the same species growing under less exposed conditions. The occasional presence or absence of a layer of thin-walled cells, presumably water-containing, just beneath the epidermis, should also be noted, as well as the position and number of the rows of stomata.

The histological structure of the temporary foliar members, such as the cotyledons, is less highly developed than in the more permanent foliage. Certain characters which are common to all the species in their juvenile state may sometimes continue in adult life with comparatively little modification. Thus the unbranched bundle, which is a common characteristic of the cotyledons and the primordial leaves, in some species remains in the fully developed adult foliage, while in others the bundles become branched. It is probable, therefore, that the species with branched bundles are derived from those of a simpler form, an assumption which is supported by other characteristics, such as the nature of the bud-scales and peculiarities of the cone-scales.

There is usually no distinct palisade layer in the leaves of *Pinus*, the structure differing in that respect from that of the leaves of *Abies* and other flat-leaved genera.

As regards the value of histological characters for taxonomic purposes, the author regards them as useful but not infallible guides. For the most part they are of a physiological or adaptive nature, and there-

* Journ. Linn. Soc. (Bot.) xxxv. (1904) pp. 560–659, (4 pls. and figs. in text).

fore likely to vary according to varying conditions to a much greater extent than other characters less dependent on existing circumstances and more fixed in the long course of descent.

The species are grouped in two divisions: TENUISQUAMÆ, with thin cone-scales; and CRASSISQUAMÆ, where the cone-scales are notably thickened towards the apex and are more woody than in the preceding group. Division I. includes two sections: *Strobus*, with resin-canals marginal, and seeds winged; and *Cembra*, with resin-canals median, and seeds nearly or quite wingless. Division II. contains eight sections which fall into two sets, one in which the bud-scales are deciduous, loosely imbricate and membranous, the other in which they are persistent and coriaceous. The sections are differentiated by the number of leaves in a tuft, the shape of the leaf and of the meristele in section, the entire or serrulate margin, and the marginal or median resin-canal. Nearly eighty species are enumerated.

Morphological Peculiarities of the Nymphæaceæ and Helobiæ.* J. H. Schaffner discusses the position of Nymphæaceæ in a natural system of classification, basing his remarks partly on the result of a recent study of various species. He refers to the well-known monocotyledonous character of the vascular bundles of the Nymphæaceæ, which are of the "closed" type. The bundles of the flower stem of *Nelumbo* closely resemble the grass type. Of superficial characters, the similarity of habitat, the rhizome habit, the striking agreement of some of the leaf-forms, and the general character of the flowers suggest a relationship with the Helobiæ. A *précis* is given of the results of the study of a few representative species of Naiadales and Nymphæaceæ; "it is certainly much easier," says the writer, "to read Monocotyl characters into the flowers than Dicotyl." Thus, if we regard the so-called petals of *Nymphæa advena* as staminodes, the perianth becomes typically trimerous with three sepals and three petals. In *Castalia* there are sometimes four petals, but in *C. odorata* there are normally three in a cycle, but sometimes by the expansion of the receptacle one of the segments of the second cycle is partly or nearly completely brought to the outside. This tendency of the floral organs to fall into sets of four is seen in *Potamogeton* and other Helobiæ. The transition from comparatively simple flowers to those with great numbers of parts as appears in passing from *Cabomba* to *Nymphæa* is also characteristic of the Alismaceæ; the extreme numbers doubtless represent multiplication or augmentation. The superficial placentation of *Butomus* and *Vallisneria* finds a parallel in *Nymphæa* and *Castalia*. Coalescence and epigyny also occur in both groups.

Lyon's investigation of the embryo of *Nelumbo* suggested a monocotyl type, and the affinity of Nymphæaceæ with the Helobiæ. Cook also found that in the young embryo of *Nymphæa* the cotyledon is at first not lobed; later there is a rapid development at the two sides, resulting in a two-lobed structure. The writer finds that the embryo of *Castalia odorata* must be regarded as of the same type as *Nymphæa* and *Nelumbo*. He compares the embryo of the Nymphæaceæ with the

* Ohio Naturalist, iv. (1904) pp. 83–92, (3 pls. and 2 figs. in text).

macropodous embryo of the Helobiæ; the so-called cotyledons of *Nelumbo*, *Nymphæa* and *Castalia* represent hypocotyledonary expansions homologous to the expansions found in *Zostera* and other genera of the Helobiæ. In fine, there are several types of embryo in Angiosperms, which approach each other at various points in widely separated orders. The division line between Monocotyls and Dicotyls is not very distinct. Although Angiosperms are far removed from all other plants, they represent so vigorous a modern group that there has not been time for the extinction of intermediate forms. With the removal of a few connecting groups it would be easy to recognise six or seven classes of Angiosperms instead of two. With our increasing knowledge of the embryogeny of Angiosperms it is becoming more and more apparent that the mere difference in the character of the embryo is not sufficient to determine the position of a genus or family. The writer refers to a former conclusion which he based on palæontological studies that Monocotyledons did not come from Dicotyledons nor the latter from the former; that the Angiosperms do not represent two sharply defined classes, but that there are a number of lines of development from some common stock; and that on this account there are frequent independent duplications of important characters in quite distinct series of forms.

Byblis gigantea.*—A. G. Hamilton describes the habit and structure of this West Australian member of the insectivorous order Droseraceæ, from observations of fresh specimens. The plant grows along with *Drosera* in swamps which are deficient in nitrogenous matter. The glandular hairs, which occur on the stem, leaves, flower-stalks and calyx do not differ essentially from those found in many other plants, such as *Plumbago* or *Primula*. The writer confirms Darwin's suggestion as to its method of capturing insects, solely by the aid of the viscid secretion. When an insect is caught by the stalked glands, these collapse under the weight and pour out secretion; the insect rests on the sessile glands which add to the flow of liquid. This gradually dissolves the solvent portions, and the solution runs down the channels in which the sessile glands are seated and is absorbed by them. After all the solvent parts have been removed the glands cease to secrete, and the undigested parts dry up and drop off. The leaves are triangular in section; inside the epidermis is a layer of palisade and spongy tissue of three or four rows of cells. The centre of the leaf contains a mass of large-celled pith; there are five vascular bundles, one small and one larger in the angles of the side facing the stem, while at the outer angle of the leaf is one bundle much larger than any of the others. Towards the base of the leaf there are more than five bundles; the leaf has a nearly circular outline there, and serial sections show the bundles widening out, so that at the axil they form an incomplete ring. In the stem the bundles also form an incomplete ring. The writer suggests that the leaves are really branchlets which have taken on the functions of leaves.

Regeneration in Lentibularieæ.†—K. Goebel has studied the phenomenon in members of this order, the leaves of which show a

* Proc. Linn. Soc. New South Wales, xxviii. (1903) pp. 680–4 (1 pl.).
† Flora, xciii. (1904) pp. 98–126 (17 figs. in text).

remarkable tendency to form adventitious shoots. These appear in *Pinguicula caudata* and *P. alpina* at the leaf-base, in *Utricularia* either diffusely or in definite places. In the aquatic species of *Utricularia* they arise at the forking of the leaf or on the stalk of the bladders, according to the species. In *U. exoleta*, which normally develops adventitious shoots on the stalk of the bladder, such shoots arise in the leaf-fork of isolated portions of the leaf bearing no bladders; the winter leaves of *U. minor* behave in the same way, while in the summer leaves the adventitious shoots appear only on the base of the bladder. In the leaves on the young shoots of *U. inflata* the leaf-forks are also the place of origin. In *U. exoleta* development on the leaves is induced by removal of all the growing-points; a fact which suggests an explanation of the phenomenon of regeneration. The leaves restore what has been removed, namely, growing-points of shoots.

Physiology.

Nutrition and Growth.

Respiration of Filamentous Fungi.*—S. Kostytschew recalls the theory that "intramolecular respiration of plants is identical with alcoholic fermentation," and that the latter is a case of anaerobic growth—fermentative life without oxygen. As the latter theory had been disproved, he undertook a research to examine the former theory, and for the purposes of the inquiry he used the Phycomycetous fungi *Mucor stolonifer* and *Aspergillus niger*. He finds that the absorption of oxygen and the giving off of carbonic acid are in part at least due to a specific enzyme, which is not identical with Buchner's zymase.

Influence of External Media on Mineral Constituents and Organic Composition of Plants.—A. Hébert and G. Truffaut † give comparative tables of the mineral constituents of a number of different plants grown with and without manures. The results show that the application of manures does not induce any change in the character of the mineral constituents of a plant, although it may affect the proportion in which particular constituents occur. That is to say, merely the rate of assimilation and not the nature of the substances assimilated, is influenced by manures.

A. Hébert and E. Charabot ‡ determined the amounts of carbon, hydrogen and nitrogen in the upper parts, and also in the roots of plants of peppermint. They find that the percentage results were very similar, nothwithstanding the diversity of the salts applied as manure.

Mycorhiza of Vanilla.§—H. J. de Cordemoy describes the existence of a mycorhiza, which is both ectotropic and endotropic, between the aerial roots of the cultivated *Vanilla* and the support to which the roots adhere. The endophyte has a branched mycelium, which penetrates the

* Ber. Deutsch. Bot. Gesell., xxii. (1904) pp. 207–15.

† Bull. Soc. Chim., iii. (1903) xxix. pp. 1235–39. See also Journ. Chem. Soc., lxxxvi.–ii. (1904) p. 140.

‡ Comptes Rendus, cxxxvii. (1903) pp. 799–801. See also Journ. Chem. Soc. loc. cit.

§ Op. cit., cxxxviii. (1904) pp. 391–4.

root-hairs and thus establishes a close relation between the orchid and its support. The author suggests that this morphological connection is the expression of a symbiotic association, and that the fungal hyphæ convey nutritive matter to the orchid. He also assumes that similar facts will be discovered in connection with other orchids, and also in other climbing plants.

Resistance of Certain Seeds to the Action of Absolute Alcohol.* P. Becquerel concludes as the result of experiments that whereas the testa of a damp seed allows osmosis and is permeable to absolute alcohol, when it has been dried to a certain degree osmosis does not take place, and the seed-coat is quite impermeable to the anhydrous liquid. Consequently in this condition, if the coat form a complete covering, anhydrous poisons, such as bichloride of mercury, when added to the absolute alcohol, have no effect on the power of germination.

Permeability to Gases of Certain Dried Seeds.† — The same author, experimenting with seeds of pea, lupin and *Gleditschia*, showed that the dried seeds are impermeable to dry air and dry carbonic acid gas, but permeable when these gases are charged with water vapour. These results explain the absence of all respiratory interchange of gases when quite dry seeds are plunged into a rigorously anhydrous atmosphere. But we cannot conclude that all the phenomena of respiration in the seed are at a standstill. The plantlet, enclosed in its dry testa as in a hermetically sealed chamber, may respire imperceptibly at the expense of oxygen stored in its cells. As soon as the reserve gas is used up or a sufficiently large amount of carbonic acid gas is produced, the embryo must die either of inanition or by asphyxiation. This will explain the marked decline in germinating power which has always been observed in such experiments which have lasted from 7 to 16 years, for instance, those of Jodin and Giglioli.

NICLOUX, M.—**Sur le pouvoir saponifiant de la grain de ricin.** (On the saponifying property of the castor-oil seed.)

[The author shows that the active lipolytic substance in the seed is the cytoplasm, to the exclusion of all the other elements in the seed.]

Comptes Rendus, cxxxviii. (1904) pp. 1175–7.

General.

Pollination of the Primrose.‡ — E. Bell, the author, under the *nom de guerre* "A Field Naturalist," of "The Primrose and Darwinism," in which Darwin's theories on the relation between heterostyly and cross-pollination by insects were attacked at some length, criticises some remarks by Prof. Weiss in a pamphlet on the "Pollination of the Primrose." He maintains that of the very few insects which have been observed visiting the flowers of the primrose, the proboscis is with two exceptions too short to reach the nectar. The visits of the latter are, however, so extremely rare, as to preclude their efficiency as agents

* Comptes Rendus, cxxxviii. (1904) pp. 1179–81.
† Tom. cit., pp. 1347–9.
‡ Nature Notes, xv. (April 1904) pp. 63–9.

for cross-pollination. Darwin's suggestion of night-flying Lepidoptera as agents is not supported by any evidence. In brief, the testimony of the various observers "affords no evidence but the contrary," in support of the theory that one form of *Primula* must unite with the other form in order to produce full fertility, and much less does it support the theory that the two forms stand in the reciprocal relation of different sexes to each other.

Randia Lujæ: a New Myrmecophyte and Acarophyte.* — E. de Wildeman gives an account of a new species of the genus *Randia* (Rubiaceæ) from the Sankaru forest in the Congo, which affords shelter both to ants and acari. The acarodomatia are found at the angles of the veins on the back of the leaves and are hollowed out in the tissue of the nerves. The ant-shelters occur in the internodes which are hollow at a part only of their length; the internodes are fusiform, and the domatia in the part at the greatest diameter where there are one or two openings which at first are circular, but in the older and woody shoots become elongated and may reach a length of 3 cm.

Caulifloria.†—L. Buscalioni discusses the phenomenon of caulifloria or the production of flowers and fruits along the branches and trunk, as well as in the normal axillary or terminal positions. He gives a table of 127 cauliflorous species, belonging to 77 genera and 34 families, which have been studied by several previous authors. A subsequent list shows that 22 of the above 34 families go back to the Cretaceous times, and that certain of their genera were cauliflorous. From the long series of facts which he records, the author draws the conclusions that caulifloria is a disposition inherited from geological times, and is preferably manifested in damp tropical regions; that it chiefly occurs in plants of antique and less specialised type; that it serves to protect the flower and fruit from excessive moisture and heat; that it is accompanied by other factors which aid in this protection; that the causes for it assigned by Wallace, Johow, Haberlandt and others do not explain its antique origin; that experimental study of water distribution bears out the author's views; and that the condition is closely comparable with geocarpy as a biological means of protecting the seeds from external influences. A bibliography is added.

Classification of Flowering Plants, vol. i. Gymnosperms and Monocotyledons.‡ — A. B. Rendle gives a general morphological and systematic account of these two groups of Seed-plants. The book opens with a historical introduction in which the gradual evolution of a natural system is traced. Starting from the herbals of the sixteenth century, a brief review is given of the more important systems, and of the influence of individual workers, including John Ray, Linnæus, the Jussieus and De Candolles, Robert Brown, Lindley, Eichler, Bentham and Hooker, Van Tieghem and Engler. The system adopted for the

* Comptes Rendus, cxxxviii. (1904) pp. 913–4.

† Malpighia, xviii. (1904) pp. 117–77 (2 pls.).

‡ The Classification of Flowering Plants. By A. B. Rendle. Vol. i. Gymnosperms and Monocotyledons. 8vo, pp. xiv. 403, tt. 187. Cambridge University Press, 1904.

arrangement of the Angiosperms follows, with some modifications, that of Engler, which in turn is based on that of Eichler. In the account of the Gymnosperms an attempt has been made to arrange the fossil and recent forms in one system. A general account of the Angiosperms precedes the systematic treatment of the Monocotyledons. The latter are arranged in eight series, beginning with the presumably most primitive forms, and closing with the most elaborate, as follows: (1) Pandanales (including the orders Typhaceæ, Sparganiaceæ and Pandanaceæ); (2) Helobieæ (including Najadaceæ, Potamogetonaceæ, Alismaceæ and Hydrocharideæ); (3) Glumifloræ (Gramineæ and Cyperaceæ); (4) Spadicifloræ (Palmaceæ, Aroideæ and Lemnaceæ); (5) Farinosæ (Restiaceæ, Eriocaulaceæ, Commelinaceæ, Bromeliaceæ, Pontederiaceæ); (6) Liliifloræ (Juncaceæ, Liliaceæ and allied orders); (7) Scitamineæ; (8) Microspermæ (Burmanniaceæ, Orchidaceæ).

Under each order the author gives a general morphological account of the vegetative organs, the flower, fruit and seed, followed by a review of its systematic subdivision in the case of the larger orders. The volume concludes with a general review of the series and orders with suggestions as to their phylogeny. The book is included in the Cambridge Biological Series, of which A. E. Shipley is the editor.

Relation between the Cryptogams and Higher Plants.*—B. Renault from a brief review of some recent work in fossil botany suggests that the Cryptogams had several points of contact with Phanerogams. Thus *Colpoxylon* has affinities with both the Cycads and the Ferns; *Arthropitys* recalls both Equisetaceæ and Coniferæ, while the seeds of *Gnetopsis* suggest those of the recent Gnetaceæ.

Chinese Flora.†—The last instalment of Forbes and Hemsley enumeration contains the conclusion of the genus *Carex* by C. B. Clarke. This genus is represented by no less than 150 species, several of which are described for the first time, and is probably the largest, as regards number of species, in the flora; the contribution includes various critical notes. The same issue contains the first part of the Gramineæ by A. B. Rendle, and includes an enumeration of the two large tribes, Paniceæ and Andropogoneæ. Henry's collections, especially those from Formosa and Yunnan, supply several new and interesting species, and novelties have also been described from the late Dr. Hance's herbarium. A curious case of geographical distribution is found in *Digitaria setifolia* which, hitherto only known from South Africa, is recorded from the Island of Hongkong and the mainland near Canton.

Ash Analysis of Acacia salicina.‡—A. J. Higgin finds an extraordinarily large percentage of lime (40·7), and sulphuric anhydride (30·09) in the ash of the leaves of this plant, indicating the presence of a large percentage of calcium sulphate. The presence of the lime

* Comptes Rendus, cxxxviii. (1904) pp. 1237–9.
† Journ. Linn. Soc. (Bot.), xxxvi. (1904) pp. 297–376.
‡ Trans. Roy. Soc. S. Australia, xxvii. (1903) pp. 202–4.

explains the use of the ash by the natives of Australia for mixing with Pituri,—the dry leaves and twigs of *Dubosia Hopwoodi*, for mastication. The effect of the alkali is to liberate the alkaloid piturine, the physiological action of which has been shown by Langley and Dickenson to be identical with that of nicotine. *Dubosia* belongs to the natural order Solanaceæ.

BORZI, A.—**Produzione d'indolo e impollinazione della Visnea Mocanera L.** (Production of indol and pollination of *Visnea Mocanera.*)
[An account of the experiments made to determine the nature of the unpleasant scent which attracts flies to the inconspicuous flowers of this plant, and of the methods employed to demonstrate that the odoriferous substance belongs to the indol group.]
Atti. R. Accad. Linc. Roma, xiii. (1904) pp. 372–5.

KING, SIR G., & GAMBLE, J. S.—**Materials for a Flora of the Malayan Peninsula—continued.**
[Contains an account by Mr. Gamble of the few species belonging to the order Caprifoliaceæ which have been collected in the Malay Peninsula and adjacent islands; and a joint account by the authors of those species of the order Rubiaceæ which have more ovules than one in each cell of the ovary.) *Journ. Asiatic Society Bengal*, lxxii. (1903) pp. 112–229.

PANTANELLI, E.—**Studi sull' albinismo nel Regno Vegetale. IV. Sul turgore delle cellule albicate.** (Studies on albinism in the vegetable kingdom. IV. On the turgidity of the colourless cells.) *Malpighia*, xviii. (1904) pp. 97–105.

PIZZETTI, M.—**Sulla localizzazione dell' alcaloide nel Nuphar luteum Smith e nella Nymphæa alba.** (On the localisation of the alkaloid in *Nuphar luteum* and *Nymphæa alba.*)
[The alkaloid is protective, and occurs more or less in all parts but the seed.]
Malpighia, xviii. (1904) pp. 106–9.

SCHAFFNER, J. H.—**Ohio plants with extra-floral nectaries and other glands.**
[A review of the various kinds of extra-floral glands known to occur on Ohio plants, with a list of the plants on which they occur, and suggestions as to their use.] *Ohio Naturalist*, iv. (1904) pp. 103–6.

CRYPTOGAMS.

Pteridophyta.

Structure of Leaves of the Bracken Fern in Relation to Environment.* — L. A. Boodle gives the results of his observations on the structure of the leaf of the bracken in different natural habitats. He finds that in dry exposed situations the leaves are xerophytic and have a hypoderm, while in well sheltered and shaded habitats they show the characters of delicate shade-leaves, having no hypoderm, and either weakly developed or no palisade tissue. This range of structure may be shown by different leaves on the same plant, or by different parts of the same leaf when opposite external conditions are sufficiently localised. A plant grown first in a damp green-house and then in the garden, proproduced shade-leaves in the former and sun-leaves in the latter. The leaves developed in the green-house showed reduction of the indusia.

* Journ. Linn. Soc. (Bot.) xxxv. (1904) pp. 659–69 (figs. in text).

The mature type of structure is not determined at an early stage in the growth of the leaf. The amount of illumination is probably not the only factor which determines the leaf-structure.

BURNHAM, S. H.—**Ferns of Ann Arbor, Michigan.**
Fern Bulletin, xii. (1904) pp. 50–1.

BRITTON, E. G.—**The Jenman collection of Ferns.**
[Note on the collection of ferns of the late G. S. Jenman, acquired by the New York Bot. Garden, with a biography of the collector.]
Journ. New York Bot. Garden, iv. (1903) pp. 85–6.

CLUTE, W. N.—**New or rare ferns from the South-west.**
[Three species added to the United States Flora.]
Fern Bulletin, xii. (1904) pp. 43–5.

CURTISS, A. H.—**The Fern flora of Florida.**
[A list of 74 species and some varieties, with notes on the conditions of growth offered by Florida.] *Tom. cit.*, pp. 33–8.

DAVENPORT, G. E.—**Miscellaneous notes on New England Ferns. VI.**
Rhodora, vi. (1904) pp. 31–3.

DE TONI, G. B., & H. CHRIST—**La Pteris longifolia L. presso il lago Lario? Nota.** (Note on occurrence of *Pteris longifolia* near Lake Lario.)
Atti R. Ist. Veneto, lxii. (1903) pp. 561–5.

DUSS—**Les Lycopodes des Antilles Françaises.** (The Lycopodiums of the French Antilles.) Lons-le-Saunier, 8vo, 1903.

EATON, A. A.—**The genus Equisetum in North America.**
[*E. variegatum* and *E. scirpoides*. Continuation.]
Fern Bulletin, xii. (1904) pp. 39–43.

„ „ **A preliminary list of Pteridophyta collected in Dade County, Florida, during November and December, 1903.**
[A list of 37 species, with notes.] *Tom. cit.*, pp. 45–8.

FISCHER, H.—**Die Farne im Hohen Venn.** (Ferns of the Hohe Venn.)
Sitz. Niederrhein. Ges. Bonn, 1904, p. 73.

GILLOT, X., ET DURAFOUR—**Répartition topographique de la fougère Pteris aquilina L. dans la vallée de la Valserine.** (Distribution of the fern *Pteris aquilina L.* in the valley of the Valserine.
Bull. Soc. Nat. de l'Ain, 1904, pp. 8–22.

HOLM, T.—**Linnæus' work on Ferns.** *Torreya*, iii. (1903) pp. 187–8.

KALBFLEISCH, A. S.—**Polystichum acrostichoides and some insects that infest it.**
Fern Bulletin, xii. (1904) pp. 48–50.

LAMIC—**Une plant rare de la flore française.** (A rare plant of the French flora.)
[*Hymenophyllum tunbridgense.*]
Soc. Hist. Nat. Toulouse, xxxvii. (1904) pp. 28–9.

SCHMIDT, J.—**Die Pteridophyten Holsteins in ihren Formen und Missbildungen.** (The Pteridophyta of Holstein, their normal and monstrous forms.)
Hamburg, 1903, 8vo, 75 pp.

TRELEASE, W.—**The Ferns and Fern Allies of Alaska.**
[List of 54 species and 16 varieties.]
Harriman Alaska Exped., v. (1904) pp. 373–98 (1 pl. and 1 fig.).

TRABUT—**Sur la présence de l'Isoetes setacea Bose en Portugal.** (On the presence of *Isoetes setacea* in Portugal.) *Bull. Soc. Bot. de France*, li. (1904) p. 28.

UNDERWOOD, L. M.—**Four recently described Ferns from Jamaica.**
Bull. Dep. Agric. Jamaica, i. (1903) p. 136–8.

„ „ **Account by L. M. Underwood of explorations in Jamaica.**
[Account of a fern-collecting expedition. 400 species were collected.]
Journ. New York Bot. Gard., iv. (1903) pp. 109–19.

Bryophyta.

Biology of Hepaticæ.*—F. Cavers publishes a contribution to the biology of the four thalloid genera, *Targionia*, *Reboulia*, *Preissia*, *Monoclea*, which he has had under cultivation for the past three years, and brings out several points which have been overlooked or left obscure by previous writers. He describes for each of the genera the external features of the thallus, the epidermis, air-chambers, pores, ventral scales, rhizoids, the antheridia and archegonia with their receptacles, the sporogonium, capsule, spores and elaters, accompanying his account with several illustrations. *Monoclea* was obtained from a nursery garden in York, and the details of its morphology and biology are the most complete that have yet been published.

Hepaticæ of Atlantic type in Scotland.†—S. M. Macvicar discusses the distribution of the Atlantic species of hepaticæ in Scotland, that is of certain species which are characteristic of the west coast of Europe and the Atlantic islands, a few of them occurring along the Mediterranean and in America. Having referred to the importance of moisture, equable temperature and condition of the soil, and having shown that the main watershed of Scotland is not of much importance in the distribution of these plants, the author divides the Atlantic species into groups, showing that sixteen occur only on the western watershed; two occur only on the east coast, but not inland; five cross a little way over into the eastern watershed; seven, common in the west, cross over to the east, but are rare; seven, of Alpine type, are common to the western watershed and the eastern Grampians. Further, ten Scottish species are not found in England; six not found in Ireland; one English and eight Irish species are absent from Scotland. All the Atlantic species are found in the British Isles, but thirteen British species are absent from the east of Europe, and these are of tropical affinity; seven are common to Norway and France; eleven occur in Norway but not in France; and seven in France but not in Norway. The origin of the Atlantic species in our country cannot be traced to any known geological period.

Plagiothecium piliferum.‡—D. A. Jones adds to the British moss-flora *Plagiothecium piliferum*, gathered in fruiting state by Duncan on Ben Lawers in Aug. 1902, and gives its synonymy and a translation of Schimper's description of the species. Only one tuft of the plant was found. It grows on granite mountains in the north and south of Europe.

Hepaticæ of Puerto Rico.§—A. W. Evans gives a detailed account of the genera *Odontolejeunea*, *Cyclolejeunea*, and *Prionolejeunea*. The first of these is represented by two species in Puerto Rico, the second by four, and the third by five, four of which are new. The genus *Cyclolejeunea* is new, and is separated from *Odontolejeunea*, from which it differs in its leaves and underleaves, and in its vegetative reproduction by means of

* Leeds, 1904, 8vo, 47 pp., 12 figs.
† Ann. Scot. Nat. Hist., 1904, pp. 119–25.
‡ Journ. of Bot., xlii. (1904) pp. 156–7.
§ Bull. Torrey Bot. Club, xxxi. (1904) pp. 183–226 (5 pls.).

marginal gemmæ, and not by leafy propagula. The processes of vegetative reproduction in these two genera are discussed at some length. The specific descriptions are exhaustive, fully illustrated, and accompanied by an abundance of critical remarks.

A New Irish Hepatic.*—I. Douin describes *Adelanthus dugortiensis*, a new and remarkable hepatic gathered by H. W. Lett in Achill Island. Its affinity is with *A. unciformis*, which occurs at the Cape of Good Hope, Madagascar, and Cape Horn. It is a further instance of the survival in Ireland of remnants of a flora usually with tropical affinities, and, as is usual with these survivals, it is sterile.

Mosses of Korea.†—J. Cardot publishes a list of 98 mosses gathered by the Abbé Faurie in seven localities in Korea. No previous list has ever been published. Descriptions and figures of 27 new species are given. Though the climate of Korea has been stated to resemble that of China and Manchuria, the moss-flora approximates to that of Japan, 50 of the species being common to Korea and Japan, while only 20 are found in China. The bryology of Manchuria is almost unknown. In Korea are found 12 species of North American type, 10 of them occurring east of the Rocky Mountains—a curiosity of distribution which applies to several Japanese mosses.

North American Mosses.—A. J. Grout‡ continues his notes on the peristome, treating specially of the structures found in *Encalypta* and the affinity shown to *Georgia*, *Webera*, and *Tortula*. He also calls attenattention § to W. Gardiner's "Twenty Lessons on the British Mosses" (Dundee, 1847), a little book very rare in the United States, but important as an early contribution to the development of nature study. The same author ‖ urges American bryologists to examine hundreds of specimens of the common species of *Bryum*, and to keep a record of the variations in the arrangement of the archegonia and antheridia; for he is confident that far too many species in the genus have been based upon the character of the inflorescence, which may not be so constant as has been supposed. For instance, Corbière has found that *B. pallescens* may be either monoicous, dioicous, or synoicous. J. M. Holzinger¶ describes *Rhacomitrium Fletii*, a new species collected near a steam-jet in the crater of Mt. Tacoma, in the Cascade Mountains, at an altitude of 14,500 ft. In another article** he gives instances of the occurrence of species in localities so widely separated (e.g. Caucasia and North America) as to be suggestive of the evolutional and geological history of our floras. E. G. Britton †† publishes notes on nomenclature with reference to species of *Brachelyma*, *Papillaria*, *Pilotrichella*, *Ectropothecium*, and *Homalothecium*.

* Rev. Bryol., xxxi. (1904) pp. 53–5 (fig.).
† Beih. Bot. Centralbl., xvii., (1904) pp. 1–44 (27 figs.).
‡ Bryologist, vii. (1904) pp. 37–9 (1 pl. and fig.).
§ Tom. cit., pp. 39–40.
‖ Tom. cit., pp. 50–1.
¶ Tom. cit., pp. 41 (with fig.).
** Tom. cit., pp. 42–3.
†† Tom. cit., pp. 48–50.

ANDREWS, A. LE R.—**Some interesting mosses from a southern Vermont peat-bog.** *Rhodora*, vi. (1904) pp. 43–4.

BLIND, C.—**Les Hépatiques de la région jurassienne.** (The hepatics of the region of the Jura.)
[A list of 111 species, with their distribution according to regions—plain, mountain, lake, marsh, etc.] *Bull. Soc. Sci. Nat. Ain*, 1904, pp. 31–6.

BRUNARD, A.—**Contribution à l'étude des Mousses du département de l'Ain.** (Contribution to the study of the mosses of the Department of the Ain.) *Tom. cit.*, pp. 26–31.

CALDERÓN, S.—**Nota preliminar sobre la turba y los turbales de España.** (Preliminary note on the peat and peat-bogs of Spain.)
[A discussion on the features of the peat-bogs in various parts of Spain, the causes of their formation, and the value of their contents for fuel.] *Bol. Soc. Español. Hist. Nat.*, iii. (1903) pp. 417–28.

CARDOT, J., & THÉRIOT, I.—**The Mosses of Alaska.**
[List of 281 mosses, 125 new to Alaska, 46 new to science.] *Harriman Alaska Exped.*, v. (1904) pp. 251–328 (11 pls.).

CARESTIE—**Muscinées des environs de Saint-Amour.** (Mosses of the environs of Saint-Amour in the Jura.) *Arch. Flore Jurass.*, 1904, pp. 9–10.

DUSÉN, P.—**Sur la Flore de la Serra do Itatiaya au Brésil.** (On the flora of the Serro do Itatiaya, in Brazil.)
[Contains six new species of hepaticæ named by Stephani. A number of Andine species occur in this high range.] *Arch. Mus. Nacion. Rio de Janeiro*, xiii. (1903).

DUSS—**Enumération méthodique des Muscinées des Antilles Françaises.** (Systematic enumeration of the mosses and hepatics of the French Antilles.) Lons-le-Saunier, 1903, 8vo, 82 pp.

EVANS, A. W.—**Hepaticæ of Alaska.**
[List of 82 species, 40 new to Alaska.] *Harriman Alaska Exped.*, v. (1904) pp. 339–72 (3 pls.).

FAMILLER, I.—**Zusammenstellung der in der Umgebung von Regensburg und in der gesamten Oberpfalz bisher gefundenen Moose.** (List of all the mosses hitherto found in the neighbourhood of Regensburg and the entire Oberpfalz.) *Denkschr. K. Bot. Ges. Regensburg*, viii. (1903) pp. 1–54.

GROUT, A. J.—**Mosses with Hand-lens and Microscope. Part II.**
[A non-technical handbook of the commoner mosses of the north-eastern United States; freely illustrated. Includes Dicranaceæ, Grimmiaceæ, Tortulaceæ.] New York, 1904, pp. 87–166.

LINGOT, F.—**Appel aux botanistes de l'Ain, et la genre Polytrichum.** (Appeal to the botanists of the Ain; and [a list of the species of] *Polytrichum* [found in that Department]). *Bull. Soc. Sci. Nat. Ain*, 1904, pp. 24–6.

MATOUSCHEK, F.—**Bryologisch-floristiche Beiträge aus Mähren und Oesterr.-Schleisen. III.** (Moss contributions from Moravia and Austrian Silesia.) *Verh. Naturf. Ver. Brünn*, xlii. (1904) 24 pp.

PARIS, E. G.—**Quelques nouvelles pleurocarpes japonaises et tonkinoises.** (Some new pleurocarpous mosses from Japan and Tonkin.)
[Descriptions by Brotherus and Paris of 22 new species gathered by Faurie and others.] *Rev. Bryol.*, xxxi. (1904) pp. 56–65.

PAUK, H.—**Beitrag zur Moosflora Oberbayerns.** (Contribution to the moss-flora of Upper Bavaria.) *Mitt. Bayer. Bot. Ges. Erf. Heim. Flor.*, 1904, pp. 366–72.

ROTH, G.—**Die europäischen Laubmoose.** (The mosses of Europe.) Lief. 6 (Leipzig, 1904) 128 pp. 10 pls.).

SCHIFFNER, V.—**Bryologisch-Fragmente.** (Notes on Muscineæ.)
[Continuations.] *Oesterr. Bot. Zeitschr.* liv. (1904) pp. 102–4, 128–34.

SCHINNERL, M.—**Ueber den gegenwärtigen Stand der Labermoosforschung in Oberbayern.** (On the present condition of Hepaticology in Upper Bavaria.) *Ber. Bayer. Bot. Ges., Erf. Heim. Flora*, ix. (1904) pp. 1–49.

STEPHANI, F.—**Species Hepaticarum.** (Species of Hepaticæ.) [Continuation of monograph of *Plagiochila.*] *Bull. Herb. Bois*, ser. 2, iv. (1904) pp. 345–61.

TORKA, V.—**Bryum uliginosum Br. et Sch.** *Alg. Bot. Zeitschr.*, 1904, pp. 84–5.

TRELEASE, W.—**Alaskan species of Sphagnum.** [List of 22 species with 19 varieties; two species are new to North America.] *Harriman Alaska Exped.*, v. 1904, pp. 329–337.

ZSCHACKE, W.—**Weitere neue Moosfunde aus Anhalt.** (Further new moss records for Anhalt.) *Deutsch. Bot. Monatsschr.*, xxii. (1904) pp. 3–6.

Thallophyta.

Algæ.

Plankton of Certain Alpine Lakes.* — Brehm and Lederbauer publish the first part of their paper on this subject, and analyse the plankton of certain lakes in North Tyrol, ranging in height from 915 m. to about 2400 m. above sea level. They intend to examine also certain lakes in South Tyrol, Carinthia and upper Austria. They propose to deal with several questions of general interest in the matter of distribution, which they will discuss in the last part of the paper when the flora of the individual lakes has been described.

Morphology of Diatoms.† — C. Méreschkowsky embodies many of the results of his large experience in the study of Diatoms in a book with the above title. It is divided into two parts: (1) Historical, and classification of Diatoms; (2) the endochrome of Diatoms. A complete *résumé* is given of the literature dealing with morphology of diatoms, and this is followed by a treatment of classification on his own new system. He divides Diatomaceæ into two classes: (1) the mobile, or Raphidiophoreæ or sexual; (2) the immobile, or Anaraphideæ or asexual. The former is characterised as follows: with raphe; mobile; endochrome almost always plate-shaped; the auxospores formed sexually. The latter is defined thus: without raphe; immobile; endochrome generally granular; auxospores formed asexually. Each of these main groups is divided into respectively, Raphideæ, Carinatæ, Archaideæ and Bacilloideæ, Centrales, with sub-divisions. A table of the system shows the phylogenesis of Diatoms. The second part of the book contains a detailed description of the endochrome (chromatophores) and its contents. The author maintains that endochrome serves as a systematic character, since in most cases it remains constant in form and position. The elaioplasts are also constant in many species.

Diatoms from Madagascar.‡ — P. Petit enumerates the diatoms collected at Fort Dauphin by Ferlus, and at Nosi-bé by Corre, forming together a fairly representative list of Madagascar species. A novelty in distribution is *Actinoptychus splendens* var. *californica*, previously recorded from San Francisco. Many descriptions of already existing species have been corrected or completed, and ten species are figured.

* Ver. K. K. Zool.-bot. Gesell. Wien, liv. (1904) pp. 48–58 (3 figs.).
† Kasan, 1903, 427 pp., 6 col. pls.
‡ Assoc. franç. Avancem. Sci., 1902, 10 pp., 1 pl. Paris, 1903.

Uses of Diatoms.*—M. Lanzi considers the diatoms from a biological point of view, and mentions some of the uses to which they may be put. Besides the function which they exercise in common with other algæ—that of assimilating nitrogen in one form or another—they help to form food for certain animals in both salt and fresh water. They are found in Peruvian and other guanos, showing that they have been devoured by birds; and in certain parts of the world, notably, on the shores of the Orinoco and in Italy, a fossil flour containing diatoms is used as food by the human inhabitants. The paper closes with two lists of thirty-two and fifty-two species found in the stomach and intestines of two fish, *Leuciscus muticellus* and *Chrysophrys aurata* respectively. Diatoms are also employed as objects for testing the powers of definition of a Microscope lens.

Transmutation of Various Stages in Diatomaceæ.†—C. Méreschkowsky continues his explanation of the law which governs the forms of certain diatoms. As stated in the account of the first part of his paper, he calls it the law of translation of stages in Diatoms. In this, the concluding part, he gives several instances of genera and species which show certain markings hitherto not to be explained, but easily accounted for if the existence of his law be granted. The longitudinal sinus or fissure in the plaque of Pyrenophoreæ is thus the crystallisation, so to speak, into a permanent form, of an otherwise passing stage of development. The same explanation holds good for *Catenula*, *Neidium* and certain species of *Nitzschia*, for example, *N. angularis* and var. *affinis*, and *N. distans*. In the same way transverse fissures are seen in species which divide transversely, as *Navicula digitoradiata*, and certain species of *Gyrosigma* and *Caloneis*. This law does not explain, however, such transverse fissures as those of *Cymbella*, *Rhoicosphenia*, etc., which divide longitudinally. The author gives other instances of peculiarities which may be explained by his law, and suggests that not only species but also genera may have originated in a short time from the arresting of certain stages in the development of a species. He thinks that the same law may possibly hold good among Hydroids, Crustaceans, Infusoria, and even Fungi.

Alga Related to Raphidium polymorphum.‡—M. G. Raymond describes the life-history of an alga from the pools in clay soil at Trappes in France. It is closely analogous to *Raphidium polymorphum*. It lives at the bottom of shallow pools fed by rain-water, and cultures of it are destroyed by the addition of calcareous water. It possesses but slight mobility, and strong sunlight destroys cultures of it in a short time. The gametes appear after the cessation of the severe cold; the zygotes, which result from copulation, sink to the bottom and give rise to: (1) A first generation of zoospores, which form large zoosporangia, from which issue, as a rule, four new zoospores. (2) The zoospores of the second generation reproduce themselves by transverse division. (3) This third generation gives rise to the gametosporangia,

* Att. Pont. Accad. Rom. Nuov. Lincei, lvi. (1903) pp. 129–41.
† Journ. de Bot., xviii. (1904) pp. 76–83 (3 figs. in text).
‡ Micrographe préparateur, xii. (1904) pp. 11–19.

which pass the winter at the bottom of the water. In the species studied here, the daughter nuclei in the zoosporangia are disposed alternately along the main axis of the body. In another and closely allied species the division of the primitive nucleus takes place in an equatorial plane, and the individuals are grouped in the zoosporangium in a parallel spiral bundle.

Myriactis Areschougii and Coilodesme californica.* — M. Rathbone describes briefly the work hitherto done on *M. Areschougii* Batters, especially that of Mons. Sauvageau. She has been unable to trace the infection of the host-plant or the early stages of the parasite, as in the early months of the year the thallus of the host-plant, *Himanthalia lorea*, is invaded by the filaments of numerous penetrating algæ. M. Sauvageau suggests that infection takes place by means of zoospores which germinate in the cryptostomata or conceptacles; but the author finds no connection between these bodies and the mature plants of *M. Areschougii*. The rhizoids travel for long distances in the tissue of the host and probably act as stolons for propagating the plant, as in *M. stellulata*. In fresh material the rhizoids are easily distinguished by their pinkish-brown colour, and in spirit material they stain more deeply with Hoffman's blue than do the host-cells. Active cell-division of the host-cells is often seen below and around the tufts of the parasite, and these host-cells take a rather different stain with Hoffman's blue from that of the surrounding tissue. Mucilage occurs chiefly at the base of the hairs and round the assimilating filaments, but is also found far down in the cushion of the parasite. The penetrating rhizoids of *Coilodesme californica* Kjellm., are also described, which have hitherto been overlooked in descriptions of the plant. These rhizoids form a dense mass in the substance of the cell-walls of the host, and seen in longitudinal section they have a curiously opaque and ribbed appearance. Figures are given of the rhizoids of both plants, and also of the plurilocular sporangia of *Myriactis stellulata*, figured and described by Harvey in his *Phycologia Britannica* as "paranemata."

Sphacelariaceæ.† — C. Sauvageau continues his treatment of this order and deals with *Halopteris Novæ-Zelandiæ* Sauv., of which he gives a long description, the formal diagnosis and figures. He also describes and figures *H. obovata* Sauv. = *Sphacelaria obovata* Hook. fil. et Harv., and *H. platycena* sp. n., which he describes and figures.

New Genus of Corallinaceæ.‡ — F. Heydrich has succeeded in finding the antheridia of *Lithophyllum expansum* Phil., and since these occur on different plants from the cystocarps or tetraspores, the author founds for this species a new genus, *Stereophyllum*. He recognises two forms, f. *stictæformis* Aresch. and f. *agariciformis* Hauck., of which he gives short diagnoses. The principal characteristic of the vegetative thallus is the absence of a "co-axile stratum," the cells of the entire thallus ascending in straight lines to the surface. This constitutes a difference between *Stereophyllum* and other species which resemble it in

* Journ. Linn. Soc. (Bot.) xxxv. (1904) pp. 670–5 (1 pl.).
† Journ. de Bot., xviii. (1904) pp. 88–104 (5 figs. in text).
‡ Ber. Deutsch. Bot. Gesell., xxii. (1904) pp. 196–9.

external appearance. The male and female conceptacles and tetraspores are described.

Chinese Marine Algæ.*—E. S. Gepp publishes a list of twenty-seven marine algæ from Wei-hai-wei and Swatow. Two of them are new species, *Chordaria firma* and *Ceramium Boydenii*. The original diagnosis of *Polysiphonia japonica* is quoted, as it has been omitted from J. G. Agardh's *Species Algarum*, and De Toni's *Sylloge Algarum*, and the original place of publication is difficult of access. This plant is figured, together with the two new species.

Alaskan Algæ.† —The algæ of the Harriman Alaska expedition were edited by A. Saunders, and the list of them which was originally published in the Proceedings of the Washington Academy of Sciences, 1901, is now republished in a volume dealing with all the cryptogamic collections of the expedition. The algæ have been named by various experts, and form an imposing list of 380 species, of which nine are new to science and 240 are new to Alaska. The author makes some interesting remarks on the general distribution of algæ along the Pacific coast of North America, dividing it into three distinct regions. The first, or southern, extends from Point Conception southwards to the equator, and is characterised by *Nereocystis giganteus*, *Sargassum agardhianum*, *Taonia Lennebackeræ*, *Zonaria Tournefortii*, and other tropical species. The second, or Californian, region extends from Point Conception on the south to Puget Sound on the north, and is characterised by forms like *Dictyoneuron*, *Postelsia*, *Laminaria Sinclairii*, *L. Andersonii*, etc. The northern region begins at Puget Sound and extends northwards to and including Bering Sea. It is characterised by *Odonthalia aleutica*, *Polysiphonia bipinnata*, *Enthora cristata*, *Rhodymenia pertusa*, etc.

AMBERG, O.—**Biologische Notiz über den Lago di Muzzano.** (Biological Note on Lago di Muzzano.) *Forschungsber. Biol. Stat. Plön*, x. (1903) pp. 74–85.

„ „ **Untersuchung einiger Planktonproben aus demselben vom Sommer 1902.** (Examination of several Plankton-samples from the same lake collected in the summer of 1902.) *Tom. cit.*, pp. 86–9.

BERGON, P.—**Études de la flore diatomique d'Arcachon et des parages voisins.** (Studies on the diatom-flora of Arcachon and the adjacent districts.) *Lab. Biolog. Bordeaux* (1903) 64 pp., 2 pls. col.

GÉZA, ENTZ, Jun.—**Adatok a Balaton plaktonjának ismeretéhez.** (Contributions to a knowledge of the plankton of Platten-Lake.) *A. Balaton. tudom. lanulm. eredm.*, ii. supp. 2, pt. I. (Budapest 1903) 26 pp., 48 figs., 9 pls.

GOMONT, M.—**Sur la végétation de quelques sources d'eau douce sous-marines de la Seine-Inférieure.** (On the vegetation of certain fresh-water submarine springs of the Department Seine-Inférieure.)
[The complete paper, of which a preliminary notice had been published in *Comptes Rendus*, and was noticed in the last Number of this Journal.]
Bull. Soc. Bot. de France, li. (1904) pp. 36–55.

GRAN, H. H.—**Diatomaceæ from the Ice-floes and Plankton of the Arctic Ocean.** *Nansen's Norwegian North Polar Exped.*, iv. (1904) No. 11.

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* Journ. Bot., xlii. (1904) pp. 161–5 (1 pl.).
† Harriman Alaska Expedition, v. (New York, 1904) pp. 155–251 (20 pl.).

HINZE, G.—**Ueber Schwefeltropfen im Innern von Oscillarien.** (Concerning drops of sulphur in Oscillariæ.)

[Describes the investigation of a species, near *Oscillatoria tenuis*, the cells of which contained certain drops which proved to be sulphur.]

Ber. Deutsch. Bot. Gesell., xxi. (1903) pp. 394–8 (2 figs. in text).

HOWE, MARSHALL A.—**The Museum Exhibit of Sea-weeds.**

Journ. New York Bot. Garden, v. (1904) pp. 56–64, figs. 9–12.

" " **The Pike Collection of Algæ.** *Tom. cit.*, pp. 86–7.

KELLER, K.—**Das Leben des Meeres. Tier- und Pflanzenwelt des meeres, ihr Leben und gegenseitige Beziehung.** (The life of the sea. Animal- and plant-world of the sea, their life and mutual relations.)

St. Petersburg (1904) 4to, 144 pp., pt. 2 (16 pls., 10 col., 30 woodcuts).

KAFOID, C. A.—**The Plankton of the Illinois River, 1894–1899, with introductory notes upon the Hydrography of the Illinois and its Basin. Part I. Quantitative investigations and general results.**

Campaign, Ill.: *Bull. St. Labor. Nat. Hist.* (1903) 535 pp., 50 pls.

LARGAIOLLI, V.—**Le Diatomee del Trentino. XV. Lago di Nambino.** (The diatoms of Trentino. XV. Lake Nambino.)

Tridentum, vi. (1903) Fasc. 6–7, pp. 270–4.

MAGNIN, A.—**Les Diatomées des lacs de Nantua et de Sylans.** (The diatoms of Lake Nantua and Lake Sylans.)

Arch. Flore Jurass., xliii. xliv. (1904) pp. 24–6.

MARSSON, M.—**Die Fauna und Flora des verschmutzten wassers und ihre Beziehung zur biologischen Wasseranalyse.** (The fauna and flora of fouled water and its relation to the biological analysis of water.)

Forschungsber. Biol. Stat. Plön, x. (1903) pp. 60–73.

MAZZA, ANGELO—**Un manipolo di Alghe marine della Sicilia.** (A handful of marine algæ from Sicily.)

[Continuation of the list begun in a previous Number. Records 84 species, bringing the total to 139. Critical and topographical notes are appended.]

Nuov. Notar., xv. (1904) pp. 49–75.

MIQUEL, P.—**Recherches expérimentales sur la Physiologie, la Morphologie, et la Pathologie des Diatomées.** (Experimental researches on the physiology, morphology and pathology of diatomaceæ.)

[A continuation, dealing with the re-establishment of the so-called sporangial form of *Nitzschia palea*.] *Micrographe préparateur*, xii. (1904) pp. 32–7 (4 figs. in text).

MÖBIUS, M.—**Ueber den gegenwärtigen stand der Algen-forschung.** (On the present condition of the study of algæ.)

Ber. Deutsch. Bot. Gesell., xxi. (1904) Generalversamml.-Heft, pp. (135)-(146).

MÜLLER, O. — **Bacillariaceen aus dem Nyassalande und einigen benachbarten Gebieten.** (Bacillariaceæ from Nyassaland and some of the surrounding districts.)

Engler's Bot. Jahrb., xxxiv. (1904) pp. 9–38 (2 pls., 5 figs. in text).

OSTENFELD, C. H., & PAULSEN, OVE—**Planktonprover fra Nord-atlanterhavet, c. 58°–60° N. Br., samlede: 1899 af Dr. K. J. V. Steenstrup.** (Plankton-samples collected in the North Atlantic Ocean, lat. 58°–60° N., in 1899, by Dr. K. J. V. Steenstrup.)

[Describes results obtained with new apparatus.]

Medd. om Grönland. Copenhagen, xxvi. (1904) pp. 143–210.

OSTWALD, W.—**Ueber eine neue theoretische Betrachtungsweise in der Planktologie.** (On a new theoretical treatment in Planktology.)

Forschungsber. Biol. Stat. Plön, x. (1903) pp. 1–49.

SNOW, J. W.—**The Plankton Algæ of Lake Erie, with special reference to the Chlorophyceæ.** *U.S. Fish Commission Bull.*, 1902 (issued 1903) pp. 369–94 (4 pls.).

WESENBERG-LUND, C.—**Studier over de danske Söers Plankton.** (Studies on the plankton of the Danish lakes.)

Spec. Del., Copenhagen (1904) 232 pp., 8 maps, 10 pls., 9 plankton-tables.

Fungi.

Membrane of Zygospores.*—Paul Vuillemin publishes the results of a research as to the nature and origin of the zygospore layers in the Mucoraceæ. He distinguishes five of these, the innermost being the matrix of the membrane, closely united to the protoplasm and having a formative function. The other four layers are: from within outwards, the cartilaginous layer, the median cuticle, the carbon layer (*Assise charbonneuse*), and the external cuticle. All these are protective layers. The author finds that they are not peculiar to the zygospore, but that they are also present in a modified form in the suspensors. He concludes that the zygospore is not formed endogenously, but that it is covered by a unique membrane of remarkable complication.

Bulgaria globosa Fr.†—G. Lagerheim gives an account of this fungus which occurs frequently in Sweden on the ground among Pine needles. The author proves its identity with *Sarcosoma globosum* and *S. platydiscus*. The spores in the various species of *Bulgaria* remain colourless for a long time, and become brown only when they are quite mature.

Sclerotinia and Monilia.‡—Rud. Aderhold restates the observations made on the species of *Monilia* that infest our orchards; one of which, *Monilia fructigena*, had been associated by Norton with the *Peziza* form *Sclerotinia fructigena*. Aderhold has kept apples infested with *Monilia fructigena*, and has watched the development on them of a *Sclerotinia* which does not agree with that described by Norton. He holds, therefore, that the one found by Norton, as it grew on stone-fruit, was associated with *Monilia cinerea*, and should rather be designated *S. cinerea*. He gives a detailed account of the asci and spores of the species, which, he holds, is the true *S. fructigena*.

Sclerotinia Alni.§—Fr. Bubák has found on the fruits of *Alnus glutinosa* the sclerotia and their apothecia. The Alnus cones are usually buried under a thin layer of earth. The stalk of the apothecium rises just to the surface of the ground, and the disc, which measures 2–5 mm. across, looks at first like a *Humaria*. Stalk and apothecium are both brown.

Epiplasm in the Ascomycetes.‖—A. Guilliermond has followed his previous studies on the metachromatic corpuscles by a more detailed account of the occurrence of these and other bodies in the ascus. Conte and Vaney have recently announced that these corpuscles in a *Protozoon* were identical with grains of zymogen, and have showed that they were derived from the chromatin of the nucleus from which they were ejected at certain stages of development. Guilliermond's research had led him to believe that metachromatic corpuscles were formed from the cytoplasm of the cell independently of the nucleus.

* Bull. Soc. Sci. Nancy, iv. (1904) ser. 3, pp. 239–67 (4 pls.). See also Bot. Centralbl. xcv. (1904) pp. 541–2.

† Botan. Notiser, 1903, pp. 249–67 (1 pl.). See also Hedwigia, xliii. (1904) p. 50.

‡ Ber. Deutsch. Bot. Gesell., xxii. (1904) pp. 262–6 (1 pl.).

§ Ann. Mycol., ii. (1904) pp. 253–4.

‖ Rev. Gén. Bot., xvi. (1904) pp. 49–65 (3 figs. and 2 pls.).

He gives the methods of fixation and staining, and the species of fungi in which he studied this subject. They were selected chiefly from the larger Discomycetes. The results are followed out in detail in the case of *Aleuria cerea*, and a *résumé* is given of special points noted in the other species examined.

The mother-cell of the ascus, he finds, is derived from a filament with bi-nucleate cells, which bends over like a crook; the nuclei each divide, and a cell is cut off at the bend containing the two central nuclei, which fuse. The cell then grows in length and forms the ascus. At first it is filled with a dense cytoplasm, but gradually this becomes vacuolated and the metachromatic corpuscles make their appearance in the meshes between the vacuoles, not only in the neighbourhood of the nucleus, but through the entire length of the cell. Glycogen was also found in the epiplasm and globules of oil, which are secreted in the same manner as the corpuscles. Guilliermond considers them all to be reserve bodies. He did not find that the corpuscles were bodies acting on glycogen and transforming it into oil, nor were they elaioplasts for the formation of oil. These different bodies exist separately or together in different cells. The final absorption of the corpuscles by the maturing spores proves that they, as well as the other bodies formed, were reserve material to be used up in the growth of the spore.

In one of the fungi examined, a species of *Peziza*, it was found that the ascus was formed in a slightly different manner. The primary cell did not bend over. The nuclei divided and remained attached in pairs as in the basidiomycetes, the cell elongated, and the upper cell with its pair of nuclei was cut off and formed the ascus. The nuclei fused, and development proceeded as in the other cases. The writer notes the appearance of the band of amyloid round the operculum of the ascus in *Aleuria*; he does not consider it to be a reserve body in this instance, its function being concerned with the escape of the spores. He confirms Harper's work on the development of the spores in the ascus.

Critical Notes on Exoascaceæ.* — R. Sadebeck describes a new *Exoascus* found on a member of the Euphorbiaceæ. He found three types of ascus present on the leaves attacked. They were long and slender, or short and clavate, or of an ovate form on a long slender stalk-cell. The author is quite certain that the first two forms belong to one fungus, and he thinks it very probable that the third is also part of the same growth, though the polymorphism of the asci is as marked as it is unusual. The number of spores varies from four to eight in each ascus; the hymenium is formed under the cuticle of the leaf. He calls the new species *E. Sebastianæ*.

Specialisation of Parasitism in Erysiphaceæ.†—E. S. Salmon has continued his inoculation experiments with *Erysiphe Sphærotheca* on various host-plants. The results, he says, seem to show that in every case the form of the fungus has become specialised into a "biologic form." In each experiment the conidia of the fungus were used, but

* Ber. Deutsch. Bot. Gesell., xxii. (1904) pp. 119–33 (1 pl.).
† New Phytol., iii. (1904) pp. 109–21.

the infection powers of the ascopores have been proved to be strictly similar to those of the oidia. Special economic interest is attached to experiments with hop-mildew. The fungus which causes this disease, *Sphærotheca Humuli*, grows on a variety of different plants; but it was found that it was specialised on each host, and could not be transferred from one to the other. Again, in the case of *E. Cichoracearum*, conidia collected from *Plantago major* infected *P. major*, producing an abundant crop of oidia and perithecia, while on *P. media* there was mostly only a feeble sub-infection, and *P. lanceolata* was immune. The author gives detailed tables of the various experiments.

Mycological Notes.*—E. S. Salmon finds that the asci of *Erysiphe graminis* do not form spores until the conditions of moisture, etc., are favourable for their subsequent germination and development. He tested this repeatedly in the laboratory, and found that in a damp chamber the spores matured quickly, were ejected from the perithecium and at once germinated. He infected leaves of *Triticum vulgare*, and in about ten days powdery *Oidium*-patches were observed on the grass. He thinks the fungi may go through the life-cycle more than once in the course of the season. He adds some notes on the mycophagus larvæ that feed on the conidia, and which doubtless aid in checking the spread of the fungus.

Observations on Gymnoascaceæ and Aspergilleæ.†—P. A. Dangeard publishes notes on the question of sexuality in the genera and species of these fungi. He records the occurrence of the two coiled cells in the early stage of fruit formation in species belonging to *Ctenomyces*, *Gymnoascus* and *Aphanoascus*. He denies that sexual fusion takes place. In *Aphanoascus*, the most easily observed, the sterile cell becomes large and spherical, enclosing four or five nuclei, which increase to about forty. The nuclei of the ascogonial cell also increase. This cell winds round the central sterile cell, and then gives rise to five or six branches, which also encircle it, and these branches divide into isodiametric cells. There never is any trace of anastomosis or of fusion to be observed between the two organs.

Yeast Nucleus.‡—A. Guilliermond reviews the work done by himself and others on *Saccharomyces*. He insists on the correctness of his statements as to the existence of a vacuole with metachromatic corpuscles, and a nucleus close by—the nucleolus of Wager. He also insists on the existence of only one nucleus in the sporulating cell. He describes the division of this nucleus into two or four daughter-nuclei previous to sporulation—a division first into two masses which emigrate to the two poles, and then divide again in the same manner. He has never seen any case of karyokinesis. The achromatic spindle seen by Janssens and Leblanc is only "sporogenous plasma." He noted, further, that the epiplasm of the cell contained small oil-globules, which in this case are reserve bodies.

* Journ. Bot., xlii. (1904) pp. 182–6.
† Comptes Rendus, cxxxviii. (1904) pp. 1235–7.
‡ Ann. Mycol., ii. (1904) pp. 184–9 (1 fig.).

Sterigmatocystis versicolor. — Henri Coupin and Jean Friedel* have studied the biology of this fungus, which changes its form and colour according to the medium in which it is grown. It resembles closely *St. nigra*, except that it will scarcely grow in the presence of an acid, while *St. nigra* develops well in an acid solution. Normally, it is of a rusty red colour, and secretes a pigment varying from clear yellow, when an acid is present, to deep red when an excess of carbonate of potassium renders the solution alkaline.

Paul Vuillemin † also publishes notes on the same subject. He distinguishes the two colour forms, green and rose, due to the medium in which the fungus is cultivated, and therefore depending on definite chemical properties. The colour of the spores is less easily controlled, as both kinds may appear in the same growth. Cultures were made on the same substratum of green and rose-coloured conidia, and it was found that the colour form was constant. In this case the medium was not the determining cause of the colour.

Culture of Oospora destructor.‡—This fungus, previously known as *Isaria destructor*, is parasitic on insects. A. Vast cultivated the spores on a large variety of media, and describes the influence that the substratum had on the growth of hyphæ and conidia. The fungus developed more quickly and luxuriantly on potato than on any of the other substances experimented with. In some of the cultures, patches of sterile yellow mycelium were developed, in others there was a considerable formation of crystals. Vast infected the larvæ of *Coleoptera* by plunging them in sterilised water containing conidia, or in brushing them over with the conidia themselves.

Conidial Form of Daldinia concentrica.§ — Marin Molliard has gone over the work done by Tulasne on this fungus. He got the same conidial growth, but some additional discoveries have enabled him to place the conidial fungus in the genus *Nodulisporum*, considered by some authors to be a section of *Botrytis*. Molliard finds that it is in many points similar to a Mucedine studied by Matruchot, *Costantinella cristata*, and he thinks that probably the latter is the conidial form of a Pyrenomycete closely related to *Xylaria*.

Fungi imperfecti.‖—G. Lindau is the author of the section Hyphomycetes in the "Kryptogamen-Flora," the first part of which has just been issued. He discusses their systematic position in the preface, and states the difficulty of classifying them properly. Many of them have been proved to be conidial forms of Ascomycetes, but while it has been proved that allied species of Ascomycetes often have very similar conidial forms, it as often occurs that neighbouring Hyphomycetes may form part of the life-cycle of widely separated higher fungi.

The author remarks, too, on the difficulty in recognising the plants which the older writers had under observation. The type specimens have

* Comptes Rendus, cxxxviii. (1904) pp. 1118–20. † Tom. cit., pp. 1350–1.
‡ Bull. Soc. Mycol. France, xx. (1904) pp. 66–71.
§ Tom. cit., pp. 55–60 (1 pl.)
‖ Rabenhorst's Kryptogamen-Flora, Band. I., Abth. viii., Lief. 92. 135 pp. Leipzig, Eduard Kummer, 1904.

succumbed to the influences of time, and the drawings and descriptions are vague and general. It has thus become necessary to drop out many of the old species.

Lindau follows the usual line of classification, dividing the group into four families, Mucedineæ, Dematiaceæ, Stilbaceæ, and Tuberculariaceæ. Spore characters are the determining factors in the system. The Mucedineæ, which have colourless or brightly-coloured hyphæ and spores, are divided up according to their form and disposition. Lindau treats of almost the whole of two of the sub-divisions of the family in this first part, the Chromosporeæ and the Oosporeæ. Both of them are grouped under the Micronemeæ. They have an insignificant vegetative development and very short conidiophores.

Triphragmium.*—M. Milesi and G. B. Traverso publish the sketch of a monograph of this genus. They use colour as one of the most salient characters, and divide the species into two groups: *Xanthotriphragmium*, of which the teleutospores are yellow in colour, and the epispore warted or comparatively smooth; and *Phæotriphragmium*, which includes species with spores of a deeper brown colour ornamented with long processes. A detailed account of the different species follows.

New Species of Uredineæ.†—J. C. Constantineau describes two new species which he found on well-known plants. An *Æcidium* on *Inula Helenium*, and *Uromyces* (teleutospores) on *Viccia Cracca*; of the latter, he notes that it attacks only the leaves of the host-plant; the sori are to be found on both surfaces. The membrane of the spore is brownish and is ornamented by bands of longitudinal thickening, which often anastomose. There is a small colourless papilla at the top of the spores.

Vegetative Life of Cereal Rusts.‡—J. Eriksson and G. Tischler have carried out a research on *Puccinia glumarum* which occurs on wheat. The aim was to examine further the mycoplasma-hypothesis. Material and methods are fully described. No trace of mycelium was found in the cells of the host, but a more dense condition of the protoplasm was noted in preparations made from spring and autumn material to which the name "mycoplasma" was given. This condition of the cell-contents was compared with that of other preparations of grass leaves known to be free of rust, and in such cases no "mycoplasma" was found. Very early stages of mycelium were noted in Uredo pustules, mere threads of protoplasm without nucleus or cell-membrane in the intercellular spaces of the host-plant. A later stage showed distinct nuclei. Both these appearances are termed by the authors "Protomycelium," and they have no doubt that they are successive stages of growth. Haustoria were developed later and septation of the mycelium. The research was made on young corn seedlings. The origin of the mycoplasm has not yet been traced.

Mycoplasma Hypothesis.§—H. Klebahn has reviewed his own work on *Puccinia glumarum* in the light of Eriksson and Tischler's publica-

* Ann. Mycol., ii. (1904) pp. 143–56 (1 pl.). † Tom. cit., 250–3 (1 fig.).

‡ K. Svensk. Vet.-Akad. Handl., xxxvii. (1904) pp. 1–19 (3 pls.). See also Bot. Centralbl., xcv. (1904) pp. 353–5.

§ Ber. Deutsch. Bot. Gesell., xxii. (1904) pp. 255–61 (2 figs.).

tion. He noted in connection with this rust that the mycelium was rather scanty, but of very large dimensions. It fills the whole of the intercellular spaces where it has penetrated. It is of a dense protoplasmic structure and contains numerous small bodies, which he considers to be nuclei. These nuclei diminish in number as development goes on. Klebahn draws attention to a special case he came across in his examination of *P. glumarum*, which he considered to be somewhat abnormal rust hyphæ, and which bear a strong resemblance to Eriksson's mycoplasma. He points out the difficulty that Eriksson presents us, in asking us to believe that nuclei appear spontaneously; and he also refers to the almost impossible task of detecting spots where uredo pustules will appear, while as yet there is no visible trace of them. He considers the question still unsettled.

Rust of Cereals in Silesia.*—W. Remer publishes a report on the prevalence of rust diseases during the summer of 1903. He found that the two species most frequently met with were *Puccinia dispersa Tritici* and *P. graminis Tritici*. The rusts attacked the cereals in greatest abundance in the localities where the ground had been richly supplied with nitrogenous manure, either artificial or from the farmyard. The rich growth of the grass thus induced, seemed to afford a more satisfactory condition for the parasite. Phosphates, especially superphosphate of ammonia, seemed to be most effectual in checking the spread of the rust. The presence of other fungus parasites rendered the cereal still more liable to attack. The author did not find that the rusts spread from the Æcidia of the alternate hosts, but he thinks that the wild grasses of the woods and hedgerows act as intermediate hosts, and to them the presence and continuance of the disease are largely due.

Myxosporium, Myxolibertella and Sporodiniopsis.†—Franz v. Höhnel points out that *Myxosporium Tulasnei* is identical with *Septomyxa*. He criticises Saccardo's action in sinking the form, genus *Myxolibertella* (Melanconieæ), which possesses two kinds of spores. He insists also that the genus *Sporodiniopsis* should stand, as the fungus described could not be placed under any of the existing genera without a confusion of diagnoses.

American Mycology.—A. P. Morgan ‡ describes a new species of *Melogramma* that grew on dead branches of *Carpinus*. T. D. A. Cockerell § gives a short list of fungi collected by him in New Mexico. W. R. Dudley and C. H. Thompson ‖ publish notes on Californian Uredineæ and descriptions of new species, of which there are three of *Puccinia* and one of *Uromyces*.¶ A descriptive list of Fascicle ix. of Ohio fungi is given by W. A. Kellerman,** who also publishes notes on species of *Podosphæra*. He concludes that *P. tridactyla* is a true species and not merely a variety of *P. oxyacanthæ* as described by Salmon. The author is led to the decision by the difference in form of the peri-

* Zeitschr. Pflanzenkr., xiv. (1904) pp. 65–70.
† Ann. Mycol., ii. (1904) pp. 247–9.
‡ Journ. of Mycology, x. (1904) p. 49.
§ Tom. cit., pp. 49–51.
‖ Tom. cit., pp. 52–5.
¶ Tom. cit., pp. 55–62.
** Tom. cit., pp. 62–4 (1 pl.).

thecial appendages. Kellerman * also continues his index of Uredinous culture experiments for North America, with lists of species and hosts; and † under the title "Elementary Mycology" he advises beginners how to set about the study of fungi.

Root Excrescences of Alnus.‡—There have been many different opinions as to the nature and origin of the outgrowths on alder roots. C. G. Bjorkenheim has examined them recently and has concluded that they are due to the hyphæ of a parasitic fungus. It was not possible to determine the species. He finds two forms of hyphæ inhabiting the cells. Extremely fine filaments occupied the central cells and often terminated in a globose swelling. The cells of the cortical tissue were filled with hyphæ of larger dimensions, which formed clumps inside the cells. In the invaded cells the starch had usually disappeared. The author considers that the large hyphæ are produced after the first infection, and that the filaments become finer as they penetrate deeper into the tissue of the host.

Mycopathological Notes from Hungary.§—Karl Posch-Grinàd gives a *résumé* of his observations on plant diseases during the years 1902–3. Rust was specially destructive, and the cereals were also attacked by species of *Helminthosporium*, *Erysiphe*, *Claviceps*, *Ophiobolus*, etc. He records also disease of roots and tubers, and of various vegetables. Fruit trees and vines were injured by various fungi, and in some cases great mischief was done. *Charrinia Diplodiella*, the origin of white-rot, caused a loss of about 8 million crowns (kronen).

Australian Fungi.‖—D. McAlpine describes a number of new species and one new genus, *Schizotrichum*, a Hyphomycete found on the flowering stems of a native *Lobelia* (*L. gibbosa*). This genus has a dark-coloured sporodochium, but the conidia are hyaline, hence it belongs to the series *Tuberculariea mucedinæ* Sacc. On account of its septate spores it must be placed near *Leptotrichum* Corda. It was found at Sandringham, Victoria. The new species belong to fifteen different genera, including *Fusarium*, *Puccinia*, *Rhabdospora* and *Septoria*.

Diseases of Plants.—R. Farneti ¶ describes a fungoid disease which has recently been detected on apricots. It appears first as grey-green spots in the young fruit, which gradually become brown. The fruits may ripen if the attack is only slight; the more seriously diseased have a bitter astringent taste. The fungus belongs to the Dematieæ, and has been named *Stigmina Briosiana*.

R. Aderhold ** has been experimenting with *Fusicladium dendriticum* which causes a disease of apples, to see if it were the same species as that which grows on *Cratægus*. He found that the fungus from one

* Journ. of Mycology, x. (1904) pp. 64–81. † Tom. cit, pp. 90–5.
‡ Zeitschr. Pflanzenkr., xiv. (1904) pp. 129–33 (1 pl.).
§ Tom. cit., pp. 158–60.
‖ Proc. Linn. Soc., N.S.Wales, xxviii. (1903) pp. 553–63.
¶ Atti. Ist. Pavia, vii. ser. 2, pp. 23–31 (1 pl.). See also Zeitschr. Pflanzenkr., xiv. (1904) p. 183.
** Kais. Gesundh.-Amt, iii. (1903) p. 436. See also Zeitschr. Pflanzenkr., xiv. (1904) p. 182.

host would not infect the other, and he found also that the perfect fruit form belonged to two different species of *Venturia*.

Fungi of the Soil.* — C. J. Koning has published the results of his investigations on humicolous fungi, and on the chemical phenomena that accompany the process of humification. He finds that at each stage of leaf disintegration some special fungus, usually a Hyphomycete, grows more freely than any other. He notes these fungi, and takes account also of the insects that aid in the distribution and propagation of the different moulds. The leaves that bear the richest crop of fungi are the first to decay; oak leaves, that provide better nourishment for the fungi, disintegrate more rapidly than those of beech or of pine. The odour of the soil is due to several species of moulds. The author devotes a large part of the work to a discussion of the chemical changes that go on. He states that the process of humification could be explained by the study of chemical phenomena that are produced during the life of the fungus. He gives lists of the fungi found on different trees, and also a list of chemical substances, organic and inorganic, isolated from the soil.

Disease of Cork Trees.† — F. Bordas has found that the "cork taste" is given to wine by corks that have been cut from a piece of the tree affected with "yellow spot." On examination, the spot was found to be caused by the presence of *Aspergillus niger* and *Penicillium glaucum*. The tree is usually found to be spotted on the side most exposed to rain. Advice is given as the methods to be employed for preventing contamination of the trees.

Sorica g. n., Parasitic on Ferns.‡ — K. Giesenhagen describes a curious pyrenomycete from Brazil. It attacks the sori of *Polypodium*, which become studded with the fructifications of the fungus. There is a black thread-like stalk about 2 mm. in height bearing a perithecium at the apex, which is furnished with a long beak. The spores are globose and brown. The sori of the leaf alone are infected by the fungus: the intervening tissue is free from mycelium.

Errors in Determination of Fungi due to Misconception of Host-Plants.§—W. Franzschel has inquired into this subject in reference to a number of species, and he finds that carelessness in accurately determining the host-plant has led to a considerable duplication of species. Where a parasite has been recorded only once on a somewhat universal host species, the author sees constant reason to doubt its occurrence at all, and he has several times proved the justness of his surmise. Thus a leaf of *Epilobium* was confounded with that of a *Veronica*, leaves of *Thalictrum* were mistaken for those of one of the Umbelliferæ, and of *Plantago lanceolata* for those of *Scorzonera humilis*.

Fossil Fungi.—Fungi have been recorded by several workers in connection with plants from Palæozoic times, some of them saprophytic,

* Arch. Néerl. Sci. exact. et Nat., ix. (1904) pp. 34–107.
† Comptes Rendus, cxxxviii. (1904) pp. 928–9.
‡ Ber. Deutsch. Bot. Gesell. xxii. (1904) pp. 191–6 (1 pl.).
§ Ann. Mycol., ii. (1904) pp. 157–61.

others evidently parasitic. F. E. Weiss * has recently described a specimen that he has found on rootlets from the lower coal-measures, which seems to correspond with the *Mycorhiza* of recent times. In the root or rhizome examined, the fungus mycelium was very evident in the exocortex. In the cells of the medio-cortex there were somewhat indefinite masses that recalled the "clumps" characteristic of the *Mycorhiza* of living plants, but no definite details could be made out. The clumps were connected with the cell-walls by delicate protoplasmic filaments, which were probably contracted hyphæ. The whole fungus differs materially from other cases of endophytic fungi observed in fossil plants, and is evidently neither parasitic nor saprophytic on the host-plant. The author has been unable to identify the root; he therefore gives it the non-committal name of *Rhizonium*. The fungus he designates provisionally as *Mycorhizonium*.

BOULANGER, EM.—**La culture artificielle de la Truffe.**
[The author claims to have developed truffle-beds in new localities, and explains the methods he has followed.]
Bull. Soc. Mycol. France, xx. pp. 77–82.

BUBAK, FRANZ UND KABAT, J. E.—**Einige neue Imperfekten aus Böhmen und Tirol.**
[One new genus, *Kabatia* (Leptostromaceæ), is described; there are a number of new species.] *Oesterr. Bot. Zeitschr.*, liv. (1904) pp. 22–31 (10 figs.).
See also *Hedwigia*, xliii. (1904) p. 46.

BUBAK, FR.—**Eine neue Agaricaceen-Gattung aus Böhmen.**
[The new genus is near akin to *Lentinus*, and has been named *Lentodiopsis* by the finder.] *Hedwigia*, xliii. pp. 195–6.

DIEDICKE, H.—**Fungi Imperfecti aus Thüringen.**
[The author describes some new species, and gives the results of his cultures of spores of *Pleomassaria siparia*. He succeeded in producing the pycnidial spores of *Prosthemium betulinum*.)
Ann. Mycol., ii. (1904) pp. 179–83 (9 figs.).

HARIOT, P., ET PATOUILLARD, N.—**Description de Champignons nouveaux de l'Herbier du Muséum.**
[Descriptions of ten new species from various countries.]
Bull. Soc. Mycol. France, xx. (1904) pp. 61–5 (1 fig.).

HENNINGS, P.—**Einige neue Pilze aus Japan.**
[The new genera are *Kusanobotrys* (Asterinaceæ), *Yoshinagaia* and *Coccodiscus* (Coccoideaceæ.) *Hedwigia*, xliii. (1904) pp. 140–6, 150–3.

„ „ **Einige neue Pilze aus Costarica und Paraguay.**
[Diagnoses of seven new species.] *Tom. cit.*, pp. 147–9.

„ „ **Fungi Amazonici I. a il Ernesto Ule collecti.**
[The list includes a very large number of new species, more especially among the Uredineæ. *Tom. cit.*, 154–86 (1 pl. and 2 figs.).

„ „ **Fungi Australiensis II.**
[Diagnoses of nine new species from Queensland or from Western Australia.]
Tom. cit., pp. 187–9.

„ „ **Einige schädliche Blattpilze auf cultivierten Himalaya-Rhododendron.**
[The author found a number of new species, mostly small Pyrenomycetes, especially on *Rhododendron Falconeri*, which has a hairy under-leaf surface.]
Gartenflora, lii. (1903) pp. 575–7.
See also *Bot. Centralbl.*, xcv. (1904) p. 369.

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* Annals of Botany, xviii. (1904) pp. 255–65 (2 pls.).

HENNINGS, P.—**Beitrag zur Pilzflora von Rheinsburg.**
[A number of new species of micro-fungi are described.]
Abhandl. Bot. Ver. Brandenb., xlv. (1903) pp. 12–18.
See also *Hedwigia*, xliii. (1904) pp. 47–8.

" " **Fungi Africæ Orientalis iii.**
[A considerable number of new forms are included in this account of fungi from German East Africa. The new genera are *Englerula* and *Asterothyrium*.]
Engler, Bot. Jahrb., xxxiv. (1904) pp. 39–57.
See also *Hedwigia*, xliii. (1904) p. 48.

HOLLOS, L.—**Gasteromycetes Hungariæ.**
[About 100 species described.]
Magyarország Gasteromycetái, 194 pp., xxxi. pls.
Budapest, 1903 (Hungarian).
See also *Hedwigia*, xliii. (1904) pp. 49–50.

HOLLRUNG, M.—**Sphaeronema Betæ nov. spec.**
[The author describes the new species, and discusses the systematic position of the genus.] *Ber. Deutsch. Bot. Gesell.*, xxii. (1904) pp. 199–202 (5 figs.).

KANTER, R. M.—**Ueber die wirkung einiger Salze der Schwermetalle auf das Wachsthum und die chemische Zusammensetzung von Aspergillus niger.**
[The author worked with the salts of such metals as iron, copper, cobalt, zinc, etc. Iron be found indispensable for the growth of the fungus, though only a trace was necessary.]
Inaug. Diss. St. Petersburg, 1903 (Russian).
See also *Bot. Centralbl.*, xcv. (1904) p. 369.

KELLERMAN, W. A.—**Index to Uredineous culture experiments, with list of species and hosts from North America.** *Ohio Naturalist*, iv. (1904) pp. 78–82.

LAGERHEIM, G.—**Om af swamp angrifna fikon och dadlar.**
[Notes on the systematic position and development of *Sterigmatocystis*.]
Svensk. Farm. Tidskrift, No. 18 (1903) 6 pp. 7 figs.
See also *Hedwigia*, xliii. (1904) p. 51.

LISTER, ARTHUR, & GULIELMA.—**Notes on Mycetozoa.**
[Descriptions of new species, and notes on species already recorded.]
Journ. Bot., xlii. (1904) pp. 129–40 (2 pls.).

MAUBLANC, M.—**Espèces nouvelles de Champignons inférieurs.**
[Diagnoses of ten new species of micro-fungi.]
Bull. Soc. Mycol. France, xx. (1904) pp. 72–6 (1 pl.).

OUDEMANS, C. A. J. A.—**A new microscopic fungus occurring on the Larch, and very injurious to this tree.**
[The fungus belongs to a new genus of Tuberculariaceæ, *Exosporina*; it grows on the needles of the larch.]
K. Akad. Wetensch. Amsterdam, vi. (1904) pp. 498–501 (1 pl.).
See also *Hedwigia*, xliii. (1904) p. 51.

PATOUILLARD, N.—**Champignons algéro-tunisiens nouveaux ou peu connus.**
[A detailed account of three new species of the larger fungi.]
Bull. Soc. Mycol. France, xx. (1904) pp. 51–6 (1 pl.).

PECK, CHARLES H.—**New species of fungi.**
[Diagnoses of 16 species of the larger fungi; collected in the United States.]
Bull. Torrey Bot. Club, xxxi. (1904) pp. 177–82.

REHM, H.—**Ascomycetes Americæ borealis.**
[Notes on various Pyrenomycetes, several of them new species.]
Ann. Mycol., ii. (1904) pp. 175–8.

RENAULT, B.—**Quelques remarques sur les Cryptogames anciennes et les sols fossiles de végétation.**
[From the plant-remains and the strata in which they are found, the author indicates the appearance of the fossil vegetation, and draws attention to various problems that have been solved by this local grouping of plants.]
Comptes Rendus, cxxxviii. (1904) pp. 1237–9.

SACCARDO, P. A.—**De diagnostica et nomenclatura mycologica. Admonita quædam.**
[A series of rules for systematists, to guide them in diagnosing and naming new forms. *Ann. Mycol.*, ii. (1904) pp. 195–8.

SYDOW, H. & P.—**Novæ Fungorum species.**
[Micro-fungi from various parts of the world. The new genera are *Microcyclus*, *Phæodothis* and *Maurodothis* (Dothideaceæ). They differ from *Dothidea* and from each other in the form of the stroma, and in the form and colour of the spores.] *Tom. cit.*, pp. 162–74.

SYDOW—**Mycotheca Germanica, Fasc. iii.–iv. (Nos. 101–200).**
[A list of the species is given, and diagnoses of the new forms.]
Tom. cit., pp. 190–4.

WENT, F. A. F. C.—**Krulloten en verstende Vruchten van de Cacao in Suriname.**
[Account of a disease that has attacked cacao-plants.]
K. Svensk. Vet.-Akad. Handl., xxxviii. (1904) 40 pp., 6 pls.

Lichens.

Studies of Peltigera.*—Georg Bitter records a case of *Peltigera malacia* in which he found the normal apothecia formed on the upper surface of the thallus, and also small apothecia formed on the under surface, beneath the upper fruit. They resembled somewhat the apothecia of *Nephromium*, but they were developed further from the apex of the fertile lobe. Anatomically the fruits formed on the upper and under surfaces do not differ from each other. In one of the fruits examined, a hole had been formed through both the apothecia.

In a second paper he describes the thallus of a small lichen, *Peltigera lepidophora*. The species is always sterile, and on the surface are formed outgrowths of gonidia and hyphæ which he proposes to call autosymbiontic Cephalodia—because they enclose the same gonidia as those that are found in the thallus, whereas the true Cephalodia are formed of another alga. They have a quite different structure from Isidia, their gonidia being entirely separate from those of the underlying thallus. They have the same function as soredia and serve to propagate the lichen.

Collema and Leptogium.†—Carolyn W. Harris describes in popular terms these two genera and a few of the species of each. She instructs the student how to discriminate between them in the field. She finds that *Leptogium* differs from *Collema* in the presence of rhizoids in some form or other, either in clusters or as a fine close nap. The two genera inhabit the same localities, and are not always easily to be distinguished the one from the other.

Swedish Lichens.‡—B. Nilson gives the result of a careful search for lichens in Kullen. He describes minutely the locality and the condition of soil, etc., and gives a list of the lichens that occur the most frequently. The stone and rock inhabiting species form a large majority. A number were found on trees, and only a few Cladonias were common on the soil. In some notes on *Nephromium lævigatum* he criticises the presence or absence of soredia, and the colour of the medullary tissue as species-characters. They are due he thinks to

* Ber. Deutsch. Bot. Gesell., xxii. (1904) pp. 248–56 (1 pl.).
† Bryologist, vii. (1904) pp. 45–8 (1 pl.).
‡ Arkiv. für. Bot. K. Svensk. Vet.-Akad., i. (1904) pp. 467–96.

habitat alone. On the same specimen he has found both yellow and white medullary hyphæ, and sorediate and non-sorediate lobes. In this judgement he differs from Nylander, Crombie and others. He records altogether eighty species on stones, seventeen on the soil, and fifty-five on trees.

Protection of Lichens against Animals.*—E. Stahl finds that the protective substances elaborated by lichens are the lichen acids, especially vulpin acid. Not only do these acids ward off snails, caterpillars, etc., but they prevent the development of bacteria, as they have antiseptic properties. He found, however, that their presence does not affect the growth of filamentous fungi.

Lichens as Endosaprophytes.†—A. Elenkin has examined a number of heteromerous lichens in the Lecideæ, Acarosporeæ and Endocarpeæ, to determine the relation between the fungi and algæ constituting the lichen plant. In many of the specimens he finds layers of dead gonidia (*nekrale zone*). In *Lecidia atro-brunnea* he noted the outgrowths of fungus hyphæ piercing the *Pleurococcus* gonidia, which in this case are very large. These outgrowths are similar to the haustoria described by Schneider and Peirce, but the author considers that they destroy the algæ rather than that they live in symbiotic union with them.

ARCANGELI, A.—**Sulla struttura dell' Usnea articulata.** (On the structure of *Usnea articulata*.)

[The writer describes the vegetative structure in great detail. He concludes that *U. articulata* is only a variety of *U. barbata*.]

Atta. Soc. Jose. Sci. Nat., xiv. (1904) pp. 46–52.

ZAHLBRUCKNER, A.—**Neue Flechten.**

[Diagnoses of six new species from Trieste, Java, Australia and Nicaragua.]

Ann. Mycol., ii. (1904) pp. 267–70.

Mycetozoa.

Studies of Mxyomycetes.‡—E. Jahn gives the results of observations on nuclear division in the formation of the cilium in the swarm-spores of *Stemonitis flaccida*. The cilia, he finds, grow out from the poles of the nucleus; their earliest development coincides with the beginning of the cell-division. They increase slowly, and have hardly attained full growth when the nucleus is fully formed. At the base of the cilia are strongly staining granules, which are identical with the centrosomes of the spindle. Jahn discusses the nature and function of these granules, comparing them with those found in other nuclei. He also gives a minute account of the stages of nuclear division observed by him in the swarm-spores.

Schizophyta.

Schizophyceæ.

Studies on Cyanophyceæ.—F. E. Fritsch publishes the first of a series of papers under this title. The present communication deals with

* Festsch. siebzigst. Geburtst., von Ernst Haeckel, Jena, G. Fischer, 1904, pp. 353–76. See also Ber. Deutsch. Bot. Gesell., xliii. (1904) p. 55.

† Bull. Jardin Imp. Bot. St. Petersb., iv. (1904) pp. 25–39 (2 pls. and 4 figs.). See also Ber. Deutsch. Bot. Gesell., xxii. (1904) pp. 54–5.

‡ Ber. Deutsch. Bot. Gesell., xxii. (1904) pp. 84–92 (1 pl.).

§ New Phytologist, iii. (1904) pp. 85–96 (figs. in text.).

'Some points in the structure of an Anabæna.' The material was taken from the main tank in the Victoria Regia House at Kew, and was at first intended for the study of an *Œdogonium*, but a month or two later that alga had almost entirely disappeared from the glass vessel, and was superseded by a rich growth of blue-green algæ. The species of *Anabæna* here considered occurred in all stages of development, and was remarkable for the abundant heterocysts. These were not much larger than the ordinary vegetative cells, and sometimes were even smaller. They developed from the vegetative cells, and were generally to be recognised at a very early stage. Two kinds were to be distinguished: terminal ones, of a spherical shape, flattened on the sides towards the vegetative cells; and intercalary ones, more or less barrel-shaped and flattened at each end. The structure and development of these heterocysts is described, and the author remarks that his account scarcely agrees with Brand's observations on *Nostoc commune* and *Tolypothrix*. In young filaments the heterocysts occur singly and at considerable intervals from one another, but in older filaments the author has seen as many as four heterocysts side by side at one extremity of a filament, the distal one being often the most fully differentiated. Various reagents were tried on these bodies, and the respective results are described. The presence of cyanophycin-granules has been demonstrated in the vegetative cells of the young filament, and in older filaments it is noticed that they disappear from the vegetative cells and are found in the heterocysts. A protoplasmic communication is shown to exist between the heterocysts and the adjacent vegetative cells, and it is supposed that the cyanophycin-granules pass to the heterocysts by this passage. The author regards the heterocyst as a recipient of reserve-substances—an organ for storing up the contents of neighbouring vegetative cells, when these, owing to unfavourable external conditions, or to active spore-formation in the central portion of a filament, become exhausted. In the case of centripetal spore-formation, as in *Sphærozyga*, it is possible that the function of the heterocysts may be taken over by the intercalary ones. As regards Brand's observation of the germination of the contents of heterocysts, it stands alone: but Fritsch considers that these bodies may be the remnants of important reproductive organs of the Cyanophyceæ, whose functions have now in great part been taken over by the spores; and the failure to confirm Brand's observation may lie in the fact that very unusual conditions may be necessary to cause the heterocyst to revert to its former functions, and these extreme conditions but rarely occur.

Schizomycetes.

Action of Radium on Micro-organisms.* — A. B. Grün has subjected certain micro-organisms to such emanations from radium bromide as passed through thin talc, i.e. the β and γ rays. Experimenting with calf vaccine, he found that the specific germ in no case survived a longer exposure than 22 hours at a distance of 1–2 mm. The extraneous micro-organisms of the vaccines employed, viz. *S. pyogenes aureus*, *S. pyogenes albus*, *S. cereus flavus*, *S. cereus albus*, in no case

* Proc. Roy. Soc., lxxiii. (1904) pp. 375–81.

survived a longer exposure than 15 hours. The same was found to be the case with *Streptococcus pyogenes*, *B. prodigiosus*, *B. proteus vulgaris*, *B. pyocyaneus*, *B. typhosus*, *B. coli communis*, *B. mallei*, *B. pestis*, *B. tuberculosis*, the bacillus of Malta fever, and *Spirillum choleræ Asiaticæ*. Bacteria containing spores were more resistant, e.g. *B. mesentericus vulgatus*, *B. mesentericus ruber*, *B. subtilis*, *B. anthracis*, *B. tetani*, Gärtner's bacillus, the bacillus of malignant œdema, and the bacillus of Rauschbrand. These were not killed by less than a 72 hours' exposure. At 10 cm. distance the radium was found to have no germicidal action. It was found that when micro-organisms have been exposed to radium emanations for 24 to 120 hours, they themselves may become radio-active. This induced radio-activity can be demonstrated by bringing the bacteria so exposed in contact with a "rapid" photographic plate, and then developing the latter.

Accumulation Experiments with Denitrifying Bacteria.*—G. van Itersen, junior, by accumulation experiments (*Anhäufungsversuche*) claims to have established a simple method for the isolation and culture of denitrifying bacteria, obtained from earth, canal-water, horse-dung, etc. His method is to introduce such material into a stoppered flask, filled, to the exclusion of all air, with a solution of organic salts and nitrate, to incubate for several days at 28° C., and then with the frothy development so obtained to incubate a second flask filled with a similar solution. When this has been repeated three times the last flask will be found to contain practically a pure culture. In this way were isolated *B. Stutzeri* (Neumann and Lehmann), *B. denitrofluorescens* sp. n., and *B. vulpinus* sp. n. *B. Stutzeri* merits attention on account of the characteristic form (a rosette) of its colonies on gelatin. *B. denitrofluorescens* is the first example of a fluorescent denitrifying non-liquefying bacterium. *B. vulpinus* is chromogenic, but it requires light for the development of its pigment. In the presence of free oxygen *B. Stutzeri* and *B. vulpinus* behave as aerobic spirilla, and *B. denitrofluorescens* as an ordinary aerobic bacterium. The denitrifying bacteria can themselves, with the smallest quantities of many organic substances, bring about the disappearance, in the form of free nitrogen, of estimated quantities of nitrate. In the same earth in which nitrification can take place by aeration, denitrification can take place by exclusion of air.

Ferments of Diseases of Wines.†—P. Mazé and P. Pacottet, in a research on this subject, succeeded in isolating the ferments of *la tourne*, *la graisse* and *l'amer*. They used wines that had been for many years in bottle, such being free from yeasts, fungi, and the common bacteria. Such wine gave rise to no growth when inoculated in ordinary media, aerobically. Anaerobic methods were therefore employed, and haricot bouillon used as a culture medium. 1·2 c.c. of the deposit at the bottom of the bottles was taken up into a Roux's pipette with 15–20 c.c. of haricot bouillon, containing 3 p.c. saccharose and 0·2–0·3 p.c. tartaric acid. After many weeks a whitish deposit appeared, which microscopic-

* Verslagen der koninkl. Akad. van Wetensch. te. Amsterdam, xi. (1902–3) blz. 135. See also Centralbl. Bakt., 2te Abt., xii. (1904) pp. 106–15.

† Ann. Inst. Past., xviii. (1904) pp. 244–63.

ally was seen to consist of chains of ovoid elements (the ferment of *la graisse*), and rods and elongated filaments, if the wine under examination had become turned or sour. The growth is increased by several changes into fresh media, and takes place most favourably *in vacuo*. Cultures, however, succeed in open tubes when sown in quantity. From such, isolations were made, haricot bouillon being used solidified with agar. The authors obtained thus: 4 bacilli from *vins amers*; 4 bacilli from *vins tournés*; 2 mannitic ferments; 1 coccus; and 3 ferments in chains. All these ferments had certain characters in common. They were Gram-positive, non-spore-forming and non-liquefying. They were killed by 10 min. at 65° C. They grew preferably in the depth of the agar medium. Air hindered their development.

The authors conclude that: diseased wines are invaded by a certain number of species of microbes which are almost always associated. *Vins tournés* contain sometimes almost all the species studied. The ferment *de l'amer* is always accompanied by the ferment *de la graisse*. The physiological properties of the two latter are nearly identical; they destroy ordinary sugars in the same way, with the formation of products in the same proportions. They are able to develop in the same media, and they proliferate indifferently in all wines, provided that they find in them sugars and nitrogenous matters. The most widely spread of all disease-producing ferments is that of *la graisse*. Wines poor in sugar and nitrogen are stable as regards disease-producing ferments, but when these two substances are present in sensible quantities, no constituent element of this wine can offer a sufficient barrier to the development of the microbes.

Resistance of the Micrococcus melitensis to Moist Heat.*—F. J. A. Dalton and J. W. H. Eyre have determined the "thermal death point" of *M. melitensis* to be 57·5° C., this temperature invariably causing the death of all the individual organisms exposed to it for a period of ten minutes. They experimented with the organism at the period of its maximum vegetative growth. This was obtained by cultivating it aerobically on the sloped surface of nutrient glycerin agar (5 p.c. glycerin) reaction + 10, for a period of 48 hours, at a temperature of 37° C. They employed a water-bath, the heat of which was regulated by a delicate and accurate thermo-regulator—Hearson's thermostatic capsule. Emulsions were made in the proportion of 1 mgrm. of the culture to 1 c.c. of 0·6 p.c. sterile salt solution. These emulsions were filtered before use to remove clumps. The germ-content of the emulsions was determined by plating out in dilutions of $\frac{1}{100}$ and $\frac{1}{10000}$. The authors lay stress on the importance of not using test-tubes the walls of which are thinner than 1 mm., which would permit of a too rapid transmission of heat, leading to the evaporation of the small quantities of fluid which frequently adhere to the glass just above the upper limit of the bulk of the emulsion. When this happens, the organisms previously suspended in that fluid become more resistant to heat as the result of their desiccation, and fallacious results may be obtained. Five different strains of the organism were employed.

* Journ. Hygiene, iv. (1904) pp. 157–72.

Spirillosis in Fowls.*—C. Levaditi, in an important paper, gives the results of a research on this subject. If blood containing spirilla is injected subcutaneously into a fowl, spirilla are not found in the circulation until after the second day. If the site of inoculation be examined microscopically, the vibrios will be found numerous and active 35 min. after injection, much diminished in number after the second hour, and rare after the ninth, with their mobility much impaired; none are to be found the next day. There is no sign of local phagocytosis. The spirilla have left the place where they were introduced, and have gone to certain internal organs, e.g. the spleen and the liver, where they rapidly multiply. This the author has demonstrated experimentally. These events are accompanied by histological changes in the blood, leucocytosis, mono- and polymorpho-nuclear, and basophilia of the red blood-corpuscles. There is also the appearance of large non-granular mononuclear cells, probably of splenic origin, as well as vacuolisation of all the leucocytes, which becomes more marked as the crisis approaches. In blood obtained at this time there is observable a pseudo-agglutination of the vibrios.

From the second day onward the spirilla increase in the blood till the fifth or sixth, when in the course of a few hours they suddenly disappear. Of the two theories to explain this disappearance, *extra-cellular dissolution* and *phagocytosis*, the author inclines to the latter—from the fact that the vibrios preserve their motility and power of division up to the end, and do not exhibit granular or moniliform changes, and also that at the crisis the large cells of the spleen and bone-marrow become vacuolated and contain spirilla. Serum obtained a few days after the crisis possesses marked immobilising and agglutinating properties. It contains a thermolabile cytase and a thermostabile sensibilisatrice. It is probable that the assimilating power of the leucocytes increases in the course of spirillic infection, and that at the moment of the crisis the vibrios are absorbed as soon as they are englobed by the leucocytes. It is possible also that the sensibilisation plays a certain role in the rapid destruction of the spirilla in the interior of the macrophages. The presence in the fluids of the infected organism of a quantity of amboceptors insufficient to provoke extra-cellular dissolution of the vibrios, may facilitate their intra-protoplasmic digestion.

If serum from a fowl which has recovered be injected into a fowl in the third or fourth day of the disease, it usually causes death, by producing agglutination of the spirilla in the blood. The clumps so formed are surrounded by vacuolated leucocytes, and are carried as emboli to the lungs and nervous system.

Plasma prepared after the method of Delezenne was found to have an intense agglutinating and immobilising power, even on vibrios actively motile in the circulation of the fowl supplying the blood for the plasma.

Growth of Bacteria in Salt Solutions of High Concentration.†—F. Lewandowsky finds that the most concentrated solution of sodium

* Ann. Inst. Past., xviii. (1904) pp. 129–49.

† Arch. Hygiene, xlix. (1904) pp. 47–61. See also Journ. Chem. Soc., cccxcviii. p. 276.

chloride, in which bacterial growth takes place, contains 25 p.c. of the salt. Potassium salts have less effect, growth being very active in broth saturated with potassium nitrate.

Production of Acetylmethylcarbinol by the Bacteria of the Group Bacillus mesentericus.* — Henri Desmots finds that *Bacillus mesentericus vulgatus*, *B. fuscus*, *B. flavus*, *B. niger* and *B. ruber* attack solutions of glycerol, mannitol, dextrose, sucrose, dextrin, inulin and starch. Acetic acid, valeric acid, and small quantities of ethyl-alcohol were produced in each case. By distilling the product a lævo-rotatory solution was obtained, which reduces Fehling's solution at the ordinary temperature, and with excess of phenyl-hydrazin acetate gives a precipitate of osazone of acetylmethylcarbinol. This osazone forms pale yellow, fern-like crystals, melting at 243° C.

Growth of Bacteria under Altered Pressure.† — G. Marpmann has investigated the influence of alteration in pressure on the growth of bacteria. His method is to introduce into a chamber of glass, or metal, culture masses inoculated on nutrient gelatin, or in fluid media. This chamber contains a thermometer, and is furnished with a screw-top by means of which it is closed hermetically. It is then connected with a manometer. The manometer readings must always be taken at the same temperature. The author found that, from the pressure point of view, bacteria fall into three groups: the gas-producing, the non-gas-producing, and the gas-absorbing. The following were found to produce gas copiously in glucose agar: *Bacterium coli*, *Bacillus pneumoniæ*, *B. vulgare* (*Proteus*), *B. chauvœi*, *B. tetani*, and *B. œdematis maligni*.

Chemistry of Tubercle Bacillus.‡ — W. Bullock and J. J. R. Macleod find that on extraction with ether dried tubercle bacilli yield large percentages of fatty substances. On filtering the boiled extracts, a white precipitate deposits on cooling. After saponification of the filtrate with sodium hydroxide, two extracts, aqueous and ethereal, are obtainable; the latter contains some fats; the fatty acids are probably oleic, isocetic, and myristic. The aqueous extract contains a soap, the fatty acid of which corresponds in melting-point with lauric acid. The filtrates also contain lipochromes. The white precipitate mentioned above can be saponified with difficulty by means of alcoholic potash: a white powder, which is an alcohol, is deposited, and the filtrate contains fatty acids.

Bacterial Flora of the Male Urethra.§ — H. Pfeiffer has studied the bacterial contents of twenty-four normal male urethræ, and found one only culturally sterile. For the study of the posterior portion of the urethra he employed an endoscope tube, and for that of the anterior portion a medium-sized ear-speculum. Samples of the urethral secretion were obtained from both these situations by means of a looped platinum needle inserted through the tube, or speculum, and rubbed

* Comptes Rendus, cxxxviii. (1904) pp. 581–3. See also Journ. Chem. Soc., ccccxcviii., pp. 276–7.

† Zeitschr. ang. Mikrosk., ix. (1903) pp. 293–7.

‡ Journ. Hygiene, iv. (1904) pp. 1–10. See also Journ. Chem. Soc., ccccxcviii. p. 277.

§ Archiv. Derm. u. Syph., 1904, pp. 379–410.

gently over the mucous membrane. Cultures were made on ox-serum-agar plates and on ordinary agar, both aerobically, and in an atmosphere of hydrogen. The author found, in comparing the bacterial contents of the anterior and posterior portions, that the numbers diminished from before backwards, although the species did not vary. Constant forms were *Bacillus pseudo-diphtheriæ*, *Strepto-bacillus urethræ*, *Staphylococcus albus*, *aureus* and *citreus*, *Sarcina alba typica*, *alba atypica* and *flava*, and *Micrococcus candicans*. Occasional forms were a vibrio, a coccus negative to Gram, an influenza-like bacillus, and *Bacterium bruneum*. The author concludes that (1) the normal urethra even in its posterior part contains numerous bacteria; (2) the presence of *Bacillus pseudo-diphtheriæ* and *Strepto-bacillus urethræ* can become important in conditions of post-gonorrhœal urethritis and cystitis; (3) none of the obtained forms are pathogenic to animals; and (4) it is worthy of note that in none of the studied cases were typical *Streptococci* or *Bacillus coli communis* found.

MICROSCOPY.

A. Instruments, Accessories, &c.*

(1) Stands.

Draw-Tube Stop.† — S. Gelblum discusses the general conditions which a draw-tube stop should fulfil; he suggests the best practical means for arriving at the result. He considers that, inasmuch as the stop would have to be applicable to objectives of different lengths as well as to preparations of different thicknesses, it would be best to attach the stop to the objective itself. He recommends that the objective mount should be provided with a small cincture to which could be

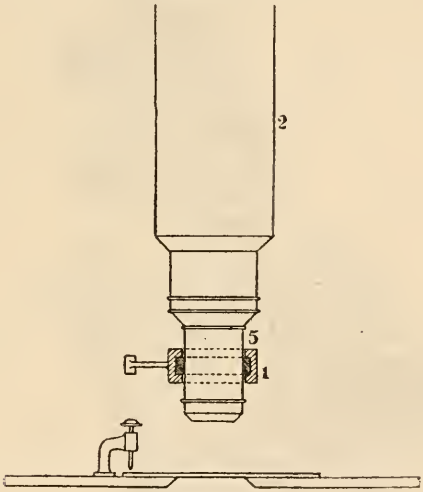

Fig. 64.

attached a removable band of brass (fig. 64). From this band a small arm terminating in a kind of button would project; this button would, on lowering the tube, come into contact with an adjustable button on the stage, and so prevent the tube from being lowered beyond safety distance. This stage button would, in reality, be the head of a screw working in a small right-angled arm attached to the stage. The screw could be adjusted at various heights, as required.

Beck's London Petrological Microscope.‡—This instrument (fig. 65) embodies the principle invented by Allan B. Dick,§ but numerous im-

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

† Zeitschr. wiss. Mikr., xx. (1903) pp. 129–32 (3 figs.).

‡ R. and J. Beck, Special Catalogue, 1904.

§ See this Journal, 1889, p. 432, fig. 57.

provements suggested by Dr. Flett, of H.M. Geological Survey and Museum, have been introduced. The base is heavier and more solid, while the general arrangement of the parts allows freer access to the

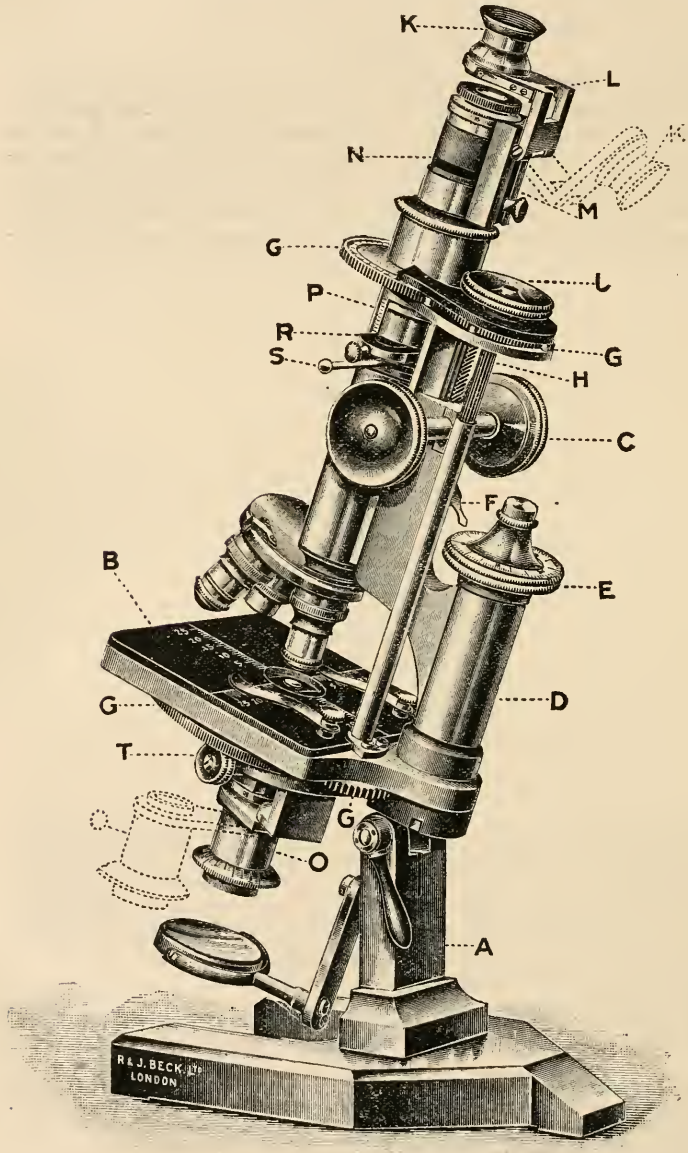

Fig. 65.

apparatus above and below the stage. The stage is covered with vulcanite and measures 4 by 4 in. The analyser and polariser are simultaneously rotated by means of cogwheels connected by a shaft H, so placed that it does not interfere with the use of the stage: there is a distance of 2 in. from the centre of the stage and the edge of the slow-motion pedestal, and the cogwheel shaft is 1·8 in. from the centre of the stage. The analyser K is carried on a swinging bracket L, and is usually supplied on a sliding dovetail M, so that its height can be adjusted to the eye-point of the Microscope, and the slide is provided with a clamp to fix the analyser in any position.

Within the body-tube is a slot P, through which an inner tube carrying a Bertrand lens can be slid up and down. Below the Bertrand lens is an iris diaphragm S.

Two kinds of condensers are supplied, the simpler form (fig. 66)

Fig. 67.

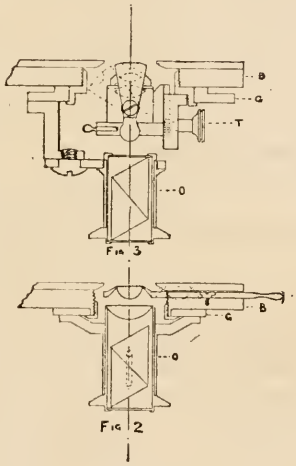

Fig. 66.

consisting of a couple of lenses placed above the polariser. The more complete form (fig. 67) consists of an achromatic and aplanatic condenser 1·0 N.A., or semi-apochromatic condenser 1·2 N.A., and has a pivoted top lens which can be swung out of the optic axis by means of a handle below the stage. An iris diaphragm is affixed to the condenser to reduce the aperture when necessary.

The top lenses of the eye-pieces have a special adjustment to enable either the micrometer or the cobwebs to be focussed. The principal cobweb of the crossed pair is marked by a V.

Zeiss' Rotary Projection Slide Carrier.* — E. Richter describes this apparatus, whose general nature is that of a square rotary drum with its axis transversely in the axis of the optical lantern. It is placed between the illuminating apparatus and the objective. When

* Zeitschr. wiss. Mikr., xx. (1903) pp. 132–7 (2 figs.).

the carrier is in its initial position the slide is placed horizontally in a sort of recess prepared for it at the top of the drum, which is then rotated backwards through 90°, so as to bring the slide in front of the condensing lens: it is now in the proper position for projection. A second slide is now put in at the top and the drum rotated through a further 90°. The first slide is now horizontally at the bottom of the drum, and automatically falls out on to a soft surface suitable for its reception; the second slide has now come into the projection position. The fourth side of the drum, viz. that opposite the slide displayed, is always clear and therefore offers no obstacle to the free passage of the light. A suitable arrangement of bars ensures that the apparatus shall stop accurately in the proper positions. The foot has been designed for attachment to the prismatic bar of an optical bench, but could, of course, be modified for other applications.

BERGMANN—**Das Trichinoskop.** *Zeitschr. Fleisch u. Milchyg.*, xiii. (1903) p. 111.

DOWDY, S. E.—**Attachable Object-finder.** *English Mechanic*, lxxix. (1904) p. 410 (1 fig.).

HITCHCOCK, R.—**The Ideal Projecting Microscope.** *Journ. New York. Micr. Soc.*, Annual of 1902, pp. 19–23.

IVES, F. E.—**Ein neues Binocularmikroskop.** *Centralzeitg. Opt. u. Mechan.*, xxiv. (1903) p. 38.

" " **Französische Mikroskop.** *Op. cit.*, xxiii. (1902) p. 98.

KÖHLER, A.—**Das Zeiss 'sche Trichinoskop.** *Zeitschr. Fleisch u. Milchyg.*, xiii. (1903) p. 107.

LEITZ, E.—**Ein neues Mikroskopstativ und seine feine Einstellung.** *Zeitschr. Instrumentenk.*, xxiii. (1903) p. 79.

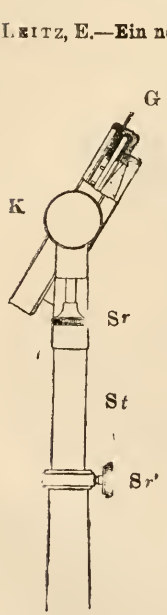

FIG. 68.

(2) Eye-pieces and Objectives.

Zeiss' Compound Lens with Iris Diaphragm.* This is shown, one-third full size, in fig. 68. The lens having an aperture of about 6 cm. with a focal length of about 12·5 cm., is secured in a ring, which carries an iris diaghragm of aperture 3 to 6 cm. The desired aperture is attained by means of the lever G. The ring hangs in a semi-circular sleeve, and is rotated by means of the knob K, about a horizontal axis capable of being clamped by the screw S*r*. The sleeve is screwed on to a rod S*t*, which a clamping screw S*r*[1] grips inside a rider or cylindrical foot. The lens is primarily useful for illumination in photomicrography, in case light sources with enlarged surface, such as incandescent gas and petroleum light, are used; it can be applied to the upright or sloping Microscope. With transparent light it must be used in conjunction with a condenser. With reflected light it can be used either alone or with a vertical illuminator. The instrument can be also used for ordinary microscopic work.

* Deutsche Mechaniker-Zeitung, No. 3 (Feb. 1, 1904) p. 28 (1 fig.).

(3) Illuminating and other Apparatus.

Watson and Sons' New Objective Changer.—This apparatus (fig. 69) was exhibited at the May meeting, and is fully described in the Proceedings of the Society (see *ante*, p. 382).

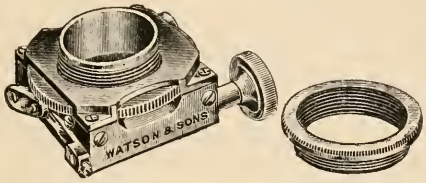

Fig. 69.

Fedorow, E. von—**Einige neue Hülfsapparate für das polarisationsmikroskop.**
Ann. Géol. et Minér. de Russie, iv. (1901), p. 142;
Zeitschr. Krystallogr., xxxvii. (1903) p. 413.

Metcalf, M. M.—**An electric lamp for Microscope illumination.**
Science Notes, xv. (1902) p. 937.

Patterson, W. L.—**A new changing nose-piece.**
Journ. Applied Micros., vi. (1903) p. 2162.

Schmidt, H.—**Ueber projections-und Vergrösserungsapparate.**
Centralzeitg. Opt. u. Mechan., xxiii. (1902) pp. 253, 265.

(4) Photomicrography.

Photomicrography of Rock Sections.* — This is one of the most interesting applications of the Microscope, says W. Forgan, and one to which, so far as can be learned, not much attention has been paid in photographic literature. The sections of rocks are so varied in their character that to very few of them can the same mode of lighting and illumination be applied. It may be stated generally that granite and its three components, quartz, felspar and mica, form the basis of all rocks. Many other chemical substances assist in giving character and variation in a greater or less degree; but the three components of granite are the ruling features in the whole of them. The chief use of the photography of rock sections may be said to be the production of lantern slides for teaching purposes. A good negative when reproduced in this way most materially assists in the illustration of a geological lecture. In fact, to a class, or in a lecture of a more popular form, such asssistance has now become indispensable. In the production of negatives from rock sections it is, with few exceptions, only necessary to use low magnifications. Only the other day a section of rock was asked to be photographed, having an elliptical shape, the major axis of which was over an inch in diameter. As no micro low-power objective covers more than $\frac{5}{8}$ in., recourse was had to a Zeiss Unar of $4\frac{1}{2}$-in. focus stopped down to f 11, and this gave a very fine sharp negative. The Microscope portion of the camera was removed, and a supplementary stage on an improvised suitable rigid easel was used to carry the section. Another method used for a different material

* Brit. Journ. Photography, li. (1904) p. 489.

may be mentioned, with which very fine results were obtained. If, for instance, one is required to take a negative of some grains of sand to show the character of any particular variety, the procedure may be as follows: Take an ordinary glass slip 3 in. by 1 in., give it a few strokes with virgin wax (white wax), hold the slip over a Bunsen burner, or spirit lamp, until the wax melts, which may then be spread with the finger, then sprinkle the sand over the melted wax, to which it adheres. The wax will cool at once. The slide is placed on the Microscope stage, with a piece of dead black paper behind it, and after focussing by means of a gas-jet or lamp, the illumination is made by burning a few inches of magnesium ribbon held behind the objective, and gently waved about. The objective used in such a case may be a 70 mm. by Zeiss, and a camera extension of about 18 in. A great number of rock sections, to enable them to be photographed well, require the use of polarised light to differentiate their structure, and many also as well the use of a depolarising selenite. Some of them show best for photographic purposes when examined with the crossed nicols only without the selenite, while others again absolutely require the selenite to reveal the structure properly. Agate and the various forms of felspar may be mentioned as rendering this illumination necessary; while, on the other hand, the selenite may not be used with many of the forms of granite, as the crystals of granite show so much colour that only the crossed nicols are required. No absolute rule can be laid down as to the mode of procedure either as regards the illumination required or the use of polarised light. Every one must just exercise his own discretion and skill in such matters. When a considerable experience with the Microscope is possessed by the operator no difficulty will be found in judging what is the best mode of operating to obtain the best results. One thing is essential above all others for success in this work, and this undoubtedly is that the sections must be thin. There is not much difficulty nowadays in getting thin sections compared to those which could be obtained some years ago. Another point is that the objectives used must be corrected for the chemical focus. It will not do to attempt this work with any ordinary micro-objectives. Even with the low powers which are, except in certain cases, only required, the results obtained must be sharp and clear. They have to be so, as, when projected by the lantern, defects become so very apparent. The illumination used by the writer is invariably magnesium ribbon. The image is first focussed by an ordinary lamp, which is then removed, and a small piece of brass tube, about $\frac{3}{16}$ in. in diameter, having been previously fixed in a shutter, and placed exactly in line with the optical axis of the Microscope, the magnesium ribbon is pushed through the tube and ignited. In this way the exposures are so short that little time is lost. No instructions, however, will render experience useless. It is only by long practice that any one can hope to succeed in any department of photography.

CROSBIE, F.—**Directions for Photomicrography.** *Lancet*, 1903, p. 233.

D'ARCY POWER, H.—**Laboratory Photography.** *Journ. Applied Micr.*, vi. (1903) p. 2282.

ELLIOTT, L. B.—Ditto. *Ibid.*, p. 2239.

FISCHER, H.—**Mikrophotogramme von Inulitsphäriten und Stärkekörnern.** *Ber. d. Deutsch. Botan. Gesellsch.*, xxi. (1903) p 107.

IVES, F. E.—**Eine photomikrographische Vorrichtung.**
Zeitschr. Opt. u. Mech., xxiv. (1903) p. 3.

" " **Stereoscopic Photomicrography with high powers.**
[The apparatus used seems to be much the same as that figured in Journal R.M.S., 1903, p. 224. The lenses, etc., were a Zeiss 3 mm. apochromat; 18 compensating eye-piece; amplification, 1700; Welsbach light; Cramer isochromatic plates without colour-screen. The objects were *Pleurosigma angulatum, Coscinodiscus asterocephalus*, and a *Triceratium*.
Trans. Amer. Micr. Soc., xxiv. (1902) pp. 23-7 (1 pl.).

MOLESCH, H.—**Bacterienlicht und photographische Platte.**
Anz. d. k. k. Acad. d. Wiss., Wien, 1903, p. 50.

(5) Microscopical Optics and Manipulation.

Jamin's Circle for Reflexion, Refraction and Polarisation.*—This instrument (fig. 70) is adapted for repeating the experiments on

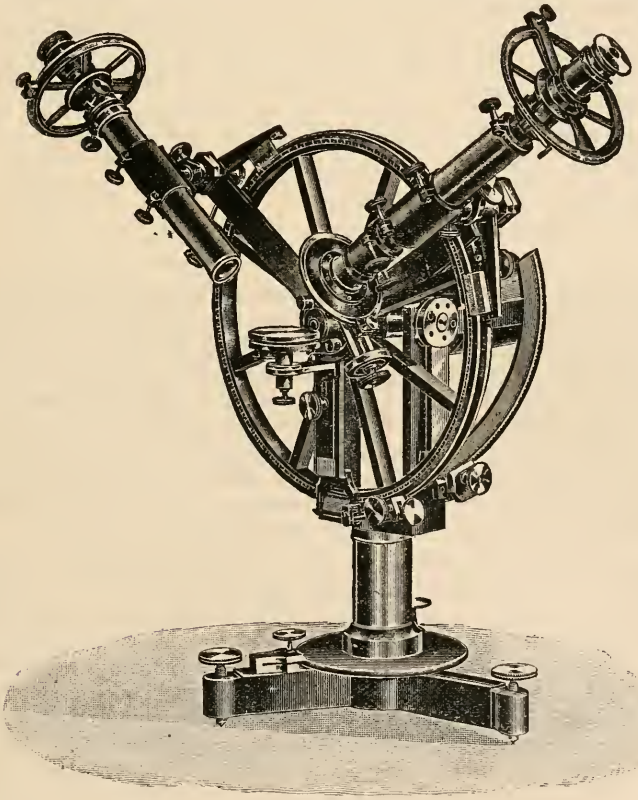

FIG 70.

the above branches of Optics as described in the *Cours de Physique de Jamin*.

* Catalogue of the Société Génévoise, 1900, p. 112, No. 2870.

New Kinds of Glass of Increased Ultra-violet Transparency.*—E. Zschimmer has renewed some earlier attempts to manufacture a glass at Jena, which should be less opaque to ultra-violet radiation than is usually the case. The only media at present known to answer the purpose are quartz, fluorspar, and molten silica; but these, excellent as they are, are never likely to come much into ordinary use. The result has been to discover a method, according to which various kinds of optical glass of large size can be produced; and these glasses are notably more transparent for ultra-violet than the best glasses hitherto known. Whilst with other glasses, 1 cm. thick, rays of wave-length 305 $\mu\mu$ are as good as completely absorbed, the new glass transmits about 50 p.c. of the original intensity.

The following table gives some of the optical constants of the new glass (U.-V. glass).

Title.	N_D	$(F - C)\,10^5$	$\frac{N^D - 1}{F - C} = \nu$
U.V. Crown, 3199	1·503	781	64·4
U.V. Flint, 3248	1·533	963	55·4
U.V. Flint, 3492	1·533	968	55·2
Heaviest U.V. Flint, S. 249 ..	1·653	1270	51·4

As for many purposes it is desirable that the visible spectrum should be excluded, the inventor has endeavoured to meet this want, and he has been so successful that the light as far as the blue is absorbed, while ultra-violet as far as 280 $\mu\mu$ is transmitted. This particular glass therefore serves as a filter for photography: it is called "Violet, U.-V. Glass" (No. 786'''). A U.-V. aplanat compared with an ordinary apochromatic aplanat in an astrophotographical test showed 359 stars in α Ursæ minoris as against 264. Other tests were equally successful. The glass is also produced as cover-glasses and window glass. A table of photographs shows very clearly the superiority of U.-V. glass.

Direct Micrometric Measurement of Fog Particles.†—C. Barus succeeded in this object by means of a compound Microscope, magnifying about 100 diameters, provided with a filar ocular micrometer. The objective and the whole lower part of the Microscope was submerged in the condensation chamber and suspended from a wide rubber cork through which it passed. All lenses below the cork were hermetically sealed with wax. The lower face of the objective was protected by a glass shield, whose underside was covered by perforated wet blotting-paper. Below this was a horizontal plate of thin microscopic glass covered with a film of oil, and attached to a vertical brass rod by a suitable clip. This rod passed through the cork and terminated in a small lever by which the glass plate could be rotated and focussed.

* Zeitschr. Instrumentk., xxiii. (Dec. 1903) pp. 360–2 (1 pl. of photos. of spectra).
† Amer. Journ. of Science, xvii. (1904) pp. 160–70 (5 figs.)

The part of the rod within the cork was enclosed in a small brass tube, soldered above and below the cork to the body of the Microscope tube. The lowest part of the small brass tube was arranged as a stuffing-box, so that no ingress of external air could take place, but the whole arrangement formed an eccentric focussing device whereby the oiled plate could be made to explore the atmosphere of the condensation chamber, and then rotated for examination into the proper position. The particles observed seem to have varied in diameter between ·0003 and ·0008 cm.

HARTMANN, J.—**Objectivuntersuchungen.**
[An article full of practical details regarding all varieties of optical errors.]
Zeitschr. Instrumentenk., xxiv. (Jan. 1904) pp. 1–12 (9 figs., 7 numerical tables).

PLANK, M.—**Uber die Extinction des Lichtes in einen optischhomogenen Medium von normaler Dispersion.**
[The author compares his results with those of Lord Rayleigh's paper, and finds that they agree.] *S.B. König. preussichen Akad. der Wiss.* xxii. (April 1904) pp. 740–50.

SATO TSUNEJI—**Zur Mikroskopischen Technik.**
[Recommendation to insert coloured glass or gelatin-paper between the mirror and condenser when examining by artificial light. Complementary colours should be employed, e.g. for saffranin, green; for methylen-blue, orange.]
Münchener Med. Wochenschr., l. (1903) p. 327.

(6) Miscellaneous.

Electro-thermic Regulator and Electric Incubators.*—Cl. Regaud and R. Fouilliand have applied the principles, considered by them in an earlier memoir,† to the construction of thermostats for biological laboratories. The subject is considered under five heads: (1) Mode of heating; (2) mode of regulation; (3) various details of construction; (4) practical results; (5) review of previous works upon electric heating and regulation of stoves.

Mode of Heating. The heat is entirely furnished from within, and is radiated from a series of bare wires coiled along the walls and floor of the cupboard. This method is considered much superior to one of radiation from a focus, such as an electric incandescent lamp. To produce uniformity of temperature the number of coils is diminished in the upper tiers and no coils are placed in the ceiling (fig. 71).

Mode of Regulation. The regulation, which is obviously of capital importance, is shown in fig. 72. It consists of a tube A B C D bent into a U. The part A B, or ampulla, is relatively wide and thin-walled; B C D is narrow and thick-walled. To the lower part of the ampulla a pouch G is soldered on. The wall of the thick tube is pierced by two platinum threads placed opposite one another. One of these tubes, E, is bent in the axis of the tube, and its pointed interior extremity is directed towards the elbow C; the other, F, is straight. The regulator is completely closed, and the extremities of the pouch G

* Zeitschr. wiss. Mikr., xx. (1903) pp. 138–68 (8 figs.).
† Chauffage et régulation des étuves par l'électricité. Journ. de Physiol. et de Pathol. Générale, 1900, p. 457.

and of the ampulla are sealed after filling. A B contains pure and dry hydrogen, whose pressure is in equilibrium with the column of pure

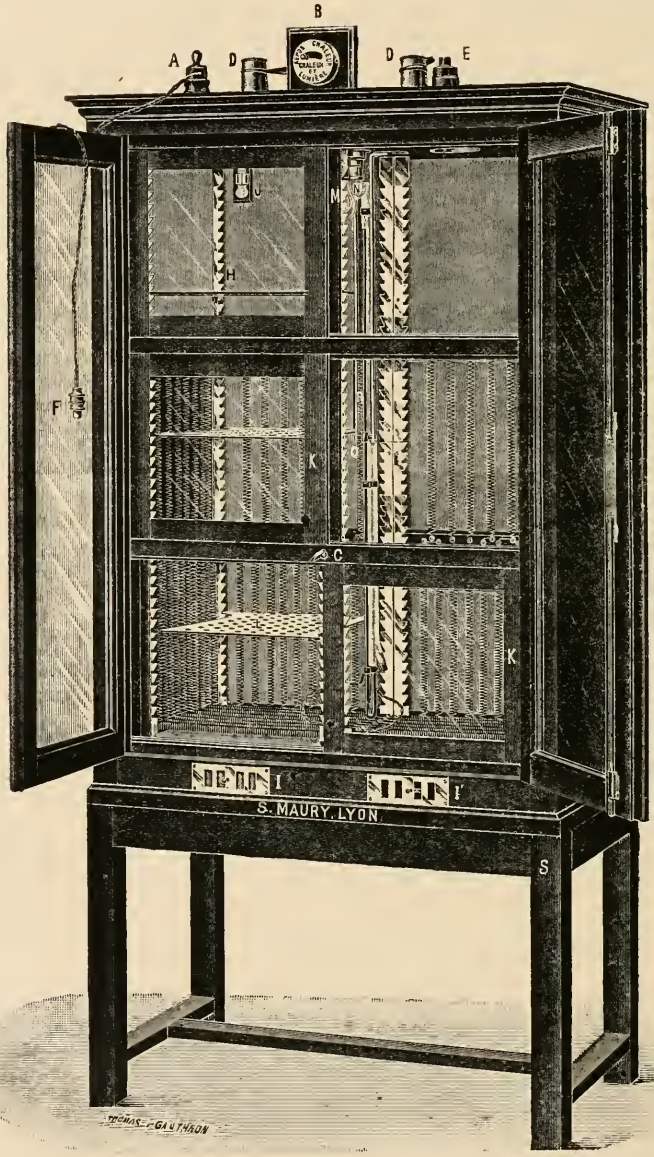

Fig. 71.

and dry mercury in B C D. Above the mercury in C D there is a barometric vacuum. When the regulator is vertical and at ordinary temperature (e.g. 15°) the inferior level of the mercury in B C is above the thread E. The total length varies between 45 and 75 cm., and the hydrogen pressure between 0·45 and 0·75 mm. of mercury, according to the size of cupboard. The regulator is intended to be suspended and in circuit with the heating wire. The current can only circulate when there is contact between the platinum thread E and the mercury; the level of the mercury in B C is dependent upon temperature variations of the hydrogen, the inclination of the regulator to the vertical and the allotment of the mercury between the pocket G and the tube B C D. The effect of each of these is separately considered by the designers. It will be understood that by inversion of the instrument the proportion of mercury and hydrogen in the limbs can be easily adjusted and that the increase of pressure, as the temperature is raised, of the hydrogen in A B will depress the mercury so that electric contact is at length automatically severed. The authors give tables for determining the adjustment.

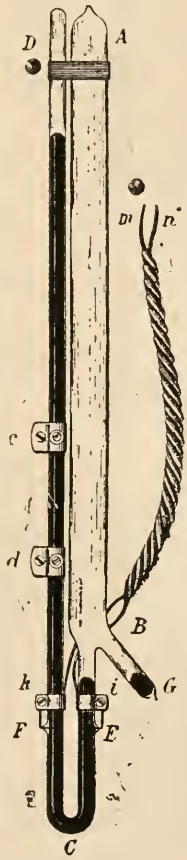

Fig. 72.

Various Details of Construction. The walls are made of wood, varnished externally; the wood is of two thicknesses, enclosing a layer of wadding and lined with glass. In the larger stoves there are two systems of doors, the inner ones being made to slide, the outer ones hinged. Certain modifications of these arrangements obtain in the smaller stoves. A rheoscopic lamp (fig. 73) is in the electric circuit, not for illumination but for signalling the interruption of current. This lamp is formed of a test-tube constricted so that the lower part is bulbous. Above this constriction is a block of paraffin fusible at the temperature at which the circuit is to work; above the paraffin is a small quantity of mercury into which pass the ends of the wires. This mercury ensures contact, and if, from any cause whatever, the temperature rises too high, the underlying paraffin is melted by the heat of the mercury, which thereupon falls into the bulb. In this way the contact is broken and accident from over-heating prevented.

Practical Results. The conditions of maintenance of uniform temperature are fully discussed, and, as an example of the working of the stove, the temperature statistics for a certain day are given. On that day the mean temperature of the stove was 37·9° C., the variations being within 37·7° and 38·2° C. The coefficient of loss of heat from small stoves was found to be greater than from large ones; or, in other

words, the working of large stoves is more economical. The authors are quite clear as to the overwhelming advantages of electric stoves, but admit that the cost of electricity must in many cases be a difficulty.

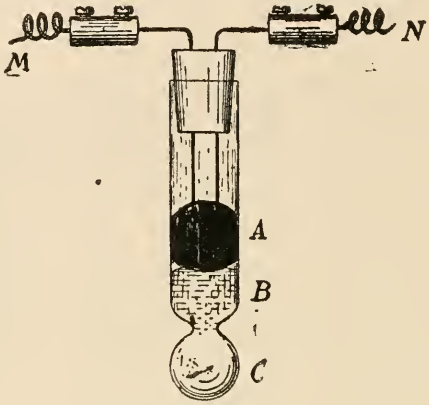

Fig. 73.

Review of Previous Works. This includes a bibliography in chronological order.

B. Technique.*

(1) Collecting Objects, including Culture Processes.

Apparatus for the Continuous Agitation of Cultures.†—E. Bodin and E. Cartex describe such an apparatus which they have found especially useful in obtaining homogeneous cultures of the tubercle bacillus.

It consists of a platform *a*, on which rest the tubes to be shaken. This platform is able to turn on a horizontal axis *b b*, and receives an alternating movement by means of a small roller *c*, rolling on an elliptical and eccentric cam *d*, connected by a shaft *e*, with a pulley *f*. The axis of rotation of the platform is constituted by two pegs of wood fixed to it opposite one another. These turn in two supports *g g*, fixed to the table *h*. Between the platform and the supports are two washers *i i*. The roller made of wood or of metal, and surrounded with india-rubber, turns between two pieces of copper, *j j*, 1 mm. thick. The shaft of the cam is a tube of copper or brass, 8 mm. in diameter and 1 mm. thick. The cam is fixed to the shaft by means of a pin. The shaft turns in two wooden supports, *k k*, the holes of which are lined with pieces of copper tubing, *l* D, of sufficient diameter to admit the shaft. Just outside the supports two pieces of the same copper tubing, *m m* A D, are fixed to the shaft to limit lateral movement. 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.

† Ann. Inst. Pasteur, xviii. (1904) pp. 264-6.

pulley of wood is fixed to a washer *n* C, soldered to a piece of the same copper tubing *o*, which is fixed to the shaft by a pin.

The apparatus can be placed in an incubator, e.g. that of Roux No. 2

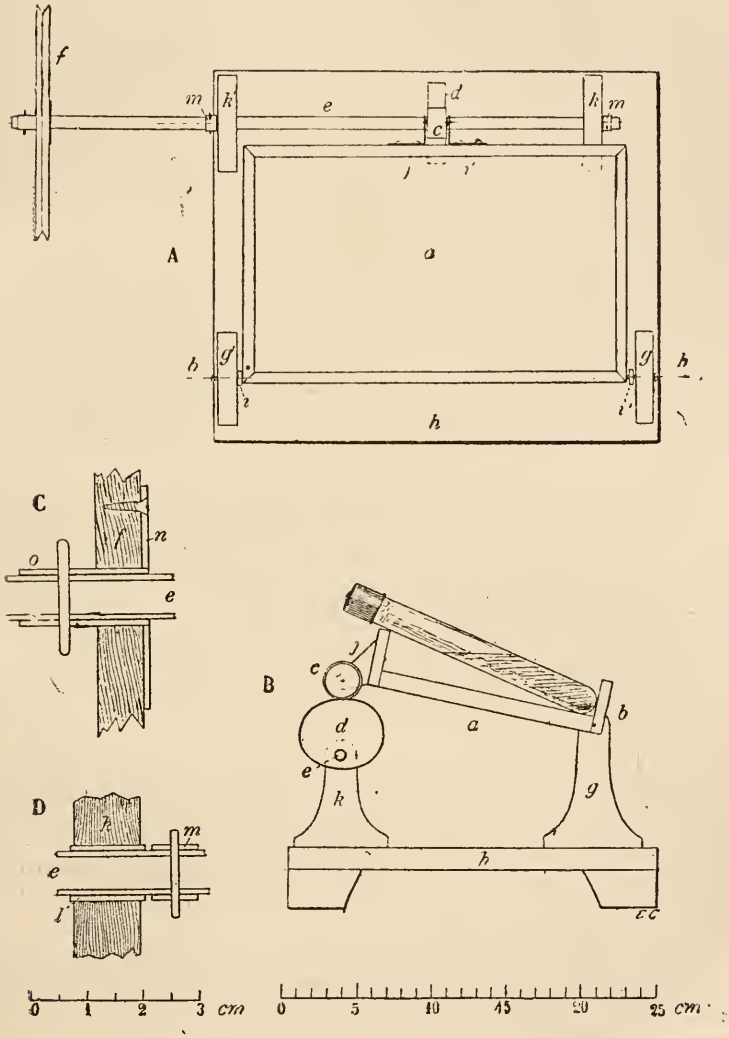

FIG. 74.

model of Weisnegg, the shaft projecting from one of the aerating apertures, and the pulley being thus outside. Movement is supplied by means of a turbine or small electromotor.

The inclination of the platform is such that the liquid contained in the tubes is not able to come in contact with the cotton-wool plugging them. When the apparatus is working the liquid is given a to-and-fro movement, which is sufficient to shake up the whole mass.

Pure Cultures of Diatoms.*—O. Richter has found that by the aid of the Koch-Beijerinck isolation method on agar cultivations of diatoms† can be obtained in a pure condition so that sub-cultures can be made on gelatin. The agar medium is made by washing 10 grm. agar in running water for 2 or 3 days, and then in distilled water, frequently changed, for one day. The mass is then dissolved in boiling distilled water, and after filtering, made up to 1000 c.cm. with distilled water. Then are added 0·2 grm. KNO_3, 0·2 grm. K_2HPO_4, 0·2 grm. $MgSO_4$, 0·2 grm. $CaSO_4$, and a trace of $FeSO_4$. The reaction of the agar should be slightly alkaline.

It was found that the $CaSO_4$ might be omitted with the advantage that 2 p.c., 1·5 p.c., 0·7 p.c., and 0·5 p.c. agar could be used.

The gelatin medium is made by soaking 100 grm. white gelatin in 700 to 800 c.cm. distilled water for two or three hours and then dissolving it. The solution is made up to 1000 c.cm., and then 0·2 grm. K_2HPO_4 and 0·2 grm. $MgSO_4$, and a trace of $FeSO_4$ added. The solution is made slightly alkaline with soda and cleared with egg-albumen.

New Method of Demonstrating Typhoid Bacilli.‡—W. Hofmann and M. Ficker recommend the addition of coffein to media as it inhibits the growth of *B. coli communis*, though it has little influence on other water bacteria. The medium used consisisted of beef 1 kilo., pepton 60 grm., salt 5 grm., water 1·5 litre, reduced to 1 litre by boiling. One part of this stock fluid is mixed with an equal bulk of 1·2 p.c. coffein solution. To 200 c.cm. of the mixture 1·4 c.cm. of 0·1 p.c. crystal-violet solution is added.

In this culture fluid some of the suspected stool is placed, and after 24 hours plates are made.

Demonstrating Typhoid Bacilli in Water.§—M. Ficker finds that when there are but few typhoid germs in water, the sediment may be enriched by precipitating with iron sulphate. To 2000 c.cm. of the water add 0·8 grm. sodium carbonate and 0·7 grm. sulphate of iron. In about two hours a sediment will have formed. The supernatant fluid is decanted off, and some of the deposit pipetted on to litmus-lactose-agar plates.

Preparation of Nutrose Agar.‖—J. W. H. Eyre gives the following improved method of preparing nutrose agar. This medium was originally devised by Drigalski and Conradi,¶ but the author has introduced important modifications.

A. (1) Emulsify 20 grm. pepton sicc. Witte in 100 c.cm. of dis-

* Ber. Deutsch. Bot. Gesell., xxi. (1903) pp. 493–8 (1 pl.).
† See this Journal, *ante*, p. 335.
‡ Hygien. Rundschau, xiv. (1904) p. 1.
§ Loc. cit.
‖ Trans. Path. Soc., lv. (1904) pp. 102–3.
¶ See this Journal, 1902, p. 371.

tilled water previously heated to 60° C.; (2) add 10 grm. sodium chloride; (3) emulsify 40 grm. powdered agar in 400 c.cm. cold distilled water, and mix with the pepton salt solution in a litre flask; (4) Dissolve the ingredients thoroughly by bubbling live steam through the mixture for half an hour, the flask being suspended in a bath of boiling water during the process.

B. (1) Measure out 500 c.cm. ox serum into a "tared" 3-litre flask, and add to it 900 c.cm. distilled water; (2) heat in the steam chamber at 100° C. for half an hour.

C. (1) Add the agar mass to the diluted ox serum, shake thoroughly to mix, and weigh the mixture; (2) titrate the mixture and add sufficient $\frac{n}{1}$ NaOH to adjust the reaction of the mixture to $-3 \cdot 5$; (3) emulsify 20 grm. nutrose in 100 c.cm. distilled water, add the emulsion to the mixture in the flask and heat in the steamer for 30 minutes; (4) weigh the mixture and make up to 2090 grm. by the addition of boiling distilled water; (5) titrate again, and add sufficient standardised $\frac{n}{1}$ lactic acid to render the reaction $+2 \cdot 5$; (6) cool to below 60° C., add the well-beaten whites of four eggs, and heat again in the steam chamber for 30 to 45 minutes; (7) filter through papier chardin with a tared 2-litre flask, and weigh the filtrate; about 1900 grm. or c.cm. clear agar will be obtained: (8) fill the nutrose agar into small flasks in quantities of 150 c.cm.; (9) if not needed for immediate use, sterilise in the steamer at 100° C. for 20 minutes on each of three successive days.

D. (1) Take as many sterilised test-tubes as there are 150 c.cm. flasks of medium, and fill 20 c.cm. Kuhlbaum's litmus solution into each; (2) heat in the steamer at 100° C. for 20 minutes; (3) weigh out and dissolve 1·5 grm. lactose in each tube of litmus solution; (4) add 1·5 c.cm. of a 0·01 p.c. solution of crystal violet (B. Höchst) to each tube; (5) sterilise in the steamer at 100° C. on each of three successive days.

Preparing Plates of Nutrose Agar.* — J. W. H. Eyre gives the following method of making plates of nutrose agar: (1) Liquefy a flask of nutrose agar (for composition and mode of preparation see *ante*) by immersion in a water-bath at 100° C. As soon as the medium is fluid add the contents from one of the prepared test-tubes and mix thoroughly. (2) Pour the coloured fluid medium into sterile Petri dishes to the depth of 3 or 4 mm. One flask (of 150 c.cm.) will supply sufficient medium for about six Petri dishes of 11 cm. diameter. (3) Open each plate and rest the edge of its cover on the side of the lower half, and so allow the steam to escape freely whilst the agar is solidifying. (4) When the medium has set, open and invert the Petri dishes and place in an incubator at 60° C. for 45 minutes, or at 42° C. for 2 hours. At the end of this time the surface of the medium will be firm and dry and ready to inoculate. (5) The material to be plated must first be suspended in either sterile salt solution or sterile broth,

* Trans. Path. Soc., lv. (1904) p. 104.

and a few drops of the emulsion deposited on the surface of the medium in one of the plates by means of a platinum loop, resting the lid of the plate on the bench during the process of inoculation. (6) Smear the suspension over the surface of the medium by means of the short-arm of an L-shaped sterilised glass rod. (7) Without sterilising or recharging the rod smear the surface of a second plate, then a third, and if necessary a fourth. (8) Cover the plates, invert them, label the under surface which now is uppermost, and incubate (still in the inverted position) at 37° C.

Nets for Gathering Plankton.*—J. Richard describes two nets for obtaining plankton. The first is made of coarse packing cloth at about 5*d.* a yard. The cloth is attached to a strong square iron frame, the sides of which are 3 metres long. The length of the net is about 6 metres, and its bottom is formed by a pail supported by means of cords to the iron frame. It is heavily weighted, and is employed for gathering at considerable depths. The other is a simple net 50 cm. long, with an opening of 6 cm. This is allowed to trail on or near the surface. Both nets have given great satisfaction and are very easily and cheaply made.

(2) Preparing Objects.

Fixative Solutions Isotonic with Sea Water.†—M. C. Dekhuyzen makes a fixative solution isotonic with sea water by mixing 250 c.cm. of 2·5 p.c. potassium bichromate dissolved in filtered sea water; to this, 25 c.cm. of 6·3 p.c. nitric acid and 54 c.cm. of 2 p.c. osmic acid are added. The specific weight of this fluid is 1·038 at 20° C. Its great advantage is that it can be mixed with sea water without altering the osmotic pressure. It fixes the blood-cells of *Sipunculus nudus* admirably, and is equally successful with other organisms such as Cydippa, Terebellina, etc. For fixing organisms which contain calcareous matter, such as larvæ of sea-urchins, the author has devised an isotonic fluid which does not contain free acid. This is prepared by mixing 26·9 c.cm. of 2 p.c. osmic acid and 173·1 c.cm. of 2·5 p.c. bichromate of potash in filtered sea water.

Picroformol for Fixation.‡—A. Guilliermond, for studying the formation of asci and the epiplasm of Ascomycetes, used Maire's modification of Bouin's picroformol. Formalin 40 p.c., 30 grm.; acetic acid, 5 grm.; distilled water, 20 grm. Picroformol to saturation.

Preparing, Staining and Mounting Fresh-water Fauna.§—K. [illegible] recommends a funnel-shaped silk gauze net for catching [illegible] fauna, which should be transported to the laboratory in glass vessels. The great secret of obtaining a successful preparation depends on the skilful use of narcotics. These should be used in very dilute solution, and the palsy of animals awaited with patience. The animal to be mounted should be removed with a pipette to a slide, and on this the rest of the manipulation carried out. The narcotising fluid

* Comptes Rendus, cxxxviii. (1904) pp. 1436–7.
† Tom. cit., pp. 415–7; 445–7. ‡ Rev. gén. Bot., xvi. (1904) p. 49.
§ Zeitschr. ungew. Mikr., x. (1904) pp. 5–8.

is then to be mixed with the water in which the animal is swimming. The narcotic may be cocain, of which a drop of 1 p.c. solution is usually sufficient to numb and kill the animal in about 10 minutes. Chloral hydrate $\frac{1}{5}$ to $\frac{1}{10}$ p.c. is also good, especially for Bryozoa. The best narcotic is hydroxylamin in $\frac{1}{10}$ to $\frac{1}{4}$ p.c. aqueous solution. But as the commercial article often contains hydrochloric acid, it is necessary to neutralise carefully with soda before using.

The animals are next to be fixed by means of the usual methods, but if cocain has been used for narcotising, corrosive sublimate must not be employed, as a copious precipitate forms; and as hydroxylamin has a strongly reducing action, easily reducing fixatives should be avoided. Instead of ordinary fixatives graduated alcohols answer well. If it be necessary to bleach the animal, peroxide of hydrogen in 1 p.c. solution, much diluted eau de Javelle, or magnesium peroxide may be used.

The preparation should now be thoroughly washed, and is then ready for staining. Mayer's paracarmin is very good for this purpose, and it is prepared as follows: 1 grm. carminic acid, $\frac{1}{2}$ grm. chloride of aluminium, 4 grm. calcium chloride are dissolved in 100 c.cm. of warm 70 p.c. alcohol. The object to be stained should not have an alkaline reaction, and should be washed with a weak solution of aluminium chloride in alcohol.

Nikiforow's neutral borax carmin is also serviceable. This consists of 3 grm. carmin, 5 grm. borax, which are boiled in 100 c.cm. of water. As much ammonia as will dissolve the carmin is then added, and the mixture evaporated down to half its bulk. Dilute acetic acid is then added until the cherry-red colour disappears. This solution should be diluted when used. The preparation should then be dehydrated if it is to be mounted in balsam. But a better medium is prepared as follows: (1) Pyroxylic acid with a little salicylic acid diluted freely with water and glycerin. (2) Ten parts of selected gum arabic are dissolved in 10 parts of water and 5 parts of glycerin, and a little camphor is added. Equal parts of the two solutions are mixed together when required.

As a substitute for Canada balsam, Vosseler's turpentine mixture is recommended. This is prepared by mixing equal bulks of Venetian turpentine and 96 p.c. alcohol in a tall vessel, which is placed in some warm situation. After 3 or 4 weeks the clear supernatant fluid is decanted off. Mounted in this medium, the fine details of an object stand out excellently well.

Fixing and Examining Cyrripida Larvæ.* — H. Rössig, for his researches on gall-formation, mostly used sublimate for fixing the larvæ. The solution employed was Petrunkewitsch's modification of Gilson's formula. This was used hot for a few seconds, the larvæ being afterwards transferred to a cold solution. Flemming's and vom Rath's fluid were also used, but the internal parts were often cloudy.

After the larvæ had remained in the sublimate for 2 to 12 hours, they were washed in 70 p.c. alcohol to which iodine was added. The

* Zool. Jahrb., xx. (1904) pp. 28-9 (4 pls.).

objects were then hardened in 96 p.c. and in absolute alcohol, and afterwards passed through xylol to paraffin. For young larvæ ½ to 1 hour in melted paraffin was sufficient; the larger ones on account of the fat bodies required several hours.

Longitudinal and transverse sections were made, the former being both sagittal and frontal. In thickness the sections varied from 2½ to 15 μ, according to the size and the cuticular density of the animal. The sections were stuck on with glycerin albumen, but occasionally with water; they were then stained and imbedded in balsam. The stain mostly used was Böhmer's hæmatoxylin followed by picrocarmin, but other pigments were also tried.

Preparing and Demonstrating the Structure of Arenicola.*—J. H. Ashworth adopts the following procedure for making sections of Arenicola (lugworm). It is advisable to use specimens not longer than 6 in., as longer ones are difficult to deal with on account of the hardness of the musculature. The sand is first removed from the alimentary canal by keeping the animals for 4 or 5 days in sea water. When free from sand, absolute alcohol is dropped in until the water contains about 5 p.c. After a few hours the animals will be sufficiently narcotised and may then be killed in the extended condition by treating them with sublimate acetic (95 parts sublimate and 5 parts glacial acetic acid) for a few hours. On removal, the worms are washed in fresh water and then transferred to alcohols of increasing strength (50, 70, 90). To the last, iodine is added to remove the sublimate. Pieces intended for sectioning are then dehydrated in absolute alcohol (three changes) and then cleared up with xylol or, preferably, cedarwood oil. The pieces are next impregnated with paraffin in the usual way. Wax with a melting-point of 56° to 58° C. is best for Arenicola.

The best staining results were obtained with iron-alum-hæmatoxylin, but borax carmin, acid hæmalum, Grenacher's and Delafield's hæmatoxylin were also used.

Modification of Zenker's Fluid.†—K. Helly recommends the following modification of Zenker's fixative: it consists of potassium bichromate 2·5, sulphate of soda 1, sublimate 5, distilled water 100. To 100 parts of this fluid are added, immediately before use, 5 parts of formalin. This solution works better at incubation temperature, and should not be allowed to act for more than 6 hours. The after treatment is the same as for Zenker's fluid, viz. thorough washing, graded alcohols, and iodine alcohol to remove sublimate.

Dowdy, S. E.—**Preparing Diatoms.** *English Mechanic*, lxxix. (1904) p. 194.
Smith, H. E.—Ditto. *Loc. cit.*

(3) Cutting, including Imbedding and Microtomes.

Preparation of Frozen Sections by Means of Anæsthol.‡—Katz advocates for the above purpose the use of anæsthol, a solution of

* Liverpool M.B.C. Memoirs, xi. (1904) 118 pp., 8 pls.
† Zeitschr. wiss. Mikr., xx. (1904) pp. 413–5.
‡ Deutsche Med. Wochenschr. (1903) No. 24, p. 331. See also Centralbl. Bakt. xxxiv. (1904) Ref. pp. 652–3.

methyl-chloride in ethyl-chloride, having its boiling-point at 4° C. When an object is exposed to a spray of anæsthol it very quickly becomes frozen. Alcohol-hardened preparations should be placed for a few hours, and fresh preparations for a few minutes, in formalin before being frozen.

NEUHAUS, E.—**Beitrag zur mikroskopischen Technik.**
[On the value of the freezing method, and on the superiority of ethyl chloride as a freezing agent over ether.]
Deutsche Med. Wochenschr., xxix. (1903) pp. 569–70.

RAMÓN Y CAJAL, S.—**Un consejo util para evitar los inconvenientes de la frabilidad y arrollamiento de los cortes en los preparados de Golgi y Marchi.** (Device for obviating the brittleness and curling up of sections prepared by the Golgi and Marchi methods.) *Trabajos lab. investigacion biol. Madrid.* ii. (1903) pp. 99–100.

(4) Staining and Injecting.

Concretions in Acetic-methyl-green.*—E. André calls attention to the concretions which form in acetic-methyl-green, and points out that their presence may give rise to some confusion, as they present the appearance of organised bodies. They look something like starch-grains, are concentrically laminated, are liable to linear fracture, are round, ovoid, or occasionally of irregular shape. They begin to deposit themselves in from 2 to 3 months; at first are very small, but eventually may attain a considerable size. They are easily dissolved by alkalis, are not attacked by weak acids, and are coloured yellow by iodopotassic iodide.

Hæmatein and Hæmalum.†—P. Mayer writes that for some time past he has made hæmalum directly from hæmatoxylin by oxidation with sodium iodate, $NaIO_3$, and that he has recently prepared hæmateïn in a similar way. For the complete conversion of hæmatoxylin into hæmateïn, nine parts of the former to two of the latter would suffice; but in order to avoid too strong oxidation it is advisable to mix them in the proportion of 10 to 2.

One gramme of hæmatoxylin is dissolved in 10 c.cm. of distilled water by boiling; to the hot solution is added 0·2 grm. of sodium iodate dissolved in about 2 c.cm. of water. The mixture is well shaken and then cooled by placing the vessel in cold water.

The hæmateïn comes down as minute spherules or as microscopic crystals. The deposit is placed on a filter and washed with cold water to get rid of any sodium iodide. The hæmateïn is then dried at room temperature or with moderate heat.

To make hæmalum, 1 grm. of hæmatoxylin is dissolved in water by boiling. The solution is made up to 1 litre with water; 0·2 grm. sodium iodate and 50 grm. alum are added and allowed to dissolve at ordinary temperature. When quite dissolved the mixture is filtered, and is then ready for use.

After a lapse of time hæmalum becomes liable to the formation of scum on the surface, and a sediment. These may be avoided by the addition of both chloral-hydrate and citric acid; of the former, a

* Zeitschr. wiss. Mikr., xx. (1904) p. 412. † Tom. cit., pp. 409–11.

quantity equal to that of the alum used; of the latter, as much as the hæmatoxylin. These additions impart to the hæmalum a red-violet hue. The stained sections should be treated with tap-water to bring out the blue.

Both preparations can be obtained ready-made from Grübler, of Leipzig.

Modified Nocht's Stain for Blood Films.*—T. W. Hastings gives the following modification of Nocht's stain. Three solutions are required: (A) 1 p.c. eosin; (B) 1 p.c. alkalin-methylen-blue; (C) 1 p.c. methylen-blue. B is prepared by adding to a warm 1 p.c. solution of dry sodium carbonate 1 p.c. of methylen-blue powder. The mixture is heated over a water-bath for 15 minutes, and 30 c.cm. of water added for each 100 c.cm. of original fluid to replace loss by evaporation. After heating a second time over a water-bath for 15 minutes, the warm alkalin-methylen-blue solution is poured off from the gummy residue, partially neutralised with 5 to 6 c.cm. of 12·5 p.c. acetic acid, and mixed with solutions A and C as follows: Distilled water, 1000 c.cm.; eosin solution A, 100 c.cm.; alkalin-methylen-blue solution B, 200 c.cm.; methylen-blue solution C, until a fine precipitate forms (from about 70 to 80 c.cm.). This mixture of three solutions is allowed to stand for ½ to 1 hour, filtered through one filter, the residue allowed to dry in the air for 24 to 36 hours, and then dissolved in methylic alcohol. About 0·3 grm. will dissolve 100 c.cm. of methylic alcohol, but must be rubbed well in a mortar with pestle to obtain solution.

To use the stain no fixation is required. The dried blood smears are flooded with the staining solution for 1 minute; the solution is then diluted with distilled water (a few drops), and the diluted stain allowed to act for 5 minutes. The specimen is then washed thoroughly with distilled water and mounted in the usual way.

Staining the Myelin in Sections of Nervous Tissue previously treated by Marchi's Method.†—S. Ramón y Cajal recommends the following procedure. Thin sections are first washed in distilled water, and then placed for 24 hours in the following solution: Hydrochinon 4 grm., water 100 grm., glacial acetic acid 5 grm. After washing in distilled water for a few seconds they are transferred to silver nitrate solution: silver nitrate 1 grm., water 100 grm., ammonia 1 drop. After 10 minutes the sections are re-transferred to the hydrochinon solution for 2 to 5 minutes. After a rapid washing in distilled water they are placed again in the silver bath for 5 to 10 minutes. On removal they are again washed and then placed in a decolorising fluid, composed of potassium ferricyanide 1 grm., water 100 grm., potassium carbonate 0·5 grm. Herein they remain until the white substance has assumed a pale brown hue (from 2 to 5 minutes). The sections are then immersed for 2 to 5 minutes in a 12 p.c. solution of sodium hyposulphite. After this the sections must be washed in several changes of water, and then treated with 40 p.c. and absolute alcohol; this last step must be done rapidly in order not to damage the celloidin. They are then cleared up in bergamot oil and mounted in dammar.

* John Hopkins Hosp. Bull., xv. (1904) pp. 122–3.
† Trabajos Lab. Investigacion biol. Madrid, ii. (1903) pp. 93–7.

Methods for Silver Impregnation of Nervous Tissue.*—S. Ramón y Cajal describes the following methods for impregnating nervous tissue with silver.

1. Method specially adapted for the fibrils of small and medium-sized cells. Pieces of tissue about 3 mm. thick, and as fresh as possible, are immersed in a 0·75 to 3 p.c. solution of silver nitrate in distilled water, and incubated for 3 days at from 30° to 35° C. On removal, the pieces are washed for a minute or two in distilled water, and placed in the following reducing medium for 24 hours: Pyrogallic acid or hydrochinon 1 to 2 grm., water 100 grm., formalin 5 grm. The pieces are washed for some minutes in distilled water, hardened in alcohol and imbedded in celloidin.

2. Method adapted for medullated nerves and the fibrils of the large cells. The pieces of tissue are fixed for 24 hours in 97 p.c. alcohol. After washing in distilled water for a few seconds, the pieces are immersed in 1 p.c. silver nitrate solution and incubated at from 30° to 35° C. After washing for a few seconds the pieces are placed in a reducing solution composed of hydrochinon 2 grm., water 100 grm., formalin 5 grm. The reduction may be hastened by the addition of 0·5 grm. sodium sulphite. The pieces are then washed, dehydrated and imbedded in celloidin. Should the sections from the deeeper parts be insufficiently impregnated they are to be treated with the following gold solution: Ammonium sulphocyanate 3 grm., sodium hyposulphite 3 grm., gold chloride 1 p.c. solution (a few drops). The sections are washed, dehydrated, cleared up and mounted in dammar.

3. Method for staining non-medullated fibres and terminal twigs. The pieces are fixed for 3 days in alcohol, but all the other steps are the same as in the two previous methods.

4. Staining the fibrils of large cells and of fine nerve-fibres. The pieces of tissue are placed in the following solution: Alcohol 97 p.c. 100 c.cm., ammonia 0·5 to 1 c.cm. If the pieces are large or numerous a 1·5 ammoniated alcohol solution may be used, or the immersion may be prolonged up to 2 days.

The preparations are next washed in water, and then transferred to 1·5 p.c. silver nitrate solution; after which they are treated with the reduction fluid previously described.

The best results were obtained by an immersion of the pieces for 24 to 36 hours in the ammoniated alcohol. Should the sections be insufficiently impregnated they may be afterwards treated with the gold chloride solution. Instead of alcohol, ammoniated formalin may be used, e.g. formalin 20 c.cm., water 100 c.cm., ammonia 0·5 c.cm. The pieces must be washed in running water for 24 hours in order to get rid of the formalin before they are placed in the silver nitrate solution.

Demonstrating a Parasite Found in Cases of Enlarged Spleen.† S. R. Christophers, in a preliminary report on a parasite found in persons suffering from enlargement of the spleen in India, employed the following method for demonstrating their presence in the tissues.

* Zeitschr. wiss. Mikr., xx. (1904) pp. 401–8.

† Scientific Mem. Med. and San. Departs., Govt. of India, No. 8 (1904) 17 pp., pl 1.

Fix in absolute alcohol or in saturated aqueous solution of sublimate. Embed in paraffin. Stain the sections for 10 to 15 minutes in 1 to 1000 eosin. Pour off excess of eosin and mop up with filter-paper. Stain for 15 to 20 minutes with methylen-blue solution prepared as follows: 100 c.cm. medicinal methylen-blue solution in distilled water, 5 c.cm. of 10 p.c. solution of sodium carbonate. Leave in sunlight till deep red colour is seen on shaking. Dilute 25 times for use. Pour off excess of stain and wash rapidly in 70 p.c. alcohol. Transfer to water. If too blue, wash in 0·25 p.c. acetic acid and then in water. Allow the section to dry on the slide. Mount in balsam or keep as a film moistened with cedar oil.

BIELSCHOWSKY, M.—**Die Silberimprägnation der Neurofibrillen.** *Neurol. Centralbl.*, xxii. (1903) pp. 997–1006 (5 figs.).

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

New Mounting Device.—This apparatus (fig. 75) by Watson and Sons was exhibited at the May meeting, and was described by Mr. Watson Baker (see *ante*, pp. 382–3).

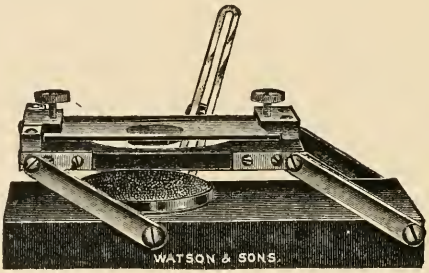

FIG. 75.

(6) Miscellaneous.

New Method for Sterilising Vessels.* — Rothenbach states that flasks and other vessels can be effectually sterilised by merely inverting a glass cap over the neck or other opening of the apparatus.

Differentiation of B. typhosus and B. coli communis by Means of the Photographic Plate.†—W. C. Stevenson claims to be able to differentiate *B. typhosus* from *B. coli communis* by means of their action on the gelatino-bromide photographic plate. His method is as follows: Cultures of the bacilli are made in broth, samples of the same broth being used for each culture. After, say, 24 hours, a few drops of each culture are placed upon the sensitive surface of the plate, and spread out so as to wet an area of any desired extent. This is done in a faint red light. The plates are then covered up, and allowed to stand for 40 minutes. They are then developed in the usual way. It will be found that the moistened areas develop with very different densities

* Deutsche Essigindustrie, vii. No. 37. See Centralbl. Bakt., 2te Abt. xii. (1904) pp. 152–3. † Brit. Med. Journ., i. (1904) p. 1004.

of silver deposit. The coli culture produces a full and marked reduction of the salt, but with the typhoid culture only a very faint deposit is, in general, obtained.

Kingsford's Glass Troughs.—For the description and purposes of these troughs (figs. 76, 77) see *ante*, p. 383.

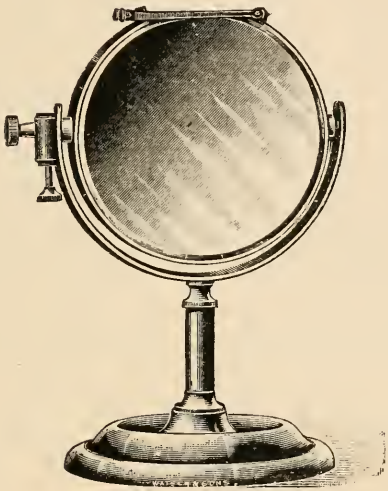

Fig. 76.

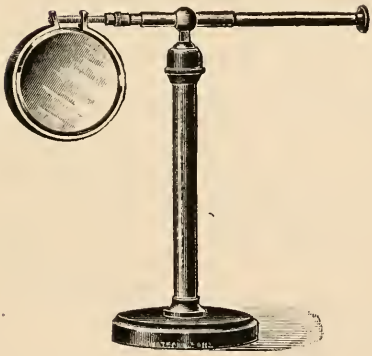

Fig. 77.

Ebonising Laboratory Tables.*—W. J. Wood states that any kind of wood may be stained by the following method: (*a*) 250 grm. of anilin chloride dissolved in 1 litre of water. This solution is applied daily for 2 or 3 days. (*b*) 125 grm. of sulphate of copper dissolved in 80 grm.

* Journ. Quekett. Micr. Club, ix. (1904) pp. 67–8.

of boiling water, and 125 grm. of potassium chlorate dissolved by boiling in about 250 grm. of water. These solutions are mixed together while quite hot, then allowed to cool. Then filter, and dilute the filtrate to 1 litre. This solution is applied to the wood the same as *a*, the wood being allowed to dry thoroughly after each application. (*c*) At the end of this operation all crystals covering the surface of the wood are to be washed off with clean water. (*d*) Once more dry the wood thoroughly and then paint over with cottonseed or raw linseed oil. Leave the oil for one day and then rub dry. This preparation takes about six days, allowing two days for *a*, two for *b*, one for *c*, and one for *d*. The result is a beautiful black surface, which will withstand the usual reagents used in biological work.

Preparing Lantern Slides of Histological Objects.*—J. Cameron employs the following method of making lantern slides, the chief advantage being that it saves the trouble and expense of preparing photographs. The first requirement is a set of glass plates, lantern size, finely ground on one surface. Camera lucida tracings are made of the desired specimen on the ground surface. A sheet of white paper placed behind the plate makes the object more distinct. Flaws or inaccuracies in the drawing are easily removed by means of a wet cloth. When the drawing is complete the surface of the plate is covered with a layer of transparency varnish. The film should be thin, and care should be taken that the plate is quite dry before the varnish is applied.

Instead of making a drawing directly on the plate, a tracing on paper may be placed under the plate and the outlines of the object copied indirectly.

After the varnish has become quite dry it is best to place a lantern slide cover-glass over the plate ; a suitable form of lantern slide mask being previously inserted between the two in the usual way.

Prints from these slides may be made, and, though negatives, are useful for handing round during a communication.

ABEL, R.—**Taschenbuch für den bacteriologischen Praktikanten, enthaltend die wichstigsten Detailvorschriften zur bacteriolgischen Laboratoriumsarbeit.** *7 Aufl. Würzburg* (Stuber, 1903) 108 pp., 8vo.

KAMEN, L.—**Anleitung zur Durchführung bacteriologischen Untersuchungen für Klinisch-diagnostiche und hygienische Zwecke.** Wien (Safár, 1903) 311 pp., 8vo, 118 figs., 12 plates.

ŘEZNIK, B.—**Technika mikroskopická.** *Brünn*, 1903, 168 pp. 8vo.

MERLIN, A. A. C. E.—**Amphipleura pellucida (Resolution of).** *English Mechanic*, lxxix. (1904) p. 284.

TREADLE—**Amphipleura pellucida (Resolution of).** *Tom. cit.*, p. 63.

„ „ **Diatom resolving.** *Tom. cit.*, pp. 84–105.

„ „ **Pinnularia nobilis (Resolution of).** *Op. cit.*, lxxviii. (1904) p. 554.

„ „ **Ditto.** *Op. cit.*, lxxix. (1904) p. 35.

„ „ **Pinnularia nobilis (Resolution and Structure of).** *Tom. cit.*, p. 14 (1 fig.).

VILLAGIO—**Resolution of Diatoms, etc.** *Tom. cit.*, p. 193.

* Proc. Scot. Micr. Soc., iii. (1904) pp. 350–2.

Metallography, etc.

Sorbitic Steel.*—H. C. Boynton finds that: (1) Furnace-cooling of an under-saturated steel produces ferrite and *pearlite*; (2) air-cooling of the same steel produces in samples of relatively small section, ferrite and *sorbite*; (3) the composition of sorbite depends upon the rate of cooling; (4) the carbon in sorbite is partially in the hardening condition, therefore all specimens subjected to "colour analysis" should be previously annealed; (5) air-cooling of a supersaturated steel greatly increases the tensile strength and elastic limit, producing a structure made up of pearlite containing an excess of cementite, and less free cementite than under-furnace cooling.

DUDLEY, P. H.—**Unit Fibre Stresses in the Base of Steel Rails.**

[Microscopical measurements and investigations of autographically-recorded strains in the base of steel rails under moving locomotives, cars and trains, to ascertain the apparent mean unit fibre-strains of the extreme fibres of the metal, and some of the experimental laws of their distribution.]

Journ. New York Micr. Soc., Annual of 1902, pp. 23–42.

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* Iron and Steel Mag., pp. 470–80 (80 photomicros.).

PROCEEDINGS OF THE SOCIETY.

MEETING

HELD ON THE 15TH OF JUNE, 1904, AT 20 HANOVER SQUARE, W.
DR. D. H. SCOTT, F.R.S., ETC., PRESIDENT, IN THE CHAIR.

The Minutes of the Meeting of the 18th of May, 1904, were read and confirmed, and were signed by the President.

The List of Donations to the Society, exclusive of exchanges and reprints received since the last Meeting, was read :

	From
Two Slides of Diatoms, mounted by E. Thum in realgar, on flint glass slips, the covers being also of flint glass	*Mr. C. Lees Curties.*

The Secretary said the Society was much indebted to Mr. Curties for the two test slides mounted in realgar. They would replace a pair of similarly mounted slides which had so deteriorated owing to the decomposition of the mounting medium that they were now useless.

The thanks of the Society were voted to Mr. Curties for his donation.

Mr. Thos. Powell exhibited a $\frac{1}{40}$-in. apochromatic homogeneous immersion objective of his own make, which he thought might be of some interest as it was not likely that he would be able to make many more.

Prof. Hartog exhibited, under the Microscope, a slide prepared and lent to him by Prof. Vejdovsky, which showed with remarkable distinctness the first segmentation spindle and centrospheres in the embryo of Rhynchelmis, a somewhat rare species of leech. This was so large that it could be seen with a pocket lens and was very distinctly shown under a $\frac{1}{4}$-in. objective with a B eye-piece—usually much higher powers were required to see these things. The slides showed that with all the wealth of detail which appeared in the very beautiful drawings made by Prof. Vejdovsky * nothing had been added which could not be seen in the specimens, and that these drawings were faithful representations. It was interesting to notice the remarkable resemblance between this development and what was seen in the field of force between two unlike magnetic

* See Vejdovsky and Mrázek, "Umbildung des Cytoplasma während der Befruchtung und Zellteilung," Nach den Untersuchungen am *Rhynchelmis* Eic.: Archiv. Mikr. Anat., lxii. (1903) pp. 431–579.

poles. This and other slides which had been lent to him had shortly to be returned to Prague, but he had brought them to the Meeting thinking the Fellows of the Society would like to see such interesting and valuable preparations.

The President said he had seen this specimen under a pocket lens which showed the spindle quite distinctly. The extraordinary development of the asters at the poles was very interesting. Among the largest spindles to be found among plants were those in the pollen tubes of the Cycads.

The thanks of the Society were voted to Prof. Hartog for his exhibit.

Mr. Beck exhibited a portable Microscope, designed by Mr. Arthur Hollick. The whole was packed in a mahogany box, the bottom of which could be detached and then formed the base on which the Microscope was fixed. The instrument was used chiefly for the examination of botanical objects, but was equally useful for other purposes, and the mirror was so mounted that it could be used as a reflector above the stage in the proper position to converge the light upon the object—swinging with the object as a centre. The socket which formed the eye-piece holder when the parts were packed in the box, was utilised as a lamp holder, when in use, enabling Microscope and lamp to be handed round in a class without disturbing their relative positions. A rotating cell made of cardboard formed a convenient revolving object holder, and a simple method of mounting specimens in pill-boxes had also been devised. Another point of some interest was the manner in which the front of the objective had been coned off so as to reduce it to the dimensions necessary to admit just as much light and not more than could be utilised by the back lens. The objective exhibited was a $\frac{1}{6}$ in. coned off in this way, and it was remarkable what an amount of illumination was obtained by this simple method.

The thanks of the Society were voted to Mr. Beck for his exhibit and explanation.

Prof. J. D. Everett read his paper entitled 'A Direct Proof of Abbe's Theorems on the Microscopic Resolution of Gratings,' which he illustrated by mathematical formulæ drawn upon the board and by the exhibition of a slide as described in his paper.

Mr. J. W. Gordon said: By the courtesy of Prof. Everett I have had the opportunity not only of seeing the abstract of his paper which has been circulated but also of reading the paper itself in advance. The subject with which he deals is of particular interest to me because it relates to an experiment first, as I suppose, suggested by myself, and which formed, in a paper I had the honour of submitting to this Society at the June Meeting in 1901, the basis of a criticism of the Abbe theory as expounded by Naegeli and Schwendener. Perhaps, therefore, I may be allowed to say, without presumption, that I have read the paper with uncommon interest and that the proof which Prof. Everett gives of the changing phase relation between different parts of the spectrum and the effect of this changing relation in producing apparent movement in the

image plane seems to me to be extremely ingenious and beautifully simple. The reading of the paper has cleared up in my own mind what has long appeared to me a matter of great difficulty and some obscurity.

It is, however, worthy of remark that Prof. Everett's propositions relate, and relate only, to a very special optical system, and that that system differs entirely from the system with which we actually work in the Microscope. Furthermore, I may be perhaps allowed to add that it is a system entirely different from that which was the subject of criticism in my paper already referred to and which originally suggested the experiment of moving the grating on the stage of the Microscope. Naegeli and Schwendener who were at that time supposed to have published an authoritative exposition of the Abbe theory, had laid it down as a fundamental principle upon which their whole argument was based, that there is no phase difference between the different members of the spectrum seen in the upper focal plane of the objective. Their language was "for since these sources of light" (that is to say, the spectra of the various orders) "are point for point the optical images of the same primary source of light, there is no difference of phase between them."

This was the proposition which I mainly attacked, and Prof. Everett has now shown not only that there is a difference of phase between them but that this difference of phase is calculable, and that by the aid of the very elegant expressions which he has devised it can be calculated with ease. Thus I am entitled to say that, so far as the main controversy goes, I can claim the support of Prof. Everett's paper in my attack upon the Naegeli and Schwendener theory.

In conducting this attack I endeavoured first to show by a discussion upon geometrical lines that this proposition that there could be no difference of phase between the various members of the spectrum was preposterous, but realising that ocular proof is very much more satisfactory to many people than mathematical demonstration, I proposed also to test it by the very simple experiment of moving the object grating across the stage of the Microscope. It was obvious that this would make no difference in the position of the spectrum, and if it made no difference to the phase, as Naegeli and Schwendener asserted, then it could make no difference to the interference pattern developed in the image plane of the instrument. This was my argument, and it was to support this argument that the experiment in question was devised. Of course, when the original position is abandoned it is quite natural that the argument directed against that original position should cease to apply, and that is what has happened in the present case. I fully recognise that in the theory put forward by Prof. Everett, and so far as I know put forward for the first time by him and this evening, this particular criterion would no longer serve to distinguish the image formed by diffracted light from the image formed by transmitted light.

But at this point it will be convenient to pass over to the consideration of the difference between the optical system described and analysed by Prof. Everett this evening and the actual system with which we work in the Microscope. The fundamental difference between them is this, that whereas Prof. Everett postulates a single train of plane wave-fronts as the source of illumination, the practical microscopist is most careful

to use no plane wave-fronts at all, but spherical wave-fronts for illuminating his object, and when he desires to get very fine resolution he uses not only spherical wave-fronts but spherical wave-fronts with an extremely short radius of curvature. Now this change in the state of illumination brings about a complete change in the condition of the spectra, and a change which is extremely material from the present point of view. For it can easily be shown experimentally that the conclusions which Prof. Everett has worked out this evening and demonstrated mathematically by means of plane wave-fronts have no application when the diffraction arises from the incidence of spherical wave-fronts upon a grating. I have already shown in this room an experiment, described on pages 366 to 373 of the Journal for 1901, which demonstrates this proposition to the eye. Shortly stated it comes to this: When spherical wave-fronts are used to illuminate the grating (or other object) the state of resolution in which it is seen is wholly independent of the number of spectra transmitted by the objective. It is possible by using a wave front of short radius to collect as many as four or five orders of spectra in a lens of low angle, and, indeed, of an angle so low that it is incapable of yielding a resolved image of the grating. In that case the resolution is not in the least improved by including a large number of spectra in the image-forming beam. On the other hand, if the incident light is a spherical wave-front of comparatively long radius of curvature, then it is quite possible to get perfect resolution when only the central light is passed and even the first diffraction spectra are shut out. Now these are in fact the conditions under which the Microscope is used in practice, and this experiment shows, as I venture to think, conclusively that under these conditions the presence or absence of particular spectra makes no difference whatever to the state of resolution under which the object is seen.

There is a difficulty even more fundamental than this which appears to me to be necessarily fatal to any theory by which the phase in one focal plane is deduced from the phase in another not conjugate to the first. It is this: the corrections necessary to render the instrument aplanatic in the image plane involve its being non-aplanatic in the principal focal plane, and indeed in any other plane situate on the same side as the image plane of the principal plane of the objective. It is therefore impossible to calculate the phase which would in fact result from the formation of an imperfect image of the source of light by means of diffracted rays in the neighbourhood of the principal focus. This circumstance does not render Prof. Everett's results uninstructive, but it does show that they belong to the region of pure, and in no sense to the region of applied, mathematics. It is therefore impossible to look upon his paper as affording any proof of the Abbe theory in concrete form and as applied to any actual objective; but, within the limits to which Prof. Everett himself has restricted them, his results are, if I may say so with all humility, of very great interest and highly suggestive.

Mr. Beck said, as he had been alluded to by Prof. Everett as having lent the Abbe experiment, he would explain what it was. He then drew a diagram on the board to represent the back focal plane of an object-glass, and said that if they looked at the Microscope upon the table they

would, on taking out the eye-piece, see a small beam of light in the centre, and on either side of this a certain number of faint spectra. The apparatus of Zeiss consisted of a series of slits in a diaphragm, so spaced that, with a particular size of object-glass suited to the grating, when the series of slits was placed over the object-glass, it would cut out two alternate spectra, and the effect then produced was to double the lines in the image; and it would be interesting to recall that when Mr. Gordon read his paper he made his demonstration with a similar diaphragm with only two slits, which were so spaced that they excluded those portions of light which the three-slit diaphragm admitted. Prof. Everett's paper was especially interesting because it afforded a mathematical proof of the doubling of the lines, and showed that, provided alternate spectra were excluded, the same phenomenon was produced, so that the experiment above-mentioned was not in itself a disproof of the Abbe theory, as the three-slit and also the two-slit diaphragm cut out alternate spectra. The questions which naturally arose were, had this anything to do with microscopic vision? was the effect produced by the cutting out of the spectra, or was it produced by the slit diaphragms acting as diffraction gratings, causing a doubling of the lines? It would be perfectly possible to exclude spectra by having a cover-glass with small black spots, but would this produce a doubling of the lines? Prof. Everett's paper seemed to afford an explanation of the reason why Prof. Abbe's theory had been applied with so much enthusiasm to vision in the Microscope. Mr. Gordon showed them that although a certain series of spectra were produced with an illumination of parallel light, as soon as the quality of the light was changed from a parallel to a convergent beam these spectra shifted their positions, and that when the object became practically a radiant source, the light being focussed on the plane of the grating, then these spectra closed up and practically disappeared. When this was the case, it would be impossible to suppose that, as no spectra were now excluded by the three-slit diaphragm in the back focal plane of the object-glass, the Abbe theory could account for the doubling of the lines in the image. As a matter of fact, the doubling of the lines took place whatever the kind of illumination employed, which would appear to show that the Abbe theory was not the cause of the doubling of the lines in the well-known experiment, and that the theory was of purely academic interest, and had no direct bearing of consequence on microscopic vision.

Mr. J. Rheinberg—after reading his note 'On the Influence on Images of Gratings of Phase-Difference amongst their Spectra'—said he would have liked to discuss the standpoint taken up by Mr. J. W. Gordon and Mr. C. Beck, but time being short he would make his remarks very brief, and touch on one matter only. It appeared to him futile to argue, as they did, that because certain diffraction effects were obtained by placing diaphragms behind the objective, this fact threw doubt upon the Abbe theory. One might make a hole in a board by drilling it, or produce a hole in a board by a pistol-shot: the presence of the hole produced by the latter method would disprove nothing as to holes produced by drilling operations. Analogously (as he had endeavoured to show in a previous discussion), although by the inter-

position of a diaphragm which cut off part of the light in the upper focal plane of an objective filled with light, you might obtain somewhat similar effects to those which occur when the light distribution in the focal plane, due to the object, coincides more or less with that allowed to pass through the diaphragm, to draw conclusions from this fact as to the incorrectness of fundamental laws embodied in the Abbe theory was an illogical procedure.

Prof. Everett, being called upon by the President to reply, said that no reply was needed. He had seen Mr. Rheinberg's experiment, and the main feature of it was that the whole series of lines moved bodily across the field, thus illustrating in a very interesting way the main point of the paper.

The President, in moving a hearty vote of thanks to Prof. Everett for his paper, said it was quite clear that the subject was one which gave opportunity for much fuller discussion than was possible at that Meeting.

Mr. F. W. Millet's paper—the sixteenth of the series—'On the Recent Foraminifera of the Malay Archipelago,' was taken as read.

Mr. F. Enock then gave an extremely interesting exhibition of lantern slides photographed by the Sanger-Shepheard three-colour process from living insects, which showed the specimens in their natural colours with great brilliancy and fidelity. The advantages, and also the difficulties of successfully producing perfect pictures from objects whose least movement during either of the three exposures would spoil the set, were explained, and a brief description of each slide was given as—owing to the lateness of the hour—they were somewhat rapidly passed through the lantern.

The President was sure that all who were present must have been delighted with this demonstration. Mr. Enock had broken fresh ground in attempting to make these three-colour pictures of living subjects, and it was quite clear that in this direction the process had a great feature before it. They were extremely obliged to Mr. Enock for bringing these beautiful pictures to show them.

A hearty vote of thanks to Mr. Enock for his demonstration was unanimously carried.

The List of those gentlemen, eight in number, who were proposed for election as Honorary Fellows of the Society at the preceding Meeting was read, and, after a bollot had been taken, they were then declared all duly elected.

The President mentioned that he proposed to give a demonstration of the microscopic structure of some Palæozoic plants at the October Meeting.

Notice was given that the rooms of the Society would be closed from August 15 to September 10, and the proceedings were adjourned to October 19.

New Fellows:—The following were elected *Honorary* Fellows—Prof. Gaston Bonnier, Prof. Jacques Brun, Prof. Yves Delage, Prof. S. Ramón y Cajal, Prof. B. Renault, J. J. Harris Teall, Prof. Silvanus P. Thompson, and Dr. M. Treub.

The following Objects, Instruments, etc., were exhibited:—

Mr. C. Beck:—Portable Microscope, made by Messrs. R. & J. Beck to the design of Mr. Arthur Hollick; Microscope with grating on the stage, showing doubling of the lines by means of a triple slit in back focal-plane of the object-glass, in illustration of Prof. Everett's paper.

Prof. Marcus Hartog:—A slide, showing the first segmentation spindle and centrospheres in the embryo of *Rhynchelmis* (Leech), shown under a $\frac{1}{4}$-inch objective and B eye-piece; the preparation lent by Prof. Vejdovsky, of Prague.

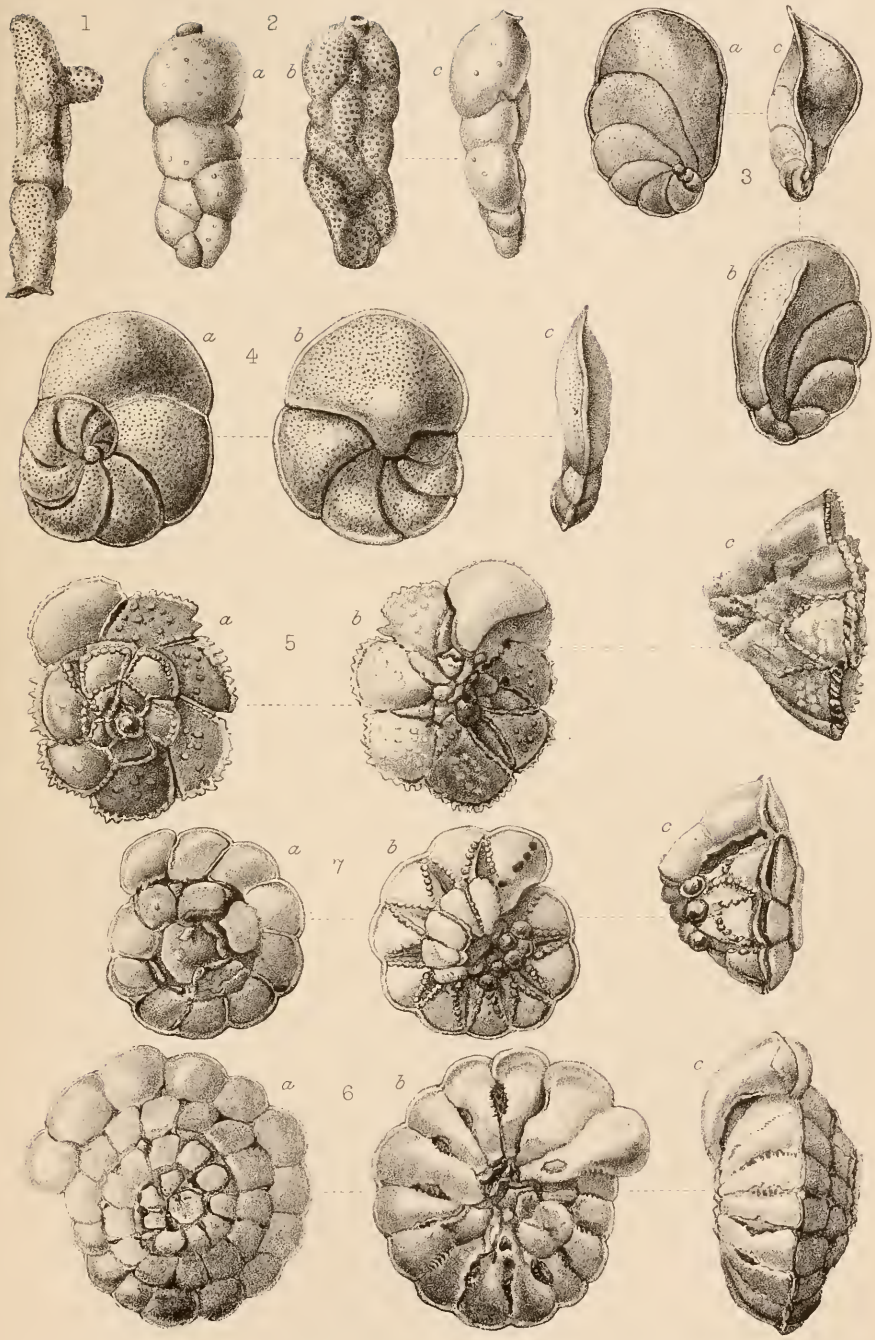
Mr. T. H. Powell:—*Pleurosigma angulatum*, under a $\frac{1}{40}$-inch apochromatic homogeneous immersion objective of N.A. 1·35.

Mr. Julius Rheinberg:—Experiment showing movement of lines in the image of a grating by creating a phase-difference amongst the spectra in the back focal-plane of the objective by means of an Abbe glass-wedge Compensator. Experiment to illustrate his remarks on Prof. Everett's paper.

After the business of the Ordinary Meeting was concluded, a Special Meeting was held, pursuant to notice given at the Ordinary Meeting of May 18 last, for the purpose of making an alteration in By-law No. 25, by the omission of the word "future."

Mr. Vezey explained that the effect of the proposed alteration would be to relieve a new Fellow, who might be desirous of compounding for his subscriptions on election, from the necessity of paying his first year's subscription as well as the full compounding fee. The entrance fee would, of course, be payable whether a Fellow compounded or not.

The rule as it originally stood, and also as it would be if altered, was then read to the Meeting, and the proposal for alteration having been put to the Meeting by the President, it was declared to have been unanimously carried.



F.W. Millett del. ad nat.

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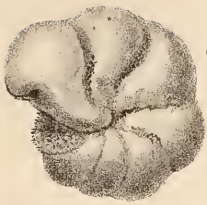
FORAMINIFERA OF MALAY ARCHIPELAGO.



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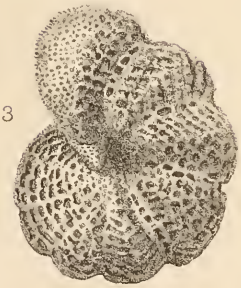

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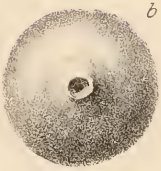

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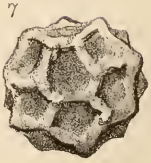

F.W.Millett del. ad nat. West, Newman lith.

FORAMINIFERA OF MALAY ARCHIPELAGO.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

OCTOBER 1904.

TRANSACTIONS OF THE SOCIETY.

X.—*Report on the Recent Foraminifera of the Malay Archipelago collected by Mr. A. Durrand, F.R.M.S.—Part XVI.*

By Fortescue William Millett, F.R.M.S.

(*Read June 15th, 1904.*)

Plate X.

Planorbulina d'Orbigny.

Planorbulina mediterranensis d'Orbigny.

Planorbulina mediterranensis d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 280, pl. xiv. figs. 4-6; Modèle, No. 79. *P. mediterranensis* (d'Orb.) Brady, Parker, and Jones, 1888, Trans. Zool. Soc., vol. xii. p. 227, pl. xlv. fig. 18. *P. mediterranensis* (d'Orb.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 380, pl. xiv. figs. 24–26. *P. mediterranensis* (d'Orb.) Goës, 1894, K. Svenska Vet.-Akad. Handl., vol. xxv. p. 91, pl. xv. fig. 786. *P. mediterranensis* (d'Orb.) Jones, 1895, Palæont. Soc., p. 298, pl. v. fig. 30. *P. mediterranensis* (d'Orb.) Flint, 1899, Rep. U.S. Nat.

EXPLANATION OF PLATE X.

Fig. 1, 2.—*Carpenteria proteiformis* Goës. Fig. 1 × 65; fig. 2 × 90.
„ 3.—*Pulvinulina oblonga* Williamson sp., var. *carinata* var. n. × 80.
„ 4. „ *Brongniartii* d'Orbigny sp. × 40.
„ 5.—*Rotalia Schroeteriana* Parker and Jones, var. *inflata* var. n. × 60.
„ 6. „ *annectens* Parker and Jones. × 30.
„ 7. „ „ var. *concinna* var. n. × 60.

Note.—In all the figures the letter *a* denotes the superior aspect; *b*, the inferior aspect; and *c*, the peripheral aspect.

Mus. for 1897 (1899), p. 328, pl. lxxii. fig. 6. *P. mediterranensis* (d'Orb.) Silvestri, 1899, Mem. Pontif. Accad. Nuovi Lincei, vol. xv. p. 286, pl. vi. figs. 4–7.

Planorbulina acervalis Brady.

Planorbulina acervalis Brady, 1884, Chall. Rept., p. 657, pl. xcii. fig. 4. *P. acervalis* (Brady) Brady, Parker, and Jones, 1888, Trans. Zool. Soc., vol. xii. p. 227, p. xlvi. fig. 11. *P. acervalis* (Brady) Flint, 1899, Rep. U.S. Nat. Mus. for 1897 (1899), p. 328, pl. lxxii. fig. 7.

Planorbulina larvata Parker and Jones.

Planorbulina vulgaris var. *larvata* Parker and Jones, 1860, Ann. and Mag. Nat. Hist., ser. 3, vol. v. p. 294. *P. larvata* Idem, 1865, Phil. Trans., vol. clv. p. 380, pl. xix. fig. 3. *P. larvata* (P. and J.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 381, pl. xiv. fig. 31.

These three forms are not well represented in the Malay Archipelago; they occur at the same Stations, and are most abundant in Area 1.

Truncatulina d'Orbigny.

Truncatulina echinata Brady.

Planorbulina echinata Brady, 1879, Quart. Journ. Micr. Sci., n.s., vol. xix. p. 283. pl. viii. fig. 31. *Truncatulina echinata* Idem, 1884, Chall. Rept., p. 670, pl. xcvi. figs. 9–14. *T. echinata* (Brady) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 403, pl. xvi. figs. 40, 41.

This is an aberrant form which seems as nearly allied to *Planorbulina* as to *Truncatulina*, and may be treated as a connecting link between the two genera.

It is not uncommon in Area 1, and occurs sparingly in Area 2. The examples are normal, both in size and form.

Brady states that it has its home amongst the coral-sands of the Pacific and Indian oceans at depths of from 2 to 155 fathoms. The 'Gazelle' Station is Mauritius, 225 fathoms.

Truncatulina reticulata Czjzek sp.

Rotalina reticulata Czjzek, 1848, Haidinger's Naturw. Abhandl., vol. ii. p. 145, pl. xiii. figs. 7–9. *Truncatulina reticulata* (Czjzek) Brady, 1884, Chall. Rept., p. 669, pl. xcvi. figs. 5–8. *T. reticulata* (Czjzek) Brady, Parker, and Jones, 1888, Trans. Zool. Soc., vol. xii. p. 228, pl. xlv. figs. 23, 24. *T. reticulata* (Czjzek) Terrigi, 1891, Mem. R. Com. Geol. d'Italia, vol. iv. p. 107, pl. iv. fig. 10. *T. reticulata* (Czjzek) Chaster, 1892, First Rept. of the Southport Soc. of

Nat. Sci., 1890–1891 (1892), p. 66, pl. i. fig. 16. *T.* (*Rotalina*) *reticulata* (Czjzek) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 402, pl. xvi. figs. 42–44; Idem, 1895, Naturhist. Ver. Passau, Jahresber., xvi. p. 32, pl. v. fig. 7. *T. reticulata* var. *tuberculata*, Silvestri, 1899, Mem. Pontif. Accad. Nuovi Lincei, vol. xv. p. 300, pl. vi. fig. 11; and var. *plano-convexa*, p. 300, pl. vi. fig. 12. *T. reticulata* (Czjzek) Flint, 1899, Rep. U.S. Nat. Mus. for 1897 (1899), p. 334, pl. lxxviii. fig. 3.

This form is very rare in the Malay Archipelago, and occurs only in Area 1.

According to Brady it has a somewhat wide geographical range, at depths of from 17 to 450 fathoms; but at one of the 'Gazelle' Stations the depth was 1914 fathoms.

Truncatulina refulgens Montfort sp.

Cibicides refulgens Montfort, 1808, Conch. Syst., vol. i. p. 122, 31e genre. *Truncatulina refulgens* (Montf.) d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 279, pl. xiii. figs. 9–11; Modèle, No. 77. *T. refulgens* (Montf.) Sherborn and Chapman, 1886, Journ. R. Micr. Soc., ser. 2, vol. vi. p. 756, pl. xiv. fig. 13. *T. refulgens* (Montf.) Terrigi, 1889, Mem. R. Accad. Lincei, ser. 4, vol. vii. p. 117, pl. viii. figs. 1–3. *T. refulgens* (d'Orb.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 401, pl. xvi. figs. 31–33. *Planorbulina refulgens* (Montf.) Goës, 1894, K. Svenska Vet.-Akad. Handl., vol. xxv. p. 89, pl. xv. figs. 775, 776. *T. refulgens* (Montf.) Jones, 1895, Palæont. Soc., p. 302, pl. v. fig. 31. *T. refulgens* (Montf.) Chapman, 1898, Journ. R. Micr. Soc., p. 1, pl. i. fig. 1. *T. refulgens* (d'Orb.) Egger, 1899, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xxi. p. 151, pl. xx. figs. 20, 21.

The examples are few and insignificant, but they occur in both Areas.

Truncatulina lobatula Walker and Jacob sp.

"Nautilus spiralis lobatus, etc.," Walker and Boys, 1784, Test. Min., p. 20, pl. iii. fig. 71. *Truncatulina lobatula* d'Orbigny, 1846, For. Foss. Vienne, p. 168, pl. ix. figs. 18–23. *T. lobatula* (W. and J.) Sherborn and Chapman, 1886, Journ. R. Micr. Soc., ser. 2, vol. vi. p. 756, pl. xvi. fig. 12. *T. lobatula* (Walker) Malagoli, 1887, Atti Soc. Nat. Modena, ser. 3, vol. iii. p. 110, pl. i. fig. 14. *T. lobatula* (W. and J.) Brady, Parker, and Jones, 1888, Trans. Zool. Soc., vol. xii. p. 227, pl. xlii. fig. 20, pl. xlv. fig. 26. *T. lobatula* (W. and J.) Terrigi, 1889, Mem. R. Accad. Lincei, ser. 4, vol. vi. p. 116, pl. vii. figs. 5–7. *T. lobatula* (W. and J.) Mariani, 1893, Ann. Istit. Tecn. Udine, ser. 2, vol. xi. p. 24, pl. i. figs. 19–21. *T. lobatula* (d'Orb.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 396,

pl. xvi. figs. 1–3, 10–12. *T. lobatula* (W. and J.) Fornasini, 1893, Mem. R. Accad. Sci. Ist. Bologna, ser. 5, vol. iii. p. 435, pl. ii. figs. 15, 16. *Planorbulina lobatula* (W. and J.) Goës, 1894, K. Svenska Vet.-Akad. Handl., vol. xxv. p. 88, pl. xv. fig. 774. *T. lobatula* (d'Orb.) Egger, 1895, Naturhist. Ver. Passau, Jahresber., xvi. p. 31, pl. v. fig. 5. *T. lobatula* (W. and J.) Burrows and Holland, 1897, Proc. Geol. Assoc., vol. xv. p. 47, pl. ii. fig. 24. *T. lobatula* (Walker) Chapman, 1898, Journ. R. Micr. Soc., p. 2, pl. i. fig. 2. *T. lobatula* (d'Orb.) Egger, 1899, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xxi. p. 151, pl. xxiii. figs. 12–14. *T. lobatula* (W. and J.) Chapman, 1902, Proc. Roy. Soc. Edinburgh, vol. xxiii. p. 392, pl. i. figs. 2, 3.

Truncatulina variabilis d'Orbigny.

Truncatulina variabilis d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 279, No. 8; Idem, 1839, Foram. Canaries, p. 135, pl. ii. fig. 29. *T. variabilis* (d'Orb.) Brady, Parker, and Jones, 1888, Trans. Zool. Soc., vol. xii. p. 227, pl. xlv. fig. 17. *T. variabilis* (d'Orb.) Terrigi, 1889, Mem. R. Accad. Lincei, ser. 4, vol. vi. p. 116, pl. vii. fig. 9. *T. variabilis* (d'Orb.) Burrows, Sherborn, and Bailey, 1890, Journ. R. Micr. Soc., p. 562, pl. xi. fig. 22. *T. variabilis* (d'Orb.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 404, pl. xvi. figs. 57–59, 63, 64. *T. varians* (Reuss) Hosius, 1893, Verhandl. Naturhist. Ver. Preuss. Rheinl. Westph., Jahrg. 1, p. 127, pl. ii. fig. 14. *T. variabilis* (d'Orb.) Jones, 1896, Palæont. Soc., p. 309, pl. vi. fig. 23. *T. variabilis* (d'Orb.) Fornasini, 1896, Revista Ital. di Paleont., p. 95, pl.

These allied forms are widely distributed in the Malay Archipelago, but are most abundant in Area 1. The examples are small and weak.

Truncatulina Wuellerstorfi Schwager sp.

Anomalina Wuellerstorfi Schwager, 1886, Novara Exped., Geol. Theil, vol. ii. p. 258, pl. vii. fig. 105. *Truncatulina Wuellerstorfi* (Schw.) Brady, 1884, Chall. Rept., p. 662, pl. xciii. figs. 8, 9. *T. Wuellerstorfi* (Schw.) Uhlig, 1886, Jahrb. k. k. geol. Reichs., vol. xxxvi. p. 174, fig. 3. *T. Wuellerstorfi* (Schw.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 397, pl. xvi. figs. 13–15. *Planorbulina Wuellerstorfi* (Schw.) Goës, 1889, K. Svenska Vet.-Akad. Handl., vol. xxv. p. 89, pl. xv. fig. 777. *T. Wuellerstorfi* (Schw.) Egger, 1895, Naturhist. Ver. Passau, Jahresber., xvi. p. 31, pl. v. fig. 6. *T. Wuellerstorfi* (Schw.) Chapman, 1893, Journ. R. Micr. Soc., p. 3, pl. i. fig. 3. *T. Wuellerstorfi* (Schw.) Flint, 1899, Rep. U.S. Nat. Mus. for 1897 (1899), p. 333, pl. lxxvii. fig. 1.

This form is represented by a few weak examples from Station 27, in Area 2.

Truncatulina Haidingeri d'Orbigny sp.

Rotalina Haidingeri d'Orbigny, 1846, For. Foss. Vienne, p. 154, pl. viii. figs. 7–9. *Truncatulina Haidingeri* (d'Orb.) Reuss, 1867, Sitzungsber. k. Akad. Wiss. Wien, vol. lv. p. 100. *T. Haidingeri* (d'Orb.) Toutkowski, 1888, Zap. Kievsk. Obsch. Estest., vol. ix. p. 58, pl. viii. fig. 3. *T. Haidingeri* (d'Orb.) Terrigi, 1889, Mem. R. Accad. Lincei, ser. 4, vol. vi. p. 118, pl. viii. figs. 7–9. *T.* (*Rotalina*) *Haidingeri* (d'Orb.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 401, pl. xvi. figs. 25–27; Idem, 1895, Naturhist. Ver. Passau, Jahresber., xvi. p. 29, pl. v. fig. 1. *Rotalina Haidingeri* (d'Orb.) Idem, 1899, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xxi. p. 159, pl. xxv. figs. 36–38; and *R. Brueckneri* (Reuss) p. 159, pl. xxv. figs. 19–21. *T. Haidingeri* (d'Orb.) Liebus, 1902, Jahrb. k. k. geol. Reichs., vol. lii. Heft i. p. 90, fig. 4.

This also is a rare form in the Malay Archipelago, but it is found at Stations in both Areas. The examples, although small, are typical.

Truncatulina Ungeriana d'Orbigny sp.

Rotalina Ungeriana d'Orbigny, 1846, For. Foss. Vienne, p. 157, pl. viii. figs. 16–18. *T. Ungeriana* (d'Orb.) Reuss, 1865, Denkschr. k. Akad. Wiss. Wien, vol. xxv. p. 161. *Planorbulina Ungeriana* (d'Orb.) Sherborn and Chapman, 1886, Journ. R. Micr. Soc., ser. 2, vol. vi. p. 757, pl. xvi. fig. 16. *T. Ungeriana* (d'Orb.) Terrigi, 1889, Mem. R. Accad. Lincei, ser. 4, vol. vi. p. 117, pl. viii. fig. 4; and *Truncatulina* sp., p. 118, pl. viii. fig. 6. *T. involuta* (Reuss) Franzenau, 1899, Math. természt. értesitö, vol. vii. p. 263, pl. iv. fig. 4. *T. Ungeriana* (d'Orb.) Terrigi, 1891, Mem. R. Com. geol. d'Italia, vol. iv. p. 106, pl. iv. fig. 9. *T. Ungeriana* (d'Orb.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. (not described) pl. xvi. figs. 19–21. *T. Ungeriana* (d'Orb.) Silvestri, 1893, Mem. Pontif. Accad. Nuovi Lincei, vol. ix. p. 213, pl. vi. fig. 3. *Planorbulina Ungeriana* (d'Orb.) Goës, 1894, K. Svenska Vet.-Akad. Handl., vol. xxv. p. 90, pl. xv. fig. 780. *T. Ungeriana* (d'Orb.) Jones, 1896, Palæont. Soc., p. 312 (1886), pl. ii. figs. 11, 12. *T. Ungeriana* (d'Orb.) Burrows and Holland, 1897, Proc. Geol. Assoc., vol. xv. p. 47, pl. ii. fig. 23. *T. Ungeriana* (d'Orb.) Egger, 1899, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xxi. p. 150, pl. xix. figs. 4–6. *T. Ungeriana* (d'Orb.) Flint, 1899, Rep. U.S. Nat. Mus. for 1897 (1899), p. 333, pl. lxxvii. fig. 2.

This form is not quite so rare in the Malay Archipelago as *T. Haidingeri*, and occurs at a greater number of Stations in both Areas.

Truncatulina Akneriana d'Orbigny sp.

Rotalina Akneriana d'Orbigny, 1846, For. Foss. Vienne, p. 156, pl. viii. figs. 13–15. *T. Akneriana* (d'Orb.) Reuss, 1865, Denkschr. k. Akad. Wiss. Wien, vol. xxv. p. 160. *T. Akneriana* (d'Orb.) Toutkowski, 1887, Zap. Kievsk. Obsch. Estest., p. 46, pl. vi. figs. 1, 2. *T. Ackneriana* (d'Orb.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 400, pl. xvi. figs. 60–62. *T.* (*Rotalina*) *Ackneriana* (d'Orb.) Egger, 1895, Naturhist. Ver. Passau, Jahresber., xvi. p. 30, pl. v. fig. 2. *T. Akneriana* (d'Orb.) Flint, 1899, Rep. U.S. Nat. Mus. 1897 (1899), p. 333, pl. lxxvii. fig. 5.

Is represented by a few characteristic examples from Stations in Area 2.

Truncatulina præcincta Karrer sp.

Rotalia præcincta Karrer, 1868, Sitzungsber. k. Akad. Wiss Wien, vol. lviii. p. 189, pl. v. fig. 7. *T. præcincta* (Karr.) Brady, 1884, Chall. Rept., p. 667, pl. xcv. figs. 1–3. *T. præcincta* (Karr.) Terrigi, 1891, Mem. R. Com. geol. d'Italia, vol. iv. p. 107, pl. iv. fig. 11. *T. præcincta* (Karr.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 403, pl. xvi. figs. 51–53. *T. præcincta* (Karr.) Fornasini, 1895, Mem. R. Accad. Sci. Ist. Bologna, ser. 5, vol. v. p. 12, pl. iv. fig. 36. *T. præcincta* (Karr.) Flint, 1899, Rep. U.S. Nat. Mus. for 1897 (1899), p. 334, pl. lxxviii. fig. 1. *T. præcincta* var. *ornata* Silvestri, 1899, Mem. Pontif. Accad. Nuovi Lincei, vol. xv. p. 299, pl. v. fig. 10.

This form also is very rare in the Malay Archipelago, and has been noted only at Station 2 in Area 1, and at Station 22 in Area 2.

According to Brady it most affects the coral reefs of the tropics, at depths of from 15 to 225 fathoms.

Anomalina d'Orbigny.

Anomalina ammonoides Reuss sp.

Rosalina ammonoides Reuss, Geogn. Skizze Böhmen, p. 214; and 1845, Verstein. böhm. Kreide, p. 36, pl. viii. fig. 53, pl. xiii. fig. 66. *A. ammonoides* (Reuss) Brady, 1884, Chall. Rept., p. 672, pl. xciv. figs. 2, 3. *Planorbulina ammonoides* (Reuss) Sherborn and Chapman, 1886, Journ. R. Micr. Soc., ser. 2, vol. vi. p. 756, pl. xvi. fig. 14. *Planorbulina ammonoides* (Reuss) Burrows, Sherborn, and Bailey, 1890, Journ. R. Micr. Soc., p. 562, pl. xi. fig. 23. *A.* (*Rosalina*) *ammonoides* (Reuss) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 378, pl. xiii. fig. 35, pl. xiv. figs. 36, 37. *A. ammonoides* (Reuss) Woodward and Thomas, 1893 (1895), Geol. and Nat. Hist. Survey of Minnesota, vol. iii. p. 44, pl. D,

figs. 28, 29. *A. ammonoides* (Reuss) Perner, 1897, Ceská. Akad. Císaře Františka Josefa (Palæont. Bohemicæ No. 4), p. 53, fig. 13. *A. ammonoides* (Reuss) Fornasini, 1898, Mem. R. Accad. Sci. Ist. Bologna, ser. 5, vol. vii. p. 205, pl. fig. 24. *A. ammonoides* (Reuss) Chapman, 1898, Journ. R. Micr. Soc., p. 4, pl. i fig. 5. *A. ammonoides* (Reuss) Egger, 1899, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xxi. p. 152, pl. xviii. figs. 10–12. *A. ammonoides* (Reuss) Flint, 1899, Rep. U.S. Nat. Mus. for 1897 (1899), p. 335, pl. lxxviii. fig. 4. *A. ammonoides* (Reuss) Bagg, 1899, Bull. U.S. Geol. Survey, No. 88, p. 67, pl. vi. fig. 5.

Anomalina grosserugosa Gümbel sp.

Truncatulina grosserugosa Gümbel, 1868, Abhandl. k. bayer. Akad. Wiss., vol. x. p. 660, pl. ii. fig. 104. *A. grosserugosa* (Gümb.) Brady, 1884, Chall. Rept., p. 673, pl. xcvi. figs. 4, 5. *A. grosserugosa* (Gümb.) Sherborn and Chapman, 1889, Journ. R. Micr. Soc., p. 487, pl. xi. fig. 34. *Truncatulina grosserugosa* (Gümb.) Terrigi, 1889, Mem. R. Accad. Lincei, ser. 4, vol. vi. p. 117, pl. viii. fig. 5. *A. grosserugosa* (Gümb.) Burrows, Sherborn, and Bailey, 1890, Journ. R. Micr. Soc., p. 563, pl. xi. fig. 25. *A. grosserugosa* (Gümb.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 378, pl. xiv. figs. 4–6. *A. grosserugosa* (Gümb.) var. Jones, 1897, Palæont. Soc., p. 315, pl. vii. fig. 30. *A. grosserugosa* (Gümb.) Burrows and Holland, 1897, Proc. Geol. Assoc., vol. xv. p. 48, pl. ii. fig. 26. *A. grosserugosa* (Gümb.) Bagg, 1898, Bull. U.S. Geol. Survey, No. 88, p. 67, pl. vi. fig. 4. *A. grosserugosa* (Gümb.) Flint, 1899, Rep. U.S. Nat. Mus. for 1897 (1899), p. 335, pl. lxxviii. fig. 5. *A. grosserugosa* (Gümb.) Chapman, 1900, Proc. California Acad. of Sci., ser. 3, Geol., vol. i. p. 253, pl. xxx. fig. 9. *A. grosserugosa* (Gümb.) Schubert, 1901, Zeitschr. deutsch. geol. Gesell., Jahrg. 1901, p. 21, figs. 5, 6.

Anomalina ariminensis d'Orbigny sp.

Planulina ariminensis d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 280, pl. xiv. figs. 1–3; Modèle, No. 26. *A. ariminensis* (d'Orb.) Brady, 1884, Chall. Rept., p. 674, pl. xciii. figs. 10, 11. *A. ariminensis* (d'Orb.) Brady, Parker, and Jones, 1888, Trans. Zool. Soc., vol. xii. p. 228, pl. xiv. figs. 20–22. *A. ariminensis* (d'Orb.) Terrigi, 1891, Mem. R. Com. Geol. Italia, vol. iv. p. 107, pl. iv. fig. 12. *Planorbulina ariminensis* (d'Orb.) Goës, 1894, K. Svenska Vet.-Akad. Handl., vol. xxv. p. 91, pl. xv. figs. 784, 785. *A. ariminensis* (d'Orb.) Fornasini, 1895, Mem. R. Accad. Sci. Ist. Bologna, ser. 5, vol. v. p. 13, pl. iv. fig. 37. *A. ariminensis* (d'Orb.) Flint, 1899, Rep. U.S. Nat. Mus. for 1897 (1899), p. 335, pl. lxxix. fig. 1.

Of these three forms, *ammonoides* and *grosserugosa* are widely distributed in the Malay Archipelago and occur at most of the

Stations; whilst *ariminensis* is rare, although it is found in both Areas. All the examples are small and thin-shelled.

A. grosserugosa is essentially a deep-water form. Brady gives depths of from 345 to 2160 fathoms; Egger records it from one 'Gazelle' Station, at a depth of 371 fathoms; whilst the 'Albatross' Stations range from 420 to 1019 fathoms.

Carpenteria Gray.

Carpenteria monticularis Carter.

Carpenteria monticularis Carter, 1877, Ann. and Mag. Nat. Hist., ser. 4, vol. xix. p. 211, pl. xiii. figs. 9–12. *C. monticularis* (Carter) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 439, pl. xxi. fig. 12. *C. monticularis* (Carter) Chapman, 1900, Journ. Linn. Soc. (Zool.), p. 14, pl. ii. fig. 5, pl. iv. figs. 5, 6.

This form is very rare in the Malay Archipelago, and has been found only at Station 4 in Area 1.

Carpenteria proteiformis Goës, plate X. figs. 1, 2.

Carpenteria balaniformis var. *proteiformis* Goës, 1882, K. Svenska Vet.-Akad. Handl., vol. xix. p. 94, pl. vi. figs. 208–214, pl. vii. figs. 215–219. *C. lithothamnica* Uhlig, 1886, Jahrb. k. k. geol. Reichs., vol. xxxvi. p. 189, pl. v. figs. 1, 2; and *C.* cf. *proteiformis* (Goës) p. 188, pl. v. fig. 3. *Karreria fallax*, Rzehak, 1895, Ann. k. k. Naturh. Hofmuseums, vol. x. part 2, p. 226, pl. vii. figs. 7, 8. *C. proteiformis* Goës, 1896, Bull. Mus. Comp. Zool. Harvard College, vol. xxix. p. 74, pl. vi. figs. 8–17. *C. proteiformis* (Goës) Chapman, 1900, Journ. Linn. Soc. (Zool.), vol. xxviii. p. 195, pl. xix. fig. 11.

This form is much more abundant than the preceding, and occurs at several Stations in both Areas. Usually the examples are irregular in growth and coarsely perforated as shown by fig. 1, but there is a solitary specimen from Station 25, which bears a remarkable resemblance to the example of *Karreria fallax*, figured by Rzehak; this is represented by fig. 2 in our Plate.

Pulvinulina Parker and Jones.

Pulvinulina repanda Fichtel and Moll sp.

Nautilus repandus Fichtel and Moll, 1798, Test. Micr., p. 35, pl. iii. figs. *a–d*. *Pulvinulina repanda* (F. and M.) Parker and Jones, 1862, in Carpenter's Introd. Foram., p. 311. *P. repanda* (F. and M.) Sherborn and Chapman, 1886, Journ. R. Micr. Soc., p. 757, pl. xvi.

fig. 18. *P. repanda* (F. and M.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 405, pl. xviii. figs. 28–30, 34, 35. *P. repanda* (F. and M.) Goës, 1894, K. Svenska Vet.-Akad. Handl., vol. xxv. p. 95, pl. xvi. fig. 801. *P. repanda* (F. and M.) Flint, 1899, Rep. U.S. Nat. Mus. for 1897 (1899), p. 328, pl. lxxii. fig. 8. *P. repanda* (F. and M.) Jones and Chapman, 1900, in a Monograph of Christmas Island, p. 228, pl. xx. fig. 1.

This species is not common in the Malay Archipelago, but it is widely distributed and the examples are large and well-grown.

Pulvinulina concentrica Parker and Jones.

Pulvinulina concentrica (P. and J., Ms.) Brady, 1864, Trans. Linn. Soc., vol. xxiv. p. 470, pl. xlviii. fig. 14. *P. concentrica* (P. and J.) Uhlig, 1886, Jahrb. k. k. geol. Reichs., vol. xxxvi. p. 190, pl. iii. figs. 3, 4. *P. concentrica* (P. and J.) Grzybowski, 1894, Rozprawy Wydz. Mat.-Przyr. Akad. Umiej-Krakowie, vol. xxix. p. 202, pl. iv. fig. 9.

This form is very rare, being represented by a solitary specimen from Station 13.

Pulvinulina lateralis Terquem sp.

Rosalina lateralis Terquem, 1878, Mém. Soc. Géol. France, sér. 3, vol. i. p. 25, pl. vii. fig, 11. *Pulvinulina lateralis* (Terq.) Brady, 1884, Chall. Rept., p. 689, pl. civ. figs. 2, 3. *P. lateralis* (Terq.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 413, pl. xviii. figs. 48–50.

This form, which in the living condition appears to be nothing more than a wild-growing variety of *P. repanda*, is tolerably plentiful at Station 22, and is represented at a few other Stations mostly in Area 2.

Like *P. repanda* it is a shallow-water variety. Our knowledge of its distribution in the existing seas, is confined to the localities mentioned by Brady, and the solitary Station recorded by Egger.

Pulvinulina oblonga Williamson sp.

Nautilus auricula var. *β*, Fichtel and Moll, 1798, Test. Micr., p. 110, pl. xx. figs. *d*, *e*, *f*. *Rotalina oblonga* Williamson, 1858, Rec. Foram. Gt. Britain, p. 51, pl. iv. figs. 98–100. *Pulvinulina repanda* var. *auricula* (F. and M.) Parker and Jones, 1862, Introd. Foram., App., p. 311. *P. oblonga* (Will.) Brady, Parker, and Jones, 1888, Trans. Zool. Soc., vol. xii. p. 229, pl. xlvi. fig. 5. *P. oblonga* (Will.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 415, pl. xvii. figs. 23–25. *P. oblonga* (Will.) Grzybowski,

1894, Rozprawy Wydz Mat.-Przyr. Akad. Umiej-Krakowie, vol. xxix. p. 203, pl. iv. fig. 8.

This form is well represented, and occurs abundantly at most of the Stations in both Areas. The examples are large and usually have a clear patch on the septal face, similar to that found in recent specimens of *P. Hauerii*.

Pulvinulina oblonga Williamson sp. var. *carinata* var. n., plate X. fig. 3.

This is a well-marked variety, and differs from the type in having an acute ridge down the centre of the septal face; this peculiarity causes the transverse section of the chambers to be of a triangular form.

It occurs at a few Stations, but in small numbers.

Pulvinulina Brongniartii d'Orbigny sp., plate X. fig. 4.

Rotalia Brongniartii d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 273, No. 27. *Rotalina Brongniarti* Idem, 1846, For. Foss. Vienne, p. 158, pl. viii. figs. 22–24. *Pulvinulina auricula* (F. and M.) Parker, Jones, and Brady, 1871, Ann. and Mag. Nat. Hist., ser. 4, vol. viii. p. 173, pl. xii. fig. 143.

This variety of the *P. auricula* group is so abundant in the Malay Archipelago, and its characters so persistent, that it may be worth while to record it under the name given to it by d'Orbigny.

The chambers are ventricose, and the sutures limbate, and formed of clear shelly matter.

It is common at several Stations in both Areas.

Pulvinulina Hauerii d'Orbigny sp.

Rotalina Hauerii d'Orbigny, 1846, For. Foss. Vienne, p. 151, pl. vii. figs. 22–24. *Pulvinulina Hauerii* (d'Orb.) Brady, 1884, Chall. Rept., p. 690, pl. cvi. figs. 6, 7. *P. petrolei* Andreae, 1884, Abhandl. geol. Special-Karte Elsass-Loth., vol. ii. p. 217, pl. viii. fig. 15. *P.* (*Rotalina*) *Haueri* (d'Orb.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 414, pl. xvii. figs. 29–31. *P. Hauerii* (d'Orb.) Woodward and Thomas, 1893, Geol. and Nat. Hist. Survey of Minnesota, vol. iii. p. 44, pl. E, fig. 34. *P. Hauerii* (d'Orb.) Chapman, 1898, Journ. R. Micr. Soc., p. 5, pl. i. fig. 7. *P. Hauerii* (d'Orb.) Egger, 1899, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xxi. p. 154, pl. xviii. figs. 4–6.

Abundant at two or three Stations, and occurs at several others in both Areas. All the examples possess the characters shown in Brady's drawing, pl. civ. fig. 6.

Pulvinulina Menardii d'Orbigny sp.

Rotalia Menardii d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 273, No. 26; Modèle, No. 10. *Pulvinulina repanda* var. *Menardii* (d'Orb.) Parker and Jones, 1865, Phil. Trans., vol. clv. p. 394, pl. xvi. figs. 35–37. *P. Menardii* (d'Orb.) Malagoli, 1887, Boll. Soc. Geol. Italia, vol. vi. p. 523, pl. xiii. fig. 10. *P. Menardii* (d'Orb.) Brady, Parker, and Jones, 1888, Trans. Zool. Soc., vol. xii. p. 228, pl. xlvi. fig. 3. *P. Menardii* (d'Orb.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 411, pl. xvii. figs. 7–9, 10–12. *P. Menardii* (d'Orb.) Woodward and Thomas, 1893, Geol. and Nat. Hist. Survey of Minnesota, vol. iii. p. 45, pl. E, fig. 33. *Discorbina pusilla* (Uhlig) Grzybowski, 1894, Rozprawy Wydz. Mat.-Przyr. Akad. Umiej-Krakowie, vol. xxix. p. 197, pl. iii. fig. 7. *P. Menardii* (d'Orb.) Burrows and Holland, 1897, Proc. Geol. Assoc., vol. xv. p. 48, pl. ii. fig. 22. *P. Menardii* (d'Orb.) Flint, 1899, Rep. U.S. Nat. Mus. for 1897 (1899), p. 329, pl. lxxiii. fig. 3. *P. Menardii* (d'Orb.) Rhumbler, 1900, in Dr. Karl Brandt's Nordisches Plankton, Heft 14, p. 14, figs. 6–8; Idem, 1902, Zeitschr. für allgem. Phys., vol. ii. part 2, p. 234, fig. 67. *P. Menardii* (d'Orb.) Fornasini, 1902, Mem. R. Accad. Sci. Ist. Bologna, ser. 5a, vol. x. p. 58, fig. 55.

Pulvinulina Menardii d'Orbigny var. *fimbriata* Brady.

Pulvinulina Menardii var. *fimbriata* Brady, 1884, Chall. Rept., p. 691, pl. ciii. fig. 3. *P. fimbriata* (Brady) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 412, pl. xvii. fig. 19. *P. Menardii* var. *fimbriata* (Brady) Flint, 1899, Rep. U.S. Nat. Mus. for 1897 (1899), p. 329, pl. lxxiii. fig. 4. *P. Menardii* var. *fimbriata* (Brady) Rhumbler, 1900, in Dr. Karl Brandt's Nordisches Plankton, Heft 14, p. 16, fig. 9.

The normal form, although stunted in growth, is plentiful and widely distributed throughout the region.

Wherever the type is abundant, examples occur which have the margin more or less fimbriated.

Pulvinulina tumida Brady.

Pulvinulina Menardii var. *tumida* Brady, 1877, Geol. Mag., ser. 2, vol. iv. p. 535. *P. tumida* Idem, 1884, Chall. Rept., p. 692, pl. ciii. figs. 4–6. *P. tumida* (Brady) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 414, pl. xvii. figs. 4–6, 35–37, 44. *P. tumida* (Brady) Flint, 1899, Rep. U.S. Nat. Mus. for 1897 (1899), p. 329, pl. lxxiii. fig. 5.

This thick variety is but poorly represented, and has been noted at two Stations only, and there only in small quantities.

Pulvinulina canariensis d'Orbigny sp.

Rotalina canariensis d'Orbigny, 1839, Foram. Canaries, p. 130, pl. i. figs. 34–36. *Pulvinulina repanda* var. *Menardii* subvar. *canariensis* (d'Orb.) Parker and Jones, 1865, Phil. Trans., vol. clv. p. 395, pl. xvi. figs. 47–49. *P. canariensis* (d'Orb.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 413, pl. xvii. figs. 20–22. *P. canariensis* (d'Orb.) Rhumbler, 1900, in Dr. Karl Brandt's Nordisches Plankton, Heft 14, p. 16, fig. 10.

Pulvinulina patagonica d'Orbigny sp.

Rotalina patagonica d'Orbigny, 1843, Foram. Amér. Mérid., p. 36, pl. ii. figs. 6–8. *Pulvinulina scitula* Brady, 1882, Proc. Roy. Soc. Edinburgh, vol. xi. p. 716. *P. scitula* (Brady) Balkwill and Millett, 1884, Journ. Micr., vol. iii. p. 85, pl. iv. fig. 12. *P. patagonica* (d'Orb.) Brady, 1884, Chall. Rept., p. 693. pl. ciii. fig. 7. *P. patagonica* (d'Orb.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 413, pl. xvii. figs. 16–18. *P. patagonica* (d'Orb.) Rhumbler, 1900, in Dr. Karl Brandt's Nordisches Plankton, Heft 14, p. 13, fig. 5.

These closely allied forms are scarce in the Malay Archipelago, and restricted to a few Stations. Of the two *canariensis* is the less rare.

Pulvinulina crassa d'Orbigny sp.

Rotalina crassa d'Orbigny, 1840, Mém. Soc. Géol. France, vol. iv. p. 32, pl. iii. figs. 7, 8. *Pulvinulina crassa* (d'Orb.) S. R. J. Owen, 1867, Journ. Linn. Soc. (Zool.), vol. ix. p. 148, pl. v. figs. 18, 19. *P. crassa* (d'Orb.) Terrigi, 1891, Mem. R. Com. Geol. Italia, vol. iv. p. 108, pl. iv. fig. 13. *P. crassa* (d'Orb.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 416, pl. xviii. figs. 7–12. *P. crassa* (d'Orb.) Flint, 1897, Rep. U.S. Nat. Mus. for 1897 (1899), p. 329, pl. lxxiv. fig. 1. *P. crassa* (d'Orb.) Rhumbler, 1900, in Dr. Karl Brandt's Nordisches Plankton, Heft 14, p. 17, figs. 12, 14, 15.

This also is a rare form in the Malay Archipelago. The examples, although small, are characteristic.

Pulvinulina Micheliniana d'Orbigny sp.

Rotalina truncatulinoides d'Orbigny, 1839, Foram. Canaries, p. 132, pl. ii. figs. 25–27. *Rotalina Micheliniana* Idem, 1840, Mém. Soc. Géol. France, vol. iv. p. 31, pl. iii. figs. 1–3. *Pulvinulina repanda* var. *Menardii* subvar. *Micheliniana* (d'Orb.) Parker and Jones, 1865, Phil. Trans., vol. clv. p. 396, pl. xvi. figs. 41–43; pl. xiv. fig. 16. *P. Micheliniana* (d'Orb.) Brady, Parker, and Jones, 1888, Trans. Zool. Soc., vol. xii. p. 229, pl. xlvi. fig. 10.

Rotalina Michelini (d'Orb.) Fritel, 1888, Foss. Caract. terr. sed. second., pl. xx. figs. 33–35. *Rotalia Michelini* (d'Orb.) Beissel (Holzapfel), 1891, Abhandl. k. Preuss. geol. Landesanst, N.F., Heft 3, p. 73, pl. xiv. figs. 7–10. *P. Micheliniana* (d'Orb.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 416, pl. xviii. figs. 1–6. *Rotalina Micheliniana* (d'Orb.) Idem, 1899, Ibid., vol. xxi. p. 155, pl. xx. figs. 1–3. *P. truncatulinoides* (d'Orb.) Rhumbler, 1900, in Dr. Karl Brandt's Nordisches Plankton, Heft 14, p. 17, fig. 16.

In according precedence to the trivial name *truncatulinoides*, Dr. Rhumbler is no doubt technically right, that is, as far as the dates on the title pages are concerned; but the name *Micheliniana* is so well established, that even a slight excuse for its retention may be willingly accepted. The uncertainty of d'Orbigny's dates is shown by the fact that the memoirs on the foraminifera of the Canary Isles, and of South America both bear on the title the date 1839. On the very first page of the latter work allusion is made to a memoir published in 1840, and this is asserted to have been issued in the year previous to 1839, whilst to complete the incongruity the original wrapper of my copy bears the date 1843. Brady, in his 'Challenger' Report, notices some of these discrepancies and accords preference to the name *Micheliniana*.

The form is rare in the Malay Archipelago, and has been found only at Station 2.

Pulvinulina Schreibersii d'Orbigny sp.

Rotalina Schreibersii d'Orbigny, 1846, For. Foss. Vienne, p. 154, pl. viii. figs. 4–6. *Pulvinulina Schreibersii* (d'Orb.) Parker and Jones, 1865, Phil. Trans., vol. clv. p. 393. *P. Schreibersii* (d'Orb.) Brady, Parker, and Jones, Trans. Zool. Soc., vol. xii. p. 228, pl. xlvi. fig. 4. *P. Schreibersii* (d'Orb.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 409, pl. xviii. figs. 31–33, 67–69.

This form also is rare in the Malay Archipelago, and has been observed only in Area 2.

Pulvinulina elegans d'Orbigny sp.

Rotalia (*Turbinulina*) *elegans* d'Orbigny, 1826, Ann. Sci. Nat., vol. xii. p. 276, No. 54. *Pulvinulina elegans* (d'Orb.) Jones and Parker, 1864, Geologist, vol. vii. p. 88. *P. elegans* (d'Orb.) Brady. Parker, and Jones, 1888, Trans. Zool. Soc., vol. xii. p. 228, pl. xlvi. fig. 2. *P. elegans* (d'Orb.) Sherborn and Chapman, 1889, Journ. R. Micr. Soc., p. 489, pl. xi. figs. 30–32. *Rotalia* cf. *Bouei* (d'Orb.) Beissel (Holzapfel), 1891, p. 72, pl. xiv. figs. 25–29. *P. elegans* (d'Orb.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 410, pl. xviii. figs. 37–39. *P. elegans* (d'Orb.)

Fornasini, 1893, Mem. R. Accad. Sci. Ist. Bologna, ser. 5, vol. iii. p. 435, pl. ii. fig. 18. *P. elegans* (d'Orb.) Goës, 1894, K. Svenska Vet.-Akad. Handl., vol. xxv. p. 97, pl. xvi. fig. 808. *P. elegans* (d'Orb.) Jones, 1895, Palæont. Soc., p. 324, pl. vii. fig. 32. *P. elegans* (d'Orb.) Chapman, 1898, Journ. R. Micr. Soc., p. 6, pl. i. fig. 8. *P. elegans* (d'Orb.) Flint, 1899, Rep. U.S. Nat. Mus. for 1897 (1899), p. 331, pl. lxxv. fig. 1.

Pulvinulina Partschiana d'Orbigny sp.

Rotalina Partschiana d'Orbigny, 1846, For. Foss. Vienne, p. 153, pl. vii. figs. 28–30; pl. viii. figs. 1–3. *Pulvinulina repanda* var. *elegans* (d'Orb.) Parker and Jones, 1865, Phil. Trans., vol. clv. p. 397, pl. xvi. figs. 44–46. *P. Partschiana* (d'Orb.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 410, pl. xvii. fig. 43, pl. xviii. figs. 25–27. *P.* (*Rotalina*) *Partschiana* (d'Orb.) Idem, 1895, Naturhist. Ver. Passau, Jahresber., xvi. p. 33, pl. v. fig. 9. *P. Partschiana* (d'Orb.) Grzybowski, 1897, Rozprawy Wydz. Mat.-Przyr. Akad. Umiej-Krakowie, vol. xxxiii. p. 299, pl. xii. fig. 25. *P. Partschiana* (d'Orb.) Egger, 1899, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xxi. p. 154, pl. xx. figs. 10–12. *P. Partschiana* (d'Orb.) Flint, 1899, Rep. U.S. Nat. Mus. for 1897 (1899), p. 331, pl. lxxv. fig. 3.

Although these allied forms occur at several Stations in both Areas; the examples are very small and weak, and nowhere numerous.

Pulvinulina Berthelotiana d'Orbigny sp.

Rotalina Berthelotiana d'Orbigny, 1839, Foram. Canaries, p. 130, pl. i. figs. 31–33. *Pulvinulina Berthelotiana* (d'Orb.) Parker and Jones, 1865, Phil. Trans., vol. clv. p. 393. *P. Berthelotiana* (d'Orb.) De Amicis, 1893, Boll. Soc. Geol. Italia, vol. xii. p. 455, pl. iii. fig. 12.

Is represented by a solitary, but fine specimen from Station 2 in Area 1.

Little is known of its distribution in the living condition; d'Orbigny found it in the sand of Teneriffe, and Brady records two 'Challenger' Stations, both near the coast of Papua, at depths from 16 to 25 fathoms.

Rotalia Lamarck.

Rotalia Beccarii Linné sp.

Cornu Ammonis Plancus, 1739, Conch. Min., p. 8, pl. i. fig. 1. *Nautilus Beccarii* Linné, 1758, Syst. Nat., p. 710, No. 237. *Rotalia*

(*Turbinulina*) *Beccarii* (Turt.) d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 275, No. 42. *R. Beccarii* (Linné) Wright, 1886, Proc. Belfast Nat. Field Club, 1884–1885, App. ix. p. 332, pl. xxvii. fig. 15. *R. Beccari* (Linné) Malagoli, 1887, Boll. Soc. Geol. Italia, vol. vi. p. 523, pl. xiii. fig. 11. *R. Beccari* var. *ammoniformis* Idem, Ibid., p. 523, pl. xiii. fig. 12; Idem, 1888, Atti Soc. Nat. Modena, ser. 3, vol. vii. p. 113, pl. iii. fig. 10. *R. Beccarii* (Linné) Terrigi, 1889, Mem. R. Accad. Lincei, ser. 4, vol. vi. p. 119, pl. viii. fig. 5. *Rotalina Beccarii* (Linné) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 420, pl. xix. figs. 25–27. *Rotalina Beccarii* (Linné) Goës, 1894, K. Svenska Vet.-Akad. Handl., vol. xxv. p. 99, pl. xvi. fig. 811. *R. Beccarii* (Linné) Rhumbler, 1894, Zeitschr. für Wiss. Zool., vol. lvii. p. 574, pl. xxii. fig. 41. *R. Beccarii* (Linné) Lister, 1895, Phil. Trans., vol. clxxxvi. p. 436, pl. viii. figs. 38–40. *R. Beccarii* (Linné) Fornasini, 1898, Mem. R. Accad. Sci. Ist. Bologna, p. 259, figs. *R. Beccarii* (Linné) Flint, 1899, Rep. U.S. Nat. Mus. for 1897 (1899), p. 331, pl. lxxv. fig. 2. *R. Beccarii* (Linné) Wright, 1900, Geol. Mag., dec. 4, vol. vii. p. 100, pl. v. fig. 22. *R. Beccarii* (Linné) Fornasini, 1902, Mem. R. Accad. Sci. Ist. Bologna, ser. 5ª, vol. x. p. 59, figs. 56–58. *R. Beccarii* (Linné) Chapman, 1902, The Foraminifera, p. 37, fig. 23. *R. Beccarii* (Linné) Lister, 1903, The Foraminifera, in Lankester's Zoology, p. 120, fig. 50.

This well-known form is very abundant and occurs at nearly all of the Stations. The examples are small, but are marked with great variety, not only in the number and degree of inflation of the chambers, but also in the thickness and translucency of the shell-substance.

Rotalia Broeckhiana Karrer.

Rotalia Broeckhiana Karrer, 1878, in Drasche's Geol. Luzon, p. 98, pl. v. fig. 26. *Rotalina Broeckhiana* (Karr.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 421, pl. xix. figs. 19–21.

This even at its best is a very unsatisfactory form, and the Malay Archipelago examples, which are always found in company with *R. Beccarii*, are small and poor.

Brady records it from off Ki Islands, 580 fathoms. The solitary 'Gazelle' Station is West Australia, 196 fathoms.

Rotalia Soldanii d'Orbigny.

Rotalia (*Gyroidina*) *Soldanii* d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 278, No. 5; Modèle, No. 36. *R. Soldanii* (d'Orb.) Terrigi, 1891, Mem. R. Com. Geol. Italia, vol. iv. p. 109, pl. iv. fig. 15. *Rotalina Soldanii* (d'Orb.) Egger, 1893, Abhandl. k. bayer.

Akad. Wiss., Cl. II. vol. xviii. p. 420, pl. xix. figs. 16–18, 51. *Rotalina Soldanii* (d'Orb.) Goës, 1894, K. Svenska Vet.-Akad. Handl., vol. xxv. p. 99, pl. xvi. fig. 812. *Rotalina Soldanii* (d'Orb.) Egger, 1895, Naturhist. Ver. Passau, Jahresber., xvi. p. 34, pl. v. fig. 10. *R. Soldanii* (d'Orb.) Grzybowski, 1897, Rozprawy Wydz. Mat.-Przyr. Akad. Umiej-Krakowie, vol. xxxiii. p. 300, pl. xii. fig. 23. *R. Soldanii* (d'Orb.) Silvestri, 1899, Mem. Pontif. Accad. Nuovi Lincei, vol. vi. p. 328, pl. vi. fig. 14. *R. Soldanii* (d'Orb.) Flint, 1899, Rep. U.S. Nat. Mus. for 1897 (1899), p. 332, pl. lxxv. fig. 4. *Rotalina Soldanii* (d'Orb.) Egger, 1899, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xxi. p. 156, pl. xx. figs. 26–28.

This form is found at two Stations in considerable numbers, but the examples are small and weak. They vary in the direction of *R. orbicularis*, but no typical specimens of this latter form have been observed.

Rotalia Schroeteriana Parker and Jones.

Ammonshorn Schroeter, 1784, Neue Litt. u. Beyträge, vol. i. p. 307, pl. i. fig. 1. *Faujasina* sp., Williamson, 1853, Trans. Micr. Soc. London, ser. 2, vol. i. p. 87, pl. x. figs. 1–6. *R. Schroeteriana* (Parker and Jones, M.S.) Carpenter, 1862, Introd. Foram. p. 212, pl. iv. fig. 3, pl. xiii. figs. 7–9. *Rotalina Schroeteriana* (Carpenter) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 422, pl. xix. figs. 10–12. *R. Schroeteriana* (P. and J.) Flint, 1899, Rep. U.S. Nat. Mus. for 1897 (1899), p. 338, pl. lxxvi. fig. 1.

This fine species is abundant, large and typical, at Stations 14 and 17.

Schroeter records it from Tranquebar, and states that the examples are the size of poppy-seeds. Brady * writes, "No well-marked specimens of *Rotalia Schroeteriana* have been met with in the 'Challenger' dredgings. Though somewhat local in distribution, it is by no means rare amongst the islands of the Eastern Archipelago, at depths of less than 50 or 60 fathoms." The 'Gazelle' Stations are West Australia, Amboyna and New Guinea, at depths of from 30 to 560 fathoms. The 'Albatross' locality is not recorded.

Rotalia Schroeteriana Parker and Jones, var. *inflata* var. n., plate X. fig. 5.

This is an interesting variety which occurs in great profusion throughout the region. The conical form of the test and the flat superior face indicate that it is a modification of *R. Schroeteriana*; whilst being constant in maintaining the conical shape, the surface

* Chall. Rept., 1884, p. 707.

is subject to great variation, being smooth in some examples, whilst others are beset with tubercles and spines in various degrees. The peripheral margin is more or less fimbriate and often deeply indented at the sutures. A series of umbilical lobes is always present.

The example illustrated shows all these characters in a modified form.

Rotalia papillosa Brady.

R. papillosa Brady, 1884, Chall. Rept., p. 708, pl. cvi. fig. 9.
R. papillosa (Brady) Flint, 1899, Rep. U.S. Nat. Mus. for 1897 (1899), p. 322, pl. lxxvi. fig. 2.

At Station 13 in Area 1 this form is common, and it occurs sparingly at a few other Stations in both Areas.

Brady states that it was obtained at seven 'Challenger' Stations in the South Pacific, and at one in the North Pacific, at depths of from 2 to 37 fathoms. The 'Albatross' locality is not recorded.

Rotalia annectens Parker and Jones, plate X. fig. 6.

Rotalia annectens Parker and Jones, 1865, Phil. Trans., vol. clv. pp. 387, 422, pl. xix. fig. 11.

Parker and Jones describe this as "A well-developed conus-shaped Rotalia, which has on its under or umbilical surface, partially formed secondary chambers, owing to angular processes of the septa nipping the umbilical lobes. It is thus a passage-form between *R. Schroeteriana* P. and J., and *R.* (*Asterigerina*) *lobata* d'Orbigny." The localities given are Hong Kong (anchor-mud) and Fiji (coral-reef).

The Malay examples are less conical than the type, and the angular processes of the septa are not so well marked.

It occurs sparingly at Stations 14 and 17.

Rotalia annectens Parker and Jones, var. *concinna* var. n., plate X. fig. 7.

This is a neat compact form, subject to but little variation. The sutures on the inferior face of the test are deeply excavated, forming angular depressions which increase in width as they recede from the peripheral margin. They are bordered by two rows of tubercles, which combine to form a zigzag beading encircling the test. The supplementary chambers are obtuse on the superior margin, and usually cover the whole of the umbilical region. In the example selected for illustration these lobes are absent from

a portion of the test, and are replaced by large clear tubercles or beads.

The variety occurs at the same Stations as the type, as well as at a few others in both Areas.

Rotalina calcar d'Orbigny sp.

Calcarina calcar d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 276, No. 1; Modèle, No. 34. *Rotalia calcar* (d'Orb.) Brady, 1884, Chall. Rept., p. 709, pl. cviii. fig. 3. *Rotalina calcar* (d'Orb.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 423, pl. xix. figs. 1–3.

Rotalia venusta Brady.

Rotalia venusta Brady, 1884, Chall. Rept., p. 708, pl. cviii. fig. 2. *Rotalina venusta* (Brady) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 422, pl. xix. figs. 13–15.

Whilst a few more or less typical examples of these two species occur in the Malay Archipelago, the greater mass is made up of forms in which the characters of both are so intermixed that it is useless to attempt to separate them. They both occur in considerable numbers at several of the Stations in both Areas.

For the occurrence of *R. venusta*, Brady names five South Pacific Stations, 3 to 11 fathoms; and off Calpentyn, Ceylon, 2 fathoms, or thereabouts. The 'Gazelle' locality is off the Cape of Good Hope, 50 fathoms.

Rotalia pulchella d'Orbigny sp.

Calcarina pulchella d'Orbigny, 1839, Foram. Cuba, pp. 80, 92, pl. v. figs. 16–18. *Rotalia pulchella* (d'Orb.) Brady, 1884, Chall. Rept., p. 710, pl. cxv. fig. 8. *R. pulchella* (d'Orb.) Flint, 1899, Rep. U.S. Nat. Mus. for 1897 (1899), p. 332, pl. lxxvi. fig. 3.

This beautiful little form is very abundant at Station 17, and occurs sparingly at other Stations in both Areas. The inferior surface of the test is much more complex than would appear from the published drawings, and is almost identical with that of *R. annectens* var. *concinna*. The superior face is usually of a delicate fawn colour.

With respect to its general distribution, d'Orbigny found a few examples in sand from Cuba; Brady gives 'Challenger' Stations, Kandavu, 255 fathoms; and Humboldt Bay, Papua, 37 fathoms. He also states that it has been obtained from the Straits of Banca, 7 or 8 fathoms; off Java; and off Penang. The 'Albatross' locality is not recorded.

SUMMARY OF CURRENT RESEARCHES

RELATING TO

ZOOLOGY AND BOTANY

(PRINCIPALLY INVERTEBRATA AND CRYPTOGAMIA),

MICROSCOPY, ETC.*

ZOOLOGY.

VERTEBRATA.

a. Embryology.†

Some Problems of Reproduction.‡—Marcus Hartog points out that the term "fertilisation" as actually used is too ambiguous for scientific precision. In its first and older sense it denotes the starting into active cell-life and multiplication of a resting-cell, and should properly be regarded as one case of germination. In its second sense, regarded now-a-days as the "strict" sense, it denotes a process of cellular (or nuclear) fusion, and is better designated as "syngamy."

Syngamy is not necessarily associated with germination; on the contrary, in the most primitive types the cell freshly produced by syngamy (the zygote) passes into a condition of rest, or gives rise only to a limited brood of resting-cells, which will only germinate after the lapse of time and under favourable conditions. The formation of a membrane round the oosphere at the onset of syngamy in Metazoa and Metaphyta is probably the last trace of this, the original consequence of syngamy.

Syngamy includes internal karyogamy and merogony, as well as the pairing of separate individual cells. It seems possible that in the Alcyonarians the oosphere is non-nucleate, and that the nucleus of the oosperm is exclusively male, as in that produced by merogony.

Progamic cell-divisions come under three formulæ:

(*a*) Gametes are morphologically equal to zoospores, and are therefore produced by multiple cell-divisions.

(*b*) No tissue-cell ever becomes directly transformed into a gamete.

(*c*) Karyogamy (with the possible exception of the Basidiomycetes)

* 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, etc., 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, Reproduction, and allied subjects.

‡ Quart. Journ. Micr. Sci., xlvii. (1904) pp. 583–608.

is never possible where both the pairing-cells (or nuclei) have had a share in active cell-life or growth.

Progamic divisions and reducing divisions, though sometimes coincident (as in Metazoa), are not necessarily associated, but may be widely divided in the life-cycle where there is "antithetic alternation of generations."

The germ formed by parthenogeny or merogony can double the number of its chromosomes.

As to the role of the sperm, there has been much debate. One school sees in it merely the bearing-in of the ferment that starts the oosperm into development, or of a new centrosome to the oosphere which has lost its own during the formation of the polar bodies. Another school refuses to consider anything but the male nucleus, which indeed constitutes the bulk of the sperm at its entrance. Others, again, insist that however small be the cytoplasm of the sperm in quantity, it is by no means negligible in quality. This third view is a decided under-statement of the case. "The impulse for division given by the sperm is no essential phenomenon of syngamous union; it is conditioned by the differentiation of binary sex, and is the indirect consequence of that reduction of the sperm which makes its growth within the egg the necessary prelude of complete fusion therewith."

Maturation Divisions in Vertebrates.* — A. and K. E. Schreiner have studied the details of chromatin division and reduction in the spermatogenesis of *Myxine glutinosa* and *Spinax niger*. The preparation of the chromatin for division and the divisions themselves are similar in both spermatogenesis and oogenesis. In the spermatogonium there is the same number of maternal and paternal chromosomes, of which every pair (male and female) are homologous. At the first phase the chromatin of the single chromosomes divides into fine threads, which by the controlling of the centriole come to lie parallel to each other, slightly converging towards the sphere. The homologous chromosomes mutually attract, and the chromatin glides in long tracts till all homologous chromosomes have found each other and have lain parallel. They then blend more or less closely. The double threads contract, and next there is a lengthwise splitting of both components. Next the thread segments crosswise, so that each piece consists of two homologous chromosomes, whose number on this account amounts to half the number characteristic for the spermatogonium and the somatic cells. By means of the first maturation division the components of the double chromosomes are separated from one another. This is a reduction division. The second is in no way distinguished from the usual equatorial division. The preparation for maturation divisions in Vertebrates cannot be brought into agreement with Boveri's scheme † for the illustration of the mechanics of the reduction divisions, since here reduction is by means of the first division, and the single chromosomes behave in mitoses quite similarly to the daughter elements of the chromosomes in ordinary mitoses, i.e. they are connected with the one-

* Anat. Anzeig., xxiv. (1904) pp. 561–78.

† Ergebn. über die Konstitution der chromatischen Substanz des Zellkerns, Jena, 1904.

spindle pole only. Even if the view be taken that the reduction takes place at the second division, this does not correspond to Boveri's scheme, since the spindle threads disappear after the first division, and a nuclear membrane is developed and new spindle threads are formed before the second division.

Phagocytic Absorption of Ova by Follicle Cells in Fasting Newt.*—Ch. Pérez describes this interesting phenomenon in a newt, *Molge marmorata* Dum. et Bibr., which had fasted for four months. Besides ova in process of normal growth, there were others of an orange colour (identical with that of the adipose bodies) which were obviously in process of being absorbed by those very elements which serve normally for their nutrition. This is a good example of a phase of internal struggle which could hardly have been predicted, even as a possibility, from what is known of the normal conditions.

Parthenogenetic Development of Lamprey's Ova.†—E. Bataillon has succeeded in evoking segmentation on to the blastula stage in ununfertilised ova of *Petromyzon planeri*, by placing them in a 5–6 p.c. sugar solution or in a salt solution. The removal of water by the solutions is regarded as the effective stimulus inducing cleavage.

Experiments on the Developing Ova of the Frog.‡—Georges Bohn records some interesting effects of light on the development of the ova of *Rana temporaria*, e.g. the general inhibitive effect, comparable to the results of radium-influence. The advent of metamorphosis appears to be in great part due to nutritive influences. Green algæ may have a more or less important influence on the development of the ova; there is sometimes a kind of symbiosis, the occurrence of which may give rise to a kind of pœcilogony.

Development of Human Milk Glands.§—H. Eggeling describes certain early stages in the development of the human mammary gland, hitherto not very clearly known. His results prove that if we are not to accept the view that the lacteal glands are *sui generis*, we must regard them as homologous with sweat-glands. He is emphatically of opinion that both have proceeded in different directions from a primitive "merocrine" skin-gland.

Development of Mandibular Articulation.‖—Knut Kjellberg has directed special attention to the "meniscus" in the mammalian articulation between the mandible and the squamosal. His observations on various embryos lead him to accept the general hypothesis that the articular and quadrate of Sauropsida are represented by the malleus and incus in Mammals, that the articular when enclosed in the tympanic cavity took with it a portion of the *M. pterygoideus externus*, while other considerable portions remained attached to the dentary and its condyle, that the most posterior muscular portion is squeezed in between

* Proc. Verb. Soc. Sci. Bordeaux, 1903, pp. 73–4.
† Comptes Rendus, cxxxvii. (1903) pp. 79–80.
‡ Op. cit., cxxxviii. (1904) pp. 1244–5.
§ Anat. Anzeig., xxiv. (1904) pp. 595–605.
‖ Morphol. Jahrb., xxxii. (1904) pp. 159–84 (8 figs.).

the tympanic and the squamosal, and forms at least a part of the *ligamentum anterius mallei*, and that the next region in front has passed between the condyle and the squamosal and become the articular meniscus.

Transition between Internal Iliac and Umbilical Arteries in the New-born.*—R. Argand finds that the structural transition between the hypogastric artery and the umbilical artery happens in the internal half of the intra-abdominal part of the latter. The calibre of the vessel progressively diminishes and the vascular walls thicken. This thickening seems to result from the formation of new longitudinal muscular fascicles. The elastic layers of the media begin to resolve into extraordinarily thin fibres. Then the internal elastic coat thins out and fibrillates in like manner. The delimitation between the internal tunic and the middle tunic becomes now very difficult, not to say impossible. It is only by analogy with the structure of the other arteries in the new-born that we consider the internal tunic as reduced to a vascular epithelium backed externally by a very thin connective tissue. The structural transformation of the umbilical artery begins near the hypogastric by local thickening of the wall as a longitudinal ridge, at whose level the artery is not long in presenting the characters seen in its extra-abdominal passage. A second thickening now appears, all the vessel thickens, and the structure of the umbilical artery is realised.

Development of Nerve Fibres.†—A. von Kölliker champions the view that all nerve-fibres in Vertebrates are direct protoplasmic outgrowths of peripheral or central nerve-cells, each nerve-cell giving rise to not more than one nerve-fibre. What are called Schwann's cells, within fused rows of which the nerve-fibres are believed by some to arise, are mesodermic enveloping elements. Nerve-fibres usually end freely, in any case, without direct connection with nerve-cells. This is the doctrine of independent nervous units or neurons. It holds true for Vertebrates, and probably for Arthropods and Molluscs.

Hypochorda of Salamandra Maculosa.‡—Ad. Reinhardt finds that this peculiar sub-notochordal rod arises in the salamander, as in all other lower Vertebrates, from the endoderm. A trunk portion appears first, then a caudal portion, and lastly a relatively rudimentary hypochorda. Degeneration begins at the two ends, and the part first formed —the anterior trunk portion—is the last to go. The degeneration is quite complete. Nothing certain can be said as to its morphological or phylogenetic import.

Visceral Arches of Urodela.§—L. Drüner completes his elaborate account of the structure and development of the skeletal parts, the musculature, and the innervation of the hyoid, branchial arches, and laryngeal region of Urodela. He deals with *Salamandra*, *Triton*,

* Journ. de l'Anat. et Phys., xl. (1904) pp. 298–304.
† Anat. Anzeig., xxv. (1904) pp. 1–6.
‡ Morphol. Jahrb., xxxii. (1904) pp. 195–231 (2 pls.).
§ Zool. Jahrb., xix. (1904) pp. 361–690 (12 pls. and 44 figs.).

Proteus, *Menobranchus*, *Menopoma*, *Siredon*, *Cryptobranchus*, *Amphiuma*, *Siren*, *and Ellipsoglossa*. He gives a summary of his morphological results, as well as a detailed account of the various forms.

Development of Mesonephros and Müllerian Ducts in Amphibia.* R. W. Hall has investigated these in *Amblystoma*, *Rana* and *Hyla*. In *Amblystoma* the mesonephric blastula is derived from a portion of the somite which is homologous with the mesomer of elasmobranchs, and it contains both splanchnoderm and somatoderm. The more anterior blastulæ probably never lose their connection with the two layers of the lateral mesoderm. The outer tubules (at least in the anterior primary units) therefore contain both somatoderm and splanchnoderm. The morphologically dorsal angle of the body-cavity is not at the upper limit of the mesentery, but lies just mesial to the Wolffian duct. Hence the germ cells (except in very early stages) all lie in the splanchnoderm. The secondary character of the dysmetamerism of the urodele shows itself in the fact that the primary blastulæ can be divided into two sets, in one of which the elements (those of the "first order") are metamerically arranged. It is suggested that the units of the "second order" represent the final product of a phylogenetic evolution in which a number of secondary units have been transformed into primary ones. Tertiary sets arise from secondary, and quaternary from tertiary, etc. At the period of metamorphosis only primary and secondary units have produced outer tubules, and in all probability the outer tubules are confined to these two sets of units throughout life. The development of the Müllerian ducts is followed in great detail. At one point it fuses with the Wolffian duct, and then grows backward free. That the Wolffian duct contributes cells helping to form the Müllerian duct in this region seems almost beyond question. The greater part, however, —throughout the entire extent of the mesonephros—grows back independent of the Wolffian duct. The results of similar observations on *Rana* and *Hyla* are included in the paper.

Development of Layers and Organs in the Terminal Bud and Tail of Teleost Embryos.†—A. Swaen and A. Brachet have studied the development of the caudal region in *Trutta fario*, *Leuciscus cephalus* and *Exocœtus volitans*. The first chapter discusses the development and growth of the trunk at the expense of the terminal bud; the second is devoted to the development and elongation of the tail; the third describes the completion of the posterior extremity, and the formation of the anal plate.

Development of Pancreas, Liver and Spleen in the Sturgeon.‡—A. Nicolas has studied the development of these organs in *Acipenser ruthenus*. He finds that the dorsal primordium of the pancreas is single; it is formed by the constricting off of a groove, which becomes a tubular diverticulum, from the region giving rise to stomach and duodenum. There is nothing peculiar except its primitive situation,

* Bull. Mus. Zool. Harvard, xlv. (1904) pp. 31–125 (8 pls.).
† Arch. Biol. xx. (1904) pp. 461–610 (4 pls.).
‡ Tom. cit., pp. 425–60 (3 pls.).

which is due to an accumulation of yolk in this region of the digestive tract. There are also two ventral primordia of the pancreas, and their history is traced. The liver arises as an isolated organ at the expense of a ventral zone of epithelium on the vitelline intestine, and it is constricted off dorsally, not ventrally, which again is due to the position of the yolk in gut. In regard to the spleen, the author confirms the conclusions of Piper and Laguesse, that this organ arises in a mesenchymatous area quite independent of the pancreas.

Development of the Swim-Bladder.*—Fanny Moser has investigated the early stages in several fishes, e.g. *Cyprinus*, *Salmo*, *Gasterosteus*. Her conclusions are in favour of a relationship between lungs and air-bladder. She noted a double movement of the intestine, a displacement from the side (from left in carp, *Rhodeus*, etc., and from the right in salmon) towards the middle line under the notochord, and then a twisting of the intestine upon its own axis, through which the origin of the ductus pneumaticus is shifted. In some cases it passes from the right side to the dorsal and even towards the left, in others from the dorsal side towards the left. The author considers the shifting permanent and not due to the changes in the yolk mass during absorption. In the trout the twisting affects to some extent the air-bladder also; in *Rhodeus* this is not the case. If a movement of the air-bladder round is possible, the hypothesis of a phylogenetic shifting gains in probability. One has only to think of the twisting of the bladder in the trout as continued; a side position would be reached as occurs in the Erythrinæ; continued further it would end in being ventral, as in *Polypterus*. It is more probable that the bladder and ductus followed the movement of the gut than that an independent twisting of the ductus took place around a fixed gut. The absence of bladder in certain forms the author regards as secondary.

Degeneration in Relation to Regeneration.†—E. Schultz kept *Dendrocœlum lacteum* throughout the winter without food. In this time—six months—they had become reduced to one-tenth of their original size. This reduction was due to falling away of a great number of cells; the size of remaining cells being unaltered. In four to six months a part of the organs had quite disappeared. Thus, of the copulatory organs only a hollow remained, which afterwards also disappeared, so that at last he found only a group of cells which was specialised to the extent that it could re-form the same organ. The vasa efferentia disappeared, also the oviducts; only the sexual organs themselves remained unattacked, in spite of the fact that the sex products do not mature during starvation. The pigment cells of the eyes fall away and the pigment disappears. The gut epithelium partly degenerates; a few cells assume an embryonic character. Here there is a whole series of retrogressive processes, which go through the stages followed in regeneration,‡ but in reverse order.

* Arch. Mikr. Anat., Band lxiii. (1904) pp. 532–74 (4 pls.).
† Biol. Centralbl., xxiv. (1904) pp. 310–17.
‡ Zeitschr. wiss. Zool., lxxii. (1902).

Viviparity and Parasitism.*—V. Faussek refers to his essay of 1893† in which he elaborated an interpretation of viviparity as a kind of parasitism within the limit of a species, "a temporary embryonic parasitism of each new generation on its predecessors." It seems important to remember that the embryo may, like an endoparasite, play an active part in securing adaptive arrangements for itself. "The formation of a placenta is the result of the aggressive activity of the embryo." The glochidia of *Anodonta*, the embryos of some species of *Peripatus* and dogfish, the state of affairs in *Pipa*, *Salamandra atra*, and so on, are alluded to. Corroboration is found by considering the alternation of generations in mosses and ferns. The author notes that Giard and Houssay have also recognised the idea of embryonic parasitism, but it is surely a fairly common idea.

b. Histology.

Twin Nuclei in Various Types of Cells in the Guinea-Pig.‡—Maurice Pacaut notes that binucleate cells have been recorded by various histologists, e.g. in the sympathetic ganglia, in the mucous membrane of tongue and palate, and so on. In studying the tissues of the guinea-pig, the author has found many examples of cells with twin nuclei, especially in the cardiac portion of the œsophagus, but also in the tongue and in the skin, and more sporadically in most of the organs.

Histology of Digestive Tract of Amblystoma Punctatum.§—G. A. Bates describes the features of the alimentary tract in this Urodele. The mouth cavity is lined by stratified epithelium. Except in these regions where the cells are low, cubical, and non-ciliate, the lining cells are of the ciliated columnar and goblet type. Glands penetrate the tongue from the dorsal surface; at the base they consist of clear mucous cells; farther forward the deeper ends consist of true secreting cells with large (zymogen?) granules in the free ends. *Amblystoma* differs from *Necturus*, *Proteus* and *Triton* in the presence of cilia in the mouth and of tubular glands in the tongue. The mucosa of the œsophagus is folded longitudinally, has ciliated epithelium, fewer goblet cells, and no muscularis mucosæ. Glands are present in the œsophagus of the young, but absent in the adult. The sub-mucosa and muscularis mucosæ are present in the stomach. This is lined by the columnar mucous cells peculiar to the Amphibia. The differentiated regions of higher Vertebrates are not present. The intestine is lined with striped columnar and goblet cells; the duodenum has folds recalling the valvulæ conniventes of the higher Vertebrates, while at their base are groups of cells suggestive of glands. The epithelium at the beginning of the cloaca is composed entirely of goblet cells, these being gradually replaced by a transitional stratified epithelium with columnar-like cells on the free surface. Below the surface epithelium of the

* Zool. Anzeig., xxvii. (1904) pp. 761–7.

† Russkoje Bogatstwo, 1903. Studien über verschiedene Fragen der biologischen Evolution. St. Petersburg, 1899 (in Russian).

‡ Comptes Rendus, cxxxviii. (1904) pp. 1241–3.

§ Tufts College Series, No. 8 (1904) pp. 411–35 (3 pls.).

cloaca are cell aggregates with abundant mitoses, which are to be regarded as germinal centres for the replacement of the degenerating cells of the surface.

Granule Cells in Mucosa of Pig's Intestine.*—C. C. Du Bois finds that this mucosa contains numerous granule cells of which two general types can be distinguished: (*a*) those with basophile granules and (*b*) those with acidophile granules. The granule cells stand in no definite relation to the lumen of the canal, to the crypts, to any lamina, or to the blood- or lymph-vessels. The acidophiles are closely related to certain granule cells in the blood as to staining properties, and probably represent a variety of the eosinophile granule cells so widely scattered about the body. The basophiles belong to the same class as the coarsely granular basophile cells described by Hardy and Westbrook, and are similar to Ehrlich's "mast-cells." But the significance of the granule cells remains obscure: possibly they store metabolic products.

Minute Structure of Supra-Renal of Guinea-Pig.†—F. Fuhrmann does not agree with the hitherto accepted division of the cortex into three parts (zonæ glomerulosa, fascicularis, reticularis, Arnold) but divides it into two according to the differentiation of the cells in development. He considers the medulla a separate structure. The outer cortical layer embraces the zona glomerulosa of Arnold and that part of the fascicularis termed by Guieysse "couche spongieuse," while the inner constitutes the rest of the cortex (the "couche fasciculée" of Guieysse, and the zona reticularis of Arnold). He is of opinion that the medulla cannot be regarded as a "paraganglion suprarenale" comparable to the "paraganglion intercaroticum" as held by Kohns. The cells of the latter are distinguished in essential points from those of the supra-renal medulla, although they behave similarly with certain reagents. He inclines to believe that there is a very close connection between the medulla and the inner cortical layer, and that a sharp division of both layers is not permissible. Worthy of note is the rare occurrence of ganglion cells in the supra-renal of the guinea-pig as compared with other animals.

Kidney of Male Elasmobranchs.‡—J. Borcea points out that the anterior portion of the kidney in male Elasmobranchs (*Squatina*, *Acanthias*, *Galeus*, *Scyllium*, *Pristiurus*, *Carchurias*, *Raia*) does not degenerate, as it does in the female, but takes on a distinct, non-renal function, providing a nutritive fluid for the spermatozoa. There is not a single malpighian glomerulus in this anterior region, and the functional kidney in the male is wholly due to the posterior nephridia.

Interstitial Tissue of Testis.§—Bouin and Ancel continue investigations on the structure and significance of the interstitial gland of the testis. They describe its special characters in the horse—young, adult, aged and cryptorchid. In the young animal there are special cells

* Anat. Anzeig., xxv. (1904) pp. 6–16.
† Op. cit., xxiv. (1904) pp. 606–8.
‡ Comptes Rendus, cxxxviii. (1904) pp. 1342–3.
§ Arch. Zool. Exp., ii. (1904) Notes et Revue, pp. cxliii.–lv.

containing yellow granules, which diminish in numbers from the beginning of the period before sexual maturity. In the adult the gland is of the usual type ; the xanthic granule cells persist in small numbers between the seminiferous tubules. In the aged animal the cells are much smaller ; the peripheral vacuolar zone is reduced or absent in most The secretory activity is diminished and the cells are full of pigment granules. The cryptorchid testis has all the histological alterations of the ectopic testis. The observers are of opinion that the interstitial gland is the only source of the internal secretion of the testicle.

c. General.

Why is the Human Ear Immobile? *—Walter Smith argues that Man's loss of mobility in the ear has resulted in a fuller appreciation of the succession of sounds, and thus has been in an important sense a condition of the social, intellectual and æsthetic development which has come with the use of language and music. It is in a high degree probable, though the data are insufficient for conclusive demonstration, that it is to the advantage given in the struggle for existence by the first stages of this development that we are to attribute the permanent alteration in the structure of the external ear.

Homology of Olecranon and Patella.†—P. le Damany discusses this subject. He is of opinion that the olecranon is anatomically comparable to the humeral trochiter, femoral great trochanter, and great tuberosity of calcaneum. It is an apophysis for muscular insertion. The patella, on the contrary, is a sesamoid bone very like the rest, and often accompanied by many congeners round the knee.

Defect of Human Hip Joint.‡—P. le Damany discusses the peculiarities of the coxa-femoral articulation, which result from the intra-uterine position, and are perpetuated by the erect habit of locomotion. Its manifestations are the ill-adapted orientation of the femoral neck and cotylus, insufficiency of femoral extension, propulsion of the head by femoral extension, and diminution or suppression of external rotation of the femur.

Domestication of Zebras.§—R. J. Stordy, in a report to the Secretary of State for Foreign Affairs, gives an account of the proceedings adopted in his experiments on domestication of the zebra. These experiments were highly successful : in some cases the animals were harnessed to vehicles in eight months, and some were ridden within five months from capture. The stallions are to be used by the Indian Government for the production of hybrids. The author is of opinion that, though the wild animal, however well domesticated, may not directly reward experiment, the progeny of semi-domesticated forms will be a success, and he is confident that in the near future the zebra, which is to-day a wild animal, will be classed as one of our most useful beasts of burden.

* Popular Science Monthly, July 1904, pp. 228-37.
† Travaux Scient. Univ. Rennes, Tom. ii. Fasc. iii. (1903) pp. 349-58.
‡ Journ. de l'Anat. et Phys., xl. (1904) pp. 1-21.
§ Journ. Soc. of Arts, London, lii. (1904) pp. 691-7.

Revision of the Chiropteran Genus Macrotus.*—J. Rehn, as the result of the examination of a large number of examples, gives an authoritative description of all the known species of this genus. He concludes that it is without doubt a member of the family Phyllostomatinæ, and a very distinct type with well differentiated external characters.

Variation Notes.†—Carl H. Eigenmann and Clarence Kennedy record several variations: a melanistic form of the cave salamander, *Spelerpes maculicaudus*, from Marble Cave, Mo.; a specimen of *Pygidium rivulatum*, a catfish from Lake Titicaca, with a dichotomously branched maxillary barbule on the left side; and a specimen of *Xiphorhamphus jenensii*, from the Rio Grande, which possessed an adventitious left ventral fin, with one ray less—eight instead of nine—than the normal fish has, and its first ray bent in sickle-fashion.

Osteology of the Dugong Flipper.‡—Ludwig Freund has used the Röntgen-ray method in investigating the bones of the dugong (*Halicore*) flipper. He gives a detailed account of the carpus, metacarpus, and phalanges, both in adult and in embryo; and discusses, more generally, the slow progress of ossification, the duplication of epiphyses, the hints of hyperphalangism, the broadening of the flipper, and the reduction of carpal elements.

Pigment of Supra-renal Capsules.§—C. Gessard finds that the chromogenic substance of the supra-renal capsules, is, in its uncoloured state, which is due to the lack of oxygen, the product (which has hitherto been known as a coloured substance) of the action of tyrosinase on tyrosin.

Fat Synthesis by Mucous Membranes.‖—J. Arnold has experimented with various fatty substances on the mucous membrane of the tongue and gut of the frog, and finds that absorption of fats and oils in both cases takes place. Colouring matter is not absorbed. Other cells which contain fat on being treated with soap or oil are leucocytes, connective-tissue cells, muscle-fibres, etc.

Ablation of Parathyroids in Birds.¶—Doyon and Jouty find that cauterisation of these in cock or hen brings on paralysis, dyspnœa, and other serious symptoms in from six to ten hours, followed by death a few hours later. In one case a cock recovered after manifesting the symptoms usually preceding death in others, and some fowls showed no ill-effects. This last may have been due to some small part of the parathyroid escaping destruction, or to the presence of accessory glands in other parts of the body.

Asymmetrical Development of Fowl's Skull.**—Xavier Raspail describes a case in which, from the seventh week of development, a

* Proc. Acad. Nat. Sci. Philadelphia, 1904, pp. 427–46.
† Biol. Bull., iv. (1903) pp. 227–30 (5 figs.).
‡ Zeitschr. wiss. Zool., lxxvii. (1904) pp. 363–97 (2 pls. and 4 figs.).
§ Comptes Rendus, cxxxviii. (1904) pp. 586–8.
‖ Anat. Anzeig., xxiv. (1904) pp. 389–400.
¶ Comptes Rendus, cxxxviii. (1904) pp. 53–4.
** Bull. Soc. Zool. France, xxix. (1904) pp. 60–3 (2 figs.).

non-accidental variation has affected the growth of the bony tissue of the lower jaw and of the left side of the skull, and has resulted in marked asymmetry.

Monograph of Genus Dendrocincla.*—H. C. Oberholser finds that individual colour variation is very marked in some forms, occasionally amounting to a greater degree of difference than that distinguishing some species. The sexes, though alike in colour, frequently differ widely in size. The colour of the bill, which some writers have relied on to furnish specific distinctions, seems to change with age. The paper contains an account of the characters of the species and sub-species, which will help to clear up the uncertainty hitherto attending the identification of the birds of this genus.

Eyes of a Blind Snake.†—Effa Funk Muhse describes the structure of the eyes in *Typhlops lumbricalis*, a blind burrowing snake generally distributed in the West Indies and Guiana, living just beneath the surface and often thrown out by the plough. The eye shows through the large ocular scale, which entirely covers it. It appears as a black spot surrounded by an unpigmented circle. The usual parts are present: a cornea, an iris, ciliary processes, a large lens, and a retina with the same layers as in snakes in general. The peculiarities are in details of the retinal layers.

Osmotic Properties of Amphibian Skin.‡—E. Overton has demonstrated various points bearing on this subject. For example, he finds that in tree-frogs water may be absorbed through the skin, and that for equally large skin surfaces of the same region of the body under like conditions, the rate of absorption is proportional to the difference of the osmotic pressure of the blood and of the external medium, in so far as the osmotic pressure of the blood is higher than that of the outside medium.

Hypophysis in Amblystoma.§—J. S. Kingsley and F. W. Thyng conclude that there is nothing in the history of the hypophysis in *Amblystoma* to support the "palæostoma theory" of von Kupffer. It arises as a paired structure; it does not present gill-slit features, for it comes into relation not with entodermal structures but rather with the infundibulum. The paired condition, and the fact that columnar cells are recognised in the early stages, imply that it was originally either glandular or sensory. The tubular connection by which it long remains in connection with the exterior (hypophysial stalk) may be interpreted either as a duct for the paired gland, or as a tube to convey water to the sense-organ at its extremity; the tube lengthening to accommodate the removal of the organ from the exterior caused by the cephalic flexure.

Abnormalities in Urodela.‖—G. M. Winslow describes three cases: *Amblystoma punctatum*, with bifid toe; *Plethodon glutinosus*, with bifid

* Proc. Acad. Nat. Sci. Philadelphia, 1904, pp. 447–63.
† Biol. Bull., v. (1903) pp. 261–70 (7 figs.).
‡ Verh. Phys. Med. Ges. Würzburg, xxxvi. (1904) pp. 277–95.
§ Tufts College Studies, No. 8 (1904) pp. 363–78.
‖ Tom. cit., pp. 387–410 (2 pls.).

tail; and *Amblystoma punctatum*, with five legs. The features present in the last specimen are discussed, with reference to their bearing on the problems of variation in the length of the pre-sacral region and of asymmetrical sacra.

Albumin Extracted from Frog's Ova.* — J. Gallimard gives an analysis of "ranovin," an albumin extracted from frogs' eggs. It is complex, slightly acid, peculiar to the species (*Rana esculenta*), and related chemically to the "clupeovin" extracted from the eggs of herring and the "vitellins" of various birds' eggs. The general result that the albumins of various ova differ according to the species is of some interest.

Oviducal Gland of Elasmobranchs.†—J. Borcea states that this gland consists of two parts, a dorsal and a ventral. The former is developed most towards the right side, and the latter towards the left. In each part there are two zones: a superior, secreting albumen, and an inferior, secreting the horny substance of the shell. In each zone there is an external part composed of secretory tubes, and an internal lamellar apparatus for receiving, conducting and disposing of the secreted products. Mucin is secreted in the part beneath the gland, which assists the egg-shell down the oviduct.

Descriptions of Bolca Fishes.‡—C. R. Eastman reviews the literature of these fishes, and gives descriptions, with synonomy of type specimens preserved in various museums. A list is also given of all the types and figured specimens in the Paris Museum of Natural History, which is the largest single collection of these fishes at present existing. The writer concludes that not only does the Eocene fish fauna bear an overwhelmingly modern aspect, but many of its types are as highly specialised as they are to-day; and forms which at the present day are widely aberrant have representatives as far back as the Middle Eocene. It is evident that an "expression point" (to use Cope's apt term) was reached in the evolution of ichthyic life exactly corresponding to, and contemporaneous with that which is so well recognised in mammalian life, although the cause of the phenomena is in each case unknown.

Pelagic Fauna of the Lake of Bret.§—Charles Linder has made a careful study, involving twenty-eight explorations, of the small Lac de Bret, not far from Lausanne. It is a small moraine lake, of Glacial origin, only about a mile long, with a maximum depth of 18 cm., but it contains no fewer than thirty-one representatives of the zooplankton, and is also very rich in littoral forms. The memoir is a good example of careful and methodical faunistric survey.

Origin of the Marine (Halolimnic) Fauna of Lake Tanganyika.‖ W. H. Hudleston discusses, as far as the available data permit, the "Tanganyika problem." The zoological aspect is mainly studied by

* Comptes Rendus, cxxxviii. (1904) pp. 1354–5.
† Tom. cit., pp. 99–102.
‡ Bull. Mus. Zool. Harvard, xlvi. (1904) pp. 1–36 (2 pls.).
§ Revue Suisse Zool., xii. (1904) pp. 149–258 (1 pl.).
‖ Geol. Mag. Decade V., i. No. 7 (1904) Supplement, pp. 337–82.

means of conchological comparisons, and the author concludes that the resemblance between the Tanganyika shells and those of the British inferior oolite is not sufficiently close to warrant any theory as to the derivation of the former from the latter, as Moore has suggested. On the other hand, the anatomy of the existing molluscs reveals a peculiarly archaic character, and also a singular blending of attributes usually held to be distinct. These gastropods may, in some way, have had a remote marine origin, although that need not have been Jurassic. The palæontological and geological evidence is also reviewed, but from no point of view is much support found for Moore's theory, and the problem in its main features remains unsolved.

Food of Fishes, Birds and Insects.*—S. A. Forbes gives a very exhaustive account of the food of young and adult fishes and birds of the State of Illinois. The paper is illustrated by numerous tables in which the "food" for each species treated is classified, and the proportions indicated. In the case of the birds, the food of each month is separately shown. In studying the food of birds, the author found it necessary to construct a key to the genera of the Carabidæ (based primarily upon the mouth structures), an outline of which he gives. Notes on the food of these insects are also given.

Phototropism of Convoluta and Nereids.†—G. Bohn has experimented with these forms, and finds that there is no phototropism such as Gamble and Keble asserted. The animals move indifferently from light to shadow and *vice versa*. There is a tendency to aggregate in the line of shadow just beyond the light, but this is done by those coming from the light and suffering from light-fatigue. The character of the water, whether salt and deep, brackish, etc., also affects their behaviour.

Dermal Fin-Rays of Fishes.‡—Edwin S. Goodrich has studied these in numerous types. In all the fins of the true Pisces there are dermal rays of mesoblastic origin, the *Dermatrichia*; but in adult living fishes there are four of these:

1. In the Elasmobranchii and Holocephali, and probably also in the Acanthodii and Ichthyotomi, these rays are unjointed, occasionally branched and composed of a fibrous substance of horny consistence without bone-cells. When placoid scales are present, they are quite independent of the rays and more superficial. The author calls these rays "*Ceratotrichia*." Their origin is unknown, but for the present they must be considered as special developments of the connective tissue.

2. All living Teleostomes—that is to say, *Polypterus* (*Calamoichthys*?) and the Actinopterygii (Ganoids and Teleosts)—are provided with small, horny, unjointed rays at the edge of their fins, to which the name "*Actinotrichia*" has been given. In the early stages of development these are the only dermal rays supporting the fins. They were probably present in the extinct Actinopterygii and Crossopterygii. They appear to be vestigial structures homologous with the ceratotrichia.

* Bull. Illinois State Lab. Nat. Hist., i. (1903) pp. 19–176.
† Comptes Rendus, cxxxviii. (1903) pp. 1292–4.
‡ Quart. Journ. Micr. Sci., xlvii. (1904) pp. 465–522 (6 pls. and 6 figs.).

3. The Teleostomi are further provided with jointed and branched bony, dermal rays, developed outside the actinotrichia. They bear, in primitive forms, the closest resemblance to the body scales, and Mr. Goodrich proposes to call them "*Lepidotrichia*." They have doubtless arisen through modification of scales, and in the primitive Teleostomes they often extended into the body by means of a long proximal unjointed piece passing below the body-scales.

4. In the Dipnoi are found jointed, branched, dermal rays, of bony substance, containing bone-cells. The name "*Camptotrichia*" is provisionally given to these rays, which appear to be in a degenerate condition in the highly modified living forms *Lepidosiren* and *Protopterus*, and even to some extent in *Ceratodus*. The camptotrichia are always provided with a proximal unsegmented region, deeply imbedded in the body, and covered by the body-scales. Scales also extend over the whole or the greater part of the fins, overlying the dermal rays. The evidence favours the view that the camptotrichia represent the lepidotrichia of the Teleostomes.

It may be that lepidotrichia have originated from modified scales, and the camptotrichia of Dipnoi from somewhat degenerate insunk lepidotrichia covered by a secondary extension of the body-scales. But the presence of a proximal joint of considerable length extending below the body-scales in some Teleostomes (such as *Cheirolepis*) is not easy to account for; and the relation which the inner ends of the ceratotrichia, camptotrichia and lepidotrichia bear to the muscles, connective tissue, and endo-skeleton, is so similar in all fishes that it is difficult to believe that all these rays have not been, at all events partly, derived from some common form.

According to the second and alternative theory, it may be supposed that the camptotrichia of the Dipnoi have been derived from the ceratotrichia of the Elasmobranchii, and that they are overlaid with scales as the horny fin-rays are overlaid with denticles. The jointing of the distal region of the rays would follow on their ossification. On such a view it might be supposed that the lepidotrichia of the Teleostomes have been formed by the fusion of the original dermal rays with the superficial scales in the distal region, but not in the proximal region, where the rays were deeply imbedded and remain unjointed. From a compound dermal ray so formed the lepidotrichia of the higher Actinopterygii would be derived by the shortening of the proximal piece. The author inclines to the first theory.

The Physiology of the Swim-Bladder of Fishes.*—A. Jaeger discusses this with particular reference to Thilo's † conclusion that "the air in the swim-bladder is drawn from the atmosphere, swallowed, and brought into the bladder through air-passages." He points out that there is present a mechanism whereby the size of the swim-bladder regulates most exactly the specific gravity of the fish. How, by the simple taking in of air from the mouth such a delicate regulation should have come into existence is not easily seen: indeed, on Thilo's explanation this mechanism is unnecessary. The whole activity of the swim-bladder organs is under

* Biol. Centralbl., xxiv. (1904) p. 129–42.
† Op. cit., xxiii. Nos. 14 and 15.

nervous influence, like the function of the lungs in higher animals. If the expansion of the bladder exceeds a certain point, then a particular set of nerve fibres (corresponding to the Vagus fibres of the lungs) is irritated, and an opening of the "oval" * follows, and an exit of oxygen into the blood results. If the cubic content of the swim-bladder becomes too small, then a set of nerves functioning in an opposite manner is excited, and the red body is induced to the secretion of oxygen.

Notes on Dipnoan Cranium.†—K. Fürbinger finds that the bone which lies concealed in cartilage in the occipital region, first noted by Huxley and termed by him "exoccipital," is, from a consideration of its relations, particularly to the spinal nerves, to be regarded rather as a neural arch. On one example he found the neural spine of this arch. The author was able to establish the same origin for this bone in an adult *Lepidosiren* and also in a young *Protopterus* of 5·5 cm. length.

Chimæroids.‡—Samuel Garman describes the interesting Japanese form *Rhinochimæra pacifica*, which requires the establishment of a new family Rhinochimæridæ, including *Harriotta*; similarly *Callorhynchus* requires a special family Callorhynchidæ, and *Chimæra* another. The author indicates how *Rhinochimæra* agrees with and differs from the other types: it has an ancestral feature in its long proboscis, its teeth resemble the embryonic and ancestral forms more than those of the other recent genera of Chimæriformes; the brain is nearer to that of *Callorhynchus* than to that of *Chimæra*; the notochord is provided with rings like that of *Chimæra*; the lateral canal system of *Rhinochimæra* and *Harriotta* are made up of pseudo-tubules, tubes narrowly slit outwardly, that of *Callorhynchus* consists of tubes, that of *Chimæra* is a system of grooves.

Garman refers to the great interest of Chimæroids, whose "line of descent extends to Devonian times and away beyond and back to a meeting with that of the Plagiostomia near the point at which the latter separated from the bony fishes." Certain peculiarities of the Chimæroids, especially of skull and brain, are perhaps best accounted for by supposing the group to have been derived from a short-snouted and short-faced stock.

Pisciculture.§—Louis Roule discusses under the title "Piscifacture" what can be done in the way of collecting ova, preventing waste of ova, ensuring fertilisation, hatching the embryos, rearing the larvæ, lessening the elimination of young forms, and liberating the young fry in closed areas or in the open sea. There does not seem to be anything new in his essay, but it discusses the possibilities and the difficulties in a lucid manner, and includes some useful hints from an expert embryologist's standpoint.

Evolution of Atherinæ in Fresh Water.‖—L. Roule describes how *Atherina lacustris* evolved itself out of *A. boyeri*, and *A. riqueti* in the

* Pflügers Arch. für Phys., Band xciv., p. 93.
† Anat. Anzeig., xxiv. (1904) pp. 405–8.
‡ Bull. Mus. Zool. Harvard, xli. (1904) pp. 245–72 (14 pls.).
§ Mem. Acad. Sci. Toulouse, iii. ser. 10 (1903) pp. 390–402.
‖ Comptes Rendus, cxxxviii. (1903) pp. 1276–7.

same way developed from *A. lacustris*. This has occurred in the Canal du Midi, and is an instance of present-day forms whose origin is quite modern and produced by natural causes—an instance of evolution *per saltum*. There are no transitional forms.

Segmental Veins in Amphioxus.* — Boris Zarnik describes the segmental veins of the lancelet and their relation to the ductus cuvieri. There seems to be no doubt that the lancelets exhibit very primitive relations in their vascular system, as in other systems. These conditions represent, as the author shows, a transition stage between the differentiated circulatory system of Craniota and the simple loops and sinuses in Invertebrates. The paper is accompanied with an exceptionally fine figure of the posterior peribranchial cavity of an adult female lancelet.

INVERTEBRATA.

Mollusca.

α. Cephalopoda.

"Albatross" Cephalopods.† — W. E. Hoyle reports on the cephalopods collected in the tropical Pacific by Alexander Agassiz on the "Albatross" Expedition. The collection consists of thirty species (six new) distributed in nineteen genera, one of which (*Froekenia*) is new. Another (*Pterygioteuthis*) was first found by the "Albatross," but its publication has been anticipated by the description of an immature example by H. Fischer. In a smaller collection made among the Pacific islands, which contained thirteen species, there was a new genus, *Cirrobrachium*. The new genus *Froekenia* is allied to *Cirroteuthis*, with paired fins at the sides, but with no connecting membranes between the arms. In the new decapod *Cirrobrachium*, based on a head and arms, there is a row of filaments along the outer or ventral side of each arm, except those of the fourth pair. An appendix contains an account of the luminous organs of *Pterygioteuthis giardi* and *Abraliopsis hoylei*.

Structure of the Heart in the Common Octopus.‡—F. Marceau notes that the descriptions of the structure of the heart in cephalopods are somewhat discrepant. He has made a histological study of the heart of *Octopus vulgaris*.

The striated fibrils composing the cortex are in some respects remarkable. They are slightly larger than those of the cardiac muscle-fibres in Vertebrates; but the muscular discs of the fibrils are more than twice as long as those of corresponding fibrils in Vertebrates.

The heart is lined by a very delicate endocardium, formed by an endothelium with very minute and much-flattened nuclei, below which there are connective cells at wide intervals.

Receptaculum Seminis and Nuptial Combat in Octopus.§—W. Bergmann has found in *Octopus de filippii* a receptaculum seminis which

* Anat. Anzeig., xxiv. (1904) pp. 609–30 (1 pl. and 7 figs.).
† Bull. Mus. Zool. Harvard, xliii. (1904) pp. 1–71 (10 pls. and map).
‡ Comptes Rendus, cxxxviii. (1904) pp. 1177–9.
§ SB. Ges. Nat. Freunde Berlin, 1903, pp. 104–9 (3 figs.).

consists of several vascular diverticula of the oviduct. They serve for the storage of spermatozoa, which fertilise the ova as these pass out.

In *Octopus vulgaris*, as others have observed, there is a keen combat between male and female prior to the discharge of the hectocotylus arm into the mantle-cavity of the female. Even in *Sepia*, where there is no hectocotylisation, there is nuptial combat.

γ. Gastropoda.

Habits of Solenogastres.*—H. Heath gives some notes on these. Their habitat is on the sea bottom between 15 and 1200 fathoms, and they appear fairly common and widely distributed. Upwards of fifty species are known, chiefly from the waters north and south of Europe and the East Indian Archipelago. They constitute the two families Chætodermatidæ and Neomenidæ. The latter rarely burrow in the mud, but crawl on hydroid colonies or alcyonarian corals, and occasionally on plants and some species of actinians. They are probably predatory rather than commensals or parasites, though one species of the genus *Neomenia* appears to be parasitic. It was found closely wrapped about a polyp of *Epizoanthus*, or some closely related genus, and subsequent examination showed that its proboscis had penetrated the body wall of its host and had removed some of the internal structures, whose remains were present in abundance in the stomach. In this species well developed ventral salivary glands opened at the free end of the fully extended proboscis, and in the absence of a radula their secretion probably exercised a solvent action on the prey. Species of *Chætoderma*, found abundant in mud at 300 fathoms, proved to be active burrowers. This was accomplished almost entirely by movements of the prothorax, similar to those of the front end of an earthworm.

Habits of the Cellar-Slug.†—Karl Künkel has made numerous observations and experiments in regard to *Limax variegatus*, the cellar-slug, which show that its habits are strictly determined in relation to its great demands for water and the correlated rapid drying of its body.

Spermatogenesis in Enteroxenos Östergreni.‡—K. Bonnevie gives a detailed account of the development of the sperm in this gastropod. The leading features are the same as are found in other gastropods and in Vertebrates, but certain differences in details from *Paludina* and others are considered.

δ. Lamellibranchiata.

Adductor Muscles of Bivalves.§—F. Marceau has studied the two portions of the adductor muscles in Lamellibranchs. These muscles have two functions—that of rapidly closing the valves and that of keeping them closed against the elasticity of the ligament. Their component parts are structurally adapted to these two functions. In the oyster, for instance, the rapid closure of the valves is wholly due to the contraction of the "vitreous" muscle, while the "nacreous" muscle has solely the

* Zool. Anzeig., xxvii. (1904) pp. 457-61. † Tom, cit., pp. 571-8.
‡ Biol. Centralbl., xxiv. (1904) pp. 267-74, 306-10.
§ Comptes Rendus, cxxxviii. (1904) pp. 1343-5.

function of acting against the elastic force of the ligament. In forms which have adductors wholly of the "vitreous" type, e.g. *Solen* and *Lutraria elliptica*, the closure of the valves, though it may be rapid, is always of short duration.

Ætheriidæ.*—R. Anthony discusses this family of bivalves, which is usually regarded as allied to Unionidæ. There are three genera: *Ætheria* from African rivers, *Bartlettia* and *Mulleria* from South American rivers. The first two are Dimyarian, the third Monomyarian.

In *Ætheria*, as in oysters, the fixation is by one valve, oftenest the left, and all their peculiarities may be related to this special condition of "*pleurothetic*" fixation. From among Unionidæ this family has arisen probably by adaptation to particular conditions of habitat. Thus the elongated fixed valve of *Ætheria caillaudi* is advantageous in quiet waters by enabling the animal to raise itself above the level of the floor.

Arthropoda.

Structure and Classification of Arthropoda.†—E. Ray Lankester has reprinted the articles Arthropoda and Arachnida which he contributed to the tenth edition of the "Encyclopædia Britannica." He adheres to his formerly expressed conclusion as to the genetic affinity and monophyletic origin of the Chætopods, Rotifers and Arthropods, for which in 1878 he introduced the term Appendiculata. The Arthropoda might be better called "Gnathopoda," since their distinctive character is that one or more pairs of appendages behind the mouth are densely chitinised and turned (fellow to fellow on opposite sides) towards one another so as to act as jaws. This is facilitated by an important general change in the position of the parapodia; their basal attachments are all more ventral in position than in the Chætopoda, and tend to approach towards the mid-ventral line. Very generally (but not in Onychophora) all the parapodia are plated with chitin secreted by the epidermis and divided into a series of joints, giving the "arthropodous" or hinged character.

Other distinctive features hold the Arthropoda together, and suggest the view that they have been developed from a single line of primitive Gnathopods, which arose by modification of parapodiate annulate worms not very unlike some of the existing Chætopods. These additional features include the ostiate heart and the "*phlebœdesis*," that is to say, the peripheral portions of the blood-vascular system are swollen so as to obliterate to a large extent the cœlom, whilst the separate veins entering the dorsal vessel or heart coalesced, leaving valvate ostia, by which the blood passed from a pericardial blood-sinus formed by the fused veins into the dorsal vessel or heart. Another feature is that the region in front of the mouth is no longer formed by the primitive prostomium, or head-lobe, but one or more segments, originally post-oral, with their appendages, have passed in front of the mouth ("*prosthomeres*"), and the brain has become a syncerebrum. Moreover, as in Chætopods, cœlomic funnels ("*cœlomoducts*") may occur right and left as pairs in

* Comptes Rendus, cxxxviii. (1904) pp. 1233–5 (2 figs.).
† Quart. Journ. Micr. Sci., xlvii. (1904) pp. 523–82 (1 pl. and 11 figs.).

each ring-like segment or somite of the body, and some of these are in all cases retained as gonoducts and often as renal excretory organs (green glands, coxal glands of Arachnida, but *not* crural glands, which are epidermal in origin), while true nephridia, genetically identical with the nephridia of earthworms, do not occur.

Prof. Lankester proposes and gives justification for the following arrangement of the larger sub-divisions of the Arthropoda :

Grade A. Hyparthropoda (hypothetical forms connecting ancestors of Chætopoda with those of Arthropoda).
Grade B. Protarthropoda. Class Onychophora, e.g. *Peripatus*.
Grade C. Euarthropoda. Class 1. Diplopoda, e.g. *Iulus*.
Class 2. Arachnida.
Grade *a*. Anomomeristica, e.g. *Phacops*.
Grade *b*. Nomomeristica.
(α) Pantopoda, e.g. *Pycnogonum*.
(β) Euarachnida, e.g. *Limulus*, *Scorpio*, *Mygale*, *Acarus*.
Class 3. Crustacea.
Grade *a*. Entomostraca.
Grade *b*. Malacostraca.
Class 4. Chilopoda, e.g. *Scolopendra*.
Class 5. Hexapoda (= Insecta Pterygota).
Incertæ sedis : Tardigrada, Pentastomidæ.

The author discusses the segmentation of the body of Arthropods, formulating twelve laws of metamerism ; the theory of the Arthropod head ; the segmental lateral appendages or limbs of Arthropods ; the branchiæ ; the eyes ; the tracheæ ; the malpighian tubes ; and so forth.

He then passes the groups of the Arthropoda in review, characterising them so as to indicate their probable affinities and genetic history.

In an interesting appendix, not contained in the "Encyclopædia" article, the author discusses the movements of the parapodia of *Peripatus*, Millipedes, and Centipedes.

a. Insecta.

Moulting Processes in Insects.*—W. Plotnikow describes (1) the separation of the old cuticle from the hypodermis ; (2) the exuvial fluid ; (3) the formation and structure of the new cuticle ; (4) the development of the exuvial hairs ; and (5) the actual process of throwing off the old cuticle. In the second part of his memoir he discusses Verson's glands in Lepidoptera, and the exuvial glands in the larvæ of *Tenebrio molitor*, of Chrysomelidæ, of Coccinellidæ, of Tenthedinidæ, etc.

Accommodation-apparatus in Compound Eyes.†—Pierre Vigier notes that each ommatidium of a compound eye includes (1) a *dioptric* apparatus of refractive elements, which alter the direction of the incident rays ; (2) a *receptive* apparatus, which receives the luminous

* Zeitschr. wiss. Zool., lxxvi. (1904) pp. 333–66 (2 pls. and 6 figs.).
† Comptes Rendus, cxxxviii. (1904) pp. 775–7.

stimuli and transmits them to the perceptive centres by the optic nerves; and (3) a *pigmentary* apparatus, which absorbs the unutilised vibrations, intercepts oblique rays, and isolates one ommatidium from another.

But this analysis is incomplete as regards the eyes of some rapidly flying insects, such as dragon-flies. For in the eyes of *Æschna*, for instance, the author has proved the presence of an *accommodation*-apparatus, which adapts vision to different distances. This apparatus lies between the ommatidia, and consists of (*a*) elastic and extensile elements (tracheæ); and (*b*) contractile elements, genuine myofibrils.

Wasps of Spain.*—Jose M. Dusmet y Alonso gives a systematic descriptive account of the Vespidæ, Eumenidæ, and Masaridæ, of Spain.

Development of Bees' Eggs.†—Otto Dickel has studied the formation of the blastoderm, the origin of the yolk-cells, the history of the yolk-cells with especial reference to the blastopore, the formation of the endoderm and mesoderm, and so forth.

No distinction can be drawn between yolk-cells and the endoderm established by invagination. Both are derived from the same material. The endoderm of insects may be formed by yolk-cells, or by invaginated material, or by both. The distribution of yolk-cells and invaginated material may be such, that in the earlier stages the yolk-cells form the endoderm of the median region, and the invaginated material forms the polar regions. Between endoderm and mesoderm there are the closest relations, for both arise in intimate interdependence.

Parthenogenesis in Telenomus.‡—J. W. Wasschew has established the occurrence of "arrenotokie" (male-producing) parthenogenesis in the genus *Telenomus*, a member of the family Proctotrupidæ among Ichneumonids.

Formica exsecta as Hill-builders in Swamps.§—N. Holmgren has noted a number of special features in the hills of this species, which are the result of competition with the mosses (Sphagnum and Polytrichum) in the vicinity. Here the hills are more numerous and smaller than in drier regions, and there is an absence of large roads leading to them. Being drier than the surrounding parts, they are soon invaded by *Polytrichum strictum*, which gradually forms a thick carpet covering and penetrating the heap. The form of the hill becomes altered as building is carried on on the side remote from the *Polytrichum* attack; in other words, they withdraw from it. In course of time the habitable part becomes too small for the ants, and migration occurs. This explains the large number of small ant-heaps in the swamps. Ultimately the ants are beaten and the moss remains in possession—for a time. But before the hill is completely covered by the *Polytrichum*, *Sphagnum* presses in upon the latter and in general crushes it out. It will thus be seen that the ants play a not unimportant role in the swamps, forming layers upon which the mosses can grow.

* Mem. Soc. Españ. Hist. Nat., ii. (1903) pp. 119–225.
† Zeitschr. wiss. Zool., lxxvii. (1904) pp. 481–527 (2 pls. and 46 figs.).
‡ Zool. Anzeig., xxvii. (1904) pp. 578–9.
§ Zool. Jahrb. xx. (1904) pp. 353–70.

Metamorphoses of Saturnian Moths. — A. S. Packard* gives descriptions of the larval stages of a number of genera of Saturniidæ, some of which are most highly specialised, while others are more primitive. It is a matter of some interest to have worked out the transformations of *Callosamia calleta*, an annectant form between *Callosamia* and *Philosamia*. The early stages of the species of *Rothschildia*, which represent in the New World the Asiatic *Attacus*, have now been discovered after several years of effort to secure the cocoons and eggs. The knowledge gained appears to be of phylogenetic significance.

Imaginal Adipose Tissue in Muscidæ.†—Ch. Pérez has made a study of this tissue, which consists of two kinds of elements—trophocytes and œnocytes. Their history shows that they are not due to old migratory elements nor to muscle-nuclei, but that, like other imaginal organs, they arise from independent and from the first specialised primordia.

Case of Dimorphism in Cecidomyidæ.‡—J. Kunstler and J. Chaine find in *Kiefferia musæ*, a new Cecidomyid, a good case of dimorphism, which is rare in dipterous insects. The peculiar form described has miniature wings with modified venation, and its head and abdomen are larger than the same parts in those which form the majority of the species. Dimorphism in Cecidomyids has been previously reported in *Monardia van-der-Wulfsi* and *M. dimorphagyna*, to which *Kiefferia* is allied.

First Abdominal Appendage in the Meal-Worm.§—Maurice de Selys Longchamps has made a detailed study of the development of the appendage of the first abdominal segment in *Tenebrio molitor*. There is no doubt that it is an appendage homologous with those of the thorax and head. Apart from the existence of a cœlomic cavity, jointing, a trachea, and so on, the structure of the organ when fully developed is obviously appendicular. The distal part suffers peculiar modification in reference to its special glandular function. The author bases on actual observations an interesting general discussion of the abdominal appendages in insects, and the degrees of their ontogenetic suppression.

Monograph of Genus Saperda.‖—E. P. Felt and L. J. Joutel contribute a beautifully illustrated monograph of this genus of tree-boring beetles. They discuss the genus as established by Fabricius, the subgeneric grouping, the distribution and relationships of the species, and the food-habits of the larvæ.

New British Spring-Tails.¶—G. H. Carpenter and W. Evans recorded in 1899 seventeen species of Collembola and Thysanura new to

* Proc. Amer. Acad., xxxix. (1904) pp. 547–78.
† Proc. Verb. Soc. Sci. Bordeaux, 1903, pp. 110–1. ‡ Tom. cit., pp. 13–4.
§ Bull. Classe Sci. Acad. Roy. Belg., No. 4 (1904) pp. 413–47 (1 pl.).
‖ Bull. 74 New York State Museum (Entomology), Albany, 1904, pp. 1–68 (14 pls. and 20 figs.).
¶ Proc. Roy. Phys. Soc. Edinburgh, xv. (1902–1904) pp. 215–20 (1 pl.).

the British fauna. They have been able to add *Isotoma sexoculata* Tullberg, found under stones below high-water mark on the shore of the Firth of Forth at Dalmeny; *Achorutes manubrialis* Tullberg, from Perth; *A. propinquus* sp. n. (= *A. manubrialis* of the 1899 list); and *Xenylla maritima* Tullberg, from Kirkcaldy.

New Machilidæ.* — Filippo Silvestri establishes the new genus *Machiloides*, with *Machilis appendiculata* Silv. as type. His conspectus of Machilid genera includes *Petrobius* Leach, type *P. maritimus* Leach; *Machilis* L., type *Lepisma polypoda* L.; *Præmachilis* Silv., type *P. excelsior* Silv.; *Machiloides* g. n., type *Machilis appendiculata* Silv.; *Meinertellus* Silv., type *M. pulvillatus* Silv.; and *Machilinus*, type *M. rupestris* Lucas (vel *M. grassii* Giard).

He also describes *Machilis alternata* sp. n., and *Præmachilis meticulosa* sp. n.; and gives an analytical table of the Italian Machilidæ. We give these details because of the systematic importance and general zoological interest of these primitive insects.

Enemies of Roses.† — Fr. Richter von Binnenthal has devoted a book to the animals that injure roses. He discusses the various modes of injury, from leaf-eating to gall-forming, the life-histories of some of the injurious forms, the means of cure and prevention, and so on. As most of the enemies are insects we have inserted our reference here, but the book also takes account of Tetranychidæ, Nematodes, etc. It is not exactly a book for specialists, but the reference may be useful to many friends of roses who are interested in the pathological aspects of rosiculture.

Habits and Development of Neocerata rhodophaga.‡ — F. M. Webster has investigated the life-history of this rose parasite infesting rose-houses in the vicinity of Chicago, but not attacking plants in the open. It affects most seriously a species of rose that requires a very warm, yet ventilated environment. It is not a native, and its gradual occurrence further and further inland does not imply an American origin. It is closely related to the European form *Dichelomyia rosarum* Hardy.

Life-History, Habits and Taxonomic Relations of a New Species of Oberea.§ — F. M. Webster gives an account of *O. ulmicola* Chittenden, a beetle of remarkable habits. Thus far it has been found only in a single city in central Illinois infesting the elm. Even there it has confined itself to a certain section of the city, within which it is so excessively abundant that the females are compelled to deposit their eggs in the same twigs again and again, notwithstanding the fact that only a single larva can survive in each twig. This congestion in numbers and restricted distribution, might be taken to indicate a spirit

* Redia, ii. Fasc. 1 (1904) pp. 1–9.

† Die Rosenschädlinge aus dem Tierreiche, deren wirksame Abwehr und Bekämpfung. E. Ulmer, Stuttgart, 8vo, 1903, x. and 392 pp. See also Biol. Centralbl. xxiv. (1904) pp. 478–80.

‡ Bull. Illinois State Labor. of Nat. Hist., vii. (1904) pp. 15–25 (1 pl.).

§ Tom. cit., pp. 1–14 (2 pls.).

of mutual toleration such as exists in social communities. In this case, however, if adults of both sexes are confined closely together, they will, regardless of sex, fall upon each other, amputating antennæ and legs with a savagery like that of the most bloodthirsty quadruped.

δ. Arachnida.

Grasping Organs in Pediculidæ.*—H. Osborn describes in *Hæmatopinus urius*, *H. macrocephalus*, and *Euhæmatopinus abnormis*, protractile discs upon the legs, whose function appears to be that of holding on to the hair. The disc, which in *H. urius* is at the distal end of the tibia, plays back and forth in a pit-like depression. There is a large muscle running through the tibia and forking near the middle of the tibial joint, one part going to the tibial spur, the other passing on to the tarsal joint, while from the latter a fibre runs to the base of the protractile disc. Muscular elements for protraction are apparently absent, and this may be provided for in the movements of the chitinous wall, assisted partially by the flexion of the tarsal joint.

Pycnogonida of West Coast of North America.†—Leon J. Cole gives an account of the Pycnogonida collected by the Harriman Alaska Expedition. The collection includes thirteen species, representing nineteen genera. After notes on the geographical distribution, the author discusses the classification and terminology, giving a useful tabular summary of the names used by various recent investigators. He also gives a diagnostic key to the species described in his memoir, which is admirably illustrated.

ε. Crustacea.

Maturation Divisions in Testicle of a Lobster.‡ — A. Labbe observes that in the state of synapsis the chromosomes unite two and two, and fuse their chromatin into a single or protetrad body. The tetrads arise from the protetrads by quaternary condensation of the chromatin. In the constitution there is no question of longitudinal or transverse division. Before the formation of the protetrads the thread prepared for the first maturation division undergoes a first longitudinal division, which effaces itself. At the first metaphase there is a second division (? longitudinal) which appears preparatory to the second kinesis and does not efface itself, but is useless, since it separates two demi-dyads which will pass into the same spermatid. These two divisions are quite independent of the formation of tetrads. They seem only a suggestion of ordinary mitoses, and are objectless. The mode of formation of the quaternary groups shows that the chromatin mass of a protetrad separates into four, without involving either equational or reduction division. The author is inclined to deduce from these facts qualitative differences between the conjugated chromosomes as important as exist between ovum and spermatozoon.

* Ohio Naturalist, iv. (1904) pp. 107–8.
† Harriman Alaska Exped., x. (1904) pp. 249–98 (18 pls.).
‡ Comptes Rendus, cxxxviii. (1904) pp. 96–9.

Isopod Parasitic in a Sacculina.* — Ch. Pérez found numerous examples of a Cryptoniscid (probably *Eumetor*) parasitic in a Sacculina which infested a *Pinnotheres* commensal in a *Spondylus*. The "emboîtement" of parasite within parasite is interesting. The males were seen coming and going through the cloacal orifice of the Sacculina; as in *Hemioniscus*, *Crinoniscus*, and other Cryptoniscids, there is protandrous hermaphroditism. The "males" cease to be male, and become "females."

Cryptophialus striatus sp. n.†—W. Berndt describes a new boring Cirriped which occurs in abundance in *Chiton magnificus*, from the Chilian coast. From the same locality Darwin described *Cr. minutus*, which bores in the shells of the Gastropod *Concholepas peruviana*. Berndt gives an account of the alimentary, nervous, and reproductive systems, and shows how this new form differs from Darwin's *Cr. minutus*.

Fixation of Coronulidæ in Skin of Cetaceans.‡—A. Gruvel makes a preliminary note on this subject, referring to *Coronula*, in which the proliferating epidermis of the cetacean insinuates itself into the lateral canals between the outer and inner wall of the Cirriped shell; to *Cryptolepas*, in which the external wall seems to have disappeared, the lateral canals are transformed into simple ridges, and the epidermis between these binds the animal to its bearer in a very effective manner; and to *Tubicinella*, in which, according to Marlotte, there is a digestion of the skin by peptonising substances.

Organ of Kœhler in Cirripeds.§—A. Gruvel describes the structure of the apparently sensory structure known as the organ of Kœhler, which is situated at the base and in the centre of the scales of *Pollicipes*. It consists of a group of cells loosely or closely united; and their innervation issuing from the mantle and extending to the surface of the scales points to a sensory function. In the scales of the upper part of the stalk there is only one basal cell; this also disappears, the nerve atrophies, and only a minute hole in the chitin is left.

New Canthocamptus from Idaho.‖—C. Dwight Marsh describes *Canthocamptus idahoensis* sp. n. from the Alturas Inlet, Idaho. The marked characters by which the species is easily distinguished are the slender furca, and the remarkably slender fifth feet of both sexes. In fact, it is possible that the peculiar characters of the fifth feet should be considered of generic value.

Free-swimming Copepods of Louisiana.¶—E. Foster gives a series of notes on the bathymetrical distribution and relative abundance of various species in the neighbourhood of the Gulf Biologic Station, as a contribution to the subject of the food of fishes.

* Proc. Verb. Soc. Sci. Bordeaux, 1903, pp. 109–10.
† SB. Ges. Natur. Berlin, 1903, pp. 436–44 (2 figs.).
‡ Proc. Verb. Soc. Sci. Bordeaux, 1903, p. 8.
§ Tom. cit., pp. 90–1.
‖ Trans. Wisconsin Acad., xiv. Part 1 (1903) pp. 112–6 (1 pl.).
¶ Report Louisiana Gulf Biol. Station, 1903, Bull. No. 2 (1904) pp. 69–79.

Annulata.

Studies on Oligochæta.*—Asger Ditlevsen discusses the systematic relations of the Oligochæta, and has made a special study of the sexual reproduction.

He begins with an investigation of the Naidæ, and of the genus *Ilyodrilus* Stolč in particular, of which two new species are established. A grouping of the forms of Tubificidæ is submitted, with descriptions of two new species of *Psammoryctes*, one of *Tubifex*, two of *Monopelephorus*. The Enchytræidæ are then dealt with, and this section includes descriptions of a new species of *Pachydrilus*, and a new species of *Mesenchytræus*.

The next section is devoted to the advent and duration of the sexual period in Tubificidæ, Naidæ, Chætogastridæ, Æolosomatidæ, and Lumbriculidæ. Then the author passes to the copulatory phenomena in Enchytræidæ, Naidæ, Chætogastridæ, and Tubificidæ, in regard to which he has much that is new to say. In Enchytræidæ, Naidæ, Chætogastridæ, Lumbriculidæ, and Tubificidæ, the clitellum functions solely as a cocoon-forming structure, while in Lumbricidæ it has also to do with copulation. The oviposition in the different families is then discussed.

Priapulidæ of Scandinavia.†—M. Hérubel gives some notes on the geographical distribution and comparative anatomy of the Priapulidæ of the west side of Scandinavia. He found their distribution very local. There appear to be four conditions requisite—shallow water with mud or sand and mud, absence of strong currents, low but variable temperature, and nearly constant salinity. He distinguished three distinct varieties of *P. caudatus*. In the first there is a medium-sized ring of denser tissue, and uniform appearance, between the introvert and the body; a second form has this ring very large, and in the third it is absent. These differences, which are accompanied by other anatomical peculiarities, were made out upon living specimens. The varieties are from separate localities. A second paper discusses the integumentary characters.

Digestive System of Hirudinea.‡—Camille Spiess compares the alimentary tracts of *Hirudo medicinalis* and *Aulastomum gulo*, and emphasises the detailed differences between a species living on blood and a species living on worms and molluscs in a voracious carnivorous fashion. The differences are striking, and illustrate, according to the author, "the modifications which the digestive apparatus may exhibit under the influence of different nutritive regime." They illustrate, at any rate, different adaptations to different diet.

Nematohelminthes.

Differences in the Chromosomes of Sister-germ-cells.§—Th. Boveri recalls the fact that in the development of Ascarids, the chromo-

* Zeitschr. wiss. Zool. lxxvii. (1904) pp. 398-480 (3 pls.).
† Bull. Soc. Zool. France, xxix. (1904) pp. 100-9, 126-9.
‡ Comptes Rendus, cxxxviii. (1904) pp. 1123-4.
§ SB. Phys. Med. Ges. Würzburg (1904) pp. 16-20.

somes of sister-cells may be quite different. Those of the one cell retain the original character, they remain "primitive chromosomes"; those of the other suffer diminution, and in *Ascaris megalocephala* the remnant of each primitive chromosome breaks up into a number of small "somatic chromosomes." The question arises, is this differentiation of chromosomes autonomic? that is, does each chromosome in certain cell-divisions divide into two different halves; or, does it depend on differences in the surrounding cytoplasm—on protoplasmic differentiations which determine whether the chromosomes are to persist along a definite cell-lineage as primitive chromosomes, while in other lateral lineages, diminution sets in? After a discussion of the problem, Boveri concludes that the protoplasmic differentiation determines the persistence or reduction of the chromosomes.

Platyhelminthes.

Terrestrial Planarians from North-East Africa.*—Camillo Moll describes a collection made by Oscar Neumann in north-east Africa. It includes *Amblyplana nigrescens* sp. n., *A. aberrana* sp. n., *A. neumanni* sp. n., and *Platydemus montanus* sp. n.,—within the family Rhynchodemidæ. We record the names, since relatively few terrestrial Planarians have hitherto been recorded from the African continent.

Sense-Organs in Digenetic Trematodes.†—D. Ssinitzin finds on definite points of the body-surface, within the cuticula, clear vesicles containing transparent substance, in which a rod-like structure and some granules can be recognised. A nerve-fibre penetrates into the vesicle. The cuticula over the slightly protruding vesicle is relatively delicate, and may bear fine hair-like processes.

Ssinitzin distinguishes: (1) sensory vesicles, without hairs; (2) sensory vesicles, with short immobile hairs (0·0006 mm.); (3) sensory vesicles, with long (0·01 mm.) immobile hairs; (4) sensory vesicles, with mobile hairs of moderate length; and (5) sensory vesicles, with long flagella-like mobile hairs.

Sexually mature Trematodes exhibit only the first two kinds of sensory organ; rediæ show the first three kinds; in cercariæ all forms occur. The research refers to Trematodes found in fresh-water molluscs, such as *Amphistomum subclavatum* and *Distomum folium*.

Echinostomum garzettæ.‡—W. G. MacCallum describes this new species collected by W. Volz while in Benakat (Lematangilir) from the intestine of *Garzetta nigripes* Temm. All the other described forms of *Echinostomum* from birds differ very decidedly from *Echinostomum garzettæ*, though this new form falls readily into the smaller group of those closely related to *E. echinatus*.

Three Species of Paramphistomum from Mammals.§—F. Fischoeder describes *Paramphistomum explanatum* Crepl., from *Buffelus*

* Zool. Jahrb., xx. (1904) pp. 471–90 (1 pl.).
† Zool. Anzeig., xxvii. (1904) pp. 767–70 (5 figs.).
‡ Zool. Jahrb., xx. (1904) pp. 541–8 (1 fig.).
§ Tom. cit., pp. 453–70 (2 pls. and 3 figs.).

indicus; *P. epiclitum* Fischer, from *Bos taurus indicus*; and *P. scoliocœlium* Fischer, from *Buffelus indicus*.

Cestodes from Mammals.* — C. von Janicki describes *Linstowia brasiliensis* sp. n. from *Didelphys tristriata*, *Oochoristica bivittata* sp. n. from *Didelphys murina*, *O. wageneri* sp. n. from *Myrmecophaga tetradactyla*, and other new species of *Hymenolepis* (nine), *Davainea* (three). He modifies the diagnosis of the genus *Anoplocephala* Blanchard, and establishes a new genus, *Schizotænia*, which comes nearest to *Bertia* in the family Anoplocephalinæ.

Incertæ Sedis.

Anatomy of Ptychodera erythræa.†—J. W. Spengel gives supplementary notes to his earlier work on this species. The details were made out on a young form imperfectly preserved, and embrace points in all the regions of the body.

Geographical Distribution of Marine Bryozoa.‡ — M. L. Calvet reviews the evidence bearing on the theory of bi-polarity supplied by a study of a collection of marine Polyzoa from South Patagonia, Tierra del Fuego, and South Georgia. They form an essentially littoral fauna. Those genera in the Austral hemisphere are represented in the Boreal by only 67·3 p.c., while the proportion of species is only 18·5 p.c. The fauna of the Southern hemisphere has a very local character. The evidence is unfavourable to the theory.

Jurassic Polyzoa.§—W. D. Lang concludes that the relationships of the Jurassic forms of the "genera" *Stomatopora* and *Proboscina* have been misunderstood. A detailed examination of all the material available in the British Museum has resulted in the following conclusions:—

The division into these two genera is unnatural. The development of a colony (the *zoarium* of Polyzoa) is comparable with and follows the same laws as the development of the individual (the *zoœcium* of Polyzoa). Therefore the diagnosis of a form, whether "species" or "circulus," is incomplete, and for practical purposes useless, unless the part of the zoarium with respect to its age is specified. In the "genera" *Stomatopora* and *Proboscina* the method of branching is of paramount importance. A re-arrangement in the light of the foregoing is believed to yield an evolutionary series.

Rotifera.

New Rotifer.‖—T. E. Lord figures and describes as new *Diaschiza crassipes*, a species characterised chiefly by a cervical eye, an arched lorica projecting over the foot, with a dorsal cleft widening considerably posteriorly, and two very stout, short, conical toes. The author found only a single specimen, which, having been imperfectly observed, is imperfectly figured and described.

* Zool. Anzeig., xxvii. (1904) pp. 770–82.
† Zool. Jahrb., xx. (1904) pp. 412–28.
‡ Comptes Rendus, cxxxviii. (1904) pp. 384–7.
§ Geol. Mag. Decade V., i. No. 7 (1904) pp. 315–22.
‖ Trans. Manchester Micr. Soc., 1903, pp. 78–80 (1 fig.).

Echinoderma.

Larval Development of Echinus microtuberculatus.*—H. Schmidt has studied one hundred and five stages, representing a continuous series, from the developed blastula before the formation of the primary mesenchyme up to the pluteus with arms and fully-formed left vaso-peritoneal vesicle. Abnormalities were exceedingly rare, and almost never occurred in the later stages. Only isolated blastulæ were observed with pathological mesenchyme and dwarfed plutei. The development was remarkably even in its course, and at the temperature (17° C.) rapid. At 36 hours the gut had reached the opposite end, and in 41 hours plutei with well-developed arms were formed. From 17 to 22 hours' larvæ showed, besides the primary mesenchyme, an animal pole consisting of a thick plate of blastoderm cells. At the end of the blastula stage there arises at the vegetative pole a specially differentiated plate, provisionally designated "endoderm plate." Very soon this plate is invaginated (20th hour). Two hours later there is present a well-developed gut. During the following hours (22 to 26) the formation and migration of the secondary mesenchyme is completed. At the same time the gut is extending towards the opposite side, while at the end of the gastrula period alterations in form and size are evident which mark the transition to the pluteus. The first hint of the mouth appears to be about the 30th hour, while the swelling of the blind end of the primitive gut to form the later vaso-peritoneal vesicle appears at 33 hours. The ciliated band inaugurating the pluteus stage is seen an hour later, and by 36 hours this stage is clearly defined. The vaso-peritoneal sacs now constrict themselves off. At the 38th hour the gut is in three parts, and it is only after 41 hours that the mouth is formed. The rest of the time up to 45 hours is occupied by the development of the larva to the typical elongated pluteus form, and the growth of the arms.

"Pentasomæa" Theory.†—E. Herouard states what he calls the "*Pentasomœa*" theory of the Echinoderm body, according to which somites arise in groups of fives, each of the groups forming a "pentasomic vesicle." The five somites potentially included in a pentasomic vesicle do not begin to be individualised until the vesicle has been liberated into the blastocœl cavity. The five somites of a pentasomic vesicle in Echinoderms are only partially individualised; their cavities remain in communication through the residue of the pentasomic vesicle which formed them—a residue that represents the enterotomes of the somites. He compares the pentasomic vesicle of Echinoderms with the enterocœlic vesicle in *Amphioxus*, which has four specialised regions: myotome, sclerotome, enterotome, and gonotome. The five somites of the superior pentasomic vesicles in Echinoderms form the radial canals, those of the lower vesicles form the general radial cavities. The general result of a theory, which is somewhat difficult to follow, is to the effect that Vertebrates and Echinoderms have had a common ancestor. A

* Verh. Phys. Med. Ges. Würzburg, xxxvi. (1904) pp. 297-336 (5 pls.).
† Bull. Soc. Zool. France, xxix. (1904) pp. 70-81 (9 figs.).

descendant affected by precocious dorsal atrophy and progressive left hemilateral degeneration gave rise to the Echinoderm stock.

Eocene Echinoids from Sokoto.*—F. A. Bather describes and discusses the significance of *Plesiolampas saharæ*, sp.n., and *Hemiaster sudanensis*, sp.n., collected by Captain Lelean in Sokoto. The occurrence of *Plesiolampas*, a genus hitherto unknown outside Sind, suggests a continuous westward extension of the Eocene Indian Ocean; and this idea is confirmed by an Egyptian fossil of the same age, identified by Gauthier as *Plesiolampas*.

Cœlentera.

Development of Hydromedusæ.†—A. Goette has studied the development of the medusoid in a number of free-swimming and sessile forms. His results are remarkably different in a number of points from those of Agassiz. The radial canals arise from the apical portions of the four tæniolæ. The circular canal arises neither from an endoderm lamella nor through side continuations of the radial canals. It appears to be formed independently from outgrowths from the tæniolæ. The cavity of the bell arises from four radial furrows of the endoderm separated by the four tæniolæ. The ova, in *Podocoryne*, arise from the ectoderm of the polyps; in *Syncoryne* and *Bougainvillea* from the endoderm of the bud. The male sexual cells in all the three genera probably have their origin in the outer ectoderm. Only in *Dendroclava* does the ectoderm of the manubrium appear to be the germinal region, and here not exclusively, since the sub-umbrellar flaps beyond the manubrium likewise give rise to germinal cells.

Solenocaulon.‡—Martin Janower does not agree with Hickson in slumping *Solenocaulon tortuosum* Gray, *Sol. grayi* Studer, and *Sol. tubulosum* Genth into one species, *Sol. tortuosum* Gray, with a widened diagnosis. He maintains that these are three good species, to which must be added *Sol.* (*Leucoella*) *cervicorne* Gray. A general discussion of the genus follows.

Anatomy of Cerianthus Borealis.§—J. S. Kingsley gives some account of this form. It is distinguished from related species in being hermaphrodite. It differs from *C. membranaceus* and *C. lloydi* in the great extension of its septa, five pairs reaching to the aboral pole. The larger and more prominent siphonoglyph in *Cerianthus* is homologous with the single groove in *Halcampa*, and hence should be termed sulcus and not sulculus as maintained by Bourne.

Studies in Anthozoa.‖—O. Carlgren has investigated the development of the first twelve tentacles in *Peachia*, *Cribrina* (*Bunodes*), etc. At the eighth tentacle stage in these forms there are only four which are homologous to each other. These are the two directive, and the two which lie on each side of the dorsal directive tentacles; the four others

* Geol. Mag. Decade V., i. No. 7 (1904) pp. 292–304 (1 pl.).
† Zool. Anzeig., xxvii. (1904) pp. 473–5.
‡ Revue Suisse Zool., xii. (1904) pp. 495–538 (2 pls.).
§ Tufts College Studies, No. 8 (1904) pp. 345–61.
‖ Zool. Anzeig., xxvii. (1904) pp. 534–49.

are not the same in the genera in question. In *Peachia* these four last are exocœl tentacles, and in *Cribrina* they are endocœl. The eight first tentacles in *Cribrina* are the six which later form the six primary endocœl tentacles plus two primary exocœl ones. In *Peachia* the eight first form the two primary endocœl (directive) tentacles plus the six primary exocœl. This is related to a difference in the position assumed by tentacles nine to twelve. There exist in the twelfth tentacle stage of Actiniarians two types, which are already indicated in the eighth tentacle stage: (1) Bilateral. On each side of the plane of direction and on both sides of the ventro-lateral tentacle of the eighth tentacle stage there arises an exocœl tentacle, so that the dorsal tentacle develops a little earlier than the ventral. (2) Biradial. Here there appear about the same time four endocœl tentacles, two on each side of the plane of direction, on both sides of the lateral tentacle of the eighth tentacle stage. The paper includes a consideration of transverse division in *Gonactinia*, as well as notes on heteromorphism in the Actiniaria.

Protozoa.

Significance of Pigment Spots in Protozoa.* — R. Halben discusses the significance of the pigment in the "eye-spots" of certain Protozoa, and generally the problem of "seeing" in simple Invertebrates. The significance of a pigmented spot in Protozoa and in transparent Metazoa he seeks to interpret in the following manner. It is capable of orientating the body with respect to light. In other words, it functions as a shadow giver. If parallel light strikes on a ball-like mass of pigment in a transparent animal a shadow-cylinder is formed, in relation to which the organism automatically seeks to orientate itself, so that the shadow coincides with the long axis of the body. The animal thus turns the "eye" to the light or seeks to withdraw from it.

Neogamous Gregarines.† — H. M. Woodcock gives a preliminary account of the life-cycle of *Cystobia irregularis* and other allied gregarines, which from their constant occurrence in pairs he terms "neogamous." *C. irregularis* is parasitic in *Holothuria forskali*. The adults are perfectly regular in form and beautifully ovoid. The two associates are sometimes separated by a distinct septum, and sometimes not, which is dependent on the time of their union. In *C. minchinii* occurs one of the most advanced instances of neogamy yet known, the fusion taking place almost at the commencement of the life-cycle when the parasites are scarcely more than sporozoites, and comprising an absolute union of the two cytoplasms, the nuclei alone remaining distinct. Here the fusion is longitudinal, that is, side by side; in *C. irregularis* it is end to end. The author regards this extremely precocious association as an adaptation on the part of the parasites to ensure a suitable association, which would otherwise be rendered very difficult by the loss of mobility characterising these cœlomic forms. Successive phylogenetic steps in the increasing intimacy of the process are seen in *Diplocystis major*, *D. minor*, and *D. schneideri*.

* Biol. Centralbl., xxiv. (1904) pp. 283–8.
† Arch. Zool. Exp. et Gen., xxxii. (1904) Notes et Revue, pp. cxxv.–cxxviii.

Protozoa of Louisiana.* — J. C. Smith gives an account of the structure and habits of various marine Protozoa as a preliminary contribution to the fauna of this region. Several forms are recorded for the first time for North America.

Trypanosoma dimorphon in Horses.†—A. Laveran and F. Mesnil discuss this new species of *Trypanosoma* found by J. E. Dutton and J. H. Todd in horses in Gambia. It seems to be structurally quite distinct from *Tr. gambiense* (in man) and from other forms. Mice, which are immune to *Tr. gambiense*, are acutely infected by *Tr. dimorphon*, and human serum, which is ineffective as regard *Tr. gambiense*, has an effect on *Tr. dimorphon*, though less than in Nagana, Surra, and Caderas. There seems little doubt that *Tr. dimorphon* is a well-characterised species, distinct from *Tr. brucei*, *Tr. gambiense*, and other forms.

Peculiar Parasite of the Embryos of Daphnia.‡ — Ch. Pérez describes *Blastulidium pædophthorum* g. et sp. n., probably one of the Haplosporidia, which is parasitic on the eggs and young embryos in the brood-pouch of parthenogenetic forms of *Daphnia obtusa* Kurz. The fertilised ova were not infected. In its adult state the parasite exhibits an ellipsoidal protoplasmic body, surrounded by a delicate envelope, with a huge hyaline vacuole in the centre, and with very numerous nuclei round about. The plasmic cortex divides into as many parts as there are nuclei, and the mature schizont has the appearance of a blastula with a large segmentation cavity.

* Rep. Louisiana Gulf Biol. Station, 1903, Bull. No. 2, pp. 43–55.
† Comptes Rendus, cxxxviii. (1904) pp. 732–7 (7 figs.).
‡ Proc. Verb. Soc. Sci. Bordeaux, 1903, pp. 75–6.

BOTANY.

GENERAL,

Including the Anatomy and Physiology of Seed Plants.

Cytology,

including Cell-Contents.

Occurrence of Mitochondria and Chondromites in Plant Cells.*—Fr. Meves finds in the tapetal cells of young anthers of *Nymphæa alba* long, irregularly wound, tolerably thick threads, which stain a deep black with iron hæmatoxylin. He regards these as identical with the *chondromites*, the term used by Benda for the thread-like aggregations of microsomes or mitochondria found in certain animal cells. He is of opinion that the filaments will be found to be generally distributed in plant-cells.

Scent of the Orange Flower.†—E. Charabot and G. Laloue find that the petals contain the greater part of the essential oil of the orange flower. During flowering the weight of oil is sensibly increased; hence, contrary to what occurs in the leaf and the stem, the formation or accumulation of scent products in the flower is more active when the organ is fully developed than in an earlier stage. The authors also give details of the chemistry of the process.

Structure and Development.

Vegetative.

Comparative Anatomy of Japanese Cucurbitaceæ.‡ — Atsashi Yasuda has studied the anatomy of various organs of fifteen genera of this family, which are found wild or are cultivated in Japan. The stems bear four kinds of trichomes, sharp-pointed and blunt conical trichomes, and short- and long-stalked glandular trichomes. There are four types of distribution of the sieve-tubes in the stems: vascular bundle sieve-tubes, ectocyclic, endocyclic and commissural sieve-tubes; all four types are found in *Cucurbita Pepo*. *Melothria japonica* and *Gymnostemma cissoides* have long, thick rhizomes, bearing at several nodes three scales which are anatomically distinguished as a shoot, a leaf and a tendril. The rhizomes are full of starch-grains; the collenchyma, sclerenchyma and fibro-vascular bundles are much reduced. There are generally six fibro-vascular bundles in the hypocotyls, except in *Citrullus vulgaris* and *Cucurbita Pepo*, which have twelve and ten respectively. *Cucurbita Pepo* is singular in having a many-layered epidermis in the leaves. The much enlarged epidermal cells on the lower face of the blade in *Momordica Charantia* contain globular cystoliths.

* Ber. Deutsch. Bot. Gesell., xxii. (1904) pp. 254–6 (1 pl.).
† Comptes Rendus, cxxxviii. (1904) pp. 1513–4.
‡ Journ. Coll. Sci. Imp. Univ. Tokio, xviii. (1903) Art. 4, pp. 1–56 (5 pls.).

The author describes six ways of arrangement of the fibro-vascular bundles in the midribs of the leaves: the number of bundles varies between one and seven. He also describes the characters of the cotyledons; the spongy parenchyma of these organs in *Actinostemma racemosum* has a reticulate appearance, the cells radiating from a fibro-vascular bundle and bearing very large intercellular spaces, recalling the leaf tissue of water-plants. The young roots of the same species have also remarkably wide inter-cellular spaces. The epidermal cells of the fruit may be radially flattened, cubical or radially elongated; a more or less complete sclerenchymatous ring is generally formed in the pericarp. The origin of the tubercles on the surface of the fruit varies: those in *Actinostemma* and *Momordica* are parenchymatous out-growths, while those of *Cucumis sativus* are the large protuberant bases of trichomes which have become detached. Sieve-tubes have a characteristic distribution in the fruits: besides those found in the phloem, there are isolated ones in the tissue of the pericarp, in the hypoderma outside the hardened ring, when such is present. A vascular bundle enters the tubercles on the pericarp in *Momordica Charantia*. Three kinds of epidermal cells may be distinguished in the seeds, flattened or cubical, prismatic, and prismatic with thickened ridges.

Development of the Bicollateral Bundle of Curcurbita.*—F. C. von Faber has worked out the development in *Cucurbita Pepo*, and finds that the bundle is a true bicollateral one. The inner phloem is differentiated at a very early stage in the same procambium strand as the other elements, and differs in no way from the external phloem; hence it seems more correct to speak of a single bicollateral bundle than to regard the inner phlœm as belonging to a second bundle which consists only of phlœm. The development of an internal cambium, and the occasional formation of xylem elements in connection with the inner phloem, cannot be regarded as an argument against the original entity of the bundle.

Leaf-form and Stomata of the Dwarf Plants of the Würzburg Limestone.†—E. Lippold has made a detailed comparison of a number of plants growing in the area in question, in which there is a marked scarcity of water, with others growing under normal conditions, from the point of view of leaf-area and distribution of stomata. A reduction of leaf-surface is general in the dwarf forms; an extreme case is seen in *Pimpinella Saxifraga*, where it is in the proportion of 24 to 1. There was also a reduced number of stomata on a square millimetre of surface; here the extreme case was supplied by *Poterium Sanguisorba*, the reduction being in the proportion of 1·8 to 1. The form and often also the size of the epidermal cells was unaltered in the dwarf forms. Generally speaking, the leaves were hairy on both sides. Transpiration is checked in these dwarf forms by one or a combination of more than one of the following factors: reduction of the leaf-surface, diminution of the number of stomata in unit area, diminution of the size of the stomata.

* Ber. Deutsch. Bot. Gesell., xxii. (1904) pp. 296–303 (2 pls.).
† Verhandl. Physik.-Medicin. Ges. Würzburg, N.F., xxxvi. (1904) pp. 337–83

Structure of the Petiolar Glands of Hevea brasiliensis.*—A. Daguillon and H. Coupin describe the anatomy of the glands, several of which occur on the upper face of the petiole between the bases of the three leaflets. Each gland consists of a central depression surrounded by a raised ring of tissue; the epidermis in the depression forms a secretive epithelium with palisade-like cells. Beneath the well developed sub-epidermal layer is a mass of relatively small cells, with dense protoplasm, large nucleus and numerous chloroleucites; near these are many cells containing crystals of calcium oxalate. Below the periglandular ring is a water-bearing ring of tracheids. A slender woody bundle ends in a cap of small tracheids beneath the centre of the subglandular mass, in which also are found the ends of some laticiferous cells. Cells rich in tannin occur in the parenchyma near the secreting surface, and especially in the subglandular mass.

These petiolar glands afford useful diagnostic characters in several other genera of Euphorbiaceæ.

Vegetative Propagation in the Floral Region in Epidendrum elongatum.†—E. Hemmendorff describes in specimens of this orchid from San Paulo, Brazil, the production of vegetative shoots on the inflorescence. Only a few flowers form fruit; generally they soon fall and the upper part of the inflorescence withers, but from the axils of the bracts immediately below the floral region new shoots are often produced. These develop in various ways. Only rarely do they bear flowers; generally they are vegetative, forming naked branches without leaves or roots, or bearing the air-roots, or air-roots and leaves. Occasionally shoots of the third order, which are flower-bearing, are developed.

GATIN, C. L.—**Sur les états jeunes de quelques Palmiers.** (On the young states of some palms.)

[Gives a few details especially in relation to the root; in some species only adventitious roots occur. The author states that the three modes of germination of palms distinguished by Micheels represent only superficial differences.] *Comptes Rendus*, cxxxviii. (1904) pp. 1625–7.

Reproductive.

Variation in the Violet Flower.‡—C. E. Britton summarises the variations detected among 1000 flowers of each of five species gathered in various parts of Surrey. The species were *Viola odorata*, *V. hirta*, *V. silvestris*, *V. Riviana*, *V. ericetorum*. The most general forms of variation were those tending towards the production of a regular flower, either by an increase in the number of spurs or the formation of petal-line sacs, or by abortion of the typical spur. Petalody of the sepals and stamens, sepalody of the petals, lobing of sepals and petals, and the development of tetramerous and trimerous flowers were also observed. External conditions, chiefly light and temperature, seem to have considerable influence on the production of aberrations among violet flowers. The effect of an unusual excess of light was seen in the case of *V. silvestris* growing in a copse which had been cut over during the previous

* Rev. Gén. Botan., xvi. (1904) pp. 82–90 (3 figs. in text).
† Arkiv för Botanik (K. Svensk. Akad.) i. (1904) pp. 516–19 (2 pls.).
‡ Journ. of Bot., xlii. (1904) pp. 140–8.

winter; in the spring abnormal flowers abounded. The author considers that the great factor in the production of abnormal violet flowers is connected with the existence of two classes of flowers, the large-petalled, which usually fail to form fruit, and the cleistogamic, which are productive.

Sexuality in the Genus Ribes.*—Ed. de Jancewski finds as a result of examination of the species of *Ribes* occurring in South America, that these are all practically diœcious, thus contrasting with the North American species. Both stamens and pistil are present in all the flowers, but on some plants the stamens, on others the pistil, show various degrees of abortion. In several species the flowers are apparently hermaphrodite, but the anthers in the fruit-producing flower contain in place of functional pollen a mass of parenchyma-like cells, which are apparently aborted pollen-mother-cells, while the ovules in the male flowers are rudimentary. The Isthmus of Panama constitutes a natural limit between species, which, while closely allied and very near in all other respects, differ in the incomplete development of the sexual organs in the Southern species.

Nutrition of the Egg in Zamia.†—Isabel S. Smith describes the mode of nutrition of the egg by jacket-cells in *Zamia*. The inner walls of the jacket-cells are pierced by numerous pores of various sizes, through which the protoplasm of the egg protrudes into the jacket-cells, forming haustoria-like processes. After passing through the pits the ends of the haustoria become distended so that the structure appears knob-shaped. The haustorium behaves like a gland cell, during the period of accumulation staining more and more deeply, then discharging, and during the following period of exhaustion staining faintly until the active period begins again. In no case was there any indication of the passage of nuclei or nucleoli from the jacket-cells into the egg, and in no case was a jacket-cell found without a nucleus. It often happens that the knob-like ends of haustoria are cut longitudinally and then closely resemble nuclei, and might be mistaken for nuclei passing bodily into the egg. This may explain the passage of the nuclei described by Arnoldi in *Pinus*, but not confirmed by subsequent investigators. No sieve-plates, or similar structures, as described by Goroschankin in *Ceratozamia*, were found in the present instance.

Embryo-sac and Fertilisation in Aster.‡—Marie Opperman has investigated these stages in the life-history of several species of *Aster*. The embryo-sac arises from the lowest cell of an axial row of four cells, and the eight-nucleate sac is formed in the usual way. There is considerable variation in the form of the embryo-sac, both in different species and in the same species. Generally the polar nuclei fuse before fertilisation, but may fuse after it. The endosperm nucleus is marked out by its large size, almost spherical shape, its large nucleolus and its position below and in contact with the oosphere. The antipodals show a remarkable growth before the time of fertilisation, and persist till the

* Bull. Internat. Acad. Sci. Cracow, 1903, No. 10 (1904) pp. 788–92 (7 figs. in text).
† Bot. Gazette, xxxvii. (1904) pp. 346–52 (6 figs. in text).
‡ Tom. cit., pp. 353–62 (2 pls.).

development of the embryo is far advanced; from one to nineteen nuclei were found in a single antipodal cell. The lowest antipodal cell is often very much enlarged. A remarkable embryo-sac was observed in a specimen of *Aster undulatus*, containing two oospheres and two endosperm nuclei. The upper part of the sac is normal, but in the lower part just above the first antipodal cell there is a cell and a large nucleus which have the same structure and the same relative position as that of the egg and the endosperm nucleus at the micropylar end. One of the sperm nuclei has passed to the lower part of the embryo-sac to fuse with the lower oosphere. This discovery of an antipodal, functioning as an egg and about to be fertilised, has, the author considers, an important bearing on the problem of the homologies of the antipodals.

In the same species, *A. undulatus*, double fertilisation was observed. The development of the embryo follows the type described for other Compositæ.

Embryo-sac and Embryology of Nelumbo.*—H. H. York gives an account of his work on the life-history of *Nelumbo lutea*. There is a single hypodermal archesporial cell, and four megaspores are formed, the lowest of which only is functional. An eight-celled embryo-sac is formed, and usually one or more imperfect sacs, presumably derived from sister megaspores. The antipodals are small and usually disappear before the conjugation of the polar nuclei; the synergids are small and degenerate about the time of fertilisation. The fusion of the polar nuclei is not complete until after fertilisation; double fertilisation was observed. An axial row of cells below the embryo-sac are large and rich in protoplasm, and form a conducting passage for food from the ower ovular tissue to the embryo-sac. The embryo-sac becomes divided, after fertilisation, into three chambers by formation of two transverse walls, and finally the whole sac becomes filled with endosperm. No free cell formation occurs at any stage of the process.

The history of the embryo is the same as reported by Lyon. A spherical embryo of several hundred cells is formed; no suspensor cell is present. When the spherical embryo has reached its maximum growth it becomes flattened at the outer end by the development of a collar-like ridge extending about two-thirds of the way round. Development then continues at the opposite side, giving rise to the two "cotyledonary" lobes, which grow downwards very rapidly outside the endosperm. The plumule forms a dome-shaped projection occupying a central position between the lobes. Both the cotyledonary ridge and the stem tip probably represent terminal structures, but on account of the spherical form of the embryo it is impossible to trace the origin of any set of cells which appear at the outer end of the more mature embryo, and the cotyledonary ridge may be lateral. The first leaf and stem tip develop side by side from the terminal mass of cells in the protuberance; the leaf arises on the side opposite the cotyledonary ridge.

The author points out the similarity in early development between the embryo of *Nelumbo* and those of certain Aroids (*Lysichiton* and others), while the development of the cotyledonary ridge shows a

* Ohio Naturalist, iv. (1904) pp. 167–76 (3 pls.).

striking resemblance to the hypocotyledonary expansion of various Helobiæ. It is probable that the broad two-lobed expansion in the *Nelumbo* embryo, commonly known as the cotyledons, is a true hypocotyledonary body, bearing a rather close resemblance to the hypocotyledonary expansion of *Phyllospadix*. The first leaf of *Nelumbo* then becomes homologous with the so-called cotyledon in *Ruppia* and *Phyllospadix*.

Jacket Layer in Sassafras.*—J. H. Schaffner describes a jacket of cells surrounding the mature embryo-sac in *Sassafras*. It shows some resemblance to the delicate zone in *Agrostemma*, but there is no distinct limiting wall on the outside. It is from one to several layers of cells thick, and behaves differently to stains from the outer layer. The cells have large vacuoles, and comparatively little protoplasm, and begin to degenerate when the embryo-sac is fully formed. It thus serves not only to nourish the developing gametophyte, but by its disintegration supplies food to the developing endosperm and embryo. This jacket layer is a purely physiological tissue developed in various ways in different angiosperms. It may be absent, as in *Sagittaria* and *Lilium*; represented by disintegrating cells in contact with the embryo-sac, as in many monocotyledons and dicotyledons; it may be developed, as in the examples just discussed; or it may be a highly-specialised layer of dark staining cells, as in *Aster Novæ-angliæ*, described by Chamberlain.

OVERTON, J. B.—**Über Parthenogenesis bei Thalictrum purpurascens.** (On parthenogenesis in *Thalictrum purpurascens.*)
[Gives cytological details of the phenomenon, a general account of which was given by the same author in 1902).
Ber. Deutsch. Bot. Gesell., xxii. (1904) pp. 274–83 (1 pl.).

ROBERTSON, C.—**The structure of flowers and the mode of pollination of the primitive angiosperms.**
[Suggests that the primitive angiosperms were entomophilous, and that the anemophilous ones are metamorphosed entomophilous flowers whose seemingly simple structures are degraded, not primitive.]
Bot. Gazette, xxxvii. (1904) pp. 294–8.

VOGLER, PAUL—**Die Variation der Blutenteile von Ranunculus Ficaria L.** (Variation of the parts of the flower of *R. Ficaria.*)
[The petals and the sporophylls show a marked parallel variation; there is no obvious compensation.]
Vierteljahrschr. Naturf. Gesell. in Zurich, xlviii. (1904) pp. 321–8, with explanatory curves.

Physiology.

Nutrition and Growth.

Assimilation of Atmospheric Nitrogen.†—Charlotte Ternetz finds associated with the roots of *Calluna*, *Erica carnea*, *Oxycoccus* and *Vaccinium* a fungus which can assimilate atmospheric nitrogen. The fungus has a much-branched septate mycelium, and forms brown pycnidia, which

* Ohio Naturalist. iv. (1904) pp. 192–3 (fig. in text).
† Ber. Deutsch. Bot. Gesell., xxii. (1904) pp. 267–74 (1 pl.).

contain small hyaline spores. The nitrogen assimilation is much less energetic than in the case of *Clostridium pastorianum*.

Intramolecular Respiration.*—E. Godlewski finds that, whereas lupin seeds in pure water develop in absence of oxygen only very slight intramolecular respiration, this form of respiration is well marked when the seeds are placed in a suitable sugar solution, and may continue for six to eight weeks. Grape-sugar is used more easily than cane-sugar, which has first to be inverted. The intramolecular respiration, which is developed at the cost of the sugar supplied to the seeds, facilitates the hydrolysis of the reserve carbohydrate of the seeds and its use for intramolecular respiration, so that seeds placed in sugar solution use more of their own carbohydrates than when lying in pure water. During intramolecular respiration under these circumstances changes also occur in the contained proteids, about 30 p.c. becoming decomposed before death occurs from want of oxygen. The nitrogen of the decomposed proteid appears chiefly (more than 75 p.c.) in the form of amino-acids; only 9 to 10 p.c. appears in the form of asparagin. This last result suggests that in absence of oxygen only dissimilation of the proteids is possible in the higher plants—not a synthetic formation of asparagin—and from this point of view a closer investigation of the formation of proteid, in absence of oxygen in the case of the higher plants, seems desirable.

Irritability.

Effect of Chemical Irritation on Respiration of Fungi.†—Ada Watterson reviews previous work on this subject, the results of which indicate that small quantities of certain poisonous substances act as stimulants, increasing the growth of certain plants, and also increasing respiration. Since, in the case of fungi, it has been found that stimulation raises the economic coefficient of the sugar—i.e. allows the plant to make use of the sugar to form a greater amount of dry substance in a given time, the question of the amount of CO_2, which is produced at the same time, becomes of interest. The author finds from her own experiments that the addition of small quantities of zinc sulphate, iron sulphate and lithium chloride, increases the rate of growth of *Sterigmatocystis* and *Penicillium*, so that a larger amount of dry substance is formed within a given time than in normal culture; that at the same time there has been an increase in the production of CO_2, but not too great to be accounted for by the enlarged area of the plant. The ratio of dry weight to CO_2 in the irritated fungus is, therefore, approximately equal to that of the normal. Taking into account previous results which show that the effect of the addition of such poisons is to enable the plant to make more economical use of the carbohydrates supplied to it, we can interpret this action as a stimulus which causes the fungus to transform more of the food material into its own substance and less into waste products such as oxalic acid, while at the same time the respiration remains relatively unchanged.

* Bull. Internat. Acad. Sci. Cracow, 1904, pp. 115-58.
† Bull. Torrey Bot. Club, xxxi. (1904) pp. 291-303.

Perception of the Force of Gravity by Plants.*—F. Darwin gives a valuable discussion on the statolith theory of geotropism, which suggests that the stimulus to geotropic curvatures is supplied by the change in position of the movable starch-grains resulting from an alteration in the position of a plant or plant-organ. Two general considerations are of interest. First, analogy with the graviperceptive organs of animals, Kreidl having shown that in the crustacean *Palæmon* the sense of verticality depends on the pressure of heavy bodies on the inside of certain cavities, or statocysts, formerly believed to be organs of hearing. When the normal particles are replaced by fragments of iron, the animal reacts towards the attraction of a magnet precisely as it formerly reacted towards gravity. Secondly, the specialisation and distribution of the falling bodies in plants. The difference between movable starch-grains (statoplasts) and the ordinary immovable amyloplasts is striking, and it is hardly possible to doubt that their function is different. In a seedling, *Phalaris canariensis*, the apical part has only falling starch-grains, while lower down both forms occur, and correspondingly, we find that the seedling is gravi-sensitive throughout, but especially so at the apex. The most striking general fact about the distribution of the statoplasts is their presence in the endodermis. If the endodermis is essentially a tissue of gravi-sensitive cells, we can understand why it contains loose starch only as long as the stem is capable of growth curvature. Other cases which strongly suggest a relation between sensitiveness to gravity and presence of statoplasts are the onion, where these occur in the root-cap, the endoderm and punctum of the seedling, but not elsewhere, and the pulvinus of grasses in which statoplasts occur, but not in the haulm. *Viscum*, on the other hand, is not geotropic, and has no statoplasts. The author has previously shown that the cotyledon of *Setaria* and *Sorghum* is the seat of gravitation, and it is there that the statoplasts are found. Physiologists have gradually come to accept Charles Darwin's view that the organ of graviperception is in the tip of the root, and it is there—generally in the root-cap and there only—that the statoplasts are found. In a large number of plants, such as Algæ and Fungi, no statoliths are known to exist; here we must either accept Noll's view of minute and hitherto unseen statoliths, or suppose a different mechanism such as hydrostatic pressure.

Reviewing, in some detail, the experimental evidence, the author expresses his opinion that it is not fatal to the statolith theory; in some cases a revision is necessary, and other considerations must be taken into account. He is impressed with the general, though not the universal, applicability of the statolith theory, and considers that in the case of the higher plants, sensitiveness to the pressure of heavy bodies will be found to be by far the most important, if not the exclusive means, by which gravity is perceived. The stimulus must depend on weight, and since neither the theory of radial pressure nor Noll's supposition of stimulation by small unknown bodies lends itself to experimental inquiry, we are driven, as practical people, to test the

* Brit. Assoc., 1901, Botanical Section. Address by the President, Francis Darwin, F.R.S.

statolithic views of Haberlandt and Němec. Their theory may fairly hold the field until better theories of both gravi-perception and of the function of falling starch-grains are established.

Aerotropism in Roots.*—Mary E. Bennett has carried out a series of experiments on the supposed aerotropic curvatures ascribed by Molisch to roots. Roots of maize, *Pisum sativum*, *Raphanus sativus*, and others were subjected to the one-sided access of oxygen, hydrogen and carbon dioxide, to determine whether the roots do really curve toward or away from these gases in natural or artificial conditions. When the roots were grown in water between submerged chambers, the one containing air and the other CO_2 or hydrogen, no constant and regular curvatures occurred; the majority of roots were indifferent to the influence of any of these gases. The same results followed when the roots were not submerged but placed between the gas chambers in a larger damp chamber. When the seedlings were grown in a thin vertical layer of earth forming a septum between air and CO_2, or air and hydrogen, or in earth permeated on one side with air, and on the other with CO_2 or hydrogen, very few curves were formed, the large majority of roots growing straight, or if curved, the curves were not directed by the presence of gases. Similarly, when the roots of seedlings were grown in a thin layer of gelatin between different gases, no curves of constant direction were shown. In experiments similar to those of Molisch, where roots were supported close to narrow slits opening into gas-chambers from which gases were constantly diffusing, curves were produced generally towards the gas-chambers, whether or no gases were diffusing from the chambers. But these curves were found to be purely hydrotropic. The author concludes that, at any rate in the case of the land plants used in the present inquiry, definite direction curvatures are not induced in roots by the one-sided access of gases, and these roots are therefore not aerotropic.

Stimulating Action of some Metallic Salts on the Growth of the Higher Plants.†—Masayasu Kanda finds that a favourable influence is exerted on the growth of some plants by a slight addition of certain metallic salts, which are not nutrient but act as poisons in larger doses. The methods which gave satisfactory results were those of water-culture and pot-culture, both of which in the case of land plants imply a departure from normal conditions. The author found that very dilute copper sulphate solution (0·000000249 p.c.) acted prejudicially on pea-seedlings in water-culture, while still further dilute solutions (0·0000000249 to 0·00000000249 p.c.) acted neither as poison nor as stimulus. In certain soils, however, the same salt had a favourable action on pea- and bean-seedlings. Very dilute solutions of sulphate of zinc had a favourable action; the optimum concentration lies between 0·00000287 and 0·0000001435 p.c.; a concentration of 0·0000287 p.c. had a poisonous effect. Pot-plants of *Vicia* and *Pisum* watered three times a week with 200 c.cm. of 0·287 p.c. solution of zinc-sulphate, showed a more rapid growth than the control plants

* Bot. Gazette, xxxvii. (1904) pp. 241–59 (5 figs. in text).
† Journ. Coll. Sci. Imp. Univ. Tokio, xix. Art. B (1904) pp. 1–37 (1 pl.).

which were watered with tap-water. Sodium fluoride acted as a stimulus to pea-seedlings in water-culture; the optimum concentration lies between 0·0021 and 0·00021 p.c. A concentration of 0·02 p.c. had a poisonous effect.

Chemical Changes.

Occurrence of Invertase in Plants.* — J. H. Kastle and Mary E. Clark have examined nineteen species representing fourteen families of plants, and find invertase abundantly in each and more constant in its occurrence than diastase. Contrary to the views of Béchamp, it occurs abundantly in the leaves; it also occurs in some rather unexpected associations—for instance, in the growing tubers of the potato and artichoke, where we should be inclined to expect the occurrence of relatively large amounts of inulase and diastase respectively, these ferments are present but in less quantity than invertase. It is of interest to note that invertase is not confined to those plants which store cane-sugar as the characteristic reserve material. The fact that it occurs so generally in foliage leaves, and is so widely disseminated throughout the various plant organs, lends support to the view of Brown and Morris that cane-sugar is the first product of photosynthesis, and the fact that it is also present in the reserve organs of plants storing inulin as well as those storing starch would seem to point to cane-sugar as the substance immediately antecedent not only to starch but to other reserve materials.

Zymase and Alcoholic Fermentation.† — P. Mazé continues his researches on this subject. The production of the zymase has hitherto been considered as limited to a larger or smaller number of living cells, and forming generally a kind of anomaly. The author has shown that the conversion of sugar into alcohol and CO_2 is very general in living cells under normal conditions. Zymase is a diastase formed in aerobic conditions, and its action on sugar must be regarded as a phenomenon of digestion. Hence the alcoholic fermentation in absence of oxygen so often observed in plant and animal tissues, must be regarded as the continuation of a diastatic action which has its origin in normal life. The general poverty in zymase of plant and animal cells is due to its rapid destruction, probably by an oxidation process.

General.

Botany of Belle Isle.‡—Emile Gadeceau gives an exhaustive account of the botany of this small Breton island. After a general account of the topography, climate, geology and cultivation, he gives a catalogue of the vascular plants found on the island, with notes on their habitat. The third part of his paper is devoted to plant-geography or œcology; here the author discusses the influence of climate, of soil, etc., on the distribution of the plants, and describes the various plant-associations. Finally he tabulates the following general conclusions. Climate exercises a strikingly preponderant influence on the dispersion of species,

* American Chem. Journ., xxx. (1903) pp. 422–7.

† Comptes Rendus, cxxxviii. (1904) pp. 1514–17.

‡ Mem. Soc. Sci. Nat. & Math. Cherbourg, xxxiii. (1903) pp. 177–368 (3 pls. and map).

many southern species attaining their extreme northern limit in the island. Water plays an important part in determining the character of the flora, xerophilous species forming the basis of the vegetation, while many hygrophilous species common in neighbouring regions are absent or rare in Belle Isle. The physical character of the soil exercises a more marked effect on the flora than the chemical character. A comparison of the flora with that of other Breton islands suggests their separation from neighbouring continents at an epoch prior to that of the formation of the Gulf-stream.

Flora of the Philippine Islands.*—E. D. Merrill gives notes on a number of new or otherwise noteworthy seed-plants recently collected by him in these islands. He also enumerates the plants of American origin which are now found in the islands. Some of these of economic or ornamental value have been purposely introduced ; others are the result of accident. The latter are for the most part generally distributed as weeds in cultivated fields. Many of those of economic importance seem to have been introduced in very early times ; both Mercado and Camell at the beginning of the eighteenth century enumerate many species of American origin. Nearly all the American species of economic importance, and a very large percentage of those accidentally introduced and now found in the islands, have been generally distributed throughout the tropics of the East by the same agencies by which they were introduced into this Archipelago ; and at the present time we find in other countries of the East, comparatively few of the tropical American species which are not also found in the Philippines. These islands must be considered as the early distributing point of American species in the East.

Antarctic Fossil Flora.†—A. G. Nathorst gives an account of the fossil plants collected in the Swedish Antarctic expedition. The most interesting is the jurassic flora found by J. G. Andersson in Hope Bay, at latitude 63° 15′ S., longitude 57° W. The plants were found in a black schist which formed part of an ancient mountain chain ; the flora is very rich in species, and the external leaf-form is well preserved. Equisetineæ are represented by a species very near *Equisetum columnare* Brongn., and the Hydropterideæ by a *Sagenopteris*, which is perhaps identical with *S. Phillipsi* Brongn. Ferns are abundant and belong to a large number of genera, and include several species of *Cladophlebis*, *Todites Williamsoni*, *Scleropteris*, *Stachypteris*, *Thinnfeldia indica*, *Pachypteris*, and *Sphenopteris*. Among the Cycadophytes are several species of *Otozamites*, *Williamsonia*, large leaves suggesting *Nilssonia tenuinervis*, and a magnificent *Pterophyllum* of the same type as the Indian *Pt. Morrisianum*. Among the Coniferæ the most interesting are cone-scales of *Araucarites cutchensis* ; leafy branches of conifers of different types were common. This jurassic flora as a whole resembles on the one hand the jurassic flora of Europe, and on the other the flora of upper Gondwana in India. In richness of species it far surpasses the jurassic floras previously known from South America.

* Department of the Interior, Bureau of Government Laboratories, Manila (1904) 3 pp. † Comptes Rendus, cxxxviii. (1904) pp. 1447–50.

Fossil Tertiary plants found in Seymour Island about latitude 64° 15′ S., as fragmentary and badly preserved leaf-impressions in a marine volcanic tufa contain different species of ferns, the determination of which is difficult, a conifer with distichous leaves, and a single leaf suggesting an *Araucaria* near *A. brasiliensis*. The leaves of the dicotyledons are generally small and have the same facies as those of certain Tertiary floras of Southern Europe; leaves of *Fagus* indicate the existence of the genus in South America or the neighbouring Antarctic regions since the beginning of the Tertiary period. Owing to their existence in a marine deposit, it is possible that these plants may have been brought some distance, for M. Agassiz has shown that fruits and leaves may be found at the bottom of the sea more than 1000 kilometres from the nearest land.

Presence of Abronia in the Tertiary Flora of Europe.* — L. Laurent refers to this American genus the specimens of fossil fruit from Cantal, which were originally referred to *Ulmus* by Unger, and were considered by Saporta and others to belong to *Zygophyllum*. *Abronia cycloptera* A. Gray var. *micrantha* Torr., from the mountains of Wyoming, has fruits identical with the fossil specimens. *Abronia* is a herbaceous plant belonging to the order Nyctagineæ, and is at the present day confined to Western North America. It will rank with the Californian element represented by *Taxodium* and *Sequoia*, which is so abundant in the Tertiary forests of Europe.

De Wildeman—**Sur les Acarophytes.** (On myrmecophilous plants.)
[The author suggests that the considerable variations found in the form of the acarodomatia on the leaves of species of *Coffea* in tropical Africa are due to hybridisation.] *Comptes Rendus*, cxxxviii. (1904) pp. 1437–40.

Harshberger, J. W.—**A photogeographic sketch of extreme south-eastern Pennsylvania.**
[An account of the various plant formations, and suggestions as to the origin of the flora.] *Bull. Torrey Bot. Club*, xxxi. (1904) pp. 125–59 (4 figs. in text).

Malme, G. O.—**Beitrage zur Kenntnis der sudamerikanischen Aristolochiaceen.** (South American Aristolochiaceæ.)
[A systematic account, with notes on morphology and distribution.] *Arkiv för Botanik* (*K. Svensk. Akad.*) i. pp. 521–52 (3 pls. and 4 figs. in text).

Sherman, P. L., Jun.—**The gutta-percha and rubber of the Philippine Islands.**
[An account of the subject from historical, botanical and economic points of view.] *Department of the Interior, Bureau of Government Laboratories*, Manila, 1903, 43 pp., 2 maps, 41 pls.

CRYPTOGAMS.

Pteridophyta.

Anatomical Structure of Hymenophyllaceæ.†—E. Ott has made a careful study of this order, and finds that fresh light is thrown on the systematic classification by taking into account the anatomical structure of the rhizome. Other authors have treated of the general anatomical structure of Hymenophyllaceæ, but rather in order to compare it with

* Comptes Rendus, cxxxviii. (1904) pp. 996–9.
† SB. Akad. wiss. Wien, cxi. (1902) pp. 879–925 (3 pls. and 9 figs.).

other ferns than as a guide to a systematic arrangement of the order itself. The present work makes a special study of the rhizome in this respect. The author gives a short résumé of former work by Mettenius, Russow, Prantl and others. As regards nomenclature, he follows Hooker's 'Synopsis Filicum,' except that *Loxsoma* is now by common consent removed from Hymenophyllaceæ to Davalliaceæ. The structure of the rhizome is then described as it occurs in the two genera *Trichomanes* and *Hymenophyllum*. *Trichomanes* is distinguished by the following characteristics: (1) "Deckzellen," either at the junction of the sclerenchyma and the peripheral parenchyma, or, where this is absent, in contact with the epidermis; (2) tracheids of the xylem are similar almost throughout, and arranged equally in all directions when seen in tranverse section. The genus is divided into two groups, the first characterised by: (1) an elliptic and 3-sided transverse section of the rhizome; (2) the black colour of the peripheral sclerenchyma in quite mature (dried) specimens; (3) semi-parenchymatous tissue between the sclerenchyma and the bundle-sheath; (4) the eccentric collateral bundle; xylem consisting of some few tracheids; preponderance of phloem in the bundle. To this group belong 19 species, which are all small and delicate, and possess other morphological features in common.

The second group has (1) a circular transverse section of the rhizome; (2) yellow, yellow-brown to reddish coloration of the sclerenchyma; (3) central concentric bundle; proponderance of xylem, which forms a circle in the bundle; phloem forms a ring in tranverse section. To this group belong 27 species, of sturdy growth, mostly erect, sometimes having a much shortened rhizome and long-stalked fronds.

The genus *Hymenophyllum* is characterised as a whole by: (1) absence of "deckzellen"; (2) tracheids of the xylem of two kinds, symmetrically arranged; (3) unequal development of the circular tranverse section of the rhizome; (4) closely adpressed, yellow, yellow-brown or reddish sclerenchyma-cylinder; (5) central, concentric bundle. There is a preponderance of phloem in the bundle. Four different types of xylem occur in the transverse section, and on this character the genus is divided into four sections; (*a*) ring-shaped xylem; (*b*) horse-shoe shaped xylem; (*c*) fan-shaped xylem; (*d*) irregular, mostly much reduced, xylem. Among these four groups are distributed the 52 species of *Hymenophyllum*, as well as four so-called species of *Trichomanes*. The author refers to many specimens in the Vienna herbarium. The paper is illustrated by text-figures and plates.

BOODLE, L. A.—**Secondary tracheids in Psilotum. Preliminary account.**
New Phytologist, iii. (1904) pp. 48–9.

BOWER, F. O.—**Ophioglossum simplex Ridley.**
[Anatomy of a new species from East Sumatra.]
Annals of Botany, xviii. (1904) pp. 205–16 (1 pl.)

CARESTIE—**Localités nouvelles pour le Jura occidental: Aspidium auriculatum, Asplenium lobatum.** (New localities for the western Jura for these two ferns.)
Arch. Flore Jurass., iv. (1903) p. 84.

CHANDLER, S. E.—**On the arrangement of the vascular strands in the "seedlings" of certain leptosporangiate Ferns. Preliminary notice.**
New Phytologist, iii. (1904) pp. 123–5.

CHAUVEAUD, G.—**Sur le développement des cryptogames vasculaires.** (On the development of the vascular cryptogams.)
Comptes Rendus, cxxxviii. (1904) pp. 511–3

CHRIST, H.—**Loxsomopsis costaricensis g. et sp. n.**
[Allied to *Loxsoma*, but differs in the characters of the sporangia.]
Bull. Herb. Boiss., iv. (1904) pp. 393–400 (1 pl.).

DAVENPORT, G. E.—**Miscellaneous notes on New England Ferns. VI.**
[*Nephrodium spinulosum*, var. *concordianum* n. var.]
Rhodora, vi. (1904) pp. 31–3.

EATON, A. A.—**Note on Equisetum pratense.**
[Rare in the United States.] *Tom. cit.*, p. 92.

EGGLESTON, W. W.—**Addenda to the Flora of Vermont.**
[Contains a list of 11 ferns and allies.] *Tom. cit.*, pp. 137–44.

GRAND'EURY—**Sur les rhizomes et les racines des fougères fossiles et les Cycadofilices.** (On the rhizomes and roots of the fossil ferns and *Cycadofilices.*)
Comptes Rendus, cxxxviii. (1904) pp. 607–10.

" " **Sur les sols de végétation fossiles des Sigillaires et des Lepidodendrons.** (On the fossil vegetation-soils of *Sigillaria* and *Lepidodendron.*)
Tom. cit., pp. 460–3.

GREGORY, R. P.—**The Reduction Division in Ferns.**
Proc. Roy. Soc., lxxiii. (1904) pp. 86–92.

HALÁCSY, E. v.—**Aspidium aculeatum × lonchitis.**
[A new hybrid.] *Verh. Zool. bot. Gesell. Wien*, liv. (1904) pp. 129–32.

HEGI, G.—**Zwei neue Fundorte von Botrychium lanceolatum Angström und Lycopodium complanatum L. in der Schweiz.** (Two new Swiss localities for *B. lanceolatum* and *L. complanatum.*) *Hedwigia*, xliii. (1904) pp. 312–3.

KENNEDY, G. G.—**Flora of Willoughby, Vermont.**
[Contains a list of 62 ferns and fern allies.] *Rhodora*, vi. (1904) pp. 93–134.

KIDSTON, R.—**On the fructification of Neuropteris heterophylla Brongn.**
Phil. Trans. Roy. Soc., cxcvii. (1904) pp. 1–5.

LANKESTER, MRS.—**British Ferns: their classification, structure, functions. Illustrated new edition.** Gibbings (1904) 132 pp.

LEAVITT, R. G.—**Trichomes of the Root in Vascular Cryptogams and Angiosperms**
Proc. Boston Soc. Nat. Hist., xxxi. (1904) pp. 273–313.

LIGNIER, O.—**Equisétales et Sphénophyllales. Leur origine filicinéenne commune.** (*Equisetales* and *Sphenophyllales*; their common origin in the *Filicineæ.*)
Bull. Soc. Linn. Normand., vii. (1903) pp. 93–137.

LINDMAN, C. A. M.—**Neue Speziesnamen einiger südamerikanischer Farne.** (New specific names of some South American ferns.)
Hedwigia, xliii. (1904) pp. 308–11 (fig.).

MAXON, W. R.—**Two new Ferns of the genus Polypodium from Jamaica.**
Proc. U.S. Nat. Mus., xxvii. (1904) pp. 741–4.

OLIVIER, E.—**Une fougère anormale.** (An abnormal fern.)
Rev. Sci. Bourbonn. et Centre de la France, 1904, p. 69.

OSMUN, A. V.—**Further stations for Botrychium matricariaefolium in Connecticut.**
Rhodora, vi. (1904) p. 80.

ROSENSTOCK, E.—**Beiträge zur Pteridophytenflora Südbrasiliens.** (Contribution to the fern-flora of South Brazil.)
[A list of 191 species, four being new, with critical notes.]
Hedwigia, xliii. (1904) pp. 210–38.

SLOSSON, M.—**A new hybrid fern from Vermont.**
Rhodora, vi. (1904) pp. 75–7 (fig.).

TANSLEY, A. G., & R. B. LULHAM—**The vascular system of the rhizome and leaf-trace of Pteris Aquilina L. and Pteris incisa Thunb. var. integrifolia Beddome.**
New Phytologist, iii. (1904) pp. 1–17 (59 figs.)

UNDERWOOD, L. M.—**The Early writers on Ferns and their Collections. II. J. E. Smith, 1759–1828; Swartz, 1760–1818; Willdenow, 1765–1812.** *Torreya*, iv. (1904) pp. 49–52.

URSPRING, A.—**Beiträge zum Bewegungsmechanismus einiger Pteridophyten sporangien.** (Notes on the mechanism of movement of some fern-sporangia.) *Ber. Deutsch. Bot. Gesell.*, xxii. (1904) pp. 73–84.

VRIES, H. DE.—**Schuurbiezen (Equisetum).** *Album der Natuur*, 1904, pp. 233–46.

ZEILLER, R.—**Observations au sujet du mode de fructification des Cycadofilicinêes.** (Observations on the subject of the mode of fructification of the *Cycadofilicineæ*.) *Comptes Rendus*, cxxxviii. (1904) pp. 663–5.

Bryophyta.

British Mosses.*—H. N. Dixon publishes a second and enlarged edition of the 'Student's Handbook of British Mosses,' in which he has corrected and supplemented the text of his notes, revised some of the genera, e.g. *Sphagnum*, *Weisia*, *Hypnum*, introduced some 30 recent additional species, and drawn 5 new plates. He has inserted the derivations of the genera, and employed the index as a means of hinting at the right pronunciation of generic and specific names.

Mosses of Mark Brandenburg.†—C. Warnstorf, having published his monographs of the hepatics and sphagna of the Mark, is now occupied with the mosses. The present part is concerned principally with the cleistocarpous genera and the tribes Weisieæ, Dicraneæ, Fissidenteæ, Seligerieæ, Ditricheæ, Pottieæ and Trichostomeæ. The descriptions are carefully written, and are accompanied by keys to the orders, tribes, genera and species.

Ectropothecium.‡—E. S. Salmon, having examined the type specimens of some species of the troublesome genus *Ectropothecium*, has been able to clear away much confusion. *Leskia rutilans* Brid. and *Vesicularia malachitica* C. Muell. are identical with *Ectropothecium vesiculare* (Schwaegr.), to a variety of which are reduced *Hookeria Poeppigiana* Hampe, *Hypnum conostegum* C. Muell. and *E. flavoviride* Mitt. *E. crassicaule* Mitt. is a distinct species. *Hookeria prælonga* Walk. Arn. must not be referred to *E. vesiculare*, but rather to *E. amphibolum* Spruce. The "*Hypnum Montagnei* Schimp." of C. Wright's Cuban Mosses (No. 120) is compounded of some of the above plants. The author re-describes at length *E. vesiculare* and its variety, and adds an abundance of critical notes.

French Hepaticæ.§—Abbé Boulay, who published his work on the French moss-flora twenty years ago, now gives us a companion volume on the hepatics, and promises a final one on the Sphagnaceæ. Beginning with a preface and bibliography, the author discusses at some length the structure and physiology of the hepatics and their geographical distri-

* Student's Handbook of British Mosses, ed. ii. (Eastbourne, 1904) pp. l., 586 (65 pls.).

† Kryptogamenflora der Mark Brandenburg, ii. (1. Laubmoose) Leipzig, 1904, 240 pp., with figs.

‡ Bull. Torrey Bot. Club, xxxi. (1904) pp. 309–24 (2 pls.).

§ Muscinées de la France. II. Hépatiques. Paris, 1904, pp. clxviii. 224, 15.

bution, giving lists of species characteristic of various rocks, soils, waters and trees, also lists of species grouped into several categories, according to their habitats, within the three regions—mediterranean, forest, alpine. He supplies a long dichotomous key to the 179 species, employing vegetative characters as far as possible ; also a synoptical table of the families, genera and species. He then proceeds to describe the species systematically, adding critical notes, and introducing for comparison numerous foreign species which occur in neighbouring countries.

ANDREWS, A. L.—**Some interesting Mosses from a southern Vermont peat-bog.**
Rhodora, vi. (1904) pp. 43-4.

" " **Bryophytes of the Mt. Greylock region. III.**
[A list of 23 Massachusetts mosses and 9 hepatics.]
Tom. cit., pp. 72-5.

BAILEY, J. W.—**Webera Lachenaudi Card. et Ther.**
[A new species gathered near Seattle (Wash.), U.S.A.]
Bryologist, vii. (1904) p. 66 (1 pl.).

BARSALI, E.—**À propos de la fructification de l'Homalia lusitanica Schpr.** (Concerning the fructification of *H. lusitanica*.)
[Description.] *Rev. Bryol*, xxxi. (1904) pp. 90-1.

BRITTON, E. G.—**Further notes on Sematophyllum.**
[A re-description of Richard's types of the Carolina mosses, *Leskea recurvans* and *L. squarrosa*. The former is now known as *Sematophyllum recurvans*, and the latter is reduced to the rank of a variety of it.]
Bryologist, vii. (1904) pp. 59-61.

BRUNNTHALER, J.—**Ueber die Wachsausscheidung von Ditrichum glaucescens.** (On the excretion of wax by *D. glaucescens*.)
Oesterr. bot. Zeitschr., liv. (1904) pp. 94-6.

CAMPBELL, D. H.—**Resistance of Drought by Liverworts.**
[Notes on the thalloid hepatics which survive the annual long summer drought of California.] *Torreya*, iv. (1904) pp. 81-6.

CARDOT, J., & I. THÉRIOT—**New or unrecorded Mosses of North America. II.**
[Descriptions of 24 new species and 9 new varieties.]
Bot. Gazette, xxxvii. (1904) pp. 363-82 (10 pls.).

CASARES GIL, D A.—**Catalogo de las muscineas de los alredores de Barcelona.** (Catalogue of the Muscineæ of the environs of Barcelona.)
Bol. Soc. Españ. Nat. Hist., 1903, p. 527.

CAVERS, F.—**Notes on Yorkshire Bryophytes. III. Reboulia hemisphærica (L. Raddi.**
[An account of the morphology and biology, revealing some peculiar features not fully described hitherto.] *Naturalist*, 1904, pp. 208-14 (1 pl. and 2 figs).

" " **On the structure and development of Monoclea Forsteri Hooker.**
[Living plants were examined, and consequently several new points were made out. On the whole, the affinity of the genus is with Marchantiaceæ rather than with thalloid Jungermanniaceæ.]
Rev. Bryol., xxxi (1904) pp. 69-80 (4 figs.).

CLAASSEN, E.—**On the occurrence of Fossombronia cristula in Ohio.**
Ohio Nat., iv. (1904) p. 58.

COLLINS, J. F.—**Some Maine Mosses.**
[Records five species new to the State. *Distichium capillaceum* invariably grows associated with *Mnurella Careyana*.]
Rhodora, vi. (1904) pp. 145-6.

CULMANN, P.—**Notes bryologiques sur les flores Suisse et Française.** (Bryological notes on the Swiss and French floras.)
[Five hepatics and four mosses, with figure of *Scleropodium Ornellanum.*]
Rev. Bryol., xxxi. (1904) pp. 80–3 (fig.).

DIXON, H. N., & W. E. NICHOLSON—**Bryological notes on a trip in Norway.**
[Continuation.] *Nyt Mag. Naturv.*, xlii. (1904) pp. 97–109.

EWING, P.—**Hepaticæ of the Breadalbane Range. Second contribution.**
[A list of 52 species, of which 20 are new to the district, nine to Scotland, and five to the British Isles.] *Ann. Scot. Nat. Hist.*, 1904, pp. 181–4.

FALQUI, G.—**Contributo alla Flora del bacino del Liri.** (Contribution to the flora of the basin of the Liri.)
[Mosses.] *Bull. Soc. Bot. Ital.*, 1904, pp. 56–61.

FLEISCHER, M.—**Die Musci der Flora von Buitenzorg.** (The mosses of the flora of Buitenzorg.)
[Moss-flora of Java.] Band ii. (Leiden, 1904) pp. xviii. 381–644 (49 figs.).

GILBERT, B. D.—**Mounting Mosses.**
[A simple plan of preserving specimens in pockets.]
Bryologist, vii. (1904) pp 61–2.

GRÉGOIRE, V., ET BERGHS, J.—**La figure achromatique dans le Pellia epiphylla.** (The achromatic figure in *P. epiphylla.*)
La Cellule, xxi. (1904) pp. 193–238 (2 pls.).

GROUT, A. J.—**Tortula pagorum (Milde) De Not. in Georgia.**
[An addition to the flora of North America.]
Bryologist, vii. (1904) p. 65 (1 pl.).

GYÖRFFY, I.—**Bryologiai adatok az erdelyi flóraterület ismeretéhez.** (Bryological data for a knowledge of the floral region of Siebenbürge.)
Magyar Bot. Lapok, iii. (1904) pp. 118–32.

HARRIS, W. P. & C. W.—**Mosses and Lichens of Montana.**
Bull. Univ. Montana (Biol.), ser. i. (1904) pp. 303–31.

HILLIER—**Sur quelques Hépatiques jurassiennes, notamment le Trichocolea dans les environs de Besançon.** (On some hepatics of the Jura, especially *Trichocolea*, in the neighbourhood of Besançon.) *Arch. Flore Jurass.*, 1904, pp. 23–4.

JANZEN, P. — **Bemerkungen zur Limprichtschen Laubmoosflora.** (Remarks on Limpricht's "Moss-flora.")
[A series of notes correcting or supplementing Limpricht's work.]
Hedwigia, xliii. (1904) pp. 281–94 (1 fig.).

KRIEGER, W.—**Fissidens exiguus Sull., ein neuer Bürger Deutschlands.** (*F. exiguus* Sull., an addition to the German flora.)
Tom. cit., pp. 346–8 (fig.).

" " **Ein Beitrag zur Kenntniss der Moosflora von Uruguay.**
(A contribution to our knowledge of the moss-flora of Uruguay.)
[A list of 36 species.] *Tom. cit.*, pp. 349–50.

LETT, H. W.—**A new Hepatic.**
[*Adelanthus dugortiensis* Douin and Lett, a new species found in Achill Island.]
Journ. of Bot., xlii. (1904) pp. 201–3 (fig.).

LITSCHAUER, V.—**Beitrag zur Kenntnis der Moosflora Algiers.** (A contribution to our knowledge of the moss-flora of Algiers.)
[Continuation.] *Oesterr. bot. Zeitschr.*, liv. (1904) pp. 144–6.

LOESKE, L.—**Bryologische Notizen aus den Salzburger und Berchtesgadener Alpen.** (Moss notes from the Alps of Salzburg and Berchtesgaden.)
[The author found six species new to the district, and new stations for numerous more or less rare species.]
Hedwigia, xliii. (1904) pp. 189–94.

MASSALONGO, C.—**Intorno alla Radula Visianica sp. n.** (Concerning *R. Visianica.*)
Ann. Bot. Roma, i. (1904) pp. 297–300 (fig.)

MASSALONGO, C.—**Censimento delle specie italiane del genere Madotheca.** (Enumeration of the Italian species of the genus *Madotheca.*)
Bull. Soc. Bot. Ital, 1904, pp. 36–40.

MATOUSCHEK, F.—**Ein zweiter Standort von Homalia lusitanica Schimp. in der österr.-ungar. Monarchie.** (A second station for *H. lusitanica* in the Austro-Hungarian Empire.)
[Found near Abbazia.]
Magyar Bot. Lapok, iii. (1904) p. 166.

" " **Ueber Nematoden-Gallen bei Laubmoosen.** (On nematode-galls on mosses.)
[Description of the effects observed in four pleurocarpous species.]
Hedwigia, xliii. (1904) pp. 343–5.

MEYLAN, CH.—**Notes Bryologiques.** (Bryological notes.)
[I. Contributions to the moss-flora of the Jura. II. On an abnormal form of *Orthotrichum affine.*] *Bull. Herb. Boiss.*, iv. (1904) pp. 580–5.

MIGULA, W.—**Thomé's Flora von Deutschland, Oesterreich und der Schweiz. Band V. Kryptogamen-Flora.** (Thomé's flora of Germany, Austria, and Switzerland. Vol. V. Cryptogamic flora.)
[Completes the Muscineæ.] Lief. xvii. (Gera, 1904) pp. vi. 449–512 (3 pls.).

MÜLLER, K.—**Beitrag zur oberbayerischen Lebermoosflora.** (Contribution to the hepatic-flora of Upper Bavaria.)
Mitt. Bay. Bot. Ges., 1904, pp. 307–8.

" " **Ueber die in Baden in den Jahren 1902 und 1903 gesammelten Lebermoose.** (On the hepaticæ gathered in Baden in 1902–3.)
[A list of 116 species, with critical and distributional notes; five species new to Baden, and two varieties new to science.] *Beitr. z. Bot. Centralbl.*, xvii. (1904) pp. 211–33.

NITARDY, E.—**Die Kryptogamenflora des Kreises Elbing.** (The cryptogamic flora of the environs of Elbing.)
[A list containing 53 hepatics, 22 sphagna and 223 mosses of this Prussian locality.] *Hedwigia*, xliii. (1904) pp. 314–342.

PARIS, E. G.—**Index Bryologicus sive Enumeratio Muscorum ad diem ultimam anni 1900 cognitorum.** (Bryological index or enumeration of the mosses known at the end of 1900.) Ed. II., ii. fasc. 1, 2 (Paris, 1904) pp. 1–128.

" " **Muscinées de l'Afrique occidentale française.** (Mosses of French West Africa.)
[Thirty-one mosses, fourteen being new, and four hepatics.]
Rev. Bryol., xxxi. (1904) pp. 83–90.

PEARSON, W. H.—**Scapania compacta (Roth) Dum.**
[Described by various authors as paroicous, dioicous and heteroicous; upon re-examination it proves to be variable, i.e. heteroicous.]
Journ. of Bot., xlii. (1904) pp. 208–9.

PÉTERFI, M.—**Bryologiai Közlemény.** (Bryological communications.)
[List of some Hungarian species of *Bryum.*]
Magyar Bot. Lapok, iii. (1904) pp. 116, 117.

ROTH, G.—**Die Europäischen Laubmoose.** (The mosses of Europe.)
Band ii. fasc. 6, 7, 8 (Leipzig, 1904) pp. 1–384, pls. i.–xxx.

STEPHANI, F.—**Species Hepaticarum.** (Species of Hepaticæ.)
[Descriptions of *Plagiochila* continued.]
Bull. Herb. Boiss., iv. (1904) pp. 345–360, 586–601.

THOMAS, FR.—**Moosvegetation in elektrisch beleuchteten Höhlen.** (Moss vegetation in caves electrically lighted.)
Verh. Bot. Ver. Prov. Brandenburg, xlv. (1903) p. 29.

TIMM, R.—**Die Moosflora einiger unserer Hochmoore, insbesondere des Himmelmoores bei Quickborn.** (Moss flora of some high moors, especially of the Himmelmoor, near Quickborn.)
Verh. Naturw. Ver. Hamburg, xi. (1904) pp. 34–55 (13 figs.).

VELENOVSKÝ, J.—**Bryologické příspěvky z Čech za rok 1901-1902.** (Bryological contributions from Bohemia for 1901–1902.)
[Contains one species and ten varieties new to science, and eight mosses new to Bohemia.]
Mitt. tschech. Akad. Wiss. Prag., xii. (1903) No. 11.

" " **Jatrovky české.** (The Hepaticæ of Bohemia.)
[List based on the author's collections; contains descriptions and figures of two new species and twelve new varieties.] *Op. cit.* x.–xii. (1901–3) 3 pts. 111 pp. 12 pls.

WHELDON, J. A.—**The Mosses of Cheshire.**
[The author's second contribution to the county's moss-flora.]
Journ. of Bot., xlii. (1904) pp. 203–8.

Thallophyta.

Algæ.

Sporangia of Halimeda.*—E. S. Gepp describes and compares the fruiting filaments of *Halimeda Tuna* and *H. gracilis*. The paper begins with a short account of the structure of the vegetative thallus, especially with regard to the central strand. The fruiting filaments are a continuation of the filaments of this strand, and this fact accounts for the differences in position of the fruiting filaments in the two species. In *H. gracilis* the filaments of the central strand are chiefly confined to the main axis and its lateral branches; hence the fruiting filaments emerge in isolated tufts at the angles where the strand might otherwise have produced new joints. In *H. Tuna* the filaments of the central strand spread fan-wise through a joint and the fruiting filaments therefore emerge along the upper margin of a joint, forming a continuous fringe. The question of the fusion of the filaments which precedes all growth in *Halimeda* is discussed, and it is pointed out that this fusion is not analogous to the fusion of filaments in fungi before spore-formation, as in *Halimeda* the fusion is equally characteristic of vegetative and reproductive growth.

Pleodorina in Ceylon.†—F. E. Fritsch records *P. californica*, hitherto only known from the United States, as occurring in two of the tanks of the central low country in Ceylon. He finds two other types of colonies associated with *Pleodorina*, one represented by spherical colonies of 32 cells each, and the other of 64 cells. He thinks it possible they may be developmental stages of *Pleodorina*.

Chlamydomonas.‡—F. S. Hollis describes and analyses chemically two growths of this alga in water in Connecticut. The water was turbid, and had the unpleasant odour characterising the presence of this alga. In one sample *Chlamydomonas* was present to the extent of 14,476 individuals, or 5790 standard units per c.cm. The contractile vacuole, oil globules and starch grains were well marked in the samples from each locality.

Fragilaria Harrisonii.§—R. H. Philip finds among some papers of the late Mr. Harrison a number of letters from Dr. Walker Arnott, of

* Journ. of Bot., xlii. (1904) pp. 193–97 (1 pl.).
† New Phytologist, iii. (1904) pp. 122–3.
‡ Trans. Amer. Micr. Soc., xxiv. (1903) pp. 13–6.
§ The Naturalist, July, 1904, pp. 214–6 (1 fig.).

Glasgow, giving interesting particulars respecting the original discovery of *Fragilaria Harrisonii* near the remains of the ancient Priory of Haltemprice in Yorkshire. These particulars he gives here. The species has been lately removed from *Fragilaria* to the genus *Staurosira* by Peragallo. A figure of the diatom is given attached to a sand grain.

Diatoms from Nyassaland.*—O. Müller publishes the second part of his report on the Bacillariaceæ collected by the German expedition to Lake Nyassa and the Kinga mountains. A certain number of new species and varieties are described, belonging to the section Discoideæ-Coscinodisceæ; with an addendum to Surirelleæ, carried on from the last paper. Several of the species are treated in morphological groups, and each record is followed by critical notes. Remarks are made on the subgenus *Orthosira*, and on mutation by jumps.

Studies in the Dictyotaceæ.†—J. Lloyd Williams publishes under the above title two interesting communications: (1) the Cytology of the Tetrasporangium and the Germinating Tetraspore; and (2) the Cytology of the Gametophyte Generation. The author divides his first paper into the following sections: the stalk-cell division; the first, or reducing division of the tetraspore mother-cell; the second, mitosis in the tetraspore mother-cell; karyokinesis in the germinating tetraspore; abnormalities; conclusions. The latter section is divided into (1) the alternation of generations, and (2) the nucleolus. The author has worked out the cytology of all the various kinds of cells in the three forms of *Dictyota*, male, female and asexual, and he considers that so far as cytological evidence is concerned, there seems to be no reason to doubt that there is here a clear case of alternation of generations. In the second paper the author describes the development of the oosphere and antherozoid, the fertilization of the ovum and its subsequent segmentation, together with the parthenogenesis of unfertilized eggs—the observations in this case applying to *Dictyota dichotoma* only. The sections of this paper are entitled: the development of the oogonia; the development of the antheridium; the fertilization of the egg; the segmentation of the fertilized egg; the parthenogenesis of unfertilized eggs; general considerations; summary. It is found that the sexual cells, unlike the tetraspores, are produced and liberated simultaneously in fortnightly crops. Fertilization takes place externally. Eggs not fertilized within about half or three-quarters of an hour after liberation become invested with walls and germinate parthenogenetically. The oogonium and antheridium are produced by the increased growth of surface cells, which, after cutting off a stalk-cell, form respectively a single egg, or over 1500 antherozoids. There is no division of the nucleus in the oogonium as there is in that of *Fucus*. The nuclear division is described and figured in detail.

Corallinaceæ.‡—A. Weber van Bosse and M. Foslie publish a monograph on the Corallinaceæ of the Siboga expedition to the Dutch East Indies. M. Foslie is the author of the first part of the joint paper, and

* Engler's Bot. Jahrb., 1904, pp. 256-301 (2 pls., 4 figs. in text).
† Ann. of Bot., xviii. (1904) pp. 141-60 (2 pls.); pp. 183-204 (3 pls.).
‡ Siboga-Expeditie. Monogr., lxi. (Leiden, 1904) 110 pp. (16 pls., 34 figs. in text).

this treats of Lithothamnioneæ, Melobesieæ, and Mastophoreæ. Madame Weber writes the second part, "The Corallineæ veræ of the Malay Archipelago," in which she presents a new and most important character for the determination of the genera of this group. She finds that the arrangement of cells at the nodes differs in different genera, and is always constant, so that systematists will no longer be obliged to depend almost solely on the conceptacula for the distinguishing characters of puzzling genera. She describes two new genera, *Metagoniolithon* and *Litharthron*, founded on previously known species of *Amphiroa*; and one new species *Amphiroa anastomosans*. An introduction to the monograph is also written by Madame Weber, who gives an account of the banks of coral algæ, mostly *Lithothamnion erubescens*, which she saw while on the Siboga. The subject of the coral algæ banks was studied on the spot by herself and Prof. Weber, and their results form the subject of this interesting introduction. Photographs are given of one of the *Lithothamnion* banks, showing that the surface of the reef is covered with rounded balls of the alga. The illustrations to the paper are numerous, and consist largely of reproductions of photographs, taken natural size, of the various species described.

Development of the Spermatozoid in Chara.*—D. M. Mottier alludes to the work on this subject by Belajeff, and then proceeds to describe the details of the development, in which some of his results differ slightly from those of Belajeff. The spermatozoid of *Chara* is a spirally coiled body consisting of a nucleus, and a specially differentiated part of the cytoplasm which exists in the form of a thread or band, the blepharoplast, and bears two long cilia. The nucleus occupies the middle part of the spermatozoid, while the blepharoplast extends its entire length. The development of the blepharoplast is described in detail, and the author believes it to be a modification of the plasma-membrane—a direct transformation of it. The cilia were always found attached some distance behind the anterior extremity of the blepharoplast.

Algal Vegetation of the Faeröes.†—F. Börgesen publishes an interesting account of the algal flora of these islands from a geographical point of view. He divides his book into the following sections: Introduction. I. On the external conditions of algal vegetation on the coasts of the Faeröes. II. General character of the algal vegetation. III. Regions and association of algæ on the coasts of the Faeröes. IV. Position in plant geography of the algal flora of the Faeröes. V. Biological observations. Under the first heading, the author deals with the climatological and hydrographical relations, temperatures and salinity, tides and currents, force of the waves on the outer and inner coast lines, temperature and humidity of the air, and light. The third section is divided into (1) the littoral region, (2) the sublittoral region, (3) the lowest limit of algal vegetation, the elittoral region. The author comes to the conclusion that the algal flora of the Faeröes is most closely related to that of the northern shores of the British Isles, and

* Ann. of Bot., xviii. (1904) pp. 245–53 (1 pl.).

† Om Algevegetationen ved Faeröernes Kyster. Copenhagen, 1904, 125 pp. (12 pl., 9 text figs., 1 map).

that of the north-west and south-west of Iceland. Characteristic of the Faeröe algal vegetation is the specially rich development of the littoral region. He is able to endorse the views held by Kjellman on the systematic relations of *Acrosiphonia*. The Desmid flora is nearly related to that of western Europe, especially the British Isles, but it possesses also a distinctly Arctic element. The book is illustrated by good photographs of algæ in situ. It is written in Danish.

Plankton of the Danish Lakes.*—C. Wesenberg-Lund embodies in this paper the results of the biological studies in fresh-water organisms carried out in the Danish Laboratory since 1897. The paper begins with an introduction dealing with former work on the subject, and explains the lines of the author's own investigations. In the first chapter there is given a topographical account of the lakes, height above sea-level, streams falling into or running out of them, etc. In the second chapter the author describes his methods of investigation, and in the third he deals with the general formation, the physical conditions, and the temperature of the lakes. The fourth and following chapters contain remarks on the Cyanophyceæ, Diatomaceæ, Chlorophyceæ, and Zooplankton of the region. The numerous illustrations are reproduced from photomicrographs. Explanatory tables give the date of capture, and frequency or rarity of occurrence.

Analysis of the Colour of Algæ.†—N. Gaidukov has examined the light absorption of certain living algæ with the help of Engelmann's microphotometer. The species chosen were the green *Cladophora fracta* Kütz., the blue-green *Oscillaria aerugineo-cærula* Kütz., a red *Ceramium* species, the yellow-brown *Dictyota dichotoma* Lam., brown *Fucus serratus*, and violet *Chondrus crispus*. A permanent mount of *Cryptoglena cærulescens* Ehrb., with blue chromatophores, was also analysed. The spectroscopic results which are given showed a remarkable likeness, only the spectrum of the green cells differing somewhat more markedly from the others. Colours formed artificially in the algæ by treatment with acids and alkalis show much the same spectra as the natural colours.

Growth of Algæ in Water Supplies.‡—G. T. Moore and K. F. Kellerman have made a special study of the algæ found in many reservoirs of drinking water, and have experimented in methods of exterminating them, in order to render the water once more fit for use. They find that the disagreeable odour and taste often present in drinking water are due almost exclusively to algæ, and the methods employed for removing this trouble are expensive, or in some way unsatisfactory. They therefore recommend the use of copper sulphate in a dilution so great as to be colourless, tasteless or harmless to man, while it is sufficiently toxic to the algæ as to destroy or to prevent their appearance. The cost of this treatment is slight, and the result very satisfactory. Details are given in tabulated form of the result on certain species of algæ, as well as on pathogenic bacteria.

* Dansk. Ferskvands-Biolog. Labor., v. (1904) pp. 223 (8 maps, 10 pls.).
† Ber. Deutsch. Bot. Gesell., 1904, pp. 23–9 (1 pl.).
‡ U.S. Department of Agriculture, Bureau Plant Industry, 1904, 44 pp.

Sicilian Marine Algæ.*—A. Mazza continues his list of marine algæ from Sicily, and enumerates genera and species of Fucoideæ, Chlorophyceæ and Cyanophyceæ. Critical notes are appended to many of the species named, the numbers of which are continued from 140 to 216.

BOURGON, D.—**Famille des Cryptomonadinées. Suite.** (Family of the Cryptomonadineæ.) [Continuation.] *Microgr. Prépar.*, xii. (1904) pp. 27–31.

BÜTSCHLI, O.—**Notiz über die sogenannte Florideenstärke.** (Note on the so-called Floridean starch.) *Verh. d. naturhist.-mediz. Ver. Heidelberg*, vii. (1904) pp. 519–28.

COZETTE, M. P.—**Catalogue des algues terrestres et d'eau douce du Nord de la France.** (Catalogue of terrestrial and fresh-water algæ of North France.) *C. R. Congr. Soc. Sav. Bordeaux*, 1903, pp. 254–328.

CRONHEIM, W.—**Die Bedeutung der pflanzlichen Schwebeorganismen für den Sauerstaffhaushalt des Wassers.** (The importance of vegetable floating organisms for the oxygenation of water.) *Forschungsber. Biol. Stat. Plön*, xi. (1904) pp. 276–88.

DE TONI, G. B.—**Intorno ad alcune Bangia di Bory e di Zanardini.** (Concerning certain species of *Bangia* of Bory and of Zanardini.) [A reprint of a paper previously noticed.] *Nuov. Notar.*, xv. (1904) pp. 150–4.

DIEDERICHS, K.—**Die Diatomeenpräparation.** (Preparation of diatoms.) *Nerthus*, vi. (1904) pp. 153–6.

EWALD, W. F.—**Der Planktonfang im Süsswasser.** (Plankton collecting in fresh-water.) *Tom. cit.*, pp. 88–90.

FOURNIER, P.—**Phycologie française, suite.** (Phycology of France, continued.) *Feuille Jeunes Nat.*, xxxiv. (1904) pp. 181–5.

GARBINI, ADRIANO—**Per orientarsi nella nomenclatura degli studî concernenti la vita delle acque dolci.** (An attempt to obtain a better understanding of the nomenclature of studies concerned with fresh-water life.) *La Nuov. Notar.*, xv. (1904) pp. 93–114.

KEISSLER, K. VON—**Das Plankton des Millstätter Sees in Kärnten.** (The plankton of Millstätter lake, in Carinthia.) *Oesterr. Bot. Zeitschr.*, liv. (1904) pp. 218–24.

KRASKOWITZ, G.—**Ueber norwegische Alpenvegetation.** (On the Alpine vegetation of Norway.) *Verh. Zool. Bot. Gesell. Wien*, liv. (1904) pp. 126–9.

LEMMERMANN, E.—**Beiträge zur Kenntniss der Planktonalgen. XVII. Ueber die Entstehung neuer Planktonformen. XVIII. Notigen zur Systematik einiger Formen (Chrysosphaerella longispina Lauterborn; Micractinium Fres.; Coniella Schroeder.)** (Contributions to our knowledge of the Plankton-algæ. XVII. On the origin of new Plankton forms. XVIII. Notes on the systematic position of certain forms.) *Ber. Deuts h. Bot. Gesell.*, xxii. (1904) pp. 17–22.

" " **Das Plankton Schwedischer Gewässer.** (The plankton of Swedish waters.) *Arkiv f. Botan.*, ii. (1904) pp. 1–209 (2 double plates).

" " **Beiträge zur Kenntniss der Planktonalgen. XIX. Das Phytoplankton der Ausgrabenseen bei Plön.** (Contributions to our knowledge of planktonalgæ. XIX. The phytoplankton of the Ausgraben lakes at Plön.) *Forschungsber. Biol. Stat. Plön*, xi. (1904) pp. 289–311 (17 text figs.).

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* Nuov. Notar., xv. (1904) pp. 115–49.

LORENZ, M.—**Ascosomaceæ, eine neue Familie der Siphoneen aus dem Cambium von Schantung.** (Ascosomaceæ, a new family of the Siphoneæ from the Cambium of Shantung.) *Centralbl. Min. Geol. Paläont.* (1904) pp. 193–4.

MARSH, C. D.—**The Plankton of Lake Winnebago and Green Lake.** *Wisconsin Geol. Nat. Hist. Surv. Bull.*, xii. (1903) pp. 1–94.

MONTI, R.—**Limnologische Untersuchungen über einige italienische Alpenseen.** (Limnological investigations of several Italian Alpine lakes.) *Forschungsber. Biol. Stat. Plön*, xi. (1904) pp. 252–75 (13 text figs.).

NITARDY, E.—**Die Kryptogamenflora des Kreises Elbing.** (The cryptogamic flora of the environs of Elbing.)
[A list containing 111 fresh-water algæ of this Prussian locality.] *Hedwigia*, xliii. (1904) pp. 314–42.

ODIN, A.—**Le verdissement de l'Huître.** (The green coloration of oysters.) *Le Réveil Salicole, ostreic. et de pêch. marit*, iii. (1904) pp. 24–6.

OSTENFELD, C. H. ET PAULSEN, O.—**Planktonproever fra Nord-Atlanterhave (c. 58°–60° N. Br.) samlede i 1899 af Dr. K. J. V. Steenstrup.** (Samples of plankton from the N. Atlantic Ocean (about 58°–60° N. Lat.) collected in 1899 by Dr. K. J. V. Steenstrup.) *Medd. von Grönland*, xxvi. (1904) pp. 143–250.

PETRASCHEVSKY, L.—**Ueber Atmungskoëffizienten der einzelligen Alge Chlorothecium saccharophilum.** (On the coefficient of respiration of the unicellular alga *Chlorothecium saccharophilum.*) *Ber. Deutsch. Bot. Gesell.* (1904) pp. 323–7.

PROTIČ, G.—**Beitrag zur Kenntniss der Flora der Umgebung von Vares in Bosnien. V.** (Addition to our knowledge of the flora in the environs of Vares, in Bosnia. V.)
[Written in Servian.] *Glasn. Zemalj. Muz. Bosn. i Herceg.*, xv. (1903) pp. 273–318.

REINHARD, L.—**Zur Kenntniss des Phytoplankton von Donjec.** (On the phytoplankton of Donjec.)
[Russian.] *Arb. Gesell. Naturf. Charkow* (1904) 28 pp.

SCHMIDT, GRÜNDLER, GRUNOW, JANISCH & WITT.—**Altas der Diatomaceenkunde.** (Atlas of diatoms.) Parts 62–63, Leipzig, 1904

SKORIKOW, A. S.—**Ueber das Sommerplankton der Newa und aus einem Teile des Ladoga-Sees.** (On the summer plankton of the Newa and of a part of Ladoga lake.) *Biol. Centralbl.*, xxiv. (1904) pp. 353–66, 385–91.

Fungi.

Variations of Growth in Achlya polyandra.*—L. Horn has conducted an exhaustive research on this subject, his object being to throw light on the influence of external conditions, such as culture media, in determining form variations within the species. He obtained the fungus by immersing the bodies of flies, mealworms, etc., in water collected from various suitable sources. From the hyphal growth he isolated a small piece of mycelium and produced a pure culture of the desired plant. Pepton agar and pease water were chiefly used as media, and their influence on the growth of the mycelium was noted. Attention was drawn at an early stage to certain unhealthy appearances which were found to be due to oligo-dynamic influence as described by Nägeli; that is the influence exerted by minute quantities of metals in the water used in the cultures. Nägeli's observations were made on *Spirogyra*. Horn found that *Achlya* was equally sensitive. It reacted most quickly to the presence of copper, obtained by placing a penny for a longer or shorter time in the solution. A considerable selection of

* Ann. Mycol., ii. (1904) pp. 207–41 (21 figs.).

metal salts was used, and their influence on the development of the fungus was noted. The form of the mycelium was largely affected; it became multi-septate, and often a cell complex was built up. Opaque shining plasma masses also filled many of the cells. These as well as the newly-formed septa consisted of pectin. By plasmolysing the hyphæ, the same effects were produced, and the septa and plasmic masses were formed in the hyphæ. Normal sporangia and zoospores were formed when there was a dearth of nutriment. A weak metal solution, or a slight plasmolysis, induced intercalary sporangial growth, and the plasma masses occasionally were transformed into sporangia.

Change of form was also observed in the oogonia and oospores. The oogonia in most of the culture media had smooth walls; when grown in cane- or grape-sugar, they had ornamented walls, were very large, and of somewhat oval form. Considering these variations, the alteration and correcting of the diagnoses that have been given of the species of Saprolegniaceæ is very necessary. The author gives descriptions of two new species discovered by him during his research. The first, which he calls *Achlya oidiifera*, was distinguished by the hyphæ breaking up into oidium-like cells. In pure water these "oidia" formed zoospores; in a culture medium they grew out into hyphæ. The species formed oogonia in the interior of ants' eggs, but antheridia could not be detected. Oogonia were not formed in any of the artificial cultures. In contrast to this species, the other, *A. Saprolegnia*, formed abundant oogonia and antheridia terminal on lateral branches of the hyphæ. The branchlets often formed a short spiral, and on this account the name *S. retorta* was given to the species. Sporangia were formed when the mycelium was placed in pure water. Tables are given of the different reagents used, and of their effect on the vegetative and reproductive organs, and a bibliography of the works bearing on the subject is added.

Zygospore Formation in Mucoraceæ.*—A. F. Blakeslee has found by experiment that there are two kinds of Mucoraceæ; those like *Sporodinia*, that form zygospores on the filaments of one plant, which he designates homothallic; and those in which zygospores are produced only by the copulation of hyphæ from two different strains. These, which include most of the Mucors, he terms heterothallic. He thus explains the difficulty so often experienced of inducing the formation of zygospores. This fact confirms the opinion "that the formation of zygospores is a sexual process; that the mycelium of a homothallic species is bisexual; while the mycelium of a heterothallic species is unisexual." The writer promises further investigation.

Œdomyces leproides.†—This fungus, elsewhere published as *Chrysophlyctis endobiotica*, forms the subject of a leaflet issued by the Board of Agriculture. It causes a disease of potato tubers, but does not attack turnips, carrots or cereals. The presence of the fungus is made known by the stimulating influence it exerts on the tubers, causing irregular outgrowths of a blackish colour. Experiments were conducted at Kew to test the mode of infection, and the best means of preventing the

* Science, n. s., xix. (1904) pp. 864–6.
† Board of Agric. and Fisheries, leaflet No. 105.

spread of the disease; all diseased tubers should be burned, and no potatoes planted on infected soil.

Vegetable Pathology.* — P. Viala and P. Pacottet record their observations on the development of black-rot of the vine. They find that the fungus *Guignardia Bidwellii* attacks the grapes only when they are green, that is, when the amount of organic acid in the fruit is greater than the amount of sugar. If the fruit is protected against attack until ripening has begun, by washes of copper salt, there is no further risk of disease. Temperature and humidity are also important factors in the spread of the disease. The fungus grows most freely in a moist state of the atmosphere. It rarely develops in southern vineyards. The authors give details of these artificial cultures and the effect on the fungus of varying quantities of acid.

Cultural Experiments with "Biologic Forms" of the Erysiphaceæ, etc.† — E. S. Salmon has proved that within the species *Erysiphe graminis* there are undoubted "biologic forms," both in the ascigerous and conidial stages of the fungus. He has further demonstrated that if the vitality of the host-plant is interfered with, its power of resistance to forms to which it is naturally immune breaks down. The leaves selected for experiment were superficially injured by cutting any part of the epidermis or by touching the leaf with a red-hot knife. On these injured surfaces were some conidia of various biologic forms which would not have inoculated the normal healthy plant, and it was found that they grew and produced conidiophores, which in turn served to inoculate another individual of the host species—the injured plant serving as a bridging species to enable the parasite to pass from one host to another. The author concludes with a summary of the various experiments.

Aschersonia.‡—P. Hennings has made a study of the fungi that have been placed in this genus and of the literature dealing with it. The genus has been associated with *Hypocrella* as a pycnidial form, but the author thinks that the ascus form of *Aschersonia* has probably never been met with. He notes that a number of similar leaf fungi are associated with *Coccidæ*. They grow on the bodies of the insects and exactly imitate their appearance. The stromata thus formed are as easily detachable from the leaf as are the *Coccidæ*. The genus *Aschersonia* was established by Montagne in 1848. Thirty species have been described.

Anthracnose of the Vine.§—P. Viala and P. Pacottet have cultivated the fungus causing this disease on suitable media, and have obtained the conidial form with cylindrical-ovate conidia, spermogonia with spermatia similar to the conidia, pycnidia, sclerotia giving rise to yet another conidial form with large spores and a polymorphic mycelium,

* Comptes Rendus, cxxxix. (1904) pp. 152–4.
† Phil. Trans. Roy. Soc., ser. B, cxcvii. (1904) pp. 107–22.
‡ Festschr. zu Prof. Ascherson's 70 Geburtstag (1904) 4 pp. See also Hedwigia, xliii. (1904) pp. 93–4.
§ Comptes Rendus, cxxxix. (1904) pp. 88–90.

which breaks up and forms a yeast on sugar. All these forms of fructification were proved to be connected with each other, and reproduced the disease by inoculation of green grapes. The authors consider the fungus the type of a new genus of Sphæropsideæ; and they have named it *Manginia ampelina*.

Disease of Potato.* — J. J. Vanha notes a disease of the potato plant affecting it outwardly very much like *Phytophthora*, causing brown spots on the leaves attacked and rendering the tubers small and poor in starch. The fungus has been identified as a Hyphomycete, *Sporidesmium solani varians* sp. n. It penetrates the leaf and grows in the tissue. The writer made a series of cultures and produced macrospores of few or many cells, one-celled conidia, pycnidia, and small mycelial clumps something like sclerotia.

Hyphomycetes.† — G. Lindau has issued the second part of the 'Kryptogamen-Flora' dealing with Mucedineæ. In the division Cephalosporieæ, he describes all those forms with simple colourless spores that form a head of spores. He keeps up both *Rhopalomyces* and *Œdocephalum*, very closely related genera, and also the barely distinguishable *Hyalopus* and *Cephalosporium*. He demands a more exact knowledge of the species by culture, etc., before sinking the allied genus. He begins the Aspergilleæ and describes one new genus *Eidamia* founded on *Monosporium acremonioides*.

Notes on Moulds.‡—v. Höhnel publishes an account of three different species of Hyphomycetes. *Thielaviopsis paradoxa* he found growing on the seed albumen of *Cocos nucifera*. It was identical in one stage with *Sporochisma paradoxa*, but it had also the second conidial form of *Thielaviopsis ethacetica*. He therefore unites the two species. He has also established the identity of *Helminthosporium apicale* with *Acrothecium*. It has undoubtedly two conidial forms. He creates a new genus *Atractina* from a form with upright dark coloured condiophores branched like *Penicillium* and bearing a head of septate spores. All these are saprophytes.

Ustilago violacea.§ — R. Baar describes the development of this fungus in the host-plant *Melandryum pratense*. In autumn the hyphæ penetrate the root-stock and form a resting mycelium. In summer the spores are formed in the anthers, and seed-formation is stopped.

Æcidium of Maize Rust.‖—J. C. Arthur has succeeded in elucidating the problem as to the propagation of rust on Indian corn. He found æcidia growing plentifully in a restricted area of *Oxalis* plants, and on searching for the teleutosporic host, he found some corn-stalks washed up by a neighbouring river. He followed up the clue and brought the æcidia of the *Oxalis* into contact with a healthy maize

* Naturw. Zeitschr. Land und Forstwirthsch., ii. (1904) pp. 113–27. See also Bot. Centralbl., xcvi. (1904) p. 67.

† Rabenhorst's Kryptogamen-Flora, viii. Lief. 93 (1904) pp. 65–128.

‡ Hedwigia, xliii. (1904) pp. 295–9.

§ SB. Deutsch. Nat.-Medizin. Böhm., 1903, pp. 279–85 (6 figs.). See also Ann. Mycol., ii. (1904) pp. 360–1.

‖ Bot. Gazette, xxxviii. (1904) pp. 64–7.

plant. In a very short time he got a plentiful growth of uredosori developed. He considers that the æcidia may grow on several species of *Oxalis*, and gives a list of those on which it has been found.

Water-relation of Puccinia Asparagi.*—Ralph Smith found that the rust of asparagus was peculiarly suited to test the influence of moisture on the infection and spread of the disease. In general the factors that lowered the vitality of the host-plant conduced to the growth of the parasite. When weakened by drought, the asparagus seemed less able to resist the rust, which thus gained from the want of water at the roots of the host. In autumn also the fungus was observed to be more active. Uredospores grew in conditions of moisture, etc., favourable to the fungus; at other times teleutospores were developed. In reference to the direct action of moisture on the fungus itself, it was found that dew was absolutely necessary to infection and of more importance than rain. The author found that teleutospores were a provision for enabling the fungus to survive unfavourable conditions, whether of food-supply, moisture, temperature or resistance by the host, without regard to season.

Mycoplasma in Uredineæ.†—Jakob Eriksson insists again on the endogenous development of the rust of certain cereals. He reviews the work done recently in connection with this subject on *Puccinia glumarum* and *P. dispersa*. He affirms the gradual growth of the rust pustule from strands of protoplasm in the host-cell, which form first a protomycelium and afterwards the hyphæ of the Uredine. He has found that the "corpuscules spéciaux" described before, are endogenous haustoria formed from the fungal protoplasm in the host-cell.

American Uredineæ.—E. W. D. Holway‡ continues his notes on Uredineæ already known, and describes a number of new species that have come under his observation. P. L. Ricker§ also adds one new species, and gives notes on various forms. W. A. Kellerman‖ records the results of his cultures of *Puccinia Thompsonii*. He inoculated the leaves of *Sambucus canadensis* with the teleutospores, and got a fine growth of spermogonia and æcidia. He has thus proved its identity with *Puccinia Sambuci*.

Variability of Dictyophora.¶—Advantage was taken of a plentiful growth of the common species *D. phalloidea* to make a series of comparisons between the different individuals by A. H. Christman. Height varied from 5·6 cm. to 21·2 cm. The taller plants were solitary, and grew in a fairly shaded, moist locality. The size of the collar round the pore was very variable; the veil also, both in size and structure, presented very great differences. It expanded before the stipe or after it; sometimes it was a delicate membrane perforated with round holes, or it resembled a net formed of heavy bands with large angular openings. A table is given of the measurements of twenty specimens.

* Bot. Gazette, xxxviii. (1904) pp. 19–43 (21 figs.).
† Comptes Rendus, cxxxix. (1904) pp. 85–7.
‡ Journ. Mycol., x. (1904) pp. 163–5.
§ Tom. cit., pp. 165–6.
‖ Tom. cit., p. 173.
¶ Tom. cit., pp. 101–8.

The Polyporaceæ of North America. VII.*—W. A. Murrill continues his exposition of this group of fungi, and gives an account of five genera. *Hexagona*, the first on the list, replaces *Favolus*. It is characterised, according to him, by hexagonal, radiately elongated pores. He adds several new species to those already known. *Grifola*, one of Gray's genera, is made to include a large species with a frondose branched habit. *Romellia*, a new genus, has been established for one species, *Polyporus Schweintzii*, which now figures as *R. sistotremoides*. *Coltricia*, another of Gray's genera revived, is in part synonymous with the more recent *Polystictus*. *Coltriciella*, also new, has a "pendant vertically-attached pileus." The one species, *C. dependens*, was found growing on dead oak and pine wood.

Mycorhiza of Muscineæ.†—Jaroslav Peklo has studied the occurrence and signification of mycorhiza in the Musci, Marchantiæ and Jungermanniæ. Among the mosses its appearance was definitely proved in *Buxbaumia*. The hyphæ were found filling the rhizoids and penetrating to the seta and theca. The author doubts if the fungus is of any practical value to the moss. *Fegatella* was the most liable to infection among the foliose Hepatics, but it was free from hyphæ in damp localities. *Anthoceros* was always free. Many Jungermanniæ were associated with a fungus, but here also Peklo thinks that it is questionable whether the fungus aids the nutrition of the liverwort. This whole group of plants he finds grows as luxuriantly without the aid of the mycorhiza, and the fungus must be looked on as purely parasitic.

Diseases of Economic Plants.‡—An account has been prepared for the Board of Agriculture of *Nectria cinnabarina*, a pyrenomycetous fungus that attacks many woody plants, and of the Witch's Broom in Firs, which is caused by an *Æcidium*. The alternative host of the latter has recently been determined as some form of stitchwort, or chickweed. The removal of these weeds from the neighbourhood of the Firs attacked would effectually stop the disease. Peach-leaf curl, caused by *Exoascus deformans*, is also described and remedies prescribed.

Parasites of Edelweiss.§—D. Cruchet examined some diseased plants of edelweiss, and found five species of microfungi growing on the leaves. *Leptosphæria Leontopodii* he describes as a new species. Another new species, *Stagonospora Leontopodii*, may be, he thinks, the conidial form of the *Leptosphæria*. He also noted a *Septoria* that may be new to science. He gives full descriptions of all the species found on the plants.

Diseases of Cereals.‖—D. McAlpine has described two forms of fungal disease that attack wheat in Australia, and both due to the same parasite, *Ophiobolus graminis* and the pycnidial form *Hendersonia*

* Bull. Torrey Bot. Club, xxxi. (1904) pp. 325–48.

† Bull. Acad. Sci. Bohême (1903) 23 pp. (1 pl.). See also Hedwigia, xliii. (1904) p. 99.

‡ Journ. Board Agric., xi. (1904) pp. 202–3 and 239–45 (1 pl. and 3 figs.).

§ Bull. Soc. Vaud., xl. (1904) pp. 25–31 (3 pls.).

‖ Depart. of Agric., Bull. No. 9 (1904) 20 pp. See also Ann. Mycol., ii. (1904) p. 300.

graminis. When the disease attacks the young wheat it destroys the roots and the lower part of the stem, and is popularly described as "take-all." The plant is at other times infected as the ears develop, and the seeds are destroyed. It is then known as "white-heads." The disease has also been detected in Europe.

Mycorhiza of Epiphytic Plants.*—H. Jacob de Cordemoy has continued the research commenced on the Vanilla plant in reference to the advantage gained by the roots from symbiotic fungi. He found that the fungus not only lived in symbiosis with the roots of the Vanilla, but that it also penetrated the tree on which the orchid was epiphytic, that it drew sustenance from it, and that, for this reason, the Vanilla grew more luxuriantly attached to a living than a dead support. He has examined in similar fashion three species of *Piper*, and has found the same conditions existing in them. The roots of the epiphyte are associated with a mycorhiza, fine strands of which traverse the long aerial roots and pass from them into the cork tissue of the supporting plant. Some of the filaments have been observed penetrating the cortical tissue below the cork layer. The growth of the epiphyte is evidently materially assisted by the nutritive material of the host.

Myxobacteriaceæ.†—Roland Thaxter, the discoverer of the group of organisms, reviews the work done since his first publication of them in 1897. He notes the announcement of Dr. E. Zederbauer that they do not form a separate order, but are merely a conglomeration of hyphomycetes and bacteria. Zederbauer had not seen any of the myxobacteria, and his criticisms are easily disposed of. Thaxter has not anything new to add to the general characteristics of the group as a whole, but he chronicles a number of new species belonging to the genera *Chondromyces*, *Myxococcus* and *Polyangium*, all of them of a reddish-yellow colour. He thinks that probably the myxobacteria represent transitional conditions between the higher bacteria and the lower mycetozoa.

American Fungi.—A. P. Morgan‡ traces the changes of nomenclature in the fungus originally called *Tubercularia fasciculata* by Iode, a discomycete growing on *Carpinus*. He finally names it *Dermatella scolinus*. Six new species of Pyrenomycetes are described by the same author.§ They are saprophytic on wood.

J. B. Ellis and B. M. Everhart ‖ describe a number of new American species, both Deuteromycetes and Pyrenomycetes. Elias J. Durand¶ publishes diagnoses of three species of Discomycetes. A new *Hypholoma* collected in New Mexico is described by T. D. A. Cockerell,** and W. A. Kellerman †† describes a new *Nœmosphara* found on old stems of *Luctuca virosa*, and a new *Peronospora* ‡‡ which had dwarfed its host plant *Floerkia proserpinacoides*. The whole plant was invaded by the fungus. The same writer §§ gives a second and third instalment of his

* Comptes Rendus, cxxxix. (1904) pp. 83–5.
† Bot. Gazette, xxxvii. (1904) pp. 405–16 (2 pls.).
‡ Journ. Mycol., x. (1904) pp. 98–9.
‖ Tom. cit., pp. 167–70.
** Tom. cit., p. 108.
‡‡ Tom. cit., pp. 171–2 (1 pl.).
§ Tom. cit., pp. 161–2.
¶ Tom. cit., pp. 99–100.
†† Tom. cit., pp. 113–4 (1 fig.).
§§ Tom. cit., pp. 144–9, 174–82.

'Elementary Mycology: an outlook over the whole field,' describing the growth and development of the different groups of fungi, and comparing them with the higher plants. In 'Minor Mycological Notes'* he states the occurrence on the same leaf of *Uncinula polychæta* and *U. parvula*, and he gives a list of fungi from Cedar Point on Lake Erie.

Helicomycelium fulignosum.† — E. Dubourg has studied a mould that had attacked railway sleepers although they had been impregnated with creosote. The sterilising liquid had not penetrated to the centre of the wood, and there the fungus had developed. No fructification was observed, nor could any be induced in the artificial cultures, but the brown colour and the tendency of the hyphæ to form into coils suggested the above designation. Dubourg's research deals with the physiological action of the fungus, its behaviour towards hydrocarbons, acids, sugars, etc., and the products of its metabolism. Finally he recounts the influence exerted by various antiseptics on the growth of the mycelium. Sulphate of copper in the culture was found to be ineffective. Sublimate prevented all growth, and creosote was almost as powerful in its effects. Experiments are wanted in connection with the wood itself to decide as to the best means of preventing fungoid attacks.

Growth of Moulds.‡—Jacob Nikitinsky has been testing the interaction of different moulds when grown in the same culture solution. He found that Raulin's solution was better adapted to the growth of other moulds after *Aspergillus niger* had been grown in it. On the other hand, the development of acids in the solution is fatal to the growth of some fungi, but if the acid be neutralised, the solution is found to be most favourable. The author gives also the results obtained by him with growths of yeasts, etc.

Conidial Forms of the Higher Fungi.§ — Marin Molliard has made cultures of the spores of *Sarcoscypha coccinea*, and describes and figures the conidial growth. He finds that they resemble those of *Coryne* and *Chlorosplenium* rather than those of the Pezizæ, and he considers that this rather points to the affinity of *Sarcoscypha* with the Helvellaceæ.

Disease of the Coffee Plant.‖—Georges Delacroix gives an account of various fungi that have attacked the coffee plant in different regions. He describes the fruit of *Capnodium coffeæ* which he had watched through the stages of growth. Specimens of dried branches were sent to him from Mexico, and the desiccation was due, he considered, to the presence of three fungi: one pyrenomycetous form, and pycnidia of *Hendersonia* and *Rhabdospora*, all of them new to science. He also found a new species of *Phyllosticta* on leaves of coffee from Vera-Cruz, and still another *Phyllosticta* on a different host which he names *P. comoensis*.

A. Puttemans ¶ contributes an account of the Fumagos of coffee

* Journ. Mycol. x. (1904) pp. 114–6.
† Mém. Soc. Sci. Phys. & Nat. Bordeaux, sér. 6, iii. (1903) pp. 263–72.
‡ Jahr. wiss. Bot., x. (1904) pp. 40–1. See also Bot. Zeit., lxii. (1904) pp. 213–5.
§ Bull. Soc. Mycol. France, xx. (1904) pp. 139–41 (1 fig.).
‖ Tom. cit., pp. 142–51 (1 pl.). ¶ Tom. cit., pp. 152–4 (1 pl.).

with the fruiting forms *Capnodium* and *Limacinia*. The latter was accompanied by a form of *Triposporium*.

The same writer * gives an account of the mischief done to coffee plants by *Stilbum flavidum*. He gives also a detailed description of the fungus.

Disease of Cattleya.†—Maublanc and Lasnier describe a disease which attacks orchids in the hot-houses near Paris in early spring. The leaves show at first small brown patches which gradually increase so as to cover the whole leaf. In summer the disease gradually disappears. The fungus causing the disease was found to be a *Pythium*. Later a *Glœosporium* developed on the brown spots, and connected with the latter by a similar mycelium they found the perithecia of *Physalosphora Cattleyæ* sp. n. They consider these two to be different stages of the same fungus, and to be rather in the nature of saprophytes on the tissue killed by the *Pythium*.

Fairy-Rings.‡—P. Hennings has been watching the formation of "rings" for many years, and records his observations. Regular "rings" can only be found on a flat unbroken plain either in wood or meadow. Stones, roots, etc., break the symmetry of the centrifugal growth which forms year after year. When the ring-forming fungus decays, it gives back its nitrogenous material to the soil as manure, and a rich growth of grass springs up on the site of the previous year's ring of fungi. The author gives an account of the species that tend to grow in the ring formation.

Mycological Contributions.§—F. v. Höhnel explains that his studies in mycology undertaken that he might gain a wider knowledge of the subject, have led unexpectedly to the discovery of many new forms, as well as to new observations on plants already described. The new genera are: *Neorehmia*, allied to the Perisporiaceæ; *Trichocollonema* (Sphæropsideæ); *Pseudozythia* and *Rhynchonectria* (Nectriaceæ); *Rhynchonectria* was established to include the species *Eleutheromyces longisporus* Phill. & Plowr., which is distinguished by the ciliate ascospores; *Helicostilbe*, a *Phacostilbum*, with the spiral spores of *Helicomyces*; *Collodochium*, near to *Dendrodochium*, but distinguished by the catenulate spores; *Gloiosphæra*, *Diplorhinotrichum*, and *Pedilospora* (Mucedineæ), *Gliobotrys* (Dematiæ). The writer also creates a new genus, *Pirobasidium*, for the conidial form of *Coryne sarcoides*, often wrongly described as *Tremella sarcoides*. The paper includes besides many new species, and notes on various well-known forms.

Diseases of Potatoes.‖—G. Delacroix states that *Phytophthora infestans* has been very prevalent in the neighbourhood of Paris in 1903; he has examined the fungus more carefully. He describes also a spot disease, *Pseudocommis vitis*, which he thought might have

* Bull. Soc. Mycol. France, pp. 157–64 (1 pl.).

† Tom. cit., pp. 167–72 (1 pl.).

‡ Gartenflora, liii. (1904) No. 9, pp. 228–331. See also Hedwigia, xliii. (1904) pp. 92–3.

§ SB. Akad. Wiss., cxi. (1902) pp. 987–1056.

‖ Ann. Inst. Nat. Agron., ser. 2, iii. (1904) pp. 1–40. See also Ann. Mycol., ii. (1904) p. 299.

been occasioned by *Phytophthora*. Bacterial maladies are also discussed, and the parasitism of *Fusarium solani*. He considers that this fungus is nearly always saprophytic, and only penetrates the tubers in exceptional conditions which render them more susceptible. He gives advice as to the treatment for the various diseases.

Mycological Notes.*—Franz v. Höhnel finds that *Stictis Tiliæ* and *Platygloca nigricans* are identical with *Achroomyces Tiliæ*, a fungus parasitic on *Tilia*. He founds a new genus, *Korydanella*, on a hymenomycete collected by him on pine-wood. Another new genus, *Debaryella* (Hypocreaceæ), was parasitic on *Valsa scabrosa*; the spores are colourless, fusiform, four-celled. The author adds notes on several other fungi; he thinks that a number of Sphæriaceæ with stroma forms, such as *Cryptospora* and *Cryptosporella*, ought to be classed with the Hypocreaceæ.

Fungi of Alaska.†—William Trelease writes the preface to a list of Alaskan fungi determined by P. A. Saccardo, C. H. Peck, and himself. The first fungus from the region was a *Dothedia*, recorded many years ago by Hooker and Arnott; since then there have been small additions to the list, followed now by the descriptions of species collected in the Harriman expedition. There are many new species, and an index to the various hosts of the parasitic forms is supplied, along with a record of the various substrata on which fungi were found growing. The plentiful vegetation of Alaska and the frequent rains make it probable, Trelease thinks, that a very large fungus flora exists.

BARBIER, M.—**Agaricinées de la Côte-d'or.**
[Supplement to the lists of Hymenomycetes of Dion. Critical notes are given on many of the species.] *Bull. Soc. Mycol. France*, xx. (1904) pp. 89–138.

BARSALI, E.—**Agguinte alla Micologia Pisana.**
[A list of 42 species of Hymenomycetes from the neighbourhood of Pisa, one of which, *Mycena arcangeliana* Bres., is new to science.]
Bull. Soc. Bot. Ital., 1904, pp. 78–83.

BECK, GUNTHER VON MANNAGETTA.—**Beitrag zur Pilzflora von Mährisch Weizkirchen.**
[Only the larger fungi are included; there is one new species, *Hygrophorus rubellus*.]
Sitzungsb. Deutsch. Nat. aftlichmediz. Ver. Böhm., xxiv. (1904) pp. 12–14. See also *Hedwigia*, xliii. (1904) p. 91.

" " " **Notizen zur Pilzflora von Oberösterreich.**
[A list of the larger fungi.]
Oesterr. Bot. Zeitschr., liv. (1904) pp. 121–4.
See also *Hedwigia*, xliii. (1904) p. 91.

BIGEARD, R.—**Petite Flore mycologique des Champignons les plus vulgaires.**
[A handy volume for beginners, containing keys to the common species, with special reference to those that are eatable or distinctly poisonous.]
Chalons-sur-Saone (E. Bertrand, 1903) 200 pp.

BUBAK, FRANZ, UND KABÁT, J. E.—**Dritter Beitrag zur Pilzflora von Tirol.**
[The authors describe a number of new species of microfungi, and one new genus *Colletotrichopsis* (Melanconieæ).]
Oesterr. Bot. Zeitschr., liv. (1904) pp. 134–7 and 181–6.
See also *Hedwigia*, xliii. (1904) p. 91.

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* Ann. Mycol., ii. (1904) pp. 271–7.

† Alaska. V. Cryptogamic Botany. Doubleday, Page & Co., New York, 1904, pp. 13–53 (7 pls.).

DIETEL, P.—**Kurze Bemerkungen über Triphragmium Ulmariæ.**
[The author discusses again the occurrence of teleutospores in the uredospore sorus.] *Hedwigia*, xliii. (1904) pp. 239–40.

HENNINGS, P.—**Beitrag zur Pilzflora der Umgebung Christianias (Halbinsel Bygd).**
[The author gives a list of 375 species. He describes 14 new species and varieties.]
Nyt. Magaz. Naturvidensk, xlii. (1904) p. 9–34.
See also *Hedwigia*, xliii. (1904) p. 92.

,, ,, **Ueber die auf Hevea-Arten bischer beobachteten parasitischen Pilze.**
[The author found four new parasitic fungi on the leaves of *Hevea* from the Amazon region.]
Notizbl. Kgl. bot. Gart. Mus. zu Berlin, iv No. 34 (1904) pp. 133–8. See also *Hedwigia*, xliii. (1904) p. 92.

,, ,, **Fungi Oranenses Hochreutinerani.**
[A list of fungi collected by Hochreutiner in Oran. He describes four new species of microfungi.]
Ann. du Conserv. Jard. Bot. Genève, vii.–viii. (1903–4) pp. 242–3. See also *Hedwigia*, xliii. (1904) p. 93.

,, ,, **Fungi of the Kunene-Sambesi Expedition.**
[A list of fungi from West Africa, many of them new species. The new genera are *Baumiella* (Amphisphæriaceæ) and *Hyphaster* (Phæostilbaceæ).]
Kunene-Sambesi Expedition, Kolonial Wirtschaftliches Komite, Berlin, 1903, pp. 155–69.

,, ,, **Fungi S. Paulenses iii. a cl. Pultemans collecti.**
[The list includes a number of new species.]
Hedwigia, xliii. (1904) pp. 197–209.

,, ,, **Fungi Amazonici ii. a cl. Ernesto Ule collecti.**
[In addition to many new species Hennings publishes the new genera, *Hypoxylonopsis* near to *Hypoxylon*, but with two-celled spores, *Parmulariella* and *Uleopeltis* (Hysteriaceæ) and *Rehmiomyces* (Bulgariaceæ).]
Hedwigia, xliii. (1904) pp. 242–73 (15 figs. and 1 pl.).

JAHN, E.—**Myxomyceten aus Amazonas. Gesammelt von E. Ule.**
[One new genus is recorded, *Iocraterium rubescens*, previously imperfectly described under *Craterium*.]
Hedwigia, xliii. (1904) pp. 300–5 (2 figs.).

LINDAU, G.—**Aspergillus (Sterigmatocystis) Strychni nov. spec.**
[The new species grew on the fruits of *Strychnos*; the conidiophores reached a height of 2–4 mm.] *Hedwigia*, xliii. (1904) pp. 306–7.

NITARDY, E.—**Die Kryptogamenflora des Kreises Elbing.**
[The list includes a few Mycetozoa and Lichens, and a large number of Fungi.] *Hedwigia*, xliii. (1904) pp. 315 and 319–32.

OUDEMANS, C. A. J. A.—**Contribution à la Flore mycologique des Pays-Bas. XX.**
[The author records 118 species for the locality. A number of microfungi are new to science.]
Overdr. Ned. Kr. Arch., sér. 3e, suppl. 4, pp. 1097–1132 (2 pls.). See also *Hedwigia*, xliii. (1904) p. 95.

PFUHL, FR.—**Einige Mittheilungen über die Pilze der Provinz Posen.**
[The author describes his methods of preserving and examining the spores of Agarics, etc.; he makes notes on unusual forms.]
Zeitschr. Naturw. Abth. Deutsch. Ges. Posen, xviii. (1904) pp. 1–16.
See also *Bot. Centralbl.*, xcvi. (1904) pp. 65–6.

REHM, H.—**Beitrage zur Ascomyceten-Flora der Voralpen und Alpen. II.**
[Descriptions of several new species and varieties.]
Oesterr. bot. Zeitschr., liv. (1904) pp. 81–8.
See also *Ann. Mycol.*, ii. (1904) pp. 295–6.

SCALIA, G.—**Mycetes siculi novi. II.**
[Several new parasitic microfungi are described.]
Atti dell' Accad. Giornia di Sci. Nat. in Catania, xvii. (1903) 14 pp.
See also *Ann. Mycol.*, ii. (1904) p. 297.

Lichens.

Antarctic Lichens.* —Wainio has described the Lichens collected by Racovitza during the expedition of the 'Belgica' to the Antarctic. There are 79 species, of which 32 are new. The lists give a good presentation of the Antarctic Lichen-flora.

Formation of Soredia in Lichens.†—Georg Bilter criticises Nilson's theories as to the significance of soredia formation. The latter holds that they are caused by conditions of moisture, and cannot rank as specific characters. Bilter passes in review various sorediate and non-sorediate forms to prove the insufficiency of his theory. Lichens, for instance, that live almost entirely in water, such as *Lichina* and others, are non-sorediate. Nilson had stated that the development of soredia was due to the excessive growth of the alga, which burst the rind of the thallus at the weakest spot—either at the edge or on weak portions of the old thallus. Bilter points out how insufficient this explanation is, as soredia appear unvaryingly in definite positions of certain Lichens. Nilson's statement that isidia pass over into soredia also lacks proof. Moisture is not the only condition that determines soredia formations. Other factors have an important influence on their growth.

Lichens of Alaska.‡—Clara E. Cummings has determined the Lichens of the Harriman expedition. Some 217 species were collected, including 75 new to Alaska and two new to science. An historical account of the records from Alaska is given in the preface, and a review of the forms that occur most frequently. The flora is essentially like that of other Northern regions. A large number of species of such genera as *Umbilicaria* and *Cetraria* have been found. A bibliography is published of the works consulted.

Olivier, H.—**Exposé systématique et descriptions des Lichens de l'Ouest et du Nord-Ouest de la France. Tom. ii. 1900–3.**
[This volume includes the Lecideæ, Graphideæ, Caliciaceæ, Verrucariæ, Collemaceæ, and the Parasites.] Paris, P. Klincksieck, 3 Rue Corneille.
See also *Hedwigia*, xliii. (1904) p. 98.

Zahlbruckner, A.—**Lichenes a el Damazio in montibus Serra do Ouro Preto Brasiliae lecti in herb. Barbey-Boissier asservati.**
[The author describes some new forms of *Parmelia*.
Bull. Herb. Boiss., sér. 2, tom. iv. (1904) pp. 134–6.
See also *Ann. Mycol.*, ii. (1904) p. 305.

Schizophyta.

Schizomycetes.

Bacterial Light and Photographic Plates.§—H. Molisch has shown that the luminous colonies of *Micrococcus phosphoreus* can be photographed after five minutes by their own light. The colonies then

* Anvers (1903) 46 pp. (4 pls.). See also Ann. Mycol., ii. (1904) p. 305.
† Hedwigia, xliii. (1904) pp. 274–80.
‡ Alaska. V. Cryptogamic Botany. Doubleday, Page & Co., New York, 1904, pp. 67–149 (2 pls.).
§ Photogr. Rundschau, 1903, p. 10. See also Zeit. angew. Mikrosk., ix. (1903) pp. 209–10.

appear as luminous rings. He suggests a "Bakterienlampe" for use in photography by bacterial light. Salt-pepton-gelatin is introduced into a 1–2 litre Erlenmeyer flask, and inoculated before it has set with *Micrococcus phosphoreus*. The flask is then rotated until its inner surface is covered with a thin layer of the gelatin. After two days, numerous colonies have developed which give out a beautiful blue-green light. This living lamp lasts from two to three weeks at about 10° C., after which its light diminishes. He finds that bacterial light has no power to act on photographic plates through opaque bodies such as wood, but that certain woods, cards, papers, etc., when laid on the sensitive surface of a photographic plate can influence the subjacent layer quite independently of any light. He has demonstrated thus, on a plate so treated with a piece of wood and afterwards developed, the annual rings and the distinction between wood and bark.

Gum and By-products of Bacterium Sacchari.*—A. Greig Smith has studied the slime produced by *Bact. sacchari*. He finds that in media containing saccharose *Bact. sacchari* produces a galactan gum, carbon dioxide, ethyl alcohol, lauric, palmitic, succinic, acetic and formic acids.

Effect of certain Dyes upon the Cultural Characters of the Bacillus typhosus and some other Micro-organisms.†—E. W. A. Walker and W. Murray found that when the *B. typhosus*, the *B. coli* and the cholera vibrio were grown on ordinary media containing a definite quantity of Grubler's methyl-violet (6 B), ordinary gentian-violet, fuchsin, methyl-green or methylene-blue, the cultural characters of these bacteria underwent changes, consisting in the conversion of a normal short bacillus into a form which presents itself as long filaments or threads, which may be twenty or more times the length of the ordinary bacillus. These threads often showed no sign of segmentation, and sometimes appeared truly branched. In the case of the *Bacillus typhosus* the long forms when tested for the Gruber-Durham reaction rapidly agglutinated. The best results were obtained by the addition of 0·2 p.c. methyl-violet to the culture medium.

Role of Bacteria: Saprophytic and Pathogenic.‡—E. Bodin, in an important paper, considers the properties of bacteria. He arrives at the following conclusions: That the property of being harmful to man and to animals, termed virulence, is not an absolute quality of the microbe. That this property can become attenuated, or can even disappear altogether in microbes originally highly pathogenic. That inversely, certain conditions, among which are the becoming accustomed, on the part of the microbe, to live in an animal medium, or, on the part of the organism, disturbances in its defensive (phagocytic) function, allow certain bacteria ordinarily innocuous to man and animals to become virulent and pathogenic. The author therefore condemns the classification of bacteria into the two groups of saprophytic and pathogenic. He argues in favour of all infectious diseases being caused by microbes at one time living in a state of saprophytism, instancing in

* Proc. Linn. Soc. N.S.W., xxviii. (1903) pp. 834–8.
† Brit. Med. Journ., 1904, II. pp. 16–8 (5 figs.).
‡ Travaux Scientifiques de l'Université de Rennes, ii. (1903) pp. 409–42.

support of this theory actinomycosis and aspergillosis, diseases caused by fungi normally saprophytic; tetanus and subacute septicæmia, the causing microbes of both of which have their usual habitat in the soil; and the frequent presence of the pneumococcus in the mouth and nose without giving rise to trouble. He applies his theory also to cholera and typhoid, and is not prepared to deny the possible identity of *B. coli communis* with *B. typhosus*. He discusses its possible applicability also to tuberculosis.

Bactericidal Properties of Helminthic Juice.*—L. Jammes and H. Mandoul have studied the bactericidal power of the juice of intestinal worms. They found the juice of ascaris (*A. megalocephala*, *A. vituli*, *A. mystax*) to be devoid of bactericidal power. The juice of tænia on the other hand (*T. expansa*, *T. serrata*, *T. mesocestoïdes*, *T. inermis*) could be infected with certainty only by bacilli with resistant spores. With other microbes it manifested evident but irregular bactericidal properties. When injected into guinea-pigs along with *B. tuberculosis* it caused a retardation in the evolution of tuberculosis in the animals experimented on.

Non-flagellate Typhoid Bacilli.†—J. W. W. Stephens has found that certain strains of typhoid bacilli may lose their flagella after having been repeatedly cultivated on the same medium, but that when the strain is passed through an animal, motility is regained. From this it is inferred (1) that it may be necessary to pass a bacillus, e.g. *B. dysenteriæ*, through an animal, or to examine freshly isolated bacilli, before it is quite certain that they do not normally possess flagella; (2) that as the foregoing non-flagellated typhoid bacilli reacted normally to the agglutination test, flagella cannot be an essential factor in the production of this phenomenon.

* Comptes Rendus, cxxxix. (1904) pp. 329–31.
† Lancet, 1904, II. p. 22.

MICROSCOPY.

A. Instruments, Accessories, &c.*

(1) Stands.

Ortner's Entomological Microscope.† — E. Küster describes this instrument (fig. 78) made by the firm of Ortner Bros. and Co., of

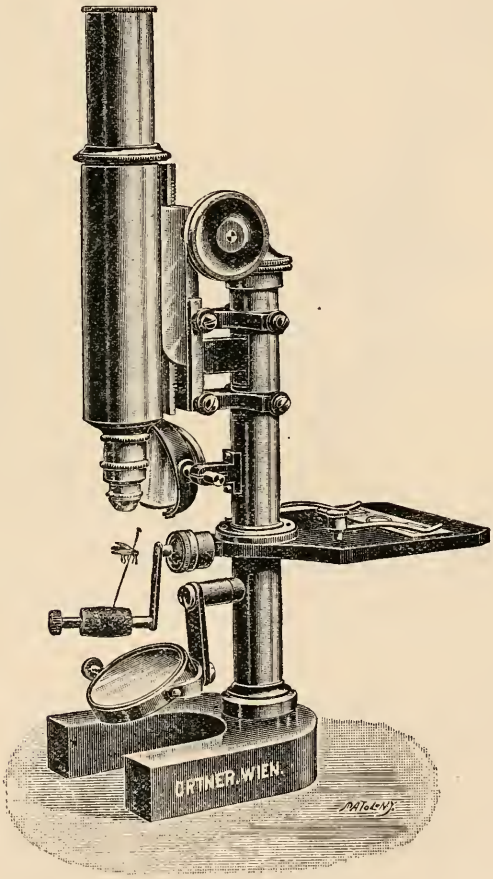

Fig. 78.

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

† Zeitschr. wiss. Mikr., xx. (1904), pp. 429, 430 (1 fig.).

Vienna. It is differentiated from ordinary Microscopes by making the object-stage swing round the tube-holder. When the stage has been rotated through 180°, a movable bent object-holder can be brought into position between the mirror and objective, and on its free end is applied an extensible collar bearing a cork. The object, on a pin, is set in this cork, and, by the variety of movements possessed by the arrangements, can be brought into any desired position in front of the objective. For the examination of opaque objects, a second mirror fastened on the tube-holder furnishes the required incident light. The instrument might also be used for botanical objects, or for any others which should be viewed from all sides.

Hollick's Naturalists' Microscope.—This instrument (fig. 79) is a modification of R. and J. Beck's well-known Star Microscope, and

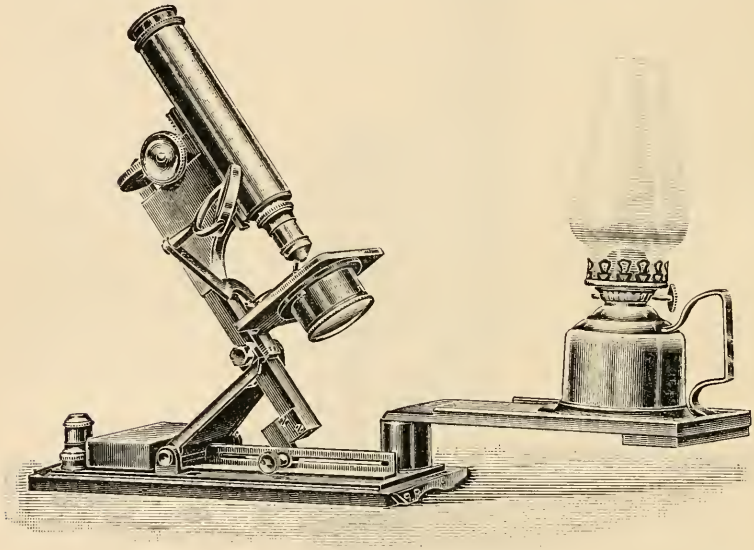

Fig. 79.

was made to the drawings of A. Hollick, who wished to have: first, the utmost compactness; and secondly, good illumination for opaque objects.

The former of these objects is obtained by making the bottom of the Microscope case the base of the instrument, and by folding the Microscope down on to it on the principle of R. and J. Beck's Popular Microscope; but the lower end of the pillar, instead of dropping into a series of holes, slides in a slot, and can be clamped in any position, so that any desired inclination can be imparted to the Microscope. Owing to its large base, the instrument, though light, is very stable.

The second object is attained by swinging the mirror on a centre above the stage approximately level with the object; that is to say, on an arm of such length that the lamp flame is focussed on to the object

with the concave mirror, and therefore, when used for opaque illumination, is practically always in focus whatever the inclination. The mirror can be swung below the stage for use with transparent objects. This arrangement is very convenient, as the mirror arm is not in the way of the fingers when manipulating the object.

Another point to be noticed is that the front lens and cell of the $\frac{1}{6}$ object-glass are coned to the utmost that is possible without limiting the aperture. The apex of the cone is so small that very effective illumination of opaque objects by the concave mirror can be obtained even with this high power.

When the Microscope is in use the fitting on the base-board in which the spare eye-piece is packed is utilised to support a wooden bracket which carries a light lamp. This arrangement allows of the Microscope being slid along a table for exhibition without disturbing the illumination. The outside dimensions are 5 in. by $3\frac{3}{4}$ in. by $9\frac{1}{4}$ in., and the weight 4 lb. 2 oz.

Notched Fine Adjustment for Optical Instruments.§—The firm of A. Pfeiffer, Wetzlar, have designed a new form of adjustment in-

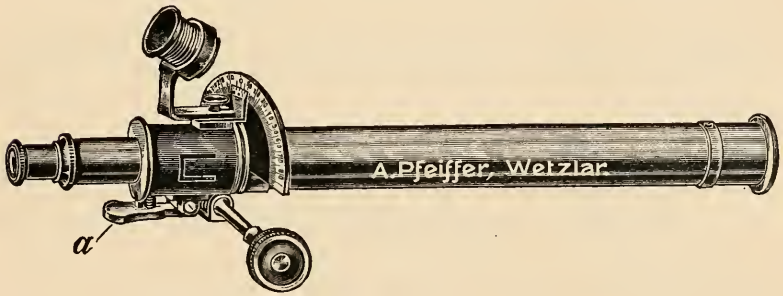

Fig. 80.

tended to simplify the movements of the usual types of coarse and fine adjustments. Fig. 80 shows it as applied to a polarimeter. The part of the apparatus acting as the fine adjustment consists of an endless screw on one end of a two-armed lever; the other end of the lever terminates in a handle *a*, a projection on which is pressed by a clip into a notch. The axis of the lever can be seen on the left of the endless screw; this axis also provides the means for securing the fine adjustment to the front part of the polarimeter. This part of the polarimeter contains the analyser, and is rotatory about the long axis of the whole instrument, and surrounds the part bearing the divided circle. This inner part also bears the thread in which the endless screw works through an opening in the analyser tube. It will now be understood that if, by pressure, the handle *a* be released the fine adjustment is put out of gear, and the movement of the front part serves as the coarse adjustment; the fine adjustment is then reinstated by relaxing the spring, and the movement completed.

* Central-Zeit. f. Opt. u. Mech., xxv. (1904) pp. 13–44 (1 fig.).

Application of the Stereo-Komparator to Monocular Use, and a Specially Designed Monocular Comparison Microscope.*—C. Pulfrich's article is mainly occupied with the testing of star-photographs; but he shows how a microscopic method may be adapted to the comparison of

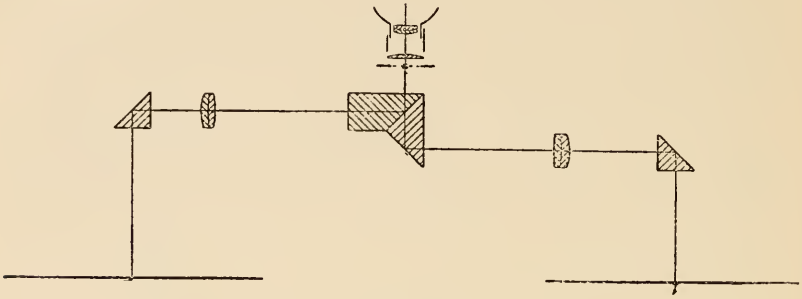

FIG. 81.

two plates for monocular observers, that is, by observers who prefer to work single-eyed. The paths of the rays are shown in fig. 81, which will be easily understood. The author seems pleased with the results obtained.

GELBLUM, S.—**Le mouvement lent du tube de microscope.**
[The author attacks the problem by methods of mathematical analysis. He suggests that a part of the tube should be threaded, and should work in a nut—the whole forming a male and female screw—so that the fine adjustment would be obtained by rotating the tube.]
Zeitschr. wiss. Mikr., xx. (June 1904) pp. 421–8 (7 figs.)

M.—**Die neue Binocular-Lupe von E. Leitz Wetzlar.**
Zeitschr. angew. Mikr., ix. (1903) p. 291.

(2) Eye-pieces and Objectives.

BLAKESLEY, TH. H.—**Single-piece lenses.**
Proc. Phys. Soc. Lond., xviii. (1903) p. 591.

CONRADY, A. E.—**On the chromatic correction of object-glasses.**
Monthly Not. Roy. Astron. Soc., lxiv. (1904) p. 274.

FÈRY, CH.—**Méthode nouvelle pour la détermination des constantes des lentilles.**
Bull. Soc. franç. de Physique, 1903, p. 226.

HARTMANN, J.—**Objectivuntersuchungen.**
Zeitschr. Instrumentenk., xxiv. (1904) p. 1.

KERBER, A.—**Ueber den Astigmatismus von Fernrohr- und Mikroskopobjectiven.**
Mechaniker, xi. (1903) p. 157.

TROTZEWITSCH, S. E.—**Anfertigung von Objectiven für Telescope, Mikroskope und photographische Apparate. Die optische Technik du Mikroskope und Teleskope.**
[Russian.] Warsaw (1903) 322 pp.

ANONYMOUS—**Sammellinse mit Irisblende von Carl Zeiss.**
Deutsche Mechaniker-Zeitung, iii. (1904) p. 28.

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* Zeitschr. Instrumentenk., xxiv. (1904) pp. 161–6 (1 fig.).

(3) Illuminating and other Apparatus.

An Easily Set-up Heliostat.*—A. W. Gray has contrived a heliostat (Fig. 82) out of simple materials. He uses a framework in the shape of a right-angled triangle, the vertical side being applied to the window of the room, and the base resting on the window-sill: means are provided for fixing. The hypotenuse of the frame must be inclined to the base at an angle equal to the geographical latitude of the place. By help of

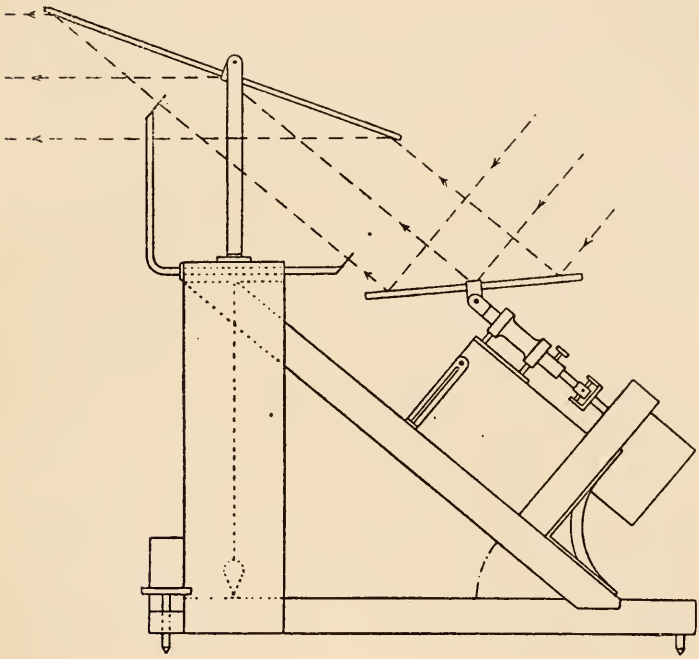

Fig. 82.

a bracket at right angles to the hypotenuse the mirror axis (made out of a bicycle pedal) is arranged parallel to the hypotenuse. One extremity of this axis bears a plane mirror, which reflects the sunlight upwards on to another plane fixed mirror, which, again, reflects it horizontally into the room. In order to secure the rotation of the lower mirror, the axis above mentioned is connected at its lower end

*Deutsche Mechaniker-Zeit., ii. (June 1, 1904) p. 104 (fig.); Zeitschr. f. d. phys. u. Chem. Unterr. xvii. (1904) p. 25.

with the hour-hand axle of an ordinary alarum clock. This hour-hand, of course, rotates twice per diem, so connexion is made between it and a wheel of twice as many teeth; but, inasmuch as the rotation is thereby reversed, a third wheel equal to one of the other two is required. It is necessary that the hypotenuse should lie due north and south.

Polariscope and Microscope Lantern.* — The following details will enable any one to make a polariscope for the lantern. Make first a tube of tin or brass, about 4 in. diameter, to fit the tube of the lantern, and at an angle of 56° 45′ fix a similar tube 4 in. long. Part of the elbow is cut away to introduce a bundle of 10 or 12 plates, $4\frac{1}{4}$ in. by $3\frac{1}{4}$ in. of thin patent plate-glass. The lowermost of these is blackened. A hole for stage, 2 in. by $1\frac{1}{2}$ in., is cut on each side of this tube, and a plate is fixed in tube here with a 2-in. hole in centre. This forms the stage. A sliding tube with a similar plate at end, and a spiral spring serves to keep objects in position. At the end of tube fix a flange and another short tube about 3 in. diameter, which carries the objective,—of about 4-in. focus. The objective moves in this tube with a sliding or rack-and-pinion movement. Beyond this again is still another tube 2 in. diameter and 2 in. long. In this slides a smaller tube, in which is fitted a Nicol prism. This fits in a cork, which cork fits in small tube, and the smaller tube rotates in the other.

Lantern Microscope. Get a brass tube 3 in. long and 2 in. diameter, and at one end fix a screw, fitting flange of the lantern. Two inches from this end cut holes on either side, 2 in. by $1\frac{1}{2}$ in., and fit for stage as in the polariscope. At about $1\frac{1}{2}$ in. from end is fitted a lens about $2\frac{1}{2}$-in. focus, which acts as an additional condenser. To the other end of the tube fix a plate, in centre of which fix a tube 1 in. diameter and $1\frac{1}{2}$ in. long. In this slides a smaller tube carrying the magnifying lenses, which may be two lenses each about 2-in. to 3-in. focus. If these are not achromatic a diaphragm with $\frac{1}{4}$-in. hole must be placed about $\frac{3}{4}$ in. in front. The best position is determined by experiment. Achromatic lenses will be best. Micro-objectives of 1-in., $1\frac{1}{2}$-in., or 2-in. focus may be utilised with advantage by fitting them by means of a cork in the sliding tube in place of those mentioned. Instead of a sliding tube a rack-and-pinion will be a great advantage.

(4) Photomicrography.

Microphotographs.† — The production of these small views, or microphotographs, is a branch of work which requires very considerable patience and skill, inasmuch as it is necessary to perform the operations of development, etc., in the field of a magnifier or small Microscope, since the size of the image is so minute. The majority of the microphotographs sold are made on the Continent, and details of their manu-

* Photographic Reference Book, 2nd ed., 1904, p. 238.
† Tom. cit., pp. 191–2.

facture are not given in English treatises. The collodion process (wet plate) is used, or collodio-albumen may also be employed. In either case, the collodion used for making the plates must be absolutely structureless, for if it is not the magnified images will have a disagreeable reticulated appearance. Pyrogallic acid is preferable to iron sulphate for development, since it gives a much finer deposit. The process consists in making a positive by copying an illuminated negative, a 1-in. microscopical objective being used for this purpose. An apparatus devised by Mr. Hislop, and described in Mr. Sutton's "Dictionary of Photography," may be employed. It consists of a rigid mahogany board about 6 in. wide and 3 ft. 6 in. in length. At one end two uprights are fixed, between which a miniature camera, fitted with the microscopical objective, can be moved up and down, so as to allow it to be placed opposite the centre of the negative to be copied. The objective is screwed to a brass tube, projecting from the camera towards the negative, the tube being fitted with stops of various sizes. A micrometer head for the fine adjustment of the lens is also necessary, because the majority of microscopic objectives are corrected only for the visual rays. The sharpest visual focus must be found by means of a powerful magnifying-glass, and the chemical focus ascertained by racking the lens in or out to various distances until the proper chemical focus is found. When this has been done, the same correction may always be applied unless the negative's distance from the lens is altered. The negative is placed in a frame at the required distance on the long mahogany board. The illumination may be natural or artificial, but must, of course, pass through the negative. The variations of light, negative, and collodion plate render it impossible to give any idea of exposure. After exposure the little plate is placed under a low-power Microscope, in yellow light, and a few drops of developer poured over it. Development must be watched through the instrument, remembering that a transparency is required, and that, therefore, rather greater density than otherwise should be obtained. After fixing and drying, the tiny plates are examined through a magnifier of about the power which it is intended to subsequently attach to them, in order to see if they are perfect and worth the subsequent trouble of mounting. The photographs chosen are then cut into small squares with an ordinary diamond. Care must be exercised that no dust adheres to the film side of these small squares. The little lenses (or Stanhopes) to which the view is to be cemented are now placed on the top of a small stove, and very cautiously heated. A drop of Canada balsam is placed on the end and allowed to soften, and the little square transparency taken up in a pair of forceps and pressed—gently at first, afterwards more strongly—into contact with the melted cement. The two are then allowed to harden together for some hours. In order to be certain that the operation has succeeded, and that the contact is perfect, the transparency is examined through the rounded end of the little glass cylinder, to which it is cemented, which acts as a Microscope, and gives a magnified and distinct image of the object. If air-bubbles show they are most likely due to unequal pressure in cementing the glass. The

balsam must be resoftened by placing it for a few minutes on the stove, and the operation repeated with greater care.

ANONYMOUS—**Praktische Arbeitserfahrungen in der Photographie (Mikrophotographie).** *Zeitschr. angew. Mikr.*, x. (1904) p. 24.

LEISS, C.—**Ueber eine neue Camera zur stereoskopischen Abbildung mikroskopischer und makroskopischer Objecte.** *Zeitschr. Instrumentenk.*, xxiv. (1904), p. 61; *Zeitschr. Krystallog. u. Mineral*, xxxviii. (1903) p. 99.

(5) Microscopical Optics and Manipulation.

CHABRIÉ, C.—**Sur la fonction qui représente le grossissement des objets vus à travers un cône de cristal.** *Comptes Rendus*, cxxxviii. (1904) p. 349.

DOKULID, TH.—**Die Bestimmung der optischen Constanten eines centrirten sphärischen Systems mit dem präcisionsfocometer.** *Der Mechaniker*, xii. (1904) p. 37.

EVERETT, J. D.—**On skew refraction through a lens; and on the hollow pencil given by an annulus of a very obliquely-placed lens.** *Proc. Roy. Soc.*, lxxi. (1903) p. 59.

„ „ **On the resolving power in the Microscope and Telescope.** *Rep. British Assoc., Glasgow*, 1901, p. 569.

KLEIBER, J.—**Astigmatismus bei Hohlspiegeln.** *Zeitschr. Unterr.*, xvi. (1903) p. 208.

MACÉ DE LEPINAY, J., & H. BUISSON—**Ueber eine neue Methode der optischen Dickenmessung.** *Zeitschr. Instrumentenk.*, xxiv. (1904) p. 30; *Comptes Rendus*, cxxxv. (1902) p. 283.

ANONYMOUS—**Ueber die Grenzen der mikroskopischen Abbildung und die Sichtbarmachung "ultra mikroskopischer." Theilchen.**

[After referring to Abbe's theorems on the limits of visibility, the writer describes the experiments of Siedentopf and Zsigmondy, which have been more than once described in our Journal.]

Central-Zeit. f. Opt. u. Mech., xxv. (March 1, 1904) pp. 51–3 (3 figs.)

(6) Miscellaneous.

Optical Bench.* — The firm of R. and J. Beck manufacture an optical bench and appliances for Microscope illumination, photomicrography, micro-projection, and optical lantern projection. It consists of a table (fig. 83), having a rigid iron framework and a wooden top, 54 in. by 20 in., which supports the optical bench, the Microscope and the illuminant. It runs on four castors, by the side of which are screw pillars with lock-nuts, by which the castors may be raised off the ground. The bench proper is a steel rail 30 in. long, with a prismatic section; this is carried on two cross bars, at the ends of which are four screwed pillars with milled heads and clamp nuts, the ends of which fit into sockets fixed upon the wooden table. By means of the pillars the rails may be raised or lowered. Along the dove-tailed rail the various pieces of apparatus slide with a spring fitting, and may be clamped in

* R. & J. Beck's Special Catalogue, 1904 (12 figs.).

any position by means of a milled head and screw. The condensers, light filters, iris diaphragms, cooling chambers, lenses, mirrors and prisms (figs. 84, 85, 86, 87, 88, 89) are so made that when in position on

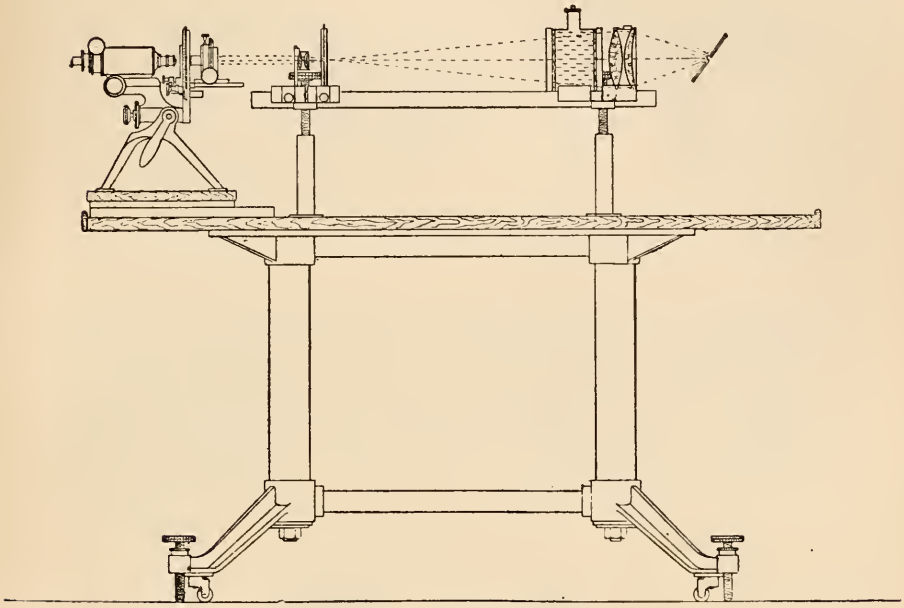

Fig. 83.

the rail their centres are in alignment on the optic axis. The illuminating apparatus, arc, incandescent gas or paraffin lamp, fits on the bench, and is provided with an adjustment for altering its position.

Fig. 84.

Fig. 85.

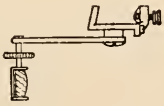

Fig. 86.

The platform upon which the Microscope is placed is provided with a tilting movement by which the optic axis of the instrument may be inclined up or down. The platform runs on three sets of steel rails;

one set places the optic axis of the Microscope in line with that of the bench; the second set allows the instrument to be placed with its optic axis parallel to but to one side of the axis of the bench, a position suitable for the illumination of opaque objects; while the third set permits the

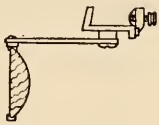

Fig. 87.

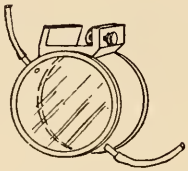

Fig. 88.

Fig. 89.

Microscope to be used at right angles to the optic axis of the bench. When used as an optical lantern the height of the bench (fig. 90) is increased by a supplementary table. A set of rods and curtains is provided to cover the apparatus. A photomicrographic and enlarging camera (fig. 91) on a similar turntable is made of the same height as the Microscope table, so that it can be placed in alignment for photomicrography. This camera carries a $\frac{1}{1}$ plate ($8\frac{1}{2}$ in. by $6\frac{1}{2}$ in.) with adapters for smaller sizes, and has a variable extension of from about

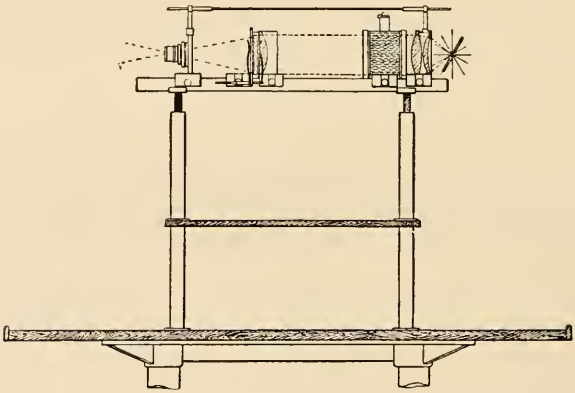

Fig. 90.

12 in. to 7 ft., the front portion being extended by means of a steel rod which slides in bushed fittings, while the back slides and clamps upon the main bar of the table. The front of the camera is arranged to take a small photographic plate-holder, and a sliding panel in the

fixed frame of the camera takes a photographic lens, so that the camera may be turned into an enlarging apparatus.

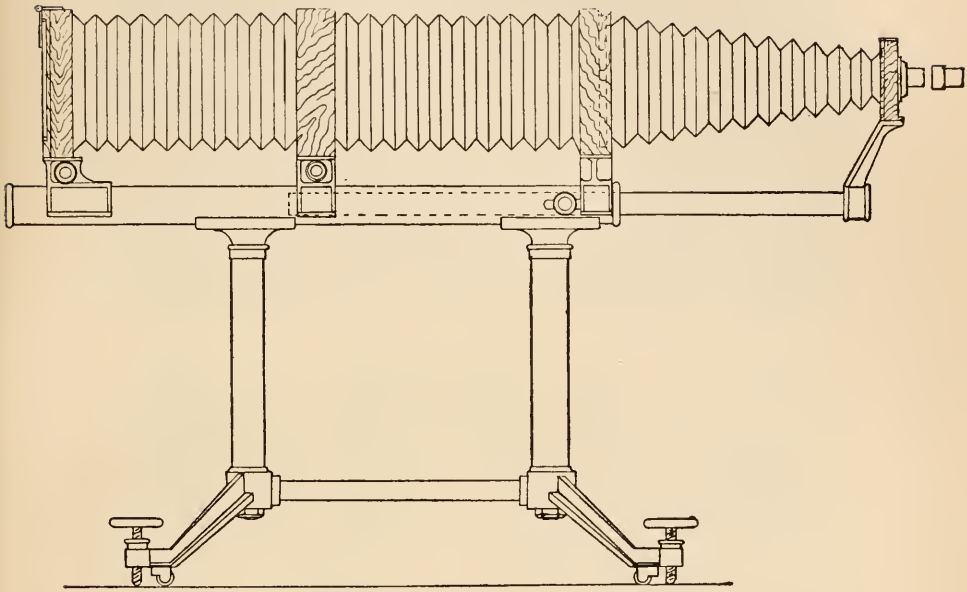

FIG. 91.

MANISSADJAM, J. J.—**Microscopical Work in Turkey.** *Journ. Applied Micr.*, vi. (1903) p. 2547.

OERTEL, T. E.—**Medical Microscopy.** London (Rebman), 9 pp.

PERCIVAL, A. S.—**The Microscope.** *English Mechanic*, lxxvi. (1903) p. 430.

B. Technique.*

(1) Collecting Objects, including Culture Processes.

Culture of Anaerobic Bacteria.†—J. Bordet recommends the following method for the cultivation of anaerobic bacteria. He employs an apparatus used ordinarily for desiccation in vacuo (fig. 92). This is composed of two receivers, the inferior of which, A, is cylindrical, and has its edges ground. It is 0·14 m. high, and has an internal diameter of 0·14 m. The superior receiver B is a hemispherical bell-glass with a stop-cock, and furnished with a flat bottom, the inferior surface of which is carefully ground for adaptation to the edges of the cylinder A. The flat bottom of the bell-glass is raised towards 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.

† Annales de l'Institut Pasteur (1904) No. 5, pp. 332–6.

centre in a ridge 0·05 m. high, and this ridge surrounds a circular opening *b*, which furnishes a communication between the two parts of the apparatus. It is in the cylinder A that the vessels are placed in which the cultures are made. This being done, a small packet of about 5 grm. of pyrogallic acid in filter-paper is introduced through the opening *b* into the bottom of the bell-glass. The latter is then applied to the cylinder. The whole apparatus is then inclined, so that the highest part of the floor of the bell-glass is that on which rests the packet of pyrogallic acid. This position is maintained by means of a block of wood (fig. 93). The stop-cock is then removed, and by means of a funnel, the stem of which is suitably bent, about 100 c.cm. of a 10 p.c. solution of caustic potash are introduced into the bell-glass in such a way that, thanks to the inclination, none of it touches the pyrogallic acid. The stop-cock is then replaced and the air exhausted. When the rarefaction has reached a maximum, the stop-cock is closed, and the

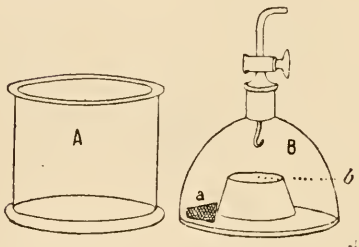

Fig. 92.

Fig. 93.

apparatus placed in a horizontal position, the latter causing the mixture of the acid with the potash solution. Thus the traces of oxygen left after exhaustion of the apparatus are absorbed by the pyrogallate of potash. Before placing in the incubator the author recommends that all the apposed glass surfaces of the apparatus should be covered with a mixture in equal parts of wax and vaselin. This renders it more surely air-tight.

Pure Cultures of Chlorella vulgaris.*—E. Herouard obtains pure cultures of this alga on potato. Obliquely cut cylinders of the medium are placed in test-tubes having a constriction near the lower end. At the bottom of the tube is placed a little water, or a mixture of water and 10 p.c. glycerin. The tube is plugged with cotton-wool and sterilised in the autoclave. The sterilisation should be lengthy or repeated on several occasions. The medium should be inoculated with the usual precautions, and care should be taken to spread the seed over

* Bull. Soc. Zool. de France, xxix. (1904) pp. 110–4.

a considerable surface, as the alga grows but little beyond the inoculation site. The tubes should be covered with rubber caps to prevent evaporation. Cultures of Chlorella obtained by the foregoing method enabled the author to rear Infusoria and Cladocera.

Scotia Closing Plankton Net.*—W. S. Bruce describes a form of closing net (fig. 94) constructed after a design the idea of which was

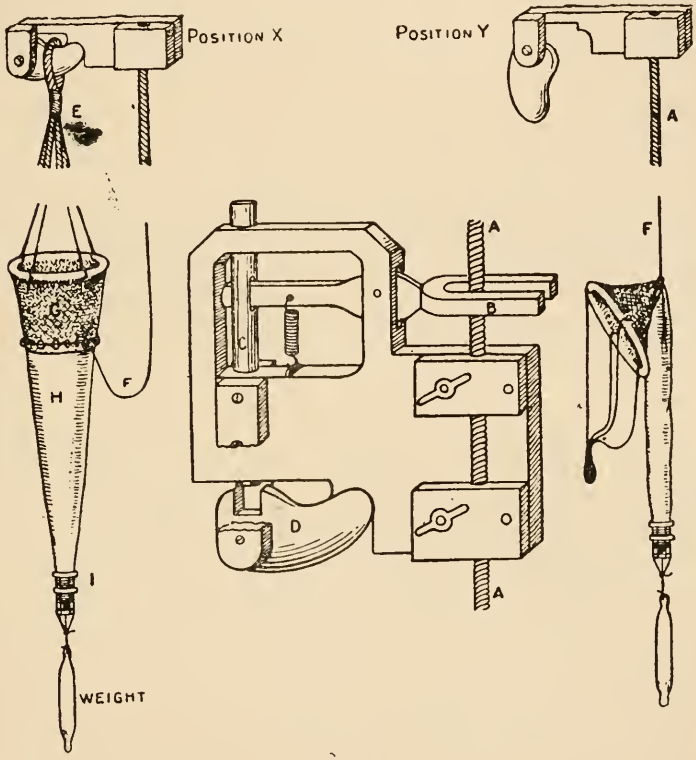

FIG. 94.

derived from the Scottish reversing thermometer frame. A weight runs down the cord A, strikes the lever B, raises brass rod C, which liberates hook D from position X to Y. This lets go net-cords E, and the net becomes suspended as in position Y by cord F, which has a continnation of A and draws up neck of net and closes it. F is passed through a series of rings round the neck. G is coarse material. H, Swiss silk or such-like material. The end takes off at I, as in Hensen's net. Thus by letting the whole apparatus down nothing enters the net, but on hauling up the tow-netting proceeds and goes on vertically until the

* Proc. Roy. Physical Soc., xv. (1904) p. 141 (5 figs.).

weight is sent down cord A at desired depth, when position Y is obtained and nothing enters or gets out of the net. It is easy to trawl in fast in this position. The net can be made of any size.

Preparing Agar.*—K. Rosam states that the following procedure prevents the too rapid setting of agar, and facilitates filtration. Powdered agar is treated for about five minutes with 10 p.c. acetic acid; it is then placed on a sieve and the acetic acid washed out with running water. Thus prepared, agar is rapidly filtered, has a low melting-point, and solidifies at 35° C. It may be stocked dry, and will keep for quite a long time. The filter-paper recommended is Schleicher and Schüll's No. 604.

Cultivation of Algæ.†—Th. Frank obtained pure cultures of *Chlamydomonas tingens* by inoculating agar with single cells. He also used Knop's medium, which consists of 4 parts calcium nitrate and 1 part potassium nitrate, magnesium sulphate, potassium monophosphate, and a trace of iron sulphate. Made up with distilled water, this medium has a slightly acid reaction, and the free acid it contains corresponds to about 0·033 p.c. phosphoric acid. When used in concentrations varying from 0·05 to 3 p.c., the results obtained were good. Besides agar and Knop's medium, cultivations were made successfully on gelatin and on clay plates saturated with nutrient fluid.

Cultivation of Anaerobes.‡—D. J. Hamilton describes a method which aims at the exclusion of any atmosphere whatever. The first step is to encourage sporulation, and this is done by incubating (at 37° to 38° C.) the organism in the liquid upon which it is found growing naturally within the animal body. The fluid is removed in a Pasteur's pipette; this is then sealed off, and the tube incubated for 24 to 48 hours. By this means the organism is obtained in the sporing state.

The medium used is glucose-pepton-beef-tea. This must be boiled and filtered until precipitation of phosphates ceases. The reaction must be distinctly alkaline to phenolphthalein. The medium is decanted into test-tubes or flasks, and sterile olive-oil to the depth of 1·5 cm. is then poured over the surface. The tubes or flasks are sterilised again on three successive days; on the first day for $\frac{3}{4}$ hour, on the second and third day for $\frac{1}{4}$ hour.

The spores are inoculated by drawing up some of the spore-containing fluid in a Pasteur's pipette, which is plunged into the beef-tea and some of the contents blown out, care being taken not to empty the tube lest any air might enter. The plug is then readjusted, and the vessels heated in a water-bath at 80° C. for 20 minutes, to kill off any non-sporing contaminations. If the organism be contained in a tissue a minute piece is snipped off and dropped into the tube or flask. After the last-mentioned heating the vessel is cooled down quickly in running water. The inoculated vessels are then incubated. Within 24 hours, as a rule, germination is in full activity, and the growth may be examined by withdrawing some fluid by means of a sterilised pipette.

* Centralbl. Bakt., 2te Abt., xii. (1904) p. 464.
† Bot. Zeit., lxii. (1904) pp. 153–88 (1 pl.).
‡ Brit. Med. Journ., 1904, II. pp. 11–2.

For making surface growths the most suitable medium is glucose-pepton-agar, but any other solid medium not coagulable by heat may be substituted. The vessels used are circular capsules, with an inside diameter of 7 cm. and a depth of 2½ cm. They are provided with a flat ground flange 1½ cm. broad. The cover is made of plate-glass and extends outwards to half the breadth of the flange, so as to leave a margin uncovered. It is ground to fit closely on to the flange. In the capsule is placed a layer of medium about 1 cm. thick, and then olive-oil is poured in nearly up to the rim. It is then covered and sterilised. When cool, the medium is inoculated by means of a pipette containing pure culture. Growth is usually abundant after incubating from 24 to 48 hours. Such cultures may be preserved permanently by killing the organisms with formalin, and then mounting the capsules with refined castor-oil.

(2) Preparing Objects.

Preserving Insects.*—In order to preserve insects collected in the summer for dissection and mounting in the winter, Villagio recommends the following procedure: Kill the insect in chloroform vapour, then drop it into a test-tube half full of water. Raise to the boiling-point and then transfer at once to 30 p.c. alcohol. After 24 hours remove to a mixture of equal parts of 90 p.c. alcohol, glycerin and distilled water, with ½ p.c. of acetic acid added. From this fluid the insect is removed to diluted alcohol for dissection, or passed through graded alcohols for imbedding in paraffin.

Preparation of Spicules of Silicious Sponges.†—R. von Lendenfeld takes a piece of the sponge of the size of a hazel-nut, and boils it in water. The piece of sponge is then placed in a test-tube and covered with strong nitric acid. After standing for some hours it is boiled until the acid is quite clear. The tube is then almost filled with distilled water and shaken, and after about 20 seconds the supernatant fluid is decanted off into another test-tube. After some 40 seconds the supernatant fluid in the second tube is removed to a third test-tube, and this procedure is repeated until no spicules are obvious to the naked eye. The last fluid is then centrifuged for 1½ minutes. The deposit is washed with distilled water several times, and afterwards placed on a slide. After removing the excess of water, the preparation is dried over the flame and mounted in balsam or dammar.

Collodionage of Cells.‡—Cl. Regaud describes an ingenious method of preparation applicable to anatomical elements naturally or artificially dissociated.

The first step consists in dissociating and fixing the cells. When dealing with a fluid rich in cells, e.g. blood, semen, etc., one or two drops of the liquid are allowed to fall into several cubic centimetres of a fixative, such as 1 to 2 p.c. osmic acid or 10 p.c. formalin. The fixative must be kept shaken for a while to prevent agglutination of the cells. If more rapidly coagulating fixatives such as chromic, picric, or

* English Mechanic, lxxix. (1904) p. 556.
† Zeitschr. wiss. Mikr., xxi. (1904) pp. 23–4. ‡ Tom. cit., pp. 10–4.

acetic acid, bichloride of mercury, alcohol, etc., be used, the cells must be previously washed with physiological salt solution, and, after sedimentation, the supernatant fluid decanted off. The deposit is then fixed. When the elements are scanty, as in urine, pleural fluid, etc., they must be concentrated by centrifuging before being fixed. In the case of cells not naturally dissociated, e.g. of the liver, spleen, bone-marrow, etc., they may be dissociated first and fixed afterwards, or *vice versâ*.

The next step consists in washing the fixed cells in a centrifuge, and this operation may be repeated once or twice.

The third step is to dehydrate the sediment by dropping in absolute alcohol, and after this an equal quantity of anhydrous ether, shaking or inverting the tube from time to time.

The fourth step is to add some few drops of collodion solution, and then shake the mixture again.

Fifth step: with a thin dry pipette draw up some of the collodionised fluid and place droplets on cover-slips. While the films are still moist, transfer the cover-slips to 80 p.c. alcohol. The preparations are next passed through 60 p.c. alcohol and then to water. After this, the treatment is the same as for ordinary histological sections stuck on a slide.

(3) Cutting, including Imbedding and Microtomes.

Rapid Method of Hardening and Paraffin Imbedding.* — The following are the steps in a method employed by O. Lubarsch by means of which hardening and imbedding are accomplished in from 1 to 3 hours, enabling perfect sections to be cut and all stains to be used with success: (1) Blocks of tissue 0·5 cm. thick are placed in 10 p.c. formalin for 10 to 15 minutes, with one to two changes; (2) 90 to 95 p.c. alcohol for 5 to 10 minutes, with one change; (3) absolute alcohol for 10 minutes, with two changes; (4) anilin oil, to clear, for 10 to 30 minutes, according to size of block of tissue; (5) xylol, to remove oil, for 10 to 20 minutes, with two to three changes; (6) paraffin for 10 to 60 minutes. All the steps of the process are carried out in a paraffin oven at 50° C. to 53° C.

Rapid Hardening and Imbedding.†—A. Stein gives the following modification of Lubarsch's method of rapidly hardening and imbedding fresh tissue: 1. Immersion in 10 p.c. formalin (5 minutes). 2. 95 p.c. alcohol (5 minutes). 3. Absolute alcohol, two changes (10 minutes). 4. Anilin oil, till quite cleared up (15 to 20 minutes). 5. Xylol, two to three changes (15 minutes). 6. Paraffin (10 to 30 minutes, according to the size of the piece). The first four stages are made in incubator at 50° to 52° C.; the last two at 58° to 60° C.

Use of Radium in Section Cutting.‡—H. H. Dixon remarks that every one who cuts paraffin sections is frequently troubled by their electrification, which makes them stick to the knife or curl up and, even when successfully removed from the knife, fly about in an erratic manner. These undesirable phenomena may be completely obviated

* Deutsche Med. Wochenschr., No. 48 (1903) p. 896.
† Op. cit., xxix. (1903) p. 806. ‡ Nature, lxx. (1904) p. 198.

by fixing a 5 mgrm. tube of radium bromide on the microtome knife close to where the paraffin ribbon is forming. Apparently the radiations from the radium discharge the electrification of the paraffin sections by ionising the air in their neighbourhood.

Fixation and Staining of Eumesostomina.*—A. Luther fixed the objects chiefly with sublimate either in the form of Lang's fluid of medium strength, or as a saturated solution in physiological salt solution. The fixative was used hot, and the objects afterwards washed in distilled water. They were then transferred to graded alcohols (50, 70, 96 p.c.). The sublimate was removed by means of iodine immediately before saturation with paraffin. Sometimes Flemming's mixture was used as fixative, the results being good, especially for the eggs of *Mesostoma lingua*. The stains mostly used were Ehrlich's hæmatoxylin and eosin, or Benda's iron hæmatoxylin and eosin. Toluidin blue (1 p.c. aqueous solution for 8 hours) combined with a weak solution of erythrosin (a few seconds) was often successful. Golgi's impregnation method and intra-vitam staining with methylen-blue were failures. As maceration fluid, especially for the isolation of muscle, nitric acid was found serviceable; 10 p.c. for fresh material, 20 p.c. for that hardened in alcohol.

BEHR, M.—**Über Schnellhärtung und Schnelleinbettung.**
[On rapid hardening and imbedding.]
Münchener Med. Wochenschr., l. (1903) pp. 2256–7.

GUTTMANN, C.—**Über Schnellhärtung und Schnelleinbettung.**
Deutsche Med. Wochenschr., xxix. (1903) pp. 740–1.

(4) Staining and Injecting.

Hæmatoxylin Staining of Nerve-fibres of the Central Nervous System.†—W. Pavlow recommends that the brain should be cut up into pieces of about 4 cm. diameter, and fixed in Müller's fluid or 3 p.c. potassium bichromate at 35° C. The fixative should be changed daily for the first week and twice a week afterwards. The pieces are fixed at 35° C. for 3 weeks, and for the next week at ordinary temperature. On removal they are washed in running water for 2 hours, and then transferred to 75 p.c. methyl-alcohol for 3 days; after this to absolute alcohol for 3 days, and subsequently to a mixture of absolute alcohol and ether for 5 days. They are next placed for a week in celloidin, kolloxylin or photoxylin solutions. The celloidin solution is made by dissolving 40 grm. of celloidin in a mixture of 500 grm. methyl-alcohol and 500 grm. of sulphuric ether. For the kolloxylin or photoxylin 30 grm. are dissolved in 800 c.cm. of the ether mixture.

The pieces of brain are then fixed on wood or paraffin blocks by means of the same mixture, and after the lapse of 15 minutes are placed in 60 p.c. methyl-alcohol.

The celloidin sections are stained with hæmatoxylin solution made by dissolving 10 parts of hæmatoxylin in 100 parts of absolute ethylic-

* Zeitschr. wiss. Zool., lxxvi. (1904) p. 3.
† Zeitschr. wiss. Mikr., xxi. (1904) pp. 14–8.

alcohol, and then adding 870 of distilled water and 20 of glacial acetic acid. This solution must stand uncovered in the light for 3 weeks before use. The sections are stained for 20 hours at a temperature of 30° C. On removal the sections are treated for 10 minutes with a saturated solution of lithium carbonate, and are then washed with distilled water until the water runs off quite clear. The sections are now decolorised after Pal's method, though the permanganate solution is stronger. In solution A (pot. permang. 5, H_2O 1000) the sections remain 1 minute; in B (acid. oxalic. 5, pot. sulphurosum 5, H_2O 1000) 5 minutes. If not sufficiently decolorised, the whole business must be gone through again.

The decolorised sections are next washed and treated successively with methyl-alcohol, creosote and carbolxylol. In each of these fluids they remain 5 minutes, after which they are mounted in balsam.

If it be desired to double-stain the sections, this may be done with magdala red, congo red, or fuchsin; but the preference is given to the following: Rubin 1, H_2O 200, glacial acetic acid 4. The counter-staining must be done after differentiation in B solution and washing in water. It takes about 3 hours, after which the sections are immersed for 24 hours in 2 p.c. acetic acid.

Modification of the Van Gieson Method.* — K. Weigert recommends the following improvement of the Van Gieson method. For alum-hæmatoxylin is substituted iron-hæmatoxylin. This is prepared by mixing, when required for use, equal parts of two solutions: A, consisting of 1 grm. hæmatoxylin to 100 c.cm. of 96 p.c. alcohol; B, of 4 c.cm. liq. ferri sesquichlorati, 1 c.cm. of hydrochloric acid, and 95 water. The iron chloride solution contains 10 p.c. iron; the specific gravity of HCl is 1·124, 'German Pharmacopœia.'

The acid fuchsin-picric acid mixture is made by adding 10 parts of 1 p.c. aqueous solution of acid fuchsin to 100 parts of saturated aqueous solution of picric acid.

The sections previously stained with iron-hæmatoxylin are placed in the picric-fuchsin solution for only a short time; they are then quickly washed in water, dehydrated in 90 p.c. alcohol, and cleared up in carbolxylol.

Method of Staining Sections Quickly with Picrocarmin.†—W. Freeman gives the following method by which staining with picrocarmin is complete in a few minutes. The staining is almost entirely that of carmin, but the picric acid can be easily added by passing the sections through alcohol tinged with picric acid in the usual way for successive double stains. The fixatives used were Müller's fluid, potassium bichromate, Weigert's chrome-alum mixture and formalin, with after-hardening in alcohol. The picrocarmins used were Bourne's and Hoyer's. (1) To 1 volume of Bourne's picrocarmin 9 volumes of 0·2 p.c. acetic acid are added; the mixture is filtered preferably after boiling. The sections cut with a freezing microtome are placed in the dilute picrocarmin, which is then heated quickly just to the boiling-

* Zeitschr. wiss. Mikr., xxi. (1904) pp. 1–5.
† Proc. Physiol. Soc., May 1903; Journ. Physiol., xxix. (1903) pp. xxx–i.

point and allowed to cool. As the fluid cools the sections stain, and are at their best in 3 to 4 minutes. (2) To 1 volume of Hoyer's picro-carmin 19 volumes of distilled water are added. The sections are treated as above, but the staining takes 10 to 15 minutes.

Fixing, Staining and Mounting Sections of Skin.*—E. Retterer, in his researches on the structure of the skin, fixed the material in Flemming's, Zenker's or Branca's fluid, giving the preference to the two last. The sections were stained by various methods: some with hæmatoxylin, and fuchsin and Israel's eosin-orange-aurantia; others with fuchsin-resorcin, followed by hæmatoxylin and safranin (24 hours); others with fuchsin-resorcin and alum-carmin; others with lithium-carmin, vesuvin and fuchsin-resorcin. The specimens were mounted in glycerin, Farrant's medium, and balsam.

The author pertinently remarks that if all the structure and details of a histological specimen are to be made out satisfactorily no single method will suffice, and that no rule can be given for determining *a priori* the precise routine for obtaining the best results.

New Method of Staining the Epithelial Fibres and the Membrane of Prickle Cells.† — P. G. Unna fixes the material partly in absolute alcohol, partly in formalin, hardens in alcohol and imbeds in celloidin. The sections are stained in the following mixture: Water blue 1; orcein 1; acetic acid 5; glycerin 20; spirit 50; water to 100. One gramme of this solution is placed in a test-tube and mixed with 0·3 grm. of 1 p.c. alcoholic solution of eosin, and then with 0·3 grm. of 1 p.c. aqueous solution of hydrochinon. The sections are stained in the cold for 10 minutes. After washing with distilled water they are immersed in 1 p.c. aqueous solution of safranin for 10 minutes. They are again washed with distilled water, and transferred to ½ p.c. bichromate of potassium solution for 10 to 20 minutes. On removal the sections are washed in distilled water, after which they are dehydrated in absolute alcohol and then mounted in balsam.

Should the sections (which should have a violet hue after dehydration) be too red from excess of safranin, they must be re-treated with alcohol.

Staining with Chrom-hæmatoxylin.‡ — O. Schultze recommends the following procedure for staining tissues previous to sectioning: (1) Fix the material in solutions of bichromate of potash or of chromic acid, or better still, with osmic acid added to both, for 12 hours or longer; (2) 50 p.c. alcohol, in the dark for 24 hours or longer; (3) 70 p.c. alcohol with 0·5 p.c. hæmatoxylin, for 24 hours or longer; (4) 80 p.c. alcohol; (5) absolute alcohol; (6) imbedding: the sections should be thin, not thicker than 5 μ.

Modification of van Ermengem's Method of Staining Flagella.§ J. W. W. Stephens describes the following modification of van Ermengem's method: (1) The mordant consists of 2 p.c. osmic acid, 1 part; tannin 20 p.c., 2 parts; this is allowed to act for ½ to 1 hour or longer.

* Journ. Anat. et Physiol., xl. (1904) pp. 337–86 (2 pls.).

† Monatsch. prakt. Dermatol., xxxvii. (1903) pp. 1–18 (1 pl.). See Zeitschr. wiss. Mikr., xxi. (1904) pp. 68–9.

‡ Zeitschr. wiss. Mikr., xxi. (1904) pp. 5–9.

§ Lancet, 1904, II. p. 22.

(2) Silver nitrate solution, 0·2 p.c. (3) Ammonium tannate solution; of this, a quantity sufficient for staining one slide is freshly made thus: tannin 20 p.c., 0·2 c.cm.; equal parts of strong ammonia and water, 1 c.cm. A clean slide is flooded with an emulsion of culture, the surplus fluid is drained off, and when dry the slides are mordanted. After washing with water a few drops of the silver solution are put on the slide, and then a few drops of ammonium tannate. The slide is rocked to and fro for a few minutes. The washing and staining are then repeated three or four times.

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

Iodine-Paraffin Oil: a New Micro-reagent and Mounting Medium.*—C. O. Harz makes this medium by dissolving one part of iodine in 100 parts of neutral, colourless paraffin oil by the aid of gentle heat. Thus prepared, the mixture has a beautiful red colour. It is well suited for mounting bacteria, fungi, starch, ligneous tissue and other vegetable preparations. The method of mounting starch-grains is simple. The grains are spread out on a slide or cover-glass, with water or with iodine solution (1 p.c. iodide of potassium solution saturated with iodine). The preparation is dried in the air or by means of gentle heat, and then mounted in the usual way in paraffin oil or in iodine-paraffin oil. The cover-glass is then ringed round with 10 p.c. gelatin previously warmed.

Method for the Removal of Air-Bubbles from Frozen Sections.† E. Neuhaus recommends the following method for use chiefly when ethyl-chloride is employed as the freezing agent in the rapid preparation of sections. The sections having been cut, placed in salt solution, stained and washed, are transferred to alcohol, which is then slightly warmed. By this the air-bubbles are seen to disappear, especially if the alcohol is agitated or the sections moved about with a needle. The warming does not interfere with the staining reaction of alum-carmin, hæmatoxylin, or any of the usual stains.

Dowdy, S. E.—**Micro-mounting methods for amateurs.**
[A useful compendium for beginners.]
English Mechanic, lxxix. (1904) pp. 580–2.

(6) Miscellaneous.

Demonstrating Fœtal Cartilage.‡—Halvar Lundvall, after alluding to Wijhe's method,§ describes his own procedure: (1) Fixation in 10 p.c. formalin for at least 48 hours; (2) 95 p.c. alcohol for at least 48 hours; (3) $\frac{1}{4}$ p.c. toluidin blue in hydrochloric acid alcohol for some days at 40° C.; (4) decolorising in hydrochloric acid alcohol at 40° C.; (5) 95 p.c. alcohol (frequently changed) for some days; (6) dehydrating in absolute alcohol for 24 to 48 hours or longer; (7) 2 parts absolute alcohol plus 1 part benzol for 12 to 24 hours; (8) 2 parts benzol plus 1 part absolute alcohol for 24 to 48 hours;

* Zeitschr. wiss. Mikr., xxi. (1904) pp. 25–7.
† Deutsch. Med. Wochenschr., No. 32 (1903). See also Zeitschr. angew. Mikr., ix. (1903) pp. 210–1.
‡ Anat. Anzeig., xxv. (1904) pp. 219–22.
§ See this Journal, 1902, p. 372.

(9) pure benzol; (10) carbon bisulphide; (11) carbon bisulphide 1 part plus benzol 4 parts. The preparations are preserved in small glass jars, the lids being luted on with sodium silicate.

Preparation of Slides for Blood Films.* — A. E. Wright states that ideally perfect films can be obtained by simply rubbing the slide with the finest emery-paper. The paper is mounted on a stout cylindrical roller by means of a rubber ring. In making a film a drop of blood is placed on a slide thus prepared; another slide is brought down on it, and as soon as the blood has spread out in the included angle the upper slide is drawn along the surface of the lower. The foregoing method is ill-adapted for a differential count of white corpuscles unless a line be ruled with a needle longitudinally from end to end through the equatorial region of the film. The count should then proceed from one end of the equator to the other.

SHENTON, J. P.—**Application of the Microscope to the study of potable water.** *Trans. Manchester Micr. Soc.*, 1903, pp. 41–53.

SIMON, R.—**Dendritic forms in paper.** *Tom. cit.*, pp. 92–5 (1 pl.).

Metallography, etc.

Hard and Soft States in Metals.†—G. T. Beilby, in a paper read before the Faraday Society, advances the following argument on the above subject. Metals ordinarily occur in two distinct solid phases—the hardened or amorphous (A phase), and the annealed or crystalline (C phase). The A phase is transformed into the C phase by the agency of heat; the C phase is transformed into the A phase by mechanically produced flow. In the transformations $A \rightleftarrows C$ there are two intermediate mobile phases, M and M′, so that the transformations may be written $A \rightarrow M' \rightarrow C$ and $C \rightarrow M \rightarrow A$. The author's experiments and observations lead to the conclusion that mere modifications of the crystalline state in respect of the arrangement and size of the crystals, forming the solid mass of a particular metal, are insufficient to explain the difference between its hard and solid state. He considers that the kind of hardening which is due to purely mechanical force involves a process the effect of which is to cause the breaking down of the crystalline condition more or less completely, and the production of a superficial, and sometimes inter-crystalline, flow of the metal, which transforms it from the crystalline to the amorphous state.

Influence of Varying Casting Temperature on the Properties of Steel and Iron Castings.‡—P. Longmuir concludes, as the result of prolonged microscopical research, that a suitable casting temperature for any given alloy is not constant, but varies with the form and weight of the casting. Other determining conditions are the rate of pouring, the form of runner and gate, and the distance travelled by the metal before entering the mould. By taking advantage of these determining conditions, and commencing with a sufficiently high casting temperature,

* Lancet, 1904, II. p. 73.

† Electro-chemist and Metallurgist (June 1904) pp. 806–26 (5 figs. and 20 photomicrographs.

‡ Iron and Steel Mag., viii. (July 1904) pp. 32–47 (20 figs.); Iron and Steel Institute May (1904) Meeting.

matters can be readily arranged so that each mould is poured at the correct heat. In determining this correct heat, experience must, until a very considerable advance has been in pyrometer methods, be the only guide. Empirical though this may be, when carefully applied regularly successful results follow.

Structure of Metals.*—J. A. Ewing, in the Rede lecture, deals with the insight into the structure of metals as yielded by metallographic methods of research. He showed by lantern projection how the crystalline nature of metals could be observed, and pointed out how stress produced slip-lines among the crystals. This was of great practical interest in connection with "fatigue" in metals, which was shown to be due first to slips appearing on isolated grains, and then to the development of these slips into cracks. He dealt at length with binary alloys and eutectics, giving it as his opinion that the formation of a eutectic occurred by alternate surfusion or supersaturation of each constituent in the other. Eutectics in which the constituents were not of the same crystalline system appeared to be mechanically weak. The properties connected with recalescence were illustrated by experiments on a steel wire coiled into the form of a spring, and carrying a light weight. The spring extended in a conspicuous way while the process of re-crystallisation associated with recalescence was going on. The gradual changes of structure which go on even at atmospheric temperature in lead and other metals after the structure has been broken up by severe straining were next described, and, in conclusion, the lecturer referred to the analogous case of glacier-ice, which had for long been known to possess a granular structure, each grain being a crystal, just as in the case of metals. Photographs by Principal Skinner, illustrating this granular structure, were shown. In the upper névé the grains were vague and comparatively small; as the glacier slowly travelled down, the grains became consolidated and large, and their outlines became well defined. Clearly a slow process of crystal growth was going on, and it was to this very process of growth that the plasticity of the glacier as a whole was to be ascribed. Nothing was more striking to a worker in this field than the evidence to be found that those substances on which we were most accustomed to rely as constant were undergoing, sometimes comparatively fast and sometimes very slowly, a process of internal flux. A monument more enduring than brass might be a lofty ideal, but it was seen at least to be an ideal easy of conception when one realised how far from constant the inner structure of brass and other metals was apt to be.

BOYNTON, H. C.—**Troostile.** *Iron and Steel Mag.*, vii. (June 1904) pp. 606–28 (22 figs.).

HOFMAN, H. O., GREEN, C. F., & YERXA, R. B.—**Laboratory study of the stages in the Refining of copper.**
[Micrographic studies of a number of copper samples in different stages were made; full statistics are given.]
Technology Quarterly and Proc. of Soc. Arts, xvii. (March 1904) pp. 76–100 (6 tables of statistics, 31 figs.).

JOHNS, C.—**Notes on the production and thermal treatment of steel in large masses.** *Iron and Steel Mag.*, vii. (June 1904) pp. 596–606 (7 figs.).

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* Abstract of Rede lecture before the University of Cambridge, June 11, 1904; and Nature, 1808 (June 23, 1904), pp. 187–8.

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DECEMBER 1904.

XI.—*Report on the Recent Foraminifera of the Malay Archipelago, collected by Mr. A. Durrand, F.R.M.S.—Part XVII. (Conclusion).*

By Fortescue William Millett, F.R.M.S.

(*Read October 19th*, 1904.)

Plate XI.

Calcarina d'Orbigny.

Calcarina Spengleri Linné sp.

"Ammonshorn" Spengler, 1781, Danske Selsk. Skrifter, vol. i. p. 379, pl. ii. fig. 9. *Calcarina Spengleri* (Gmel.) d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 276, No. 4. *C. Spengleri* (Linné) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 423, pl. xix. figs. 4–6. *C. calcitropoides* (Lam.) Idem, 1899, Ibid., vol. xxi. p. 167, pl. xvii. figs. 18, 38, pl. xxii. fig. 36.

This form is not uncommon at Stations 2, and 22. The examples are moderately large, and exhibit the usual variations.

Calcarina hispida Brady.

Calcarina Spengleri (Linné) hispid var. Carpenter, 1860, Phil. Trans., vol. cl. p. 551, pls. xix. figs. 8–11, xx. figs. 6, 8. *C. hispida* Brady, 1876, Proc. R. Irish Acad., ser. 2, vol. ii. p. 590. *C. hispida* (Brady) Lister, 1895, Phil. Trans., vol. clxxxvi. p. 437, pl. viii. figs. 34–37.

EXPLANATION OF PLATE XI.

Fig. 1.—*Nonionina orbicularis* Brady. × 75.
„ 2.—*Polystomella crispa* Linné sp. Abnormal. × 75.
„ 3.— „ *verriculata* Brady. × 60.
„ 4.—*Miliolina excisa* Brady, Parker, and Jones. × 115.
„ 5, 6.—*Pelosina distoma* sp. n. × 115.
„ 7.—*Thurammina favosa* Flint, var × 140.

In the Malay Archipelago the distribution of this form is identical with that of *C. Spengleri.* The examples are neither numerous nor large.

Brady in his 'Challenger' Report states that it has been observed at ten Stations, all of them amongst the Islands of the Pacific. The depths range from 3 to 155 fathoms.

Calcarina Defrancii d'Orbigny.

Calcarina Defrancii d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 276, pl. xiii. figs. 5–7.

In the Malay Archipelago, this is the most abundant species of the genus, and it occurs at several Stations in both Areas. The examples have the characters of the one figured by Brady in the 'Challenger' Report.*

According to Brady the best examples in the 'Challenger' collection have been found associated with the type, at one or two Stations in the Eastern Archipelago, notably off the Admiralty Islands, 15 to 25 fathoms. D'Orbigny's locality is the Red Sea.

Sub-Family **Tinoporinæ.**

Tinoporus Montfort.

Tinoporus baculatus Montfort.

Tinoporus baculatus Montfort, 1808, Conch. Syst., vol. i. p. 146, Genre 37. *T. baculatus* (Carp.) Dervieux, 1893, Atti R. Accad. Sci. Torino, vol. xxix. p. 6, pl. figs. 19, 26, 34. *T. baculatus* (Montf.) Sherlock, 1903, Bull. Mus. Comp. Zool. Harvard College, vol. xxxviii. p. 357, fig. 8.

The form is very rare in the Malay Archipelago, and has been noted only at Station 2, in Area 1.

Gypsina Carter.

Gypsina vesicularis Parker and Jones, sp.

Orbitolina vesicularis Parker and Jones, 1860, Ann. and Mag. Nat. Hist., ser. 3, vol. vi. p. 31, No. 5. *Gypsina vesicularis* (P. and J.) Carter, 1877, Ibid. ser. 4, vol. xx. p. 173. *G. vesicularis* (P. and J.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 382, pl. xiv. figs. 20–23. *G. vesicularis* (P. and J.) Jones, 1897, Palæont. Soc., p. 335, fig. 25. *G. vesicularis* (P. and J.) Chapman, 1900, Journ. Linn. Soc. (Zool.), p. 198, pl. xix. fig. 12.

This is rather rare, but occurs at Stations in both Areas.

* Plate cviii. fig. 6.

Gypsina inhærens Schultze, sp.

Acervulina inhærens Schultze, 1854, Organ. Polythal., p. 68, pl. vi. fig. 12. *Gypsina inhærens* (Schultze) Brady, 1884, Chall. Rept., p. 718, pl. cii. figs. 1–6. *G. inhærens* (Schultze) Brady, Parker, and Jones, 1888, Trans. Zool. Soc., vol. xii. p. 229, pl. xli. fig. 19. *G. inhærens* (Schultze) Goës, 1894, K. Svenska Vet.-Akad. Handl., vol. xxv. p. 91. pl. xv. fig. 787. *G. inhærens* (Schultze Flint, 1899, Rep. U.S. Nat. Mus. for 1897 (1899) p. 336, pl. lxxix. fig. 6.

This is less rare than the preceding form, and is found in small numbers at several Stations in both Areas. The individuals exhibit the usual irregularities of growth, and size.

Family NUMMULINIDÆ.

Sub-Family **Polystomellinæ.**

Nonionina d'Orbigny.

Nonionina depressula Walker and Jacob, sp.

Nautilus spiralis utrinque subumbilicatus, &c. Walker and Jacob, 1784, Test. Min., p. 19, pl. iii. fig. 68. *Nautilus depressulus* Walker and Jacob, 1798, Adams's Essays, Kanmacher's edition, p. 641, pl. xiv. fig. 33. *Nonionina depressula* (W. and J.) Parker and Jones, 1859, Ann. and Mag. Nat. Hist., ser. 3, vol. iv. pp. 339, 341. *Pulvinulina nonionoides* Andreae, 1884, Abhandl. geol. Special-Karte Elsass-Loth., vol. ii. p. 256, pl. xi. fig. 2. *Nonionina depressula* (W. and J.) Brady, Parker, and Jones, 1888, Trans. Zool. Soc., vol. xii. p. 229, pl. xliii. fig. 25. *N. depressula* (W. and J.) Terrigi, 1889, Mem. R. Accad. Lincei, ser. 4. vol. vi. p. 119, pl. x. fig. 4; Idem, 1891, Mem. R. Com. Geol. Italia, vol. iv. p. 109, pl. iv. fig. 16. *N. depressula* (W. and J.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 427, pl. xix., figs. 38, 39. *N. depressula* (W. and J.) Goës, 1894, K. Svenska Vet.-Akad. Handl., vol. xxv. p. 103, pl. xvii. figs. 825, 826. *N. depressula* (W. and J.) Morton, 1897, Proc. Portland Soc. Nat. Hist., vol. ii. p. 121, pl. i. fig. 20. *N. depressula* (W. and J.) Jones, 1897, Palæont. Soc., p. 347. *N. depressula* (W. and J.) Wright, 1900, Geol. Mag., dec. 4, vol. vii. p. 100, pl. v. fig. 23. *N. depressula* (*N. complanata* d'Orb.) Fornasini, 1904, Mem. R. Accad. Sci. Ist. Bologna, ser. 6, vol. i. p. 12, pl. iii. fig. 6.

This species is abundant in Area 2, and occurs sparingly at a few Stations in Area 1. The forms vary in the direction of *N. asterizans*.

Nonionina orbicularis Brady, plate XI. fig. 1.

Nonionina orbicularis Brady, 1881, Denkschr. k. Akad. Wiss. Wien., vol. xliii. p. 105, pl. ii. fig. 5. *N. depressula* var. *orbicularis* (Brady) Madsen, 1895, Medd. Dansk Geol. Forening, No. 2, p. 217, pl. fig. 7.

This essentially northern form is very rare, and represented only at Station 22, in Area 2. The examples are quite characteristic, even to the granulation of the sutures shown in Brady's figures.

Nonionina stelligera d'Orbigny.

Nonionina stelligera d'Orbigny, 1839, Foram. Canaries, p. 128, pl. iii. figs. 1, 2. *N. stelligera* (d'Orb.) Fornasini, 1889, Minute forme Rizopod. Retic., pl., fig. 32. *N. stelligera* (d'Orb.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 425, pl. xix. fig. 44. *N. stelligera* (d'Orb.) Goës, 1894, K. Svenska Vet.-Akad. Handl., vol. xxv. p. 104, pl. xvii. figs. 827, 828. *N. stelligera* (d'Orb) Morton, 1897, Proc. Portland Soc. Nat. Hist., vol. ii. p. 121, pl. i. fig. 18. *N. stelligera* (d'Orb.) (*N. elegans* d'Orb.) Fornasini, 1899, Mem. R. Accad. Sci. Ist. Bologna, ser. 5, vol. vii. p. 654, fig. 5.

This occurs at Stations in both Areas, but is very rare.

Nonionina umbilicatula Montagu sp.

Nautilus umbilicatulus Montagu, 1803, Test. Brit., p. 191; Suppl., p. 78, pl. xviii. fig. 1. *Nonionina asterizans* (F. and M.) var. *umbilicatula* Parker and Jones, 1859, Ann. and Mag. Nat. Hist., ser. 3, vol. iv. p. 347. *N. umbilicatula* (Montagu) Brady, Parker, and Jones, 1888, Trans. Zool. Soc., vol. xii. p. 230, pl. xliii. fig. 19. *N. umbilicatula* (Montagu) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 426, pl. xix. figs. 36, 37. *N. umbilicatula* (Montagu) Silvestri, 1893, Atti e Rendic. Acad. Sci. Lett. e Arti dei Zelanti di Acireale, vol. v. p. 20, pl. iii. figs. 26, 27. *N. umbilicatula* (Montagu) Goës, 1894, K. Svenska Vet.-Akad. Handl., vol. xxv. p. 103, pl. xvii. fig. 823. *N. Soldanii* (d'Orb.) Egger, 1895, Naturhist. Ver. Passau, Jahresber. xvi. p. 40, pl. iii. fig. 18. *N. umbilicatula* (Montagu) Jones, 1897, Palæont. Soc., p. 345, fig. 29. *N. umbilicatula* (Montagu) var. *depressula* Silvestri, 1899, Mem. Pontif. Accad. Nuovi Lincei, vol. xv. p. 331, pl. vi. fig. 15. *N. Soldanii* (d'Orb.) Egger, 1899, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xxi. p. 174, pl. xxii. figs. 7, 8. *N. umbilicatula* (Montagu) Chapman, 1900, Proc. California Acad. of Sci., ser. 3, Geol., vol. i. p. 256, pl. xxx. fig. 15.

A few characteristic examples occur at Stations in both Areas.

Nonionina pompilioides Fichtel and Moll sp.

Nautilus pompilioides Fichtel and Moll, 1798, Test. Micr., p. 31, pl. ii. figs. *a–c*. *Nonionina pompilioides* (F. and M.) Parker, Jones, and Brady, 1865, Ann. and Mag. Nat. Hist., ser. 3, vol. xvi. p. 18. pl. iii. fig. 98. *N. pompilioides* (F. and M.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 426, pl. xix. figs. 32, 33. *N. Soldanii*,(d'Orb.) Idem, 1895, Naturhist. Ver. Passau, Jahresber. xvi. p. 40, pl. iii. fig, 16. *N. pompilioides* (F. and M.) Chapman, 1900, Proc. California Acad. of Sci., ser. 3, Geol., vol. i. p. 256, pl. xxx. fig. 16.

As might be anticipated, this deep-water form is not well represented in the anchor-mud of the Malay Archipelago. It has been observed only at Station 11, in Area 1, and is there very rare.

Brady states that it is almost exclusively a deep-water Foraminifer, and mentions several localities where it has occurred at depths of from 1000 to 2750 fathoms. Amongst numerous 'Gazelle' Stations one has a depth of as little as 75 fathoms.

Nonionina scapha Fichtel and Moll sp.

Nautilus scapha Fichtel and Moll, 1798, Test. Micr., p. 105 pl. xix. figs. *d–f*. *Polystomella crispa* (Linné) var. *Nonionina scapha* (F. and M.), Parker and Jones, 1865, Phil. Trans., vol. clv. p. 404, pl. xvi. figs. 37, 38, pl. xviii. figs. 55, 56. *N. scapha* (F. and M.) Brady, Parker, and Jones, 1888; Trans. Zool. Soc., vol. xii. p. 230, pl. xliii. fig. 20. *N. scapha* (F. and M.) Terrigi, 1889, Mem. R. Accad. Lincei, ser. 4, vol. vi. p. 120, pl. x. fig. 7; Idem, 1891, Mem. R. Com. Geol. d'Italia, vol. iv. p. 110, pl. iv. fig. 18. *N. scapha* (F. and M.) Woodward and Thomas, 1893, Geol. and Nat. Hist. Survey of Minnesota, vol. iii. p. 48, pl. E, figs. 35, 36. *N. scapha* (F. and M.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 424, pl. xix. figs. 43, 44. *N. scapha* (F. and M.) Goës, 1894, K. Svenska Vet.-Akad. Handl., vol. xxv. p. 104, pl. xvii. fig. 830. *N. scapha* (F. and M.) Egger, 1895, Naturhist. Ver. Passau, Jahresber. xvi. p. 40, pl. iii. fig. 17. *N. scapha* (F. and M.) Morton, 1897, Proc. Portland Soc. Nat. Hist., vol. ii. p. 121, pl. i. fig. 23. *N. scapha* (F. and M.) Jones, 1897, Palæont. Soc., p. 342, fig. 27. *N. scapha* (F. and M.) Egger, 1899, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xxi. p. 175, pl. xxv. fig. 56. *N. scapha* (F. and M.) Flint, 1899, Rep. U.S. Nat. Mus. for 1897 (1899) p. 337, pl. lxxx. fig. 1. *N. scapha* (F. and M.) (*N. elongata* d'Orb.) Fornasini, 1904, Mem. R. Accad. Sci. Ist. Bologna, ser. 6, vol. i. p. 12, pl. iii. fig. 4. *N. scapha* (F. and M.) (*N. Grateloupi* d'Orb.), Idem, Ibid., p. 12, pl. xiii. fig. 5.

Nonionina Boueana d'Orbigny.

Nonionina Boueana d'Orbigny, 1846, For. Foss. Vienne, p. 108, pl. v. figs. 11, 12. *N. Boueana* (d'Orb.) Terrigi, 1889, Mem. R. Accad. Lincei, ser. 4, vol. vi. p. 119, pl. x. fig. 5; Idem, 1891, Mem. R. Geol. Italia, vol. iv. p. 110, pl. iv. fig. 17. *N. Boueana* (d'Orb.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 426, pl. xix. figs. 34, 35. *N. Boueana* (d'Orb.) Goës, 1894, K. Svenska Vet.-Akad. Handl., vol. xxv. p. 104, pl. xvii. fig. 829. *N. Boueana* (d'Orb.) Egger, 1899, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xxi. p. 175, pl. xxii. figs. 11, 12. *N. Boueana* (d'Orb.) var. *senensis* Silvestri, 1899, Mem. Pontif. Accad. Nuovi Lincei, vol. xv. p. 335, pl. xi. fig. 16. *N. Boueana* (d'Orb.) Fornasini, 1900, Mem. R. Accad. Sci. Ist. Bologna, ser. 5, vol. viii. p. 400, fig. 49. *N. Boueana* (d'Orb.) (*Polystomella umbilicata* d'Orb.) Idem, 1904; Ibid., ser. 6, vol. i. p. 13, pl. iii. fig. 11.

These two forms are found associated in great abundance throughout the Region. Whilst there are numerous typical examples of both forms, there is also a great mass of individuals in which the characters are mixed up in such bewildering confusion that it would be vain to attempt to assign them to either one or other of the types.

Nonionina turgida Williamson sp.

Rotalina turgida Williamson, 1858, Rec. Foram. Gt. Britain, p. 50, pl. iv. figs. 95–97. *Nonionina asterizans* var. *turgida* (Will.) Parker and Jones, 1862, In Carpenter's Introd. Foram., App., p. 311. *N. turgida* (Will.) Terquem, 1886, Bull. Soc. Zool. France, vol. xi. p. 331, pl. xi. figs. 7, 8. *N. turgida* (Will.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 425, pl. xix., figs. 45, 46. *N. turgida* (Will.) Schubert, 1900, "Lotos," vol. xx. p. 97, pl. i. fig. 10; and *turgida* var. *inflata*, p. 97, pl. ii. fig. 6.

In the Malay Archipelago this is as widely distributed as the two preceding forms, but is not quite as abundant. Its affinities are with *N. Boueana*.

Polystomella Lamarck.

Polystomella striatopunctata Fichtel and Moll sp.

Nautilus striatopunctatus Fichtel and Moll, 1798, Test. Micr., p. 61, pl. ix. figs. *a–c*. *Polystomella striatopunctata* (F. and M.) Parker and Jones, 1860, Ann. and Mag. Nat. Hist., ser. 3, vol. v. p. 103, No. 6. *P. striatopunctata* (F. and M.) Brady, Parker, and Jones, 1888, Trans. Zool. Soc., vol. xii. p. 230, pl. xliii. fig. 17. *P. striatopunctata* (F. and M.) Terrigi, 1889, Mem. R. Accad.

Lincei, ser. 4, vol. vi. p. 120, pl. x. fig. 2. *P. striatopunctata* (F. and M.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 433, pl. xix. figs. 49, 50. *P. striatopunctata* (F. and M.) Goës, 1894, K. Svenska Vet.-Akad. Handl., vol. xxv. p. 101, pl. xvii. figs. 815 (partim), 822. *P. striatopunctata* (F. and M.) Morton, 1897, Proc. Portland Soc. Nat. Hist., vol. ii. p. 122, pl. i. fig. 19. *P. striatopunctata* (F. and M.) Wright, 1900, Geol. Mag., dec. 4, vol. vii. p. 100, pl. v. fig. 24. *P. striatopunctata* (F. and M.) (*P. oceanensis* d'Orb.) Fornasini, 1904, Mem. R. Accad. Sci. Ist. Bologna, ser. 6, vol. i. p. 13, pl. iii. fig. 10. *P. striatopunctata* (F. and M.) (*P. burdigalensis* d'Orb.) Idem, Ibid., p. 13, pl. iii. fig. 12.

Polystomella crispa Linné sp., plate XI., fig. 2.

"Cornu Hammonis minus vulgare, Orbiculatum," &c., Plancus, 1739, Conch. Min., p. 10, pl. i. fig. 2. *Nautilus crispus* Linné, 1767, Syst. Nat., ed. 12, p. 1162, No. 275. *Polystomella crispa* (Linn.) Lamarck., 1822, Anim. sans Vert., vol. vii. p. 625, No. 1. *P. flexuosa* (d'Orb.) Walther, 1888, Mitth. Zool. Stat. Neapel, vol. viii. p. 382, pl. xx. fig. 5. *P. crispa* (Linn.) Verworn, 1888, Zeitschr. Wiss. Zool., vol. xlvi. p. 462, pl. xxxii. figs. 7–9, and figs. *g, h, i*. *P. crispa* (Linn.) Terrigi, 1889, Mem. R. Accad. Lincei, ser. 4, vol. vi. p. 120, pl. x. fig, 6. *P. crispa* (Linn.) Silvestri, 1893, Mem. Pontif. Accad. Nuovi Lincei, vol. ix. p. 216, pl. iv. fig. 3. Idem, Atti e Rendic. Accad. Sci. Lett. e Arti dei Zelanti Acireale, vol. v. p. 21, pl. iii. figs. 28, 29. *P. crispa* (Linn.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 432, pl. xx. figs. 20, 21. *P. crispa* (Linn.) Goës, 1894, K. Svenska Vet.-Akad. Handl., vol. xxv. p. 102, pl. xvii. figs. 820, 821. *P. crispa* (Linn.) Lister, 1895, Phil. Trans., vol. clxxxvi. p. 414, pl. vi. figs. 1–3, 5–12, pl. vii. figs. 13–27, pl. viii. figs. 28–32. *P. crispa* (Linn.) Flint, 1899, Rep. U.S. Nat. Mus. for 1897 (1899) p. 338, p. lxxx. fig. 3. *P. crispa* (Linn.) Rhumbler, 1902, Zeitschr. für allgem. Phys., vol. ii. part 2, p. 233, fig. 64. *P. crispa* (Linn.) Lister, 1903, The Foraminifera, in Lankester's Zoology, p. 62, figs. 7–12. *P. crispa* (Linné) = *angularis* (d'Orb.) Fornasini, 1904, Mem. R. Accad. Sci. Ist. Bologna, ser. 6, vol. i. p. 12, pl. iii. fig. 7.

Wherever there is an abundance of examples, the characters of these two forms become so involved that it is impossible to draw anything like a distinct line of separation between them. The rounded margin and small circular depressions of *striatopunctata*, and the acute or carinate periphery, together with the retral processes reaching from septal band to septal band, characteristic of *crispa*, are mixed together in inextricable confusion.

Both forms are abundant in the Malay Archipelago, and exhibit great variety of character, some examples being covered with short

spines, whilst others add to the nauteloid a linear series of chambers, as in the example of *P. crispa* here figured.

Although many of the specimens of *P. crispa* are much compressed, none of them have the other characters of *P. macella.*

Polystomella subnodosa Münster sp.

Robulina subnodosa Münster (fide Römer), 1838, Neues Jahrb. für Min., p. 391, pl. iii. fig. 61. *Polystomella subnodosa* (Münst.) Reuss, 1856, Sitzungsber. K. Akad. Wiss. Wien, vol. xviii. p. 240, pl. iv. fig. 51. *P. subnodosa* (Münst.) Goës, 1894, K. Svenska Vet.-Akad. Handl., vol. xxv. p. 102, pl. xvii. figs. 817–819. *P. subnodosa* (Münst.) Fornasini, 1897, Rendic. Accad. Sci. Ist. Bologna, n. s., vol. ii. pl. i. fig. 12.

Although the form is compounded of characters taken from both *P. crispa* and *P. striatopunctata*, it is subject to but little variation, and the examples can usually be identified without difficulty.

In the Malay Archipelago it is found at several Stations in both Areas, and is abundant at Stations 13, 18, and 21.

Polystomella vericulata Brady, plate XI. fig. 3.

Polystomella verriculata Brady, 1881, Quart. Journ. Micr. Sci., n. s., vol. xxi. p. 66; and 1884, Chall. Rept., p. 738, pl. cx. fig. 12.

This form occurs at most of the Stations in the Malay Archipelago. The reticulations of the surface are much more delicate than those of the example figured by Brady. Specimens of a similar character occur in some sea-sand from Sagami Bay, Japan, for which I am indebted to the kindness of Prof. Yokoyama of Tokio.

Brady gives two 'Challenger' Stations, both off the west coast of Australia.

Polystomella craticulata Fichtel and Moll sp.

Nautilus craticulatus Fichtel and Moll, 1798, Test. Micr., p. 51, pl. v. figs. *h*, *i*, *k*. *Polystomella craticulata* (F. and M.) d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 284, No. 3? *P. iberica* Schrodt, 1890, Zeitschr. deutsch. geol. Gesell., vol. xlii. p. 417, pl. xxii. fig. 9. *P. craticulata* (F. and M.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 433, pl. xx. figs. 24, 25.

A few fine examples occur at several Stations in both Areas.

Under the name of *P. iberica*, Schrodt describes a similar form from the Spanish Pliocene. If identical, this would be the first record of its occurrence in the fossil condition.

Sub-Family **Nummulitinæ.**

Amphistegina d'Orbigny.

Amphistegina Lessonii d'Orbigny.

Amphistegina Lessonii d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 304, No. 3, pl. xvii. figs. 1–4; Modèle No. 98. *A. vulgaris*, Id. Ibid., p. 305, No. 8; Modèle No. 40. *A. vulgaris* (d'Orb.) Amicis, 1886, Atti Soc. Tosc. Sci. Nat., (Mem.) vol. vii. p. 242, pl. xi. fig. 2. *A. Lessonii* (d'Orb.) Bütschli, 1886, Morph. Jahrb., vol. xi. p. 86, pl. vi. figs. 7, 8. *A. Lessonii* (d'Orb.) Brady, Parker, and Jones, 1888, Trans. Zool. Soc., vol. xii. p. 230, pl. xliii. fig. 15. *A. Lessonii* (d'Orb.) Terrigi, 1889, Mem. R. Accad. Lincei, ser. 4, vol. vi. p. 121, pl. ix. figs. 6–8. *A. Lessonii* (d'Orb.) Dreyer, 1891, Jenaische Zeitsch. für Naturwiss., vol. xxvi. pl. xxviii. fig. 267. *A. Lessonii* (d'Orb.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 431, pl. xx. figs. 18, 19. *A. Lessonii* (d'Orb.) Zittel, 1896, Bull. Soc. Géol. France, sér. 3, vol. xxiv. p. 969, fig. 1^{1-7}. *A. Lessonii* (d'Orb.) Flint, 1899, Rep. U.S. Nat. Mus. for 1897 (1899), p. 338, pl. lxxxii. fig. 4. *A. Lessonii* (d'Orb.) Chapman, 1901, Proc. R. Soc. Edinburgh, vol xxiii. p. 394, pl. iii. fig. 2. *A. vulgaris* (d'Orb.) Newton and Holland, 1902, Journ. Coll. Sci. Imp. Univ. Tōkyō, vol. xvii. p. 16, pl. ii. fig. 1. *A. Lessonii* (d'Orb.) Fornasini, 1903, Rendic. R. Accad. Sci. Ist. Bologna, n. s., vol. vii. pl. ii. fig. 1. *A. Lessonii* (d'Orb.) Sherlock, 1903, Bull. Mus. Comp. Zool. Harvard College, vol. xxxviii. p. 356, fig. 5.

This form is not abundant, but it occurs at several Stations, and is most frequent in Area 1.

Amphistegina Cumingii Carpenter.

Amphistegina Cumingii Carpenter, 1859, Phil. Trans., vol. cxlix. p. 32, pl. v. figs. 13–17, pl. vi. figs. 5, 6. *A Cumingii* Murray and Renard, 1891, Chall. Rept. 'On Deep Sea Deposits,' pls. xiii., xiv.

Is represented by a few examples from one or two Stations in both Areas.

Whether this species should be assigned to *Amphistegina* or to *Nummulina* is still undecided. The Malay specimens exhibit a greater affinity with *Operculina* than with *Nummulina*.

Operculina d'Orbigny.

Operculina complanata Defrance sp.

Lenticulites complanata Defrance, 1822, Dict. Sci. Nat., vol. xxv. p. 453. *Operculina complanata* (Basterot) d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 281, No. 1, pl. iv. figs. 7–10; Modèle, No. 80. *O. complanata* (Defr.) Woodward and Thomas, 1885, 13th Ann.

Rept. Geol. and Nat. Hist. Survey of Minnesota for 1884, p. 175, pl. iv. fig. 35. *Operculina* sp. Blackenhorn, 1890, Zeitschr. deutsch. geol. Gesell., p. 339, pl. xvii. figs. 2, 3. *O. complanata* (Defr.) Woodward and Thomas, 1893, Geol. and Nat. Hist. Survey of Minnesota, vol. iii. p. 45, pl. E. fig. 37. *O. complanata* (Defr.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 435, pl. xx. figs. 40–42. *O. complanata* (Defr.) Jones, 1897, Palæont. Soc., p. 362, pl. ii. figs. 49, 50. *O. complanata* (Defr.) Newton and Holland, 1902, Journ. Coll. Sci. Imp. Univ. Tōkyō, p. 13. pl. i. figs. 3, 5, pl. iii. fig. 3. *O. complanata* (Defr.) Lister, 1903, The Foraminifera, in Lankester's Zoology, p. 126, fig. 55.

Operculina complanata var. *granulosa* Leymerie.

Operculina granulosa Leymerie, 1846, Mém. Soc. Géol. France, sér. 2, vol. i. p. 359, pl. xiii. fig. 12. *O. complanata* var. *granulosa* (Leym.) Woodward and Thomas, 1885, 13th Ann. Rept. Geol. and Nat. Hist. Survey of Minnesota for 1884, p. 176, pl. iv. fig. 36. *O. granulosa* (Leym.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii., p. 435, pl. xx. figs. 36, 37, 43. *O. complanata* var. *granulosa* (Leym.) Idem, 1899, Ibid. vol. xxi. p. 175, pl. xix. figs. 33, 34. *O. complanata* var. *granulosa* (Leym.) Newton and Holland, 1902, Journ. Coll. Sci. Imp. Univ. Tōkyō, vol. xvii. p. 14, pl. ii. fig. 4, pl. iii. fig. 5.

Both these forms occur in the two Areas, and mostly at the same Stations. With few exceptions the examples are small and ill-developed.

Heterostegina d'Orbigny.

Heterostegina depressa d'Orbigny.

Heterostegina depressa d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 305, No. 2, pl. xvii. figs. 5–7; Modèle, No. 99. *H. depressa* (d'Orb.) Terrigi, 1889, Mem. R. Accad. Lincei, ser. 4, vol. vi. p. 122, pl. x. fig. 1. *H. curva* (Moebius) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 434, pl. xx. figs. 26–31; and *H. depressa* (d'Orb.) p. 433, pl. xx. figs. 34, 35. *H. depressa* (d'Orb.) Jones and Chapman, 1900, In A Monograph of Christmas Island, p. 229, pl. xx. fig. 1. *H. depressa* (d'Orb.) Chapman, 1900, Journ. Linn. Soc. (Zool.), vol. xxviii. p. 18, pl. iii. figs. 6, 7; Idem, 1900, Geol. Mag., n. s., dec. 4, vol. vii. pl. xiii. fig. 7; Idem, 1902, Ibid., vol. ix. p. 10, pl. iv. fig. 1. *H. depressa* (d'Orb.) Lister, 1903, The Foraminifera, in Lankester's Zoology, p. 128, fig. 56. *H. suborbicularis* (d'Orb.) (cf. *H. depressa* d'Orb.) Fornasini, 1903, Boll. Soc. Geol. Italiana, vol. xxii. p. 396, pl. xiv. figs. 5, 6.

This form is represented in the Malay Archipelago by a few small examples occurring at Stations in Area 1.

APPENDIX.

Miliolina excisa Brady, Parker, and Jones, plate XI. fig. 4.

Miliolina excisa Brady, Parker, and Jones, 1888, Trans. Zool. Soc., vol. xii. p. 215, pl. xl. fig. 33.

A solitary example of this form has been found in the material from Station 7. The *M. cristata* described and figured in Part II. of this Report differs in having only one dentate ridge.

Brady, Parker, and Jones's specimens were from the Abrohlos Bank; depth 31 fathoms.

A somewhat similar form from Delos has been described and figured by my friend Mr. H. Sidebottom, under the name of *M. seminulum* var. *cornuta*.*

Miliolina crassatina Brady.

Miliolina incrassata Brady, 1881, Quart. Journ. Micr. Sci., n. s., vol. xxi. p. 46. *M. crassatina* Idem, 1884, Chall. Rept., p. 180, pl. viii. fig. 5.

A very few examples of this ambiguous form occur at two Stations in Area 1, and at one Station in Area 2. The minute crescentic aperture is in some examples concealed by the coarse grains of sand composing the test.

Brady writes, "*Miliolina crassatina* is exceedingly rare. It has only been met with in a single dredging, off East Moncœur Island, Bass Strait, 38 fathoms."

Sigmoilina tenuis Czjzek.

Quinqueloculina tenuis Czjzek, 1848, Haidinger's Naturw. Abhandl., vol. ii. p. 149, pl. xiii. figs. 31–34. *Miliolina tenuis* (Cz.) Balkwill and Wright, 1885, Trans. R. Irish. Acad., vol. xxviii. (Sci.) p. 324, pl. xii. figs. 3–5. *Spiroloculina panda* (Schwager) var. *Rengerriana* Deecke, 1886, Mém. Soc. émul. Montbeliard, sér. 3, vol. xvi. p. 16, pl. i. fig. 28. *Sigmoilina tenuis* (Cz.) Schlumberger, 1887, Bull. Soc. Zool. France, vol. xii. p. 117. *Miliolina* sp. Burrows, Sherborn, and Bailey, 1890, Journ. R. Micr. Soc., p. 551, pl. viii. figs. 2, 3; and *Spiroloculina tenuis* (Cz.) p. 551, pl. viii. fig. 4. *Spiroloculina tenuis* (Cz.) Terrigi, 1891, Mem. R. Com. Geol. d'Italia, vol. iv. p. 65, pl. i. figs. 2, 3. *Spiroloculina tenuis* (Cz.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii.

* Mem. and Proc. Manchester Lit. and Phil. Soc., xlviii., 1904, p. 11, pl. iii. figs. 11, 12.

p. 222, pl. i. figs. 46, 47. *Sigmoilina tenuis* (Cz.) Jones, 1895, Palæont. Soc., p. 125, pl. vii. fig. 2.

This form is represented by a fine but solitary example from Station 13, in Area 1.

Pelosina distoma sp. n., Plate XI. figs. 5, 6.

Test pyriform or fusiform, with a rounded aperture at each extremity, that at the superior end being the larger. From the inferior orifice the chitinous lining protrudes in the form of a short tube. Length 0·35 mm.

In his definition of the genus *Pelosina* Brady specifies "aperture single." This limitation would exclude the species under consideration, but it is so evidently a true *Pelosina* that the emendation of Brady's definition would be less objectionable than the creation of a new genus.

The test of *P. distoma* is unusually dense, and often has a polished surface, which gives it a superficial resemblance to *Glandulina*. Sometimes there is a constriction in the test, as shown by fig. 6. The chitinous membrane is in some specimens visible at the superior orifice, but never forms there a projecting tube as in *P. rotundata*.

In its distribution it appears to be very local, being somewhat abundant at Station 6, and is represented sparingly at Station 22, but these are the only localities where it has been found.

Thurammina favosa Flint, Plate XI. fig. 7.

Thurammina favosa Flint, 1899, Rep. U.S. Nat. Mus. for 1897 (1899) p. 278, pl. xxi. fig. 2. *Thyrammina favosa* (Flint) Rhumbler, 1903, Schaudinn's Archiv für Protistenkunde, vol. iii. p. 236, fig. 65.

This is a doubtful Foraminifer, and I had hesitated in accepting it, but since it has been admitted by Flint and Rhumbler, I feel compelled to include it in the present Report. Like the also doubtful *Reophax pleurostomelloides* before described, there is a certain amount of flexibility about the test reminiscent of the vegetable kingdom, to which possibly both may belong.

In the Malay Archipelago it occurs at several Stations, but is most abundant in Area 1.

The 'Gazelle' Stations are in the Gulf of Mexico; 26 and 420 fathoms.

In conclusion, it should be explained that a few doubtful forms which may or may not be Foraminifera, have purposely been

included in this Report. By thus calling attention to them, their true position in Nature is more likely to be determined, than it would have been, had they been absolutely ignored.

CORRIGENDA AND ADDENDA.

Journ. R. Micr. Soc.

1898.

Page 610,	line	1	from top,	*for*	sp. n.	*read*	sp.

1899.

„ 249,	line	7	from foot	„	Bertholin	„	Berthelin
„ 357	„	10	„	„	× 90	„	× 40
„ 362	„	12	„	„	1895	„	1894
„ 557	„	3	„	„	*Candeina*	„	*Candeiana*
„ 560	„	13	from top	„	*Sagraina affinis*	„	*Textularia concava*
„ 562	„	20	„	„	*Candeina*	„	*Candeiana*
„ 564	„	7	„	„	Fornasini	„	Malagoli

1900.

„ 6	„	3	from foot	„	Reuss	„	Egger sp.
„ 540	„	9	„	„	6	„	10
„ 545	„	9	from top	„	42	„	62
„ 145	„	11	„	„	35	„	65

1901.

„ 4	„	24	„	„	17	„	9
„ 493	„	18	„	„	vii.	„	viii.
„ 496	„	15	„	*after*	sp.	*add*	var.

1902.

523	„	13	„	*for*	Haeussler	*read*	Haeusler

XII.—*Theories of Microscopical Vision: a Vindication of the Abbe Theory.*

By A. E. Conrady, F.R.A.S., F.R.M.S.

(*Read November 16th*, 1904).

In the early days of the compound Microscope, the performance of the instrument was judged on the basis of geometrical optics, viz. it was assumed that an optically perfect instrument should bear unlimited magnification, and that the practical limitation of resolving and defining power was due to insufficient light, and especially to the shortcomings of that long-suffering individual, the manufacturing optician.

But when the undulatory theory of light became more generally known and accepted, a direct connection between the power of optical instruments and the wave-length of the light employed was soon recognised as one of the obvious deductions from that theory.

On the assumption of a self-luminous object and a limiting aperture of 180° in air (N.A. 1·00, we should say now), the great Hermann v. Helmholtz defined that limit for the Microscope in an admirably clear and conclusive paper which must be read in the original, or at least in a straightforward translation, to be appreciated.

On the basis of that theory, microscopical vision becomes comparable with telescopic vision. Each point in the object is represented by a "spurious or diffraction disc" in the image; the latter being composed of an immense number of overlapping "spurious discs," which soften all outlines and suppress detail below the theoretical limit of resolution, but produce an otherwise faithful and exact representation of the object.

It is, however, most important to bear in mind that this convenient and comforting theory assumes that the object behaves like a self-luminous one, that is to say, that each point in the object sends out regular spherical waves independently of all other points, in the same way as the molecules of a white-hot object would do. The opinion seems to be widely held that we can satisfy that assumption by focussing a sharp image of the source of light (usually a lamp flame) upon the object by means of a well corrected condenser, and that by this procedure we can secure images which give perfectly trustworthy indications of all resolvable detail in the object.

If we *could* project a *geometrically* perfect image of a self-luminous surface upon a very thin object, by a wide-angled con-

denser, this assumption would indeed be justified, for each point in the object would send out the regular spherical waves concentrated upon it by the condenser and derived from the conjugate self-luminous point; and, as the light from each point in the object—being derived from a separate and independently vibrating point in the source of light—would also be independent from, and incapable of interference with, that from any other point in the object, the necessary consequence would be that each point in the object formed its own image in the form of a spurious disc, quite independently of adjacent points.

But unfortunately it is quite impossible to strictly realise this ideal state of illumination, and I shall show that even the best conditions to be met with in actual practice depart so far from the ideal that it is quite out of the question to adhere to the belief that the object could behave like a self-luminous one.

The following are the principal reasons for this statement:—

1. Even assuming that the whole illuminating arrangements were absolutely perfect, we should still have to reckon with that spreading of the light concentrated by the condenser which is caused by diffraction, for the condenser, like any other optical instrument, would render each point in the source of light as a spurious disc surrounded by diffraction rings; and, as the former would be at least of the same order of magnitude as the detail resolvable by the Microscope of which that condenser formed part, while the diffraction rings would cover several times that area, we should even then have neighbouring points in the object receiving light from the same source, and therefore the possibility of interference phenomena between the light from such neighbouring points.

2. But the optical perfection assumed is probably never realised, for it implies:—

(*a*) Perfect freedom from spherical and other aberration in the condenser, whilst in reality all condensers, when used with anything approaching full aperture, show considerable residuals of aberration, or, at best, easily recognisable spherical zones; hence the spurious discs produced by actual condensers are very much larger than those assumed above.

(*b*) Optical perfection of other media intervening between the source of light and the object; we should therefore have to have optically worked slips of optical glass instead of the usual ones of badly annealed common glass.

(*c*) Perfect homogeneity of the object. In the majority of cases the object itself would also take a share in spoiling the optical perfection aimed at, for very few objects would be so thin and uniform as to act like a homogeneous plate.

3. The greatest source of diffusion of light is, however, formed by the usual system of obtaining "critical light." For visual

purposes, at any rate, this usually consists in using the edge of the flame of an oil lamp as the source of light. Now this flame is probably about an inch deep in the direction of the optical axis, and, being almost perfectly transparent, a complete image (of three dimensions) is formed of it by the condenser. It is well known that the magnification (or diminution) in the direction of the optical axis is the square of that at right angles to the optical axis (this follows directly by differentiating the formula for conjugate foci: $\frac{1}{l} + \frac{1}{L} = \frac{1}{f}$); and if we take an average case, say a condenser of $\frac{1}{4}$-inch focus used with the lamp 8 inches away, the diminution will be $\frac{\frac{1}{4}}{8} = \frac{1}{32}$; the diminution of the lamp flame in the direction of the optical axis will be the square of this or near enough $\frac{1}{1000}$; the image of our flame of an assumed depth of 1 in. will therefore cover $\frac{1}{1000}$ in. along the optical axis. This *seems* small, but such a condenser would be suitable for high dry powers and objects such as our old friend *Pleurosigma angulatum*, with 50,000 dots to the inch; and if we make the further reasonable assumptions that the condenser is opened to give approximately a 60° cone, and that the centre of the lamp flame is focussed in the plane of the structure, we shall have the extreme front and back of the flame focussed $\frac{1}{2000}$ in. above and below the structure, and the cones forming their images will be $\frac{1}{2000}$ in. diameter where they cut the structure.

But these small circles have a diameter containing 25 dots in line, or an area containing something like 500 dots, and therefore this great number of dots receives light capable of producing diffraction spectra.

Of course intermediate points of the lamp flame will be focussed nearer the plane containing the structure, but it will readily be understood that the greater part of the light from the flame is diffused over a considerable number of elements of structure, and that it is probably not far wrong to say that not more than 5 p.c. of the light is or can be focussed nearly enough to satisfy the condition of *truly* critical light.

I shall show later on that the remaining 95 p.c. of the light produce diffraction spectra, and through them an image of the object, in much the same way as the parallel light assumed by the theory that we are now driven to depend upon—that of Prof. Abbe.

One more point in connection with the spurious disc theory should be borne in mind.

A self-luminous object, such as this theory assumes, would, and should, send out light in all directions like any other source of light; it would, in consequence, fill uniformly and completely

the entire aperture of any optical instrument directed towards it. It is therefore illogical to adopt this theory when, by manipulation or choice of the condenser, only part of the aperture of the objective is filled with direct light; yet this is nearly always the case, as hardly any objectives of the present day will bear the absolute filling with light which a self-luminous object would produce. One of the most obvious demands of the spurious disc theory is therefore almost invariably neglected.

Some years ago Mr. J. W. Gordon read a long paper before this Society in which several curious objections, each of which was put forward as fatal to the Abbe theory—objections which I shall dispose of further on, in so far as this has not been done already—were followed by an attempt at an extension of the spurious disc theory. Mr. Gordon speculated on the effect which diaphragms introduced between the objective and the eye-piece would produce in the image of a luminous point, and invented the name "antipoint" for the image thus obtained.

As no serious microscopist would ever think of interfering with the regular clear and round aperture of an objective, or, at any rate, would only reduce it by a "Davis diaphragm," without destroying its simple circular form, it is difficult to see how cases could arise where an "antipoint" would have to be considered instead of the well-known spurious disc resulting with a single round aperture. But to those familiar with optical experiments it should at once be clear that the real and only significance of Mr. Gordon's "antipoints" is to be found in their identification as the complete diffraction spectrum produced by the diaphragm introduced behind the objective. For, in these experiments of Mr. Gordon's, the Microscope objective takes the place of the collimator of a spectrometer, by roughly parallelising the rays from the luminous point. These rays then suffer diffraction by the diaphragm, and the resulting diffraction spectrum is observed through the eye-piece; the slight convergence of the pencils produced by the objective rendering a separate telescope objective (such as is used in the usual laboratory instrument) unnecessary.

Mr. Gordon's "antipoints" are therefore simply the familiar diffraction spectra under a new name.

I will now proceed to deal with the Abbe theory.

It would seem that at the time when he enunciated his theory, Prof. Abbe was quite unaware of the use which was, even at that time, being made of condensers in England; anyhow, he tacitly assumed a mode of illumination by daylight or diffused lamplight, directed by the mirror and limited by suitable diaphragms, and showed that the light thus transmitted to the object was of such a nature that it could not account for the formation of any image in the manner usually assumed; for the cone of rays having its apex at any one point of the object would obviously consist of

rays from different and independently vibrating points of the source of light, and the corresponding undulations—being incoherent—could not possibly unite to form the regular spherical wave-front demanded by the spurious disc theory. On the other hand, different points in the object would receive light from the same point of the source of light, and the light proceeding from different parts of the object would therefore be capable of interference—again contrary to the requirements of the spurious disc theory.

Prof. Abbe then went on to demonstrate that the image formed under these conditions of illumination could only be explained by diffraction produced by the object itself, and that microscopical images were thus something quite different from telescopic images. The logic of Prof. Abbe's reasoning is so perfect, and his theory is such an immediate and necessary consequence of the fundamental properties of light according to the undulatory theory of light, than which no theory, not even that of gravitation, is better established, that it has only been subjected to occasional decidedly futile attacks which could not but fail to impress anyone fairly well acquainted with mathematical optics. But the theory was put forward as an extension of theoretical optics rather than as a practical explanation of the formation of ordinary microscopical images, and the experiments cited in proof are subject to the same reproach; for, whilst admirably adapted to remove the slightest doubt as to the accuracy of Prof. Abbe's conclusions from the mind of any competent physicist, inasmuch as they show that theory and experiment agree even under conditions which imply the destruction of all similarity between object and image, they have created no end of confusion in the minds of practical microscopists by the grotesque dissimilarity between object and image which they proved to be possible. And thus it comes about that, through the brief and purely theoretical manner in which it has been put forward, the Abbe theory occupies a curious and anomalous position. No text-book is complete without some account of it, and especially of the famous experiments. Every serious microscopist is, as a consequence, ever afraid of spurious images comparable in dissimilarity to the original with the startling nightmares included amongst those self-same experiments. And yet it is peculiarly barren and forbidding; it frightens rather than guides the microscopist; it hints at mysterious possibilities of deception rather than supplying definite information and well-defined warnings. In other words, the Abbe theory has never been presented in a form which would appeal to practical microscopists. What the latter require to know is :—

1. Which, if any, of the many possibilities of deception demonstrated by the experiments with the diffraction plate are likely to be realised in the ordinary intelligent use of the Microscope;

is there really any danger of our seeing two or three lines where there is but one; of seeing crossed lines wrongly spaced, and running in a direction totally different from their actual direction in the object, etc., etc.?

2. Granting that, in order to obtain perfectly truthful images all diffracted light must be used, how is the immense improvement of images with only a slight increase of N.A. accounted for?

3. What is the explanation of the greatly improved images obtained with "solid" illuminating cones of considerable aperture; do these images deserve the confidence which they inspire?

The object of this paper is to attempt to answer these and similar questions: to show how the image is built up according to the diffraction theory under the usual conditions of observation, and in how far it is likely to be truthful or the reverse, and thus to rob the theory of its hidden terrors and to make it acceptable to practical microscopists.

It will be necessary to have an ideal image with which to compare those yielded by diffraction; it would be absurd to use the exact image of geometrical optics as a standard, as this is absolutely unattainable with light of finite wave-length. I shall, instead, use the image which the object would yield with the same objective if it were rendered self-luminous. That it is the most faithful image practically possible, and has the further advantage of being easily deduced by adding to all bright outlines of the geometrical image the fuzzy fringe representing overlapping spurious discs.

It will soon be noted that I apply Abbe's principle in a somewhat different manner to that familiar from the existing explanations. I do so because, in my opinion, it makes it easier to arrive at the *practically* important deductions from the fundamental principle in a straightforward manner. It is not done with a view to belittling the great physicist, nor does it imply any flaw in his own treatment of the subject. On the contrary, I trust that this paper may be of some assistance in convincing those who have looked on the Abbe theory as sterile and devoid of practical utility, that this theory, when applied to ordinary working conditions, explains every peculiarity of the microscopical image, and is, indeed, the only theory that can be applied with safety. And I thus hope to remove many doubts as to its importance, and to demonstrate to microscopists that, even if Prof. Abbe had never given us anything else, his theory of microscopic vision alone should secure him immortal fame.

I shall at first follow Prof. Abbe's lead by assuming light reaching the object in practically parallel rays or plane waves, discussing afterwards how the results are modified when condensers are interposed, and I shall limit the present paper to the consideration of perfectly regular and perfectly plane simple gratings; and

I shall further assume that these gratings are examined with an optically perfect instrument. The latter assumption—which may be considered closely fulfilled when the best of modern objectives are used with about $\frac{3}{4}$ of their total aperture—implies that all "rays" from a point in the object are united in the conjugate point; or—to express it according to the undulatory theory, and therefore more correctly—this assumption implies that all optical paths uniting a point in the object with its conjugate point in the image, are equal, and therefore that "rays," or, more correctly speaking, plane wavelets, arrive at a point in the image in the same phase-relation in which they left the conjugate point in the object. This last simple and obvious deduction will be of the greatest assistance in my inquiry.

The explanation of the diffraction spectra themselves is given in numerous books, and I shall therefore assume it as well known that when a plane wave strikes a grating of straight, parallel and equidistant slits, it is broken up into a number of "diffracted" plane waves, and that when a is the angle between the arriving wave and the grating, β that between a diffracted wave and the grating, d the spacing of the grating, i.e. the distance from centre to centre of the slits, λ the wave-length of the light employed, and χ the "order" of any spectrum, we shall have the relation

$$\text{I.} \quad \chi \cdot \lambda = d\,(\sin a \pm \sin \beta),$$

the upper sign to be taken when the diffraction-spectrum lies on the opposite side of the optical axis to that occupied by the direct light, the lower sign when both are on the same side of the optical axis; this formula being the mathematical expression of the fact that in the first spectrum the wavelets proceeding from adjoining slits meet with a difference of phase equal to one wave-length, and in any spectrum of higher order with a difference of as many wave-lengths as the number of the spectrum indicates.

But the knowledge embodied in this formula is not sufficient for our purposes. The *phase-relation* between the direct light and the several diffracted waves enters into our problem; and I proceed to discuss this, the first novel point of importance which I am going to raise.

Assuming a grating of extremely narrow slits, no question can arise, as it is obvious that all the diffracted waves leave points in the grating in phase with the arriving wave, and remain in that phase-relation, as they are not exposed to any further interferences —the wavelets from successive slits being too small to have any difference of phase within themselves, and joining up with a difference of whole wave-lengths, and therefore in the same phases. Hence, in such a grating all diffracted waves depart from points in the slits in equal phase, and consequently arrive in equal phase

in the conjugate point of a Microscope focussed on the grating. But when the slits are of a sensible width compared to the dark interval, there will be differences of phase between the light proceeding from different portions of any *one* slit; there will, therefore, be interference between these portions, and the resulting combined phase remains to be determined.

Let A and B (fig. 95) represent the centres of two adjoining slits of a grating, then we know already that the light proceeding from these points joins up with a difference of phase of one or several wave-lengths to form the plane diffracted wave C D.

If we now consider two points equidistant from the centre A, it is evident that the light emanating from these will be out of phase with that starting from A, and that the difference of phase between the light from either of those two points and A will be in the same proportion to the difference of phase of one or several

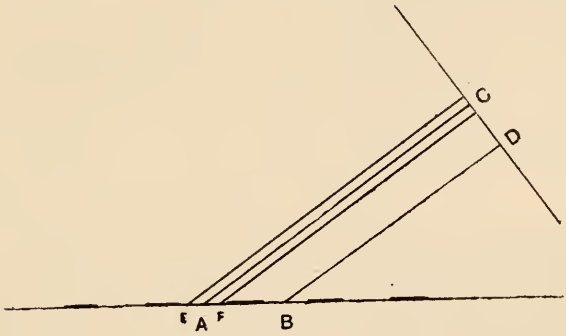

Fig. 95.

whole wave-lengths between C and D as E A = F A is to A B. The resulting phase will be determined according to the principle of Huyghens, by adding together the disturbances of all the luminous elements of surface contributing to the wave C D, and discussing the resulting integral wave. I will deduce the result in an elementary but correct manner by a rough mechanical integration, instead of the mathematical one, which might repel many of my readers.

The disturbance caused, say at C, by the light coming from A may be represented by the simple formula —

$$(1) \quad x_A = c \,.\, \sin a,$$

where a is an angle uniformly increasing by 360° for every complete vibration, and c, the amplitude of the wave, is a constant depending on the intensity of the light, the formula simply implying that the vibrations of light follow a sine law. The light from E

and F will be out of phase, that from E lagging behind, that from F leading by a certain amount expressed as an angle, depending on the distance between E or F and A compared with the distance between A and B, and on the order of the spectrum. Let this difference of phase be β, then the light emanating from E will cause the disturbance—

$$(2) \quad x_E = c \,.\, \sin (a - \beta),$$

the light from F the disturbance—

$$(3) \quad x \;= c \,.\, \sin (a + \beta).$$

Any pair of points equidistant from the centre of the slit will produce a pair of disturbances like (2) and (3); and, as the order in which the elementary disturbances are added together is immaterial, we will combine them in such pairs.

Now, solving the sines in (2) and (3) we get—

$$x_E = c \sin a \cos \beta - c \cos a \sin \beta$$

$$x_F = c \sin a \cos \beta + c \cos a \sin \beta,$$

and adding the two together we get—

$$\text{II.} \quad x_E + x_F = 2\, c \cos \beta \,.\, \sin a.$$

β and $\cos \beta$ being constants for any one pair of points, $2\, c \cos \beta$ is obviously the amplitude of the combined vibrations, and we see, firstly, that the intensity resulting from such pairs away from the centre is less than that from a similar area in the centre of the slit in proportion of $\cos \beta : 1$; secondly, that the combined phase is the same as that of the central wavelet as long as $\cos \beta$ remains positive; and thirdly, that the phase is reversed when $\cos \beta$ becomes negative, which happens when β becomes greater than 90° but less than 270°. To render this quite clear, and also to facilitate the study of these phase relations, I will tabulate the amplitudes of successive pairs from the value of $2\, c \cos \beta$ according to II., taking pairs covering 15° difference of phase, the first pair to cover the centre of the slit; and, for simplicity's sake, I will put $c = \frac{1}{2}$, its value being quite immaterial to this inquiry.

In the third column I have added up the values contained in the second, thus carrying out roughly what mathematical integration does accurately, and determining approximately the total amplitude caused by a broad slit extending over all the successive pairs it embraces, but the result is sufficient for this discussion.

It shows that, given an arriving wave of a certain intensity, and assuming slits the width of which increase from indefinite smallness, then the intensity of any diffraction spectrum will

TABLE I.

1		2	3	4*
β		Mean value of $2c\cos\beta$	$\sum_0^\beta 2c\cos\beta$	$\int_0^\beta 2c\cos\beta\, d\beta \times \frac{12}{\pi}$
	0°		0	0
	15°	+ ·99	+ ·99	+ ·989
	30°	+ ·92	+ 1·91	+ 1·910
	45°	+ ·79	+ 2·70	+ 2·701
	60°	+ ·61	+ 3·31	+ 3·308
	75°	+ ·38	+ 3·69	+ 3·690
¼ wave-length	90°	+ ·13	+ 3·82	+ 3·820
	105°	− ·13	+ 3·69	+ 3·690
	120°	− ·38	+ 3·31	+ 3·308
	135°	− ·61	+ 2·70	+ 2·701
	150°	− ·79	+ 1·91	+ 1·910
	165°	− ·92	+ ·99	+ ·989
½ wave-length	180°	− ·99	±	±
	195°	− ·99	− ·99	− ·989
	210°	− ·92	− 1·91	− 1·910
	225°	− ·79	− 2·70	− 2·701
	240°	− ·61	− 3·31	− 3·308
	255°	− ·38	− 3·69	− 3·690
¾ wave-length	270°	− ·13	− 3·82	− 3·820
	285°	+ ·13	− 3·69	− 3·690
	300°	+ ·38	− 3·31	− 3·308
	315°	+ ·61	− 2·70	− 2·701
	330°	+ ·79	− 1·91	− 1·910
	345°	+ ·92	− ·99	− ·989
1 wave-length	360°	+ ·99	∓	∓

* In column 4 the rigorous values of the integral are given, which show agreement with column 3 even more closely than could be expected. In computing these we have, of course, $\int_0^\beta 2c\cos\beta\, d\beta = 2c\sin\beta$, or ($c$ being $= \frac{1}{2}$) simply equal to $\sin\beta$. But we must remember that in columns 2 and 3 we have adopted 15° as our unit of angle, whilst in mathematical calculations the radian $= \frac{360}{2\pi}$ is the unit. Hence the value of the integral has to be multiplied by the ratio of these units, which gives $\frac{12}{\pi} \cdot \sin\beta$ as the complete formula for computing column 4.

grow as long as the edges of the slit send out light not more than 90°, or $\frac{1}{4}$ wave-length, out of phase with light from the centre of the slit; if the slit becomes still wider, the intensity of the diffraction spectrum is diminished, and becomes zero when twice the previous width is reached, i.e. when light from the edges of the slit is $\frac{1}{2}$ wave-length out of phase with that from the centre. Up to this width the combined phase is the same as that yielded by a grating of indefinitely narrow slits. But when the width of the slits is increased still further, the diffraction spectrum re-appears, and gains an equally bright maximum at a difference of phase of $\frac{3}{4}$ wave-length between centre and edges, declining beyond that point and once more disappearing when the difference of phase becomes a whole wave-length. But, and this is my great point, in this second cycle the sign of the resulting amplitude is reversed, i.e. the combined phase is in this case the *opposite* one to, or is $\frac{1}{2}$ wave-length different from that given by indefinitely narrow slits. As all trigonometrical functions have a period or cycle of 360°, it is evident that when the differences of phase between centre and edges of a slit exceed a whole wave-length, the resulting integral phase will be the same as that for the excess over a whole number of wave-lengths—i.e. for a difference of phase of, say, $3\frac{1}{2}$ wave-lengths, the resulting combined amplitude and phase would be the same as for a difference of $\frac{1}{2}$ wave-length.

It will now be easy to apply this law to the successive diffraction-spectra of a plane grating.

In the first spectrum, the difference between the light from adjoining slits is one wave-length, and the difference of phase between centre and edge of any one slit cannot exceed $\frac{1}{2}$ wave-length, as at that point the adjoining slits would coalesce. Therefore it follows that the first spectrum is always in phase with the direct light; we can also see that the brightness of the first spectrum will be a maximum when the slits are equal in width to the intervening dark spaces, for that corresponds to the difference of phase of 90°, for which we found the maximum value.

In the second spectrum, light from adjoining slits differs by 2 wave-lengths, and our angle β can therefore reach 360°, and produce any of the values in the table. In this case we shall therefore have—

The diffraction-spectrum is in phase with the direct light when the slit is narrower than the dark space, i.e. $\beta < 180°$.

The diffraction-spectrum is in opposite phase to the direct light when the slit is wider than the space, i.e. $\beta > 180°$.

The second spectrum will have maxima of brightness when the width of the slit is respectively $\frac{1}{4}$ or $\frac{3}{4}$ of the spacing of the grating; it will vanish when the slit is equal to the dark interval.

Proceeding to the third spectrum, where light from adjoining slits joins up with a difference in phase of 3 wave-lengths, β can

reach $1\frac{1}{2}$ wave-lengths, and we easily deduce the following rules:—

When the width of slit is less than $\frac{1}{3}$ of the spacing, the spectrum is in phase with the direct light.

When the width exceeds $\frac{1}{3}$, but is less than $\frac{2}{3}$ of the spacing, the spectrum is in opposite phase.

When the width exceeds $\frac{2}{3}$, the spectrum is again in the same phase as the direct light.

The spectrum has maximum brightness for a width of slit of respectively $\frac{1}{6}$, $\frac{3}{6}$, and $\frac{5}{6}$ of the spacing, and vanishes for a width equal to $\frac{1}{3}$ and $\frac{2}{3}$ of the spacing.

It will be obvious how this may be carried up to spectra of any order, and that the number of reversals of phase will constantly increase. It will also be foreseen what an important bearing these phase relations must have on the character of the image, and how vital the knowledge of their existence and nature must prove to a proper understanding of "diffraction" images. That must be my excuse for going into the question at such length.

The figures in the third column of the above table also show that, with very narrow lines, the diffraction-spectra are almost of the same brightness as the direct light, as there is little weakening of the light by interferences. The broader the lines compared to the dark intervals, the more does the direct light preponderate, and a special application of this reasoning leads to the important conclusion that with plane gratings the first spectrum is always brighter than any other; this follows because there must always be more interference between the wavelets from different portions of a slit which unite to form the higher spectra, than there can be in the case of the first.

We will now proceed to apply these principles to the Microscope.

As stated above, we assume for the present that our grating is illuminated with parallel monochromatic light, such as would be received from a distant luminous point, and, further, that the Microscope is correctly focussed on the grating, i.e. that we are looking at the image formed by the diffracted light in the plane of the *geometrical* image. The necessity of assuming this will become apparent later.

We will first take the case where oblique light is used, the direct light entering through the outer zone of the objective on one side, and a greater or lesser number of successive diffraction spectra through other zones right across the objective.

1. Let the aperture be sufficient to admit the direct wave and the first diffracted one. We have seen that the latter is always in the same phase as the direct one; hence, by applying my first theorem, i.e. that wavelets arrive at the conjugate point in the same phase relation in which they left a point in the object, we

immediately arrive at the important conclusion that the two waves (or spectra) meet in equal phase, and produce a maximum of brightness in those points of the image which are conjugate to points in the centres of grating slits; or, in other words, the diffraction-image yields maximum brightness along lines coincident with the geometrical images of the centre-lines of the slits. In order to establish the character of the diffraction-image still more closely, we have only to remember that in the first spectrum there is a difference of one whole wave-length in the portions or wavelets coming from adjoining slits; there will therefore be the same range of one whole wave-length in the phase relation through which the two waves pass between two neighbouring maxima in the image, and there can therefore be no intermediate bright lines.

The intensity curve of the light, in passing from the centre of one line in the image to the centre of the next, will be somewhat modified according to the relative brightness of the direct and the diffracted light, which in turn we found to depend on the relation between the width of the slits to the spacing of the grating; but the visual appearance has been often shown to be that of bright lines separated by more or less dark intervals of approximately the same width, the amplitude curve being of the nature of that shown in fig. 96, *a*. Hence, the image which we get in this simplest case coincides with the ideal geometrical image; but whatever the real width of the slits may be, they are always represented as equal to half the spacing—really a commendable compromise, as that is the happy mean of all possible widths.

2. Now let us proceed to the consideration of the image produced when the oblique direct light and two successive diffraction-spectra are admitted. We saw that the second spectrum is necessarily less bright than either the first spectrum or the direct light, hence its admission cannot reverse, but can only modify the effect produced by the others. The modification largely results from the phase relations, which, for this reason, I discussed at considerable length, and it takes place in this way:—

(*a*) When the slits are narrower than the dark interval, the second spectrum also is in phase with the direct light. As the second spectrum passes through two wave-lengths difference of phase from slit to slit, and consequently also from image to image, we shall have resulting from the co-operation of the direct light, and that of the second spectrum, maxima coincident with those treated above, but also intermediate maxima, corresponding to the centre of each dark space in the image, as shown at fig. 96, *b*.

In the formation of the image, the amplitudes resulting from both combinations will be added together (this is very approximately true, but not quite strictly, as there are slight differences of phase to be taken into consideration), with the result shown in

fig. 96, *c*; that is to say, the bright line becomes much brighter, but also narrower, exactly as it ought to do, and this effect will be the more pronounced the narrower the actual slits are, because the second spectrum will be relatively brighter accordingly. There will, however, be a tendency to the formation of a feeble false line midway between the true ones. Generally, these ghosts will be invisible, but I believe they have been "glimpsed."

(*b*) When the slit really *is* equal in width to the dark interval, the second spectrum disappears, and the result produced by the direct light and the first spectrum is left unchanged; and so it ought to be, for we saw that the image produced by these alone is just right in this case.

(*c*) When the slits are wider than the dark interval, we saw that the second spectrum is opposed in phase to the direct light, hence we now get an intensity-curve like fig. 96, *d*, from the combination of direct light and second spectrum, and combining this again with the effect produced by the direct light and the first spectrum, we get a curve like fig. 96, *e*—i.e. the lines are diminished in brightness, but broadened out!

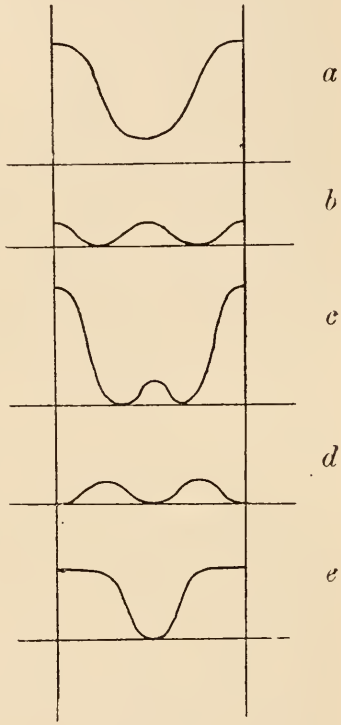

Fig. 96.

I think it will be unnecessary for the present to carry this analysis further to spectra of higher order; it must already be obvious that this improvement in the verisimilitude of the image will be maintained solely through those phase-relations—which I believe I am the first to point out, at any rate in their bearing on the formation of the microscopical image.

It will also be unnecessary to deal at any length with the case of direct light of less obliquity, or perchance proceeding along the optical axis; we shall then have some or all of the successive spectra which can enter the objective present *in pairs*; but it is easy to see that, owing to the complete symmetry of the object we are considering, the *other* spectrum of any one order can only emphasise the effect produced by its fellow. The main facts will remain as previously discussed for extremely oblique light.

Instead of going into such details, I will deal with other features of the images under consideration, most of which have at one time or another been advanced as insuperable obstacles to the validity of the diffraction theory.

The first came from Mr. Gordon, who seems to have misunderstood one of the published accounts of the theory in such a way as to lead him to claim that, according to Prof. Abbe, the image should stand still when the object is moved, and he thus appeared to have succeeded in bringing the theory under the ban of the famous "which is absurd" of our old friend or foe, Euclid. The late Prof. Everett turned the tables on Mr. Gordon in what was probably his last paper, and I fancy that Mr. Gordon's astute rejoinder to that paper failed to impress either those present at the meeting or those who read the report. However, my method of treating the problem supplies an alternative proof that the diffraction-image must move conformably to any movement of the object. For I have shown that the diffraction-spectra must always produce an image of a simple plane grating coincident with the geometrical image, and, as the latter obviously moves in proportion to movements of the object, the diffraction-image must do the same. Competent physicists will see at once that my proof is really identical with Prof. Everett's, as it relies on the same theorems; it, however, has the advantage of avoiding the intermediate step which Mr. Gordon made his sheet anchor for objection, and to thus be free from that objection; and it may therefore be acceptable to those who do not care to expend their mental energy in going through mathematical investigations.

The next objection also came from Mr. Gordon. He claims that there is nothing in the diffraction theory to show how the right number, the right shape and length, and any existing irregularity of the lines, come to be correctly shown in the image. Mr. Gordon's objection would seem to be prompted by a complete misunderstanding of the diffraction theory, for he persistently speaks of the lines seen in the image as *diffraction images of the source of light*, although it must be obvious that it is physically impossible that *such* images should be formed in the plane of the final image; I can only think that Mr. Gordon confuses the diffraction *spectra* formed in the upper *principal* focal plane of the objective, in the form of small images of the source of light, with *the diffraction pattern* resulting from the interference of the waves concentrated in these images when they have again spread out and arrive in the plane of the microscopical image of the object. I am reluctantly driven to this explanation, for how could Mr. Gordon claim as an objection to the Abbe theory the fact that, with a candle as the source of light, the image of a grating as seen through the eye-piece does not

consist of a row of candle flames, if he had *not* failed to grasp these elementary facts!

There *is*, however, an opening for a more reasonable objection in this same direction, i.e. as to the rendering of number, length and possible irregularities of the lines in the image. We may very well ask:—

1. How is it that the waves which come into interference in the plane of the image do not extend their effect beyond the geometrical image? Under my method of treating the diffraction-images the answer seems almost obvious, for it shows that there is maximum brightness only along those lines of the image which are conjugate to the centre lines of the slits of the grating; hence, there can be only the correct number of fully bright lines, and they must be shown at very nearly their exact length. According to Abbe's treatment, where the waves leaving the object are followed as such through the optical system, the answer follows from the Huyghenian principle which shows that waves in their progress conform closely to the outline of the corresponding "rays" of light, with but slight encroachment beyond that outline; hence, on reaching the plane of the final image, the waves will, with the exception of a small fringe, again be confined within the limits of the geometrical image of the object. In either case the formation of one or possibly several feeble ghost-lines beyond the limits of the geometrical image appears probable; and I believe that, as a matter of fact, feeble spurious lines of this kind are occasionally observed, even under ordinary working conditions.

2. As to the rendering of irregularities in the lines, the explanation is contained in one word: "Ghosts." I mean, of course, the "ghosts" painfully familiar to users of diffraction gratings for spectroscopical purposes. The sweet simplicity of the diffraction phenomena which results from the assumption of an absolutely regular and uniform grating, is disturbed by any irregularity in the ruling. The light from any displaced slit, or from a slit differing in width from the majority, does not completely harmonise with that from the other slits, and there results a corresponding zone of greater or less brightness in the diffracted waves, besides uncompensated, scattered light from the irregular slit; all these results combined, form in the first place so-called "ghost" spectra in the principal focal plane of the objective, and subsequently lead to a more or less faithful representation of the irregularity in the final images.

Leaving some other objections to be dealt with later, I come to a very serious one which, curiously enough, is the very one which has escaped Mr. Gordon's attention, and which, as far as I know, has formed the only really formidable barrier to reconciling a direct and necessary conclusion from Abbe's theory with the experience gained in ordinary microscopical observations. I refer

to the fact, which has been pointed out before now, and I believe by various writers, that the diffraction-image under the conditions which I have here assumed, and which have always been assumed in explaining the Abbe theory, *has no focus*—viz. whilst in ordinary microscopical observations we cannot be in doubt as to the position of the image which is sharp and thus inspires confidence, the result, when we carry out the experiment suggested by the theoretical investigation, is that either the image remains continuously sharp through quite a long range of focal adjustment, or else that we get a regular succession of sharp images all equally good. Hence the need of my stipulation, at the beginning of this section of my paper, that I intended discussing the diffraction effects produced in the plane of the geometrical image. I shall now have to show how that plane is to be found, or rather, whether and in what manner the image can be caused to be sharp in that plane only, so as to be readily picked out simply by focussing. This is the second point for the elucidation of which I am inclined to claim credit.

Let me first recall the reason for this want of focus in a simple diffraction-image.

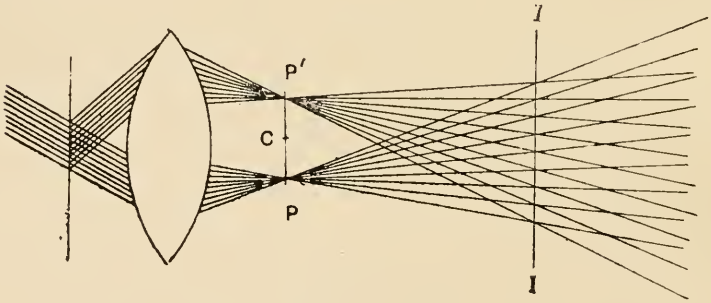

Fig. 97.

In fig. 97 the case is shown where only the direct light and first diffraction-wave of one side enters the objective. The two waves are brought to a focus * in the upper principal focal plane of the objective, and thence spread out again, coming into complete

* As the focussing of these waves by the objective is another of the points in connection with the Abbe theory which Mr. Gordon has attacked, it may be worth while to point out that we need not deal with waves filling the entire aperture of the objective, in which case the objection that there must be heavy spherical aberration would be justified. We have only to consider small wave-segments corresponding to a small number of structural elements, and therefore of very small angular extent; and for such the assumed focal properties of the points P and P′ can be shown to be rigorously correct; a reversal of Hockin's proof of the optical sine law (which latter can be proved by other methods) is perhaps the most direct and the most satisfactory.

coincidence in the geometrical focal plane; but the interference between these two waves is evidently not limited to that plane; interference can and must take place throughout the space, which in the figure has a cross-hatched appearance, where the two waves meet, producing brightness or darkness according to their phase relation at any given point within that space.

Discussing the question more closely, we know from our previous discussion that in the centre of any line of the image in the plane I I of the geometrical image, the waves from P and P′ meet with a difference of a whole number of wave-lengths, thereby producing maximum brightness; but they will do exactly the same at any point on either side of the plane I I where they meet with the same difference of phase. The geometrical locus for these points is a hyperbola having P and P′ as foci, but, owing to the extremely stretched form of the curve, we may with small error

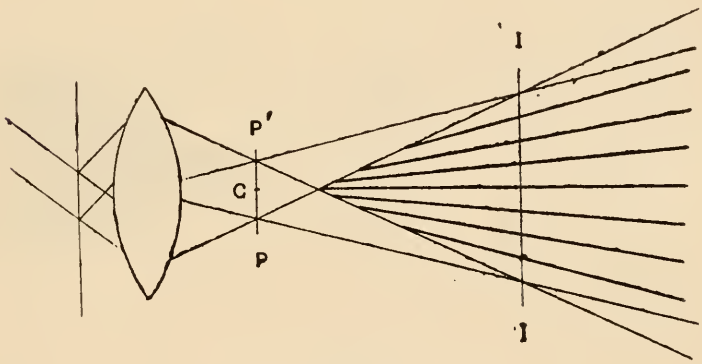

Fig. 98.

substitute its asymptote, i.e. a straight line connecting any bright point in the plane I I with the point C bisecting the distance between P and P′. There will therefore be maximum brightness along any such line, hence there can be no definite focus.

This is shown in fig. 98, where the zone of possible interference is shown in outline, and the loci, along which maximum brightness would be found, by thick lines.

It should, perhaps, be pointed out that there may, nevertheless, be something to assist us in picking out the plane I I, for fig. 97 and fig. 98 show that only close to that plane can the whole extent of the grating be shown: hence it could be focussed for by finding the adjustment showing the maximum number of lines; but even this expedient would break down with a grating extending beyond the limits of the field of the instrument, or with an object consist-

ing of a limited number of dark lines in an otherwise bright field. This want of focus accounts for the appearance often noticed by microscopists (and occasionally immortalised by photography!) of striated diatoms or similar objects, shown by a narrow pencil of oblique light, with the detail partly outside the outline of the object.

This want of focus is, however, never seen in practice to the extent which theoretical considerations prove to be possible, for the simple reason that we do not and cannot realise the condition of monochromatic light from a single distant point. Even when we use a source small enough to approximate a point, it will yield light of various colours; and as soon as we consider, say, white light, we find a substantial improvement. For we shall then have a diffraction *spectrum* instead of a single diffracted wave, and consequently there will be, instead of the single point P′ in fig. 97

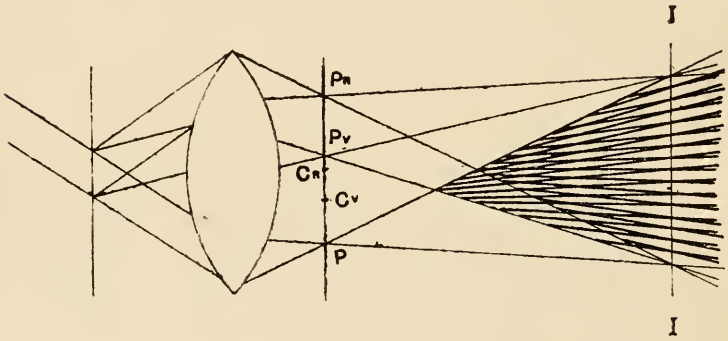

Fig. 99.

and fig. 98, a continuous row of points of different colours, each of which co-operates with the waves of the same colour expanding from the focus P of the direct light. Consider two extreme colours, and let P_R and P_V (fig. 99) be the foci of the red and violet diffracted waves. The lines along which the images of the grating slits appear will aim at the bisecting point C_R for the red, at the bisecting point C_V for the violet light; and if we draw these lines of maximum brightness, and remember that those corresponding to intermediate colours will fill the space between the extreme ones, we immediately see that there will be confusion at a little distance in either direction from the plane I I of the true image. The images of the slits will be drawn out into spectra which overlap more and more, and eventually fuse into uniform whiteness. Therefore we shall have a much better criterion for finding the true image, and a much reduced range of focus within which we might be in doubt.

But we cannot strictly realise illumination from a point-source of light and as soon as we employ an extended source of light we shall secure a still more definite focus of the image. For different points in the source of light will illuminate the object from different directions; there will be correspondingly displaced pairs of points P and P′; and the amount of confusion by overlapping of images, corresponding to different points of the source of light and to light of different colours, will become so pronounced as to destroy all semblance of a recognisable image beyond the immediate neighbourhood of the plane I I. Hence the latter will be instinctively found by focussing, because it is the only position yielding a sharp image.

When other spectra in addition to the direct light and one first diffracted wave are admitted, the same effect results from the use

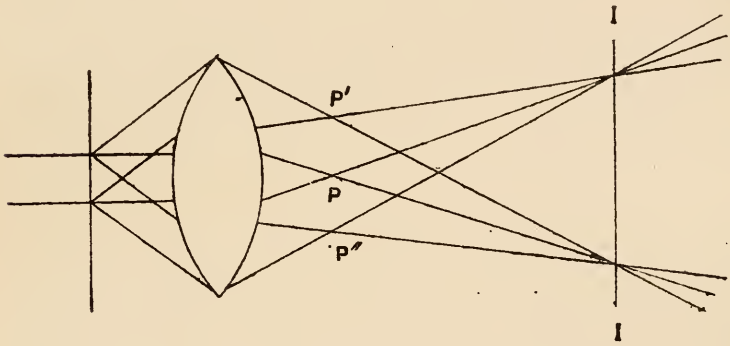

Fig. 100.

of an extended source of light; but as there is a difference in this case when a point-source of light is used, I will briefly treat an example—viz. the case when the direct light and the two first diffracted waves are admitted.

Starting in this case from a bright point in the true image, where the two diffracted waves meet the direct one with a whole number of wave-lengths difference of phase, we can apply the same reasoning which we used before, to show that the two diffracted waves will meet in phase anywhere along the line connecting the bright point in the image with the focus P of the direct light; for that point P is midway between the foci P′ and P″ (fig. 100) of the diffracted waves. But, as the path from P to a point on this connecting line shortens more quickly than the paths from P′ and P″ (owing to the inclination of the latter paths), the combined diffracted waves will meet the direct wave successively in all possible phase-relations, with the result that we get

successive dark and bright lengths; and hence the succession of sharp images referred to above. In this case the substitution of a white for a monochromatic point of light does *not* produce much improvement; the distance between the successive images is different for different colours, and the discontinuity of the successive images is in consequence diminished with white light, but the images remain comparatively sharp. But when an extended source of light is substituted, we at once get a great number of points P, from each of which the images of the slits radiate, with the result that a sharp image is only obtainable in the plane I I where all the elementary images coincide.

I hope I have now made it clear that the chief advantage of an extended source of light (which corresponds to a wide illuminating cone) is, that the ghostliness of the simple diffraction image is done away with, and that the latter is replaced by an easily focussed composite image which is more likely to inspire confidence. I will not at this stage of my inquiry enter into the question whether the image is really better, reserving this until I have dealt with structures consisting of crossed lines and of dots.

It now remains to be shown in how far the conclusions hitherto arrived at are modified when the assumption is dropped—to which all the above reasoning is subject—that the source of light is at a considerable distance from the grating; we must inquire whether there are any important changes brought about when the source of light (which will generally be a virtual image of the real source) is brought very close to the object, so that the curvature of the waves passing through the object becomes sensible. In discussing the spurious disc theory, I showed that only a small percentage of so-called "critical light" can be considered as accurately focussed on the object, and that the greater part of such light is diffused over a considerable number of structural elements—and it is this latter case which we have to discuss. Mr. Gordon has put forward an extraordinary claim, which I shall show to be contrary to the undulatory theory as well as to direct experiment, that with curved wave-fronts the diffraction spectra "will be seen to diminish in breadth and crowd together," that an aperture which will only accommodate a single spectrum produced by plane waves will pass an ever-growing number of spectra when the waves are curved; or again, in Mr. Gordon's own words, "A narrow angled objective will in this way yield the diffraction-image of an oil-immersion objective!"

If we make the experiment with a diffraction grating or a regularly striated diatom, starting of course by focussing the image, and then, having removed the eye-piece, looking down the tube at the back of the objective, we fail absolutely to see the effect described by Mr. Gordon; we may open or close the iris, we may rack the condenser up or down, in order to vary the curvature

of the wave-fronts, the diffraction spectra refuse to move; they uniformly expand and contract agreeably to the effective cones of light, but they rigorously preserve their distance apart; they absolutely decline to crowd together!

I have indeed failed to cause the diffraction spectra to disappear or to essentially change in appearance, when, by the use of an apochromatic objective as condenser (working of course at correct tube-length and through a proper cover-glass), and by choice of source of light, the theoretical conditions for getting rid of the diffraction spectra seemed completely realised; but nothing *would* do away with them except cutting down the flame-image to such a small size that it covered *one slit only.*

It would seem that Dr. Johnstone Stoney was right when he claimed that, under the conditions prevailing with "critical illumination," a flame-image behaved as if it were composed of innumerable plane waves.

The only explanation that I can suggest for the phenomenon which Mr. Gordon describes is that he must have observed the diffraction spectra without making sure that the instrument was at least approximately focussed upon the object. Only in this case would it seem possible to get the diffraction spectra to *appear* to crowd together, owing to their being observed in a wrong plane.

In cases where a coarse structure is illuminated by very wide cones, we *can* observe that the different diffraction spectra expand to such an extent as to overlap, and that indeed we may have direct light and portions of a number of diffraction spectra of several successive orders super-imposed in the centre of the objective. But it is easy to see that the portions thus super-imposed are never capable of meeting in the plane of the image of the structure in such a way as to produce an image. For, in the case assumed by Prof. Abbe, i.e. that the illuminating cone is obtained from a relatively distant *extended* source of light, these super-imposed portions are derived from different luminous points, and therefore incoherent or incapable of interference; whilst in case of an illuminating cone really consisting of spherical wave-fronts, having their focus near but not in the plane of the object, the super-imposed portions of different diffracted waves have such inclinations to each other that they cannot possibly meet in the plane of the true image. This latter case, which is the one really under discussion, I will briefly deal with.

Let A B, fig. 101, represent a grating with slits 1, 2 . . . . 7, and let a luminous point C be brought close to that grating. Those portions of the spherical waves sent out by C which fall upon slits are there diffracted according to the universal Huyghenian principle, i.e. the first effect is as if the slits themselves had become self-luminous. But the secondary waves thus set up in the indi-

vidual slits meet almost as soon as they have left the point where they originated, and get into interference with each other, just as similar portions of a plane wave would do, and the outcome must be the same, viz. one portion of the diffracted waves joins up without difference of phase and proceeds in the direction of the original wave from C, forming the direct light; but other portions join with differences from slit to slit of one or several wave-lengths, and unite to form diffracted waves of corresponding order. The mathematical treatment is extremely laborious in this case, but we can easily arrive at an approximate solution graphically.

Describe a circle D E over C as centre; this obviously corresponds to the direct light joined up in its original phase after passing the grating. To find the first diffracted wave, we have

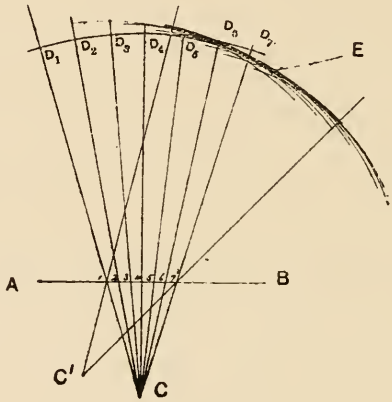

Fig. 101.

to introduce a difference of phase of one wave-length between adjoining slits. To do this we may describe a circle (representing an elementary diffracted wave) from 4 with length 4 − D4, as radius; from 3 we describe a circle with 3 − D 3 plus one wave-length (represented by a suitable length); from 2 a circle with 2 − D 2 plus two wave-lengths, from 1 with 1 − D 1 plus three wave-lengths; on the other hand, from 5 we take a radius of 5 − D 5 *minus* one wave-length, and so on throughout. A wave tangent to all these elementary ones will be the diffracted wave we are seeking; trial shows that a circle struck from C′ as centre closely fulfils this condition. It should also be clear that, considering any one slit, the angles between the direct and the diffracted "rays" must be precisely the same as with plane waves, and also that the elementary wavelets from different portions of any one slit must be subject to the same interferences amongst

themselves, and, therefore, to the law of phase which I have originally deduced for plane waves.

The whole reasoning of my paper may, therefore, be applied to this case of spherical wave-fronts. The latter will be refracted by the objective according to their apparent point of origin, which, in the case of fig. 101, is a little below the plane of the grating. The only difference as compared with figs. 97 and 98, will, therefore, be that the conjugate foci P and P′ will lie much closer to the plane I I of the true image, and that the space within which spurious interferences can take place is correspondingly curtailed. But as we can always limit the recognisable image to the plane I I by using an extended source of light, there is no very evident advantage in this one difference in favour of spherical wave-fronts.

I hope I have now made it clear that it must always be very risky to assume that an object might be treated as self-luminous; that we must, therefore, seek the explanation of microscopical images on the basis of the great principle laid down and proved by Prof. Abbe, and that this latter principle, *when applied to ordinary working conditions,* leads to the formation of images of plane gratings which are as close replicas of the original as could possibly be desired.

In a supplementary paper I hope to apply the Abbe theory to crossed lines and to dot-patterns. I shall then be in a better position to discuss the question of favourable illumination, and to show what is the real cause of the pleasing images obtained by the use of carefully regulated "aplanatic cones" of light.

NOTE.

On the Use of the Esculin Screen in Photomicrography.

By Frederic E. Ives.

I believe I was the first to point out, about fifteen years ago, in a verbal communication to the Photographic Society of Philadelphia, the advantage to be gained in photomicrography with ordinary achromatic objectives, by employing screens to cut out those spectrum rays for which the objectives are not well corrected, and presented a collection of examples obtained with colour-sensitive plates and colour screens, of a quality which could not otherwise have been obtained with the objectives employed.

Since then, I have always, until quite recently, employed a yellow screen and orthochromatic plates for photomicrography with achromatic objectives, though preferring to use apochromatic objectives for high-power work, because they are corrected for rays which resolve finer details, and also permit the use of transparency plates, which give brilliant and fine-grained negatives.

Inasmuch as most achromatic objectives appear to be well corrected for the bright blue spectrum rays, it has occurred to me that transparency plates might be satisfactorily employed with them if the action of the violet and ultra-violet rays was entirely suppressed.

To test the relative effect of the blue and ultra-violet rays, I have employed a combination of Bausch and Lomb $\frac{2}{3}$ achromatic objective and 1 in. huyghenian eye-piece, which gives an excellent image to the eye, but works very badly with daylight on ordinary photo plates.

One exposure was made through a dry esculin screen as recently described by me in "Camera Work," July 1904, p. 44, and another through a uranine screen; both with diffused daylight.

The esculin screen suppresses the ultra-violet and part of the violet spectrum rays; and the photograph, made chiefly by the blue rays, is a very good one. The uranine screen suppresses the blue spectrum rays and part of the violet; and the photograph, made chiefly by the ultra-violet rays, is very bad indeed. The photographs are submitted herewith, and the conclusions to be drawn are sufficiently obvious. With no screen, the result is intermediate in quality between the two examples shown, but is bad.

Achromatic objectives used without an eye-piece sometimes work very well on ordinary plates, but I have yet to find one that does not give distinctly better results with the esculin screen.*

* Mr. Ives kindly sent two photographs which bear out the statements in the foregoing note; one was sharp, the other quite woolly.—Ed.

SUMMARY OF CURRENT RESEARCHES

RELATING TO

ZOOLOGY AND BOTANY

(PRINCIPALLY INVERTEBRATA AND CRYPTOGAMIA),

MICROSCOPY, ETC.*

ZOOLOGY.

VERTEBRATA.

a. Embryology.†

Development of Motor Nerve-Trunks and Myotomes in Lepidosiren.‡—J. Graham Kerr concludes from a study of a series of early stages that the facts of development in the motor nerves of *Lepidosiren* give strong support to the view that the nerve-trunk is not a secondarily formed bridge between spinal cord and motor end organ. The motor-trunk can be traced back to a simple protoplasmic bridge, which already connects the substance of the medullary tube with that of the myotome at a stage when they are still in contact. As regards the origin of the protoplasmic sheath, the evidence of *Lepidosiren* is equally emphatic. At an early period the motor-trunk is perfectly naked. At a certain stage masses of mesenchymatous protoplasm laden with yolk become applied to the nerve-trunk, gradually spreading over the whole of it. As development goes on the yolk becomes used up, the protoplasm with its nuclei extends into the substance of the nerve-trunk—doubtless to keep up the proper proportion between the bulk of the nerve-trunk and its nutritive surface in contact with the sheath protoplasm. The protoplasm itself becomes less and less conspicuous, and eventually is only to be detected in the immediate vicinity of the nuclei. *Lepidosiren* offers no evidence, so far, as to the ultimate origin of the nerve-fibrils. They appear gradually in an at first simple protoplasmic matrix. The paper contains also an account of the development of the myomeres.

Influence of Constant Agitation on the Development of the Toad's Egg.§—T. H. Morgan has devised an apparatus which excludes

* 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, etc., 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, Reproduction, and allied subjects.

‡ Trans. Roy. Soc. Edinb., xli. pt. 1 (1904) pp. 119–28 (6 pls.).

§ Ana . Anzeig., xxv. (1904) pp. 94–6.

the action of gravity and also that of a constant centrifugal force. Its motion is constant and extremely irregular. Eggs which had been kept in constant motion from the moment of their removal from the toad till placed in the machine developed normally and produced normal embryos. In fact, they developed faster than those outside, a feature which appears to be due to the agitation of the eggs yielding better aeration. The effect was very different from that of a centrifugal force, which kills the eggs outright.

Influence of Radium-Rays and Radium-Emanation on Development and Regeneration.*—A. Schaper has experimented with developing embryos of frog and with regeneration in Planarians and newts, in order to detect the influence of radium-rays and radium-emanation. The experiments established a disruptive and tissue-disturbing effect, and the frequent occurrence of abnormalities.

Rudimentary Amnion in Selachians.†—T. D'Evant describes, in some very early stages of *Pristiurus* and *Scyllium*, which show the medullary groove and gut tube still open, two laterally placed double folds of the extra embryonic ectoderm. They run in the direction of the longitudinal axis, and extend towards but do not reach the mid-dorsal line. In the cranial region the folds meet; in the caudal region they become lower and disappear. The author regards these folds as a rudimentary amnion.

Development of Liver in the Pig.‡—David C. Hilton discusses the early morphogenesis and histogenesis of the liver in the pig, with notes on the development of the ventral pancreas.

The most interesting deviation of the results of this research from those of other investigators concerns the relations of the vascular system in the septum transversum to the trabeculation of the glandular structures derived from the primitive "protonic" wall. A second important difference concerns the method and direct results of the gland-formative proliferation. The hepatic tissue, instead of being grown into by the vessels, grows out and extends among and around them, although by virtue of increases in calibre, the vascular spaces actively change the location of the rods springing from the protonic wall.

Breeding Habits of Yellow-Bellied Terrapin.§—H. M. Smith notes that the nest of *Pseudemys rugosa* is usually made in sandy loam or sandy clay, flask-shaped, about 4 in. deep by 4 in. wide at the bottom, with an opening somewhat smaller than a silver dollar. All the eggs (10 to 35) are laid at once, and packed tightly by the mother. The egg-laying is in June and July, and the young remain in the nest until the following spring. Birds, especially crows, destroy some eggs. The male is smaller than the female, his claws are twice as long as hers, and the under shell is flat, while in the female it bulges slightly.

Hybridisation of Triton marmoratus and Triton cristatus.‖—W. Wolterstorff has succeeded in effecting hybridisation between *Tr.*

* Anat. Anzeig., xxv. (1904) pp. 298–314 (4 figs.).
† Op. cit., xxiv. (1904) pp. 490–2.
‡ Trans. Amer. Micr. Soc., xxiv. (1903) pp. 55–88 (4 pls.).
§ Smithsonian Misc. Collections, xlv. (1904) pp. 252–3.
‖ Zool. Anzeig., xxviii. (1904) pp. 82–6.

marmoratus and *Tr. cristatus* (sub-species *typica* and sub-species *carnifex*) in both directions. It seems that *Triton blasii* de l'Isle is simply one of such hybrids, and the author indicates that it will prove a useful subject in connection with Mendel's law.

Bilateral Symmetry in Egg of Necturus.* — A. C. Eycleshymer finds that the primary area of cellular activity is at or near the upper pole, and it determines the position of the future head-end of the embryo. There is an early appearance of a second area of accelerated cell-division, which determines the position of the forthcoming blastopore and consequently the posterior end of the embryo. A line passing through the centres of the two areas coincides with the median plane of the future embryo.

Inheritance of Mental Qualities in Man.† — B. Rawitz discusses this subject. His point of view is that inheritance here is a physiological impossibility. Ganglion cells are occupied with specific functions and cannot acquire new qualities. They are without any power of transforming received material so as to influence the molecular structure of sperm and egg.

b. Histology.

Models of Cellular Mitoses.‡—M. Hartog has studied the "magnetic spectrum" obtained in a viscous substance, in order to elucidate the play of forces in mitotic division.

His mimetic model has proved very suggestive. It is necessary to analyse the karyokinetic forces (which combine to evoke two daughter-nuclei) into at least three sets. First, there are the usual cytoplasmic movements, determining the repulsion of the poles and the elongation of the spindle, aided perhaps by osmosis, for all the appearances of turgidity are often observed. Second, there is the force which determines the mutual repulsion of the chromosomes, potent even in the still intact nucleus, and perhaps comparable to static electricity. Third, there is the force which has its seat in the kinoplasm, and which produces the chains of force which Hartog calls "*mitokinetic*" because of their analogies with magnetism. In all kinetic interpretations of cellular mitoses, it is necessary to keep in mind the distinction between lines of ideal force and chains of material force.

Comparative Histology of Pancreas.§—Giuseppe Levi has studied in particular the pancreas of *Lemur mangos* var. *rubifrons*, in which there is an enormous development of the tissue composing the islands of Langerhans. They are not only large, but unusually numerous. There is a poor differentiation of zymogenic tubules in the canalicular system of the pancreas. The author makes a number of comparative notes on the state of the pancreas, and of the islands of Langerhans in particular, in various Mammals.

The Question of Sinusoids.‖ — F. T. Lewis seeks to show that there is an essential difference between capillaries and sinusoids, and considers

* Anat. Anzeig., xxv. (1904) pp. 230–40 (47 figs.).
† Biol. Centralbl., xxiv. (1904) pp. 396–408.
‡ Comptes Rendus, cxxxviii. (1904) pp. 1523–5.
§ Anat. Anzeig., xxv. (1904) pp. 289–98 (1 pl.). ‖ Tom. cit., pp. 261–79.

that their recognition is of fundamental importance. A sinusoid is a sub-division of a vessel produced by intercrescence between its endothelium and the parenchyma of an adjacent organ. The proliferating tubules or trabeculæ of an organ encounter a large vessel and invade its lumen, pushing the endothelium before them. The vessel, on the other hand, sends out branches to circumvent the tubules. By the convolution or anastomosis of the tubules or trabeculæ, the large vessel becomes sub-divided into small ones. This is the process of intercrescence which produces sinusoids. It follows that a sinusoidal circulation is either purely venous or purely arterial. To demonstrate it for any organ, it must be possible to state what vessel has been invaded, and thus resolved into an afferent and an efferent system. An essential characteristic — a consequence of the mode of development — is the almost entire absence of connective tissue between the endothelium of the sinusoids and the cells of the adjoining trabeculæ. Sinusoids have been demonstrated histologically and developmentally in the Wolffian body, myocardium, liver, and pronephros. They possibly occur in gills, but not in kidney nor lungs. They are found in the adults of lower Vertebrates but are regressive in Mammals, and are probably primitive.

Optic Reflex Apparatus in Cyclostomes and Fishes.* — P. E. Sargent discusses very fully the structure, development, function and ontogeny of Reissner's fibre apparatus in these forms. Only a hint of his results can be given. In Cyclostomes the optic reflex apparatus is in many respects in a primitive condition, but the relative size of its elements shows it to be of great importance. It is not fully established until the second month of larval life. Judged by the relative size of the elements, the apparatus probably reaches its highest development in Selachians. Its cell nidulus extends on either side of the median plane through the length of the optic lobes, close to the ventricle. The cells are early distinguishable, but do not reach a functional condition until the young attains the free life. In Ganoids the apparatus is not fully established until several days after hatching. The cells, 40 to 100 in number, lie close to the ventricle in the anterior portion of the tectum opticum, and are grouped about the margin of that portion of the ventricle which extends above the posterior commissure. In Teleosts the cells are small and are concentrated in the torus longitudinalis. Unipolar or bipolar in their general outline, they ultimately give rise to three processes, forming three fibre-tracts on each side of the brain. Concerning the physiological value of the apparatus, the author believes that it offers a "short circuit" for the transmission of motor reflexes, by which a reaction may be brought about more quickly than when the impulse is transmitted through the nerve-tracts of the spinal cord.

Sensory Nerve-endings in Human Tongue.† — G. Ceccherelli gives an account of the many forms of nerve dilatations which occur in the human tongue, including some not hitherto described. On the external layer of the papillæ of the corium and in the filiform papillæ and interpapillary spaces he describes "corymbose" endings, and in the conical

* Bull. Mus. Zool. Harvard, xlv. (1904) pp. 129–258 (11 pls.).
† Anat. Anzeig, xxv. (1904) pp. 56–69.

and fungiform papillæ, modified corymbose forms. In the thickness of the papillæ, he finds grape-like clusters, interlacing of papillary nerves, an interpapillary net, mono- and pluri-lobed Meissner's corpuscles, etc. In the deep stratum are terminal corpuscles of Ruffini.

The Fuchsinophile Granules of Spinal Ganglia Cells.* — A. M. Coco finds that these granules increase initially in the nucleus at the stage of excitation of the nerve-cells, and they appear abundantly in the protoplasm of the cellular element. In proportion as the ganglion is exhausted by protracted or excessive work, the granules in the protoplasm and in the nucleus diminish. The young cells become exhausted first, and the granules are more permanent in the older cells when stimulated a long time. The granules stain a light blue, whose intensity is in proportion to the exhaustion of the cell.

Supra-renal Capsule of Amphibians.† — E. Grynfeltt gives an account of the histology of the several elements of this organ. (1) The chromaffin cells are abundant epithelial elements, whose regularity of form is greater than in Selachians. They cannot be confused with the nerve-cells as in the latter group, and, whatever their origin, in the adult they are absolutely independent of the elements of the sympathetic nervous system. They are glandular elements; their chromaffin granules appear to be the product of protoplasmic elaboration, and to this the chromaffin reaction peculiar to these cells is due. (2) The cortical cells form a predominating element in the glandular trabeculæ, and are of a single type. They elaborate a product of a fatty nature, whose solubility characters are similar to those of other Vertebrates, especially birds. (3) Summer cells are only existent in *Rana*. They are round or oval with an excentric nucleus, often irregular, with leucocyte features. Frogs kept in the laboratory were found to have these cells all the year round, although Stilling held they were present only in the æstivation period.

c. General.

Anatomy of Notoryctes typhlops.‡—A. Carlsson gives an account of the anatomy of this Marsupial, noting a number of points in which it differs from other members of the group. These are skeletal and muscular peculiarities, such as the absence of the par-occipital process, the fusion of the 2–6 cervical vertebræ, a short symphysis pubis, fusion of ischium with transverse processes of two last sacral vertebræ, the presence of a foramen in the proximal part of the fibula, differences in the origin and insertion of muscles of the hinder extremity, and the absence of others. A detailed comparison of *Notoryctes* and *Chrysochloris* is given.

Constrictions and Dilatations of the Ureter.§ — B. Robinson demonstrates by means of numerous preparations of ureters from man, pig, cow, sheep, buffalo, dog, etc., that Mammalia possess definite

* Anat. Anzeig., xxv. (1904) pp. 97–102.
† Jour. de l'Anat. Physiol., xl. (1904) pp. 180–224 (1 pl.).
‡ Zool. Jahrb., xx. (1904) pp. 81–122 (2 pls.).
§ Anat. Anzeig., xxiv. (1904) pp. 482–5.

ureteral dilatations and constrictions, and these he interprets as heritages from the Wolffian body enhanced by environmental factors.

Hares and their Allies.*—M. W. Lyon, jun., has made a monographic study of the hares and their allies, discussing the genera and sub-genera of the existing Leporidæ and Ochotonidæ, their dental, cranial, and other skeletal characters, their geographical distribution, and their probable relationships.

Influence of Unilateral Horn-Growth on Cranial Characters.†—J. Ulrich Duerst has made a careful study of the numerous changes which are seen in the sheep's skull when the horn is removed from one side.

Compound Rhamphotheca of Birds.‡—Einar Lönnberg seeks to show that the bill of birds is only a modification of certain common reptilian characters. It is well known that the horny sheath of the bill of some birds consists of several pieces, which are more or less distinct in different genera and species. Lönnberg believes that there are pieces of the compound or "simple" bill of birds which are homologous with the reptilian *rostrale*, *labialia*, *nasalia*, and *internasalia* of the upper jaw, and with the *mentale* (or *symphysiale*), *infralabialia*, and *submandibularia* of the lower jaw.

As long as the ancestral birds were provided with teeth, the horny covering was of less importance, but with the loss of teeth the condition was changed. The premaxillæ increased, the maxillæ decreased, and an enlarged *rostrale* developed. The *mentale* was developed in a corresponding manner. With the increased development of the premaxillary and reduction of the maxillary tract, it is probable that the anterior *labialia* were enlarged and the posterior more or less reduced. The author works this view through the chief types of birds in an interesting and suggestive paper.

Middle Ear and Columella of Birds.§—G. Smith gives an account of the disposition of the chorda tympani in *Gallus* and *Columba*, and embryological data concerning the derivation and homology of the stapes. Positively, it may be stated that in the chick the contribution of the auditory capsule to the columella is exceedingly small, probably confined to the foot plug of the stapes; at any rate, the main part of the stapes, and the whole of the columella, are formed from the hyoid arch. Negatively, the author shows the futility of basing arguments upon this question on isolated stages or on cartilaginous stages which have not been traced back to their earliest procartilaginous forerunners. The conclusion to be drawn is that the stapes of Sauropsida corresponds to that of Mammalia and to the hyomandibular of fishes. Mammalia and Sauropsida have this much in common, that they have both converted the hyomandibular or dorsal portion of the hyoid arch into the stapes, but subsequently they have gone on different lines in evolution, the

* Smithsonian Misc. Collections, xlv. (1904) pp. 321–47 (27 pls.).
† Vierteljahrschr. Nat. Ges. Zürich, xlviii. (1903) pp. 360–75 (2 pls.).
‡ Arkiv f. Zool., i. (1904) pp. 473–512 (13 figs.).
§ Quart. Journ. Micr. Sci., xlviii. (1904) pp. 11–22.

Sauropsida making use of the more ventral part of the hyoid to complete their chain of ossicles (extra columella), while the Mammalia have pressed into this service the constitnents of the arch in front—viz. the quadrate and articular (incus and malleus).

Colour Change in Anolis Carolinensis.*—F. Carlton has investigated the colour changes in the skin of this lizard, a member of the family Iguanidæ. The animal is as a rule dark brown during the day and pea-green at night. These extremes, with a series of transitional tints running through shades of brown and yellow to green, were the chief colours regularly noticed. The brown state is produced by the outward migration of pigment granules from conspicuous black bodies well buried in the derma, and sending branching processes outwards toward the epidermis (*melanophores*). The migration proceeds along the processes and into their ultimate branches ; it occupies about four minutes, and may be induced either by the mechanical stimulation of the skin, or by the action of the sympathetic nerve centres. The melanophores are not stimulated directly by light. The green state is produced by the inward migration of the pigment granules of the melanophores, whereby a reflecting "*ochrophore*" layer filling the spaces between the melanophore processes is exposed to light. The inward migration may be induced by darkness, cessation of circulation, nicotine poisoning, in fact, by any means which brings the melanophores into an unstimulated state.

Natural Immunity of Vipers.†—C. Phisalix finds experimental reasons for maintaining that the natural immunity of vipers to their own venom is to be attributed to the presence in the blood of a free antitoxin, which neutralises the poison in proportion to its entrance into the general circulation.

Reptiles and Amphibians of Asia Minor.‡—Fr. Werner gives an account of the reptilian and amphibian fauna of this region. It includes 42 species of reptiles (3 Chelonians, 22 lizards, 1 chamæleon, 17 snakes) and 15 species of Amphibians (7 Urodela and 8 Anura). Six reptiles (5 lizards and 1 snake) and 1 Amphibian must be regarded as quite peculiar to Asia Minor, and an analysis of the distribution of the others (in relation to the Caucasus, Syria, Persia, Egypt, etc.) confirms the view that for many species Asia Minor must be considered as the headquarters or centre of dispersal.

Limbs of Amphiuma.§—P. van Pée is of opinion that the two-toed *Amphiuma means* is not a distinct species, but is a regressional form of *A. tridactylum*. In two larvæ of each kind he found that seven of the eight limbs had only two elements in the carpus or tarsus, one radial or tibial, the other primary basale + intermedium + ulnar or fibular. On the peroneal border of the second cartilage there was a deep cleft, nearly subdividing it into two. Of eleven anterior extremities of *A. means*, six had three cartilages in carpus, four had two, and one had

* Proc. Amer. Acad. Sci., xxxix. (1903) pp. 259–76 (1 pl.).
† Comptes Rendus, cxxxviii. (1904) pp. 1459–61.
‡ SB. Akad. Wiss. Wien, cxi. (1902) pp. 1057–1121 (3 pls.).
§ Anat. Anzeig., xxiv. (1904) pp. 476–82.

four; while of the limbs, one had rudiments of a third toe, and one a complete third toe. Of twelve posterior extremities, the tarsus consisted six times of three elements, and six times of two; once there was a rudiment of a third toe. Both species thus appear very variable.

Fishes of Chilian Coast.*—J. Pellegrin gives a list of fishes obtained by the Crequi-Montfort expedition. He describes as of particular interest the dental and pharyngeal apparatus of *Hoplegnathus insignis*. The teeth have coalesced to form a beak resembling that of the Scaridæ. On the first branchial arch there are very long, pointed, ridged, and finely-toothed spines. On the internal side of this arch, and on both sides of the second, third, and fourth, there are short, rounded appendages, covered with fine denticulations. The inferior pharyngeal bones are very slender, quite separate, and covered with extremely sharp conical teeth in four or five rows. There are analogous teeth upon the superior bones.

Deep-Water Fishes of Japan.†—D. S. Jordan and J. O. Snyder report on a collection of fishes made by Mr. Alan Owston in the deep water of Japan. The collection includes some interesting forms:—*Pristiurus eastmani* sp. n., *Pseudotriakis aerales* sp. n., the huge *Mitsukurina owstoni*, *Trismegistus owstoni* g. et sp. n. (a Liparid with very peculiar prickles), and so on.

Pelican Fish from the Pacific.‡—B. A. Bean describes *Gastrostomus pacificus* sp. n., with a more robust body and higher fin-rays than *G. bairdii*, the Atlantic form. It is believed to be the first pelican-fish recorded from the Pacific, and was entangled on the sounding wire, near the sinker, the depth at the point of capture being between 2000 and 3000 fathoms. It was obtained half-way between Midway islands and Guam by U.S. naval ship 'Nero,' which on that voyage discovered the greatest depth of water ever recorded, 5269 fathoms in 12° 43′ 15″ N. lat.; 145° 49′ 00″ W. long.

Umbrids or Mud-Minnows.§—Theodore Gill gives an account of this feeble but interesting family represented by a single genus, whose three species are distributed in a notable manner. One species, *Umbra umbra* or *krameri*, occurs in Central and South-eastern Europe,—Hungary and the neighbouring countries—and the two others are inhabitants of the eastern slope of the American continent and the Mississippi valley, while all the intervening countries are deprived of them. They have interesting habits, e.g. the alleged segregation of the males from the females; and are very tenacious of life. With their great adaptability and power of endurance, it is remarkable that the range of the genus should now be so restricted.

Toxic Action of Serum of Torpedo marmorata.‖—E. Gley finds that the blood of this electric ray contains a substance which is highly toxic for various Mammals—dog, rabbit, and guinea-pig.

* Bull. Soc. Zool. France, xxix. (1904) pp. 117–21.
† Smithsonian Misc. Collections, xlv. (1904) pp. 230–40 (6 pls.).
‡ Tom. cit., p. 254 (1 pl.). § Tom. cit., pp. 295–305 (5 figs.).
‖ Comptes Rendus, cxxxviii. (1904) pp. 1547–9.

He proposes to inquire whether the blood of the skate, which is also electric, is equally toxic, and whether the blood of non-electric Selachians has or has not the same property.

Mitsukurina Owstoni.*—Léon Vaillant describes a specimen of this deep-sea shark, the first to reach Europe, and the third obtained. It was named in 1903 by Jordan from a specimen in the museum at Tokyo. The present specimen is 2·5 metres in length. Vaillant gives descriptive notes on the vertebral column and skull, and finds that the animal belongs to the Lamnidæ, with affinities linking it to *Oxyrhina*, *Lamna*, and *Odontaspis*.

Parasites of Fishes.†—A. Scott gives a list of parasites from fishes caught in the Irish Sea. Of Protozoa there are four species :—from *Pleuronectes flesus*, a sporozoon, *Lymphocystis johnstonei*; from the plaice a species of *Glugea* and *Sphærospora platessæ*; and *Glugea lophii* from *Lophius*. The occurrence of ten species of Trematodes and forty-six species of Copepods is noted.

Plankton of Wisconsin Lakes.‡—C. D. Marsh has made a comparative study of the plankton of Winnebago, Green, and other lakes. The author discusses the distribution of *Cyclops brevispinosus* and *C. pulchellus*; the "bloom"; the annual distribution of the total plankton; constituents which produce plankton maxima; amount in different years; and, comparatively, the plankton of the different lakes. On comparing the plankton of successive years, it is apparent that the balance of life is maintained much more evenly in deep lakes than in shallow. In the shallow lakes there is always an over-production of plants in the summer as compared with the animals. This is so much the case that sometimes in midsummer the water through the decay of the plants may become actually poisonous to the fish. From the point of view of fish production the shallow lakes must be considered the more valuable. Under similar favourable conditions deep lakes are never so productive as the shallower; yet the author thinks the difference has been greatly exaggerated.

INVERTEBRATA.

Mollusca.

γ. Gastropoda.

Anatomy and Affinities of the Trochidæ.§—W. B. Randles reviews the structure of a number of species of *Trochus*. His investigations have revealed such a striking similarity of structure as to necessitate the reduction of sub-genera amongst British Trochidæ. The section Trochocochlea cannot be retained, *T. lineatus* and *T. turbinatus* being referable to the division Gibbula. There is a very great similarity in the digestive, excretory, circulatory, and nervous systems of Trochidæ and *Pleurotomaria*. The author confirms Pelseneer's view that a right reno-pericardial canal exists in the Trochidæ, and considers that the kidney of the Mono-

* Comptes Rendus, cxxxviii. (1904) pp. 1517–8.
† Rep. Lancashire Sea Fisheries Lab., 1904, pp. 33–45.
‡ Bull. Wiscon. Geol. and Nat. Hist. Survey, xii. (1903) Sci. Ser. No. 3, pp. 1–94.
§ Quart. Journ. Micr. Sci., xlviii. (1904) pp. 33–78 (3 pls.).

tocardia has been derived principally from the right kidney of the Diotocardia. These are the true excretory organs, the left kidney or papillary sac of *Trochus* and its allies being more of the nature of a lymphatic gland. The nephridial gland of the Monotocardia possesses similar functions, and so, from a physiological point of view, can more easily be homologised with the papillary sac of *Trochus*.

Muscular Fibres in Heart of Nassa reticulata.* — M. Mader shows that the fibres in this Gastropod are in a state of differentiation intermediate between the unstriped fibre and the fibre of simple striation, described by Vigier in *Anodonta*; it is a transition-type towards the complex striated fibre of Arthropods and Vertebrates.

Phylogeny of Fusus and its Allies.†—Amadeus W. Grabau discusses the genetic relationships of *Fusus* and its allies. Starting from Eocene species of *Fusus*, he describes more than half-a-dozen series of species, and indicates their probable phylogeny. He also deals with species of Fusoid shells generally referred to Fusus—the genus *Aptyxis*, various Eocene species, the new genus *Heilprinia*, and the genus *Euthriofusus*. Then follows a discussion of phylogerontic Fusidæ—the genus *Cyrtulus* and the Eocene Clavilithoids. A study of the geographical distribution closes the memoir.

Mendelian Phenomena in Gastropods.‡ — G. Contagne maintains that Mendelian or "*polytaxic*" phenomena may be recognised in various Gastropods in natural conditions—e.g. *Cyclostoma elegans*, *Vallonia pulchella*, *Cœlistele hispanica*, *Helix planospira*, *H. pisana*, *H. nemoralis*.

Chitons from the Pacific.§—Curt von Wissel reports on collections of Chitons made by Schauinsland and Thilenius in the Pacific, nineteen forms in all, belonging to the genera *Ischnochiton*, *Mopalia*, *Chætopleura*, *Plaxiphora*, *Acanthochites*, *Cryptoconchus*, *Katharina*, *Chiton*, *Onithochiton*. The author has been able to work out the anatomy in some detail. An appendix describes three species of *Oncidiella* from New Zealand.

Anatomy of Lottia gigantea.‖—W. K. Fisher has investigated the organisation of the Acmæidæ as exhibited in this species. The following are some of the most notable points elucidated. The Acmæidæ possess a larval nautiloid shell. The lips are armed with tiny teeth. The nephridia are very unequal in size, the left being a tiny sac on the left side of the rectum. Both are in communication with the pericardium by long canals, which are really diverticula of the pericardium. The circulation is for the most part closed. Sinuses, however, collect the blood in the foot, and there are also open lacunæ of minute size in the liver. The arterial system is extensive. Over the nephridia there is present a highly developed vein-net. The mantle discharges its blood directly into the auricle. The innervation of the mantle is

* Comptes Rendus, cxxxviii. (1904) p. 1537.
† Smithsonian Misc. Collections, xliv. (1904) pp. 1–160 (18 pls. and 22 figs.).
‡ Comptes Rendus, cxxxviii. (1904) pp. 1521–3.
§ Zool. Jahrb., xx. (1904) pp. 591–676 (5 pls. and 10 figs.).
‖ Tom. cit., pp. 1–66 (4. pls.)

complex, and wholly typical of the Acmæidæ. From each pleural ganglion, there are two principal pallial nerves, which reach a circumpallial nerve completely encircling the animal near the mantle edge. This nerve is ganglionic, and supplies the finer nerves to the mantle.

Anatomy of Corolla (Cymbuliopsis) spectabilis.*—H. Heath and M. H. Spaulding give an account of the anatomy of this Pteropod. There is a symmetrical proboscis, comparatively thin and broad, and free from the fin for nearly half of its length. Its free margins form a groove of richly ciliated tall columnar cells profusely innervated. It appears to function as an organ of special sense, and as a contrivance for collecting and directing food to the mouth. The foot or fin, modified into a swimming organ, is operated by two systems of muscle bands. Along its margin there are multitudes of sense-organs, apparently light percipient structures, the details of whose development are remarkable. There are no cephalic eyes. There appear to be no data discovered by the authors to enable them to decide whether the species is truly hermaphrodite, whether the penis has entirely disappeared, whether there is progressive hermaphroditism, or whether the males are still undiscovered.

δ. Lamellibranchiata.

The Formation of Pearls.†—W. A. Herdman sums up the various points in the problem of pearl-formation. In particular he criticises Jameson's views as to the mode of origin of the epithelial sac which encloses the larval parasite, and which secretes from its cellular walls layer after layer of nacreous material so as to form a pearl. He thinks there can be little or no doubt that the cells of the pearl sac are directly and genetically connected with the cells on the outside on the mantle. He has found also that the evidence for Jameson's view that the mussels are infected by parasites from *Tapes* and *Cardium*, is very far from sufficient. There are two points in particular which require clearing up: the exact details of formation of the pearl-producing epithelial sac when deeply placed in the tissues, and the complete life-history of the parasite inside the sac.

Evolution of Pecten.‡—C. B. Davenport has made a quantitative study of *Pecten opercularis* from three separate localities of the British Isles, viz. Firth of Forth, Irish Sea, and English Channel. The general conclusions drawn from his results are that the three lots are measurably unlike in size, proportions, and average number of rays. The geographical extremes are the biological extremes also. The evidence from the shells examined bears upon De Vries' law of mutation. Where the environmental conditions of the isolated form units are similar, the differences met with are easily accounted for on the assumption of mutations which are preserved. Where, on the other hand, the environmental conditions are dissimilar, it is obvious that they must produce a change either through their direct and definite action or possibly

* Zool. Jahrb. xx. (1904) pp. 67–80 (1 pl.).
† Rep. Lancashire Sea Fisheries Lab., 1904, pp. 88–97.
‡ Proc. Amer. Acad. Sci., xxxix. (1903) pp. 123–59.

by selection. The mutation theory errs in stating only half a truth. Through mutation and also through the direct action of environment, specific changes may be produced. In another paper * the author makes statistical comparisons of Pectens from the east and west coasts of the United States.

Muscular Fibres of the Molluscan Heart.—P. Vigier has observed considerable variety in the myocardium of the Molluscan heart. The fibres are sometimes incipiently striated, and sometimes well-striated.

Those of *Anodonta*, for instance, are striated fibres of the simple type, such as has been defined by Haswell and Prenant. In Lamellibranchs generally, it seems that the fibres represent a stage far below that of Arthropods and Vertebrates, and yet above the unstriped level, as is also suggested by their brusque and rhythmical contractions. They recall the embryonic cardiac fibres in the lower Vertebrates. In Cephalopods, however, as Marceau has shown, a higher level is attained.

Arthropoda.

α. Insecta.

Habits of Sphex.‡—F. Picard relates in a lively manner his observations on *Sphex maxillosus*. This insect is, as regards its habits, still in process of evolution. It is very variable, especially as regards the prey with which it feeds its larvæ. It is not so far advanced or "fixed" as some of its fellow-species; it lingers at an ancestral level.

Picard reconstructs the history: the first Sphex was in the habit of capturing many kinds of Orthoptera; gradually the Sphexes began to confine themselves to two or three families, as *Sphex maxillosus* does; later on attention was restricted to one family, as in *Sphex albisecta*; subsequently, as in *Sphex flavipennis*, operations were confined to a genus; finally, in the most differentiated species, *Sphex occitanica*, the prey is a single species, and one sex only.

The author regards the instinct as an acquired habit, conserved by heredity, transformed little by little in adaptation to external conditions, the modifications being retained or eliminated for the good of the species by natural selection.

Insect Evolution in Relation to Plants.§—A. Handlirsch notes as factors which have essentially influenced the development of races of insects, (1) the origin of a land flora and fauna in Silurian times; (2) great climatic alterations during the Permian period (the impulse to the decidedly heterophyletic origin of metamorphoses); (3) the appearance of angiosperms in the Chalk.

Convergence Phenomena in Insects.‖—A. Handlirsch points out the frequent occurrence of "convergence" amongst insects, and the consequent difficulty of attaining a classification showing real relationships. As instances he quotes the reduction in number of stigmata in aquatic

* Mark. Anniv. Vol. Art. vi. (1903) pp. 121–36 (1 pl.).
† Comptes Rendus, cxxxviii. (1904) pp. 1534–7.
‡ Mem. Soc. Sci. Nat. Cherbourg, xxxiii. (1903) pp. 77–130.
§ Verh. Zool Bot. Ges. Wien, liv. (1904) pp. 114–9.
‖ Tom. cit., pp. 134–42.

insects or parasites, the concentration of the central nervous system into one or two masses, the presence of a sucking stomach, and the reduction of the malphigian tubes to a small number, or a remarkable increase of the same, etc. Amongst such are also to be included viviparous forms in the most different groups, polymorphism, formation of states, the origin of resting stages (pupa), and of similar larval forms in otherwise very different groups. The Holometabola, it can scarcely be doubted, form a convergent group, and are really heterophyletic. In judging and valuing characters in classification, it is well to keep in view the fact that biologically important characters may be unimportant taxonomically.

Metamorphosis of Central Nervous System in Insects.*—V. Bauer finds that the formation of the central nervous system is not completed at hatching. A post-embryonic development takes place which is continuous in the forms without metamorphosis, original in the Metabola. For the new formation of ganglia, special centres, consisting of neuroblasts, are present. Ganglionic cells arise by two divisions. The first division of the neuroblast leads to the formation of two different part-products, of which the one becomes a ganglion mother-cell, whilst the other, retaining the neuroblast character, repeats the division. The ganglion mother-cells, by simple division, give rise to ganglion cells. Ganglion cells, as well as connective tissue and tracheæ of a provisional character, degenerate partly with and partly without the aid of phagocytes.

Nutritive Role of Follicular Epithelium in Melolontha vulgaris.† Th. Mollinson finds that the terminal ovarian chamber contains only oocytes and young epithelial cells, and that it is only the latter which have to do with the nourishment of the growing ovum. In performing this function they may, it is true, sometimes utilise the debris of superfluous oocytes.

The activity of the epithelial cells finds expression not only in the formation of pseudopodia-like processes which penetrate into the ovum, but also in the formation of nutritive strands and, in some cases, of a nutritive reservoir around the ovum. There is also on the part of the ovum an active role in the formation of its cytoplasmic substances.

In *Geotrupes stercorarius* there are similar arrangements, but a central protoplasmic process formed by the ovum persists in addition to the reservoir and nutritive strand formed by the epithelial cells.

Muscle-Changes in Beetle (Thymalus marginicollis) during Metamorphosis.‡—R. S. Breed finds that some of the larval muscles remain unaltered during metamorphosis, a few degenerate, while many metamorphose into imaginal muscles. Imaginal muscles are formed in the pupa from cells of an embryonic nature, but they are few in number. Those undergoing no change are all found in the abdominal region, the typical degenerating forms in the thorax and first and last abdominal somites. The muscles of new formation were observed in only two

* Zool. Jahrb., xx. (1904) pp. 123–52 (2 pls.).
† Zeitschr. f. wiss. Zool., lxxvii. (1904) pp. 529–45 (2 pls.).
‡ Bull. Mus. Zool. Harvard, xl. (1903) pp. 317–82 (7 pls.).

somewhat questionable cases in *Thymalus*. In *Bruchus* and other forms with legless larvæ the leg-muscles belong to this class. The metamorphosing forms include all of the remaining larval muscles. The histological nature of the changes are given in detail.

Weevils of Crozet Islands.*—G. Enderlein describes, from the material of the German South Polar Expedition, three new forms of *Ectemnorhinus*. This type has hitherto been known only from Kerguelen Island. One of the forms constitutes a new genus, *Xanium*, the others are *Ectemnorhinus richtersi* and *E. crozetensis*, sp. n. They possess short and very broad scales; the hitherto known forms have long scales as thin as hairs, though in some parts the hairs are transformed into rather narrow but distinct scales.

Natural History of British Lepidoptera.†—J. W. Tutt has published the fourth volume of his encyclopædic text-book for students and collectors, which deals with the Sphingidæ.

Tsetse-Flies.‡—E. E. Austen communicates a revised synopsis of the Tsetse-flies (*Glossina*), one of which (*Gl. palpalis*) is well-known as the active agent in the dissemination of the dread disease of Tropical Africa called Sleeping-sickness. He published a monograph, dealing with seven species, in 1903; but already the attention paid to these insects has increased the number of known species by one, and has afforded material from which it has been possible to form a clearer view of the characteristics of the various species.

New Genus of Marine Diptera.§—René Chevrel gives an account of *Scopelodromus isemerinus* g. et sp. n., a new marine Chironomid, which he found at Saint-Briac. The insect passes its larval life among the seaweeds and acorn-shells *below the low-water mark*; it seems to have but two generations in the year, for the adults are only seen twice a year running or flying rapidly among the rocks, about the time of the equinoxes. Both sexes are winged; the males are much more numerous than the females, perhaps 10 to 1, as in *Clunio* and a marine *Chironomus*. The new genus differs from all other Chironomids in having in both sexes 7-jointed antennæ, and also in the venation of the wings.

Dipterous Parasites of Lepidoptera.‖—J. Künckel d'Herculais discusses the parasitism of the Bombylid Diptera of the genus *Systropus* in the cocoons of Limacodid Lepidoptera, such as *Sibine bonaërensis*. In winter the cocoons contain either the chrysalis of the Lepidopteron or the nymph of the Dipterous parasite, resting in a state of "*hypnodie*." As in other Limacodidæ, the cocoons of *Sibine bonaërensis* have no operculum to facilitate the emergence of the inmate. But both chrysalid and nymph have a similar frontal chitinous point, and similar points at the end of the abdomen, and similar energetic habits of working their

* Zool. Anzeig., xxvii. (1904) pp. 668–75.

† A Natural History of the British Lepidoptera, iv. (Sonnenschein, London, 1904) pp. xvii. and 535 (portrait and 2 pls.).

‡ Ann. Nat. Hist., xiv. (1904) pp. 151–5.

§ Arch. Zool. Expér., i. (1903) sér. 4, pp. 1–29 (1 pl.).

‖ Comptes Rendus, cxxxviii. (1904) pp. 1623–5.

way out. This is a phenomenon of "dynamic convergence," which the author calls "*homeopraxis*." It is, indeed, very striking that the rightful tenant and the insinuated parasite which replaces it should have similar adaptations, both structural and functional, securing emergence. There is a parallel adaptation of host and parasite to the same conditions.

Diptera as Ectoparasites on South American Lepidoptera.*—W. A. Schulz found, near Belem do Pará in swampy thickets, that some specimens of *Morpho achilles* bore small Diptera on the upper surface of the wing, burrowing among the scales. The Diptera seem to be members of the family Phoridæ. They were also observed on small Erycinidæ,—*Helicopis acis* and *H. cupido*.

Phagocytic Apparatus of Cleandrus graniger.†—C. Dawydoff finds that this locust possesses phagocytic organs analogous to these in Gryllidæ. They are three pairs of triangular sacs disposed on the three first abdominal segments, and having their apices touching the heart. They absorb solid substances, fat globules in milk, and bacteria with rapidity. The internal face of the gland has a very thin epithelium ; the whole of the reticular tissue of which it is composed is filled with little leucocytiform cells. These are the cells whose role in the organ predominates. On the whole, the structure of the organ is more primitive than that of Gryllidæ.

Cercopidæ of Japan.‡—S. Matsumura gives a revised and complete list of the Cercopidæ of Japan, which is supplementary to that published the previous year, and includes an account of nineteen new species. A description of a new species of *Cicada* is included, viz., *C. pyropa*, very similar to *C. flammata*, but easily distinguished from it by its yellowish-red veining.

Parthenogenesis in Copeognathæ.§ — Constantino Ribaga brings forward definite evidence that parthenogenesis occurs in *Ectopsocus briggsi*, MacLachl. var *meridionalis* Ribaga, a common Psocid in Italy, in which the male sex remains unknown.

Nymphopsocus destructor: a new Copeognathid.‖—G. Enderlein describes this form, which has appeared at Charlottenburg and elsewhere in Germany in considerable numbers, and whose introduction has not been traced. It devours furniture, forming little channels in the wood. Apparently only the female and nymph have been found.

Homoptera of North-East Africa.¶—A. Jacobi gives an account of the Homoptera from Neumann's collection. Ten new species are included in the list, which, however, is not sufficiently complete to warrant deductions regarding distribution, or general faunistic considerations.

Louse of Elephant-Seal.**—Günther Enderlein describes *Lepidophthirus macrorhini* g. et sp. n., a new louse from the elephant-seal of

* Zool. Anzeig., xxvii. (1904) pp. 42–3. † Tom. cit., pp. 707–10.
‡ Annot. Zool. Japon, v. (1904) pp. 31–55 (2 pls.).
§ Redia, ii. (1904) pp. 33–6. ‖ Zool. Jahrb., xix. (1904) pp. 727–31 (1 pl.).
¶ Tom. cit., pp. 761–82 (1 pl).
** Zool. Anzeig., xxviii. (1904) pp. 43–7 (5 figs.).

Kerguelen Islands. It differs from all known lice in a remarkable character: the upper surface of the thorax and especially of the abdomen is covered with broad scales which closely resemble those of butterflies. This new form is nearest to *Echinophthirus* from seals, e.g. *Phoca*.

Spermatogenesis of Blatta germanica.* — A. Wassilieff describes the succession of changes manifested by the centrosome in the development of the sperm-cell in *Blatta*. Briefly these are as follows: In the spermatogonia they are "points"; in spermocytes of the first order, V-shaped; in spermocytes of the second order, a pair of rods; in spermatids (*a*) a single rod; in spermatids (*b*) two point-like bodies as in the spermatogonia.

Palæoblattina Douvillei.† — M. Agnus adduces evidence to show that this fossil, described by Brongniart in 1884 as the impress of an insect wing, is to be referred to the Trilobites. As he shows from the channelling and ornamentation upon it, *Palæoblattina* is a cheek-plate of an *Asaphus*.

δ. Arachnida.

North American Species of Limnesia.‡ — R. H. Wolcott gives a diagnostic key to the North American species of this universally distributed water-mite. The list stands at nine species, the author having added five, of which two are new. This mite may be recognised, in general, by its oval, highly arched body; by the presence of two eyes on either side of the body anteriorly; by the absence of claws on the last pair of legs, which end in a sharply-pointed distal segment; and by the characters of the epimera and the genital area. The individuals are active and brightly-coloured, of rather large size, and with pronounced cannibalistic tendencies.

Notostigmata: New Sub-order of Acari.§ — C. J. Witte describes *Eucarus* (= *Opilioacarus*), a new type of mite which requires a new sub-order to itself, and appears to be of great taxonomic interest. The integument is relatively delicate, without sclerites. There is a large segmented abdomen. A movable pseudocapitulum is defined off. The labrum, divided into a basal clypeus and a distal labrum proper, is united with the fused maxillæ, and bears a pair of well-developed maxillary (lateral) lobes. Two labial appendages (= tritosternum) are present. The trochanters of the third and fourth limbs are two-jointed. There are numerous "lyriform fissures." Four dorsal stigmata occur on the abdomen. The intestine opens by an anus.

Hungarian Species of Eylais.‖ — E. von Daday, who is preparing a monograph on Hungarian Hydrachnida, discusses the genus *Eylais*. He has found sixteen Hungarian species, five of them being new.

* Zool. Anzeig., xxviii. (1904) pp. 257–60.
† Comptes Rendus, cxxxviii. (1904) pp. 398–9.
‡ Trans. Amer. Micr. Soc., xxiv. (1903) pp. 139–60 (2 pls.).
§ Vidensk. Medd. Nat. For. Kjobenhaven, 1904, pp. 137–92 (3 pls.). See Zool. Centralbl. xi. (1904) pp. 511–24.
‖ Math. Nat. Ber. Ungarn., xviii. (1903) pp. 340–64 (8 figs.).

Palæozoic Arachnida.*—Anton Fritsch describes and figures the fossil Arachnida in the Museums of London, Paris, Dresden, Breslau, and Vienna, along with those from the Coal-formation of Bohemia. Thirty-nine genera and sixty-seven species of Arachnida are recorded, and more or less fully described in this important monograph.

ε. Crustacea.

Entomostraca of Northern Swedish Mountains.†—Sven Ekman has studied the Phyllopods, Cladocera, and free-living Copepods of the various regions (birch-, grey willow-, and lichen-regions) of the Northern Swedish mountains. The hydrographic conditions are on the whole arctic, thus the ice-free period in the lakes of the birch region is from $3\frac{1}{2}$–4 months, while higher up ice is never absent. Clear tabular summaries show the composition and distribution of the Entomostracan fauna. On the whole the forms are distinctively arctic, and there is close agreement with those of the mid-European Alps. In the highest regions all the forms are monocyclic, and in some cases the whole reproductive cycle is condensed into $1\frac{1}{4}$–$1\frac{3}{4}$ months, only the first generation consisting of parthenogenetic females. There is more rapid growth than in the South, and less temporal and local variation. The author discusses the influences of the Glacial period, the results of isolation, the present-day splitting of a species like *Bythotrephes longimanus* into a northern and a southern species, and much more that is both interesting and important.

New Lernæopod.‡—Miroslav Miculicich found on the tunny (*Thynnus thynnus* L.) an interesting new Lernæopod, which he names *Thynnicola ziegleri* g. et sp. n. A brief description is given of both sexes. The new form is nearest *Tracheliastes*, with which it is compared in detail.

Memoir on Gammarus.§—M. Cussans gives a clear account of the leading structural and developmental facts in regard to this well-known Amphipod. As a "Memoir' the work seems weak on the bionomic side.

The Origin of Mysis, Pallasiella, and Pontoporeia.‖—M. Samter and W. Weltner adduce a number of facts proving the origin of these forms in an ice age. *Mysis* lives only in cold waters ; in summer in the colder depths only, but in winter in all layers. Offspring are produced only in water below 7° C., and twice in those lakes which are sufficiently cold in autumn. Furthermore, it becomes larger and lives longer in those waters which are specially cold in autumn. *Pallasiella* avoids the higher summer temperature (contrast *Gammarus*). Reproduction reaches its height in the cold time of the year, and more eggs per individual are produced in spring than in summer. *Pontoporeia*, though living in warm waters at all depths in winter, is absent in summer from all

* Prag. (1904), 88 pp. 15 pls. and 99 figs. See also SB. Akad. Wien, cxii. Review in Geol. Mag., Decade V., i. (1904) pp. 471–5.

† Zool. Jahrb. xx. (1904) pp. 1–170 (2 pls. and 12 figs.).

‡ Zool. Anzeig., xxviii. (1904) pp. 47–52 (3 figs.).

§ Liverpool Marine Biol. Committee Memoirs, xii. (1904) pp. 1–47 (4 pls.).

‖ Zool. Anzeig., xxvii. (1904) pp. 676–94.

depths below 10 m. Eggs are brought forth only in the cold season. These observations were made on the Dratzig and Madü lakes in N. Germany.

Cave-dwelling Galatheid from the Canary Islands.* — W. T. Calman discusses *Munidopsis polymorpha* Koelbel, collected by Mr. Fairfax Prevost in a cave on the island of Lanzarote. The occurrence in a littoral cave is very interesting, in view of the exclusively deep-sea habitat of the other (102) species of the genus. It seems probable that the present inhabitants of the cave are the descendants of some deep-water species which, having been carried into the fissures by which the cave communicates with the sea, found there an environment suitable, at least in the absence of light, to its habits.

Polyspermy and the Culture of Spermatozoids.†—A. Labbé finds that the ovary of *Carcinus* a few hours after fertilisation is full of spermatozoids in different stages of development. The eggs are full, and in the yolk are all stages between spermatozoids and merocytic nuclei. Many are digested in the ovarian cytoplasm, many merocytic nuclei undergo karyolytic degeneration, and only a small number persist in the vitellus till they reach the stage of definite nuclei. Full development can be secured by artificial cultures of spermatozoids upon lecithin.

Annulata.

Structure and Habits of Pœcilochætus.‡—E. J. Allen gives a very complete account of the habits and structure of a new species, *P. serpens*, of this genus. The larva has been known for years at Plymouth, but only recently has the adult been discovered. It constructs U-shaped burrows in the sand which is exposed at low spring tides, and its area of distribution is very restricted. When at rest the animal lies in its tube with the two long palps extended in front. A constant current of water, drawing small particles with it, is kept up through the tube by means of an undulatory movement of the body, and of a fan-like movement of the parapodia and bristles. If the animal reverses its position in the tube, the direction of the current is immediately reversed. The worm does not possess jaws; its food appears to consist of fine organic particles and small organisms carried in with the current. *Pœcilochætus* appears to breed practically the whole year round. The larva is remarkable for the late stage of development to which it retains the pelagic habit. One of the diagnostic features of the adult is the smooth anterior dorsal surface, with few tubercles. Parapodial cirri of segments 7–13 are different from those in the rest of the body, being flask-shaped, with long, stiff necks. The second and third segments have short, stout spines in the neuropodium. The nuchal organ is greatly developed, forming three long tentacle-like processes.

Branchial Vessels of Sternaspis.§—E. S. Goodrich points out that the so-called supporting "axis" of the branchial artery is in reality a

* Ann. Nat. Hist., xiv. (1904) pp. 213–8 (1 fig.).
† Comptes Rendus, cxxxix. (1904) pp. 75–7.
‡ Quart. Journ. Micr. Sci., xlviii. (1904) pp. 79–151 (6 pls.).
§ Tom. cit., pp. 1–10 (2 pls.).

second blood-vessel with specialised contractile walls. These walls consist of a regular series of ring-shaped cells. The vessel, which may be called the dorsal branchial vessel, is capable of undergoing great contraction and expansion, and, with a contained inner axis, forms a most efficient apparatus for propelling the blood from one end of the vessel to the other as waves of contraction pass down it. There is a communicating vessel (branchial artery of Vejdovsky and Rietsch) by means of which stoppage of the circulation is avoided on the retraction of the gill filaments, and which affords an alternative path from the main ventral to the main dorsal vessel.

Polynoid Symbion of Hydrocorallinæ.*—Emil von Marenzeller describes a new Polynoid, *Lagisca irritans*, sp. n., symbiotic on *Stenohelia profunda* and *Errina macrogastra*, sp. n., in the 'Albatross' collection of 1891. The worm is a typical *Lagisca*, but the usually strong equipment of setæ is sparsely represented.

New Deep-sea Polychæte.†—Akira Izuka describes a new species of *Panthalis*, *P. Mitsukurii*, from deep water in Sagami Bay. Nothing is known of the tube, although the presence of spinning glands from the eighth segment backwards indicates the formation of one by this species.

Memoir on Arenicola.‡—J. H. Ashworth has completed in the L. M. B. C. series an excellent memoir on *Arenicola*. The work includes an account of observations on the development and post-larval stages of *A. claparedii*, a discussion of the affinities of the Arenicolidæ, notes on parasitic Trematoda and Sporozoa, an economic section, and directions for practical work.

Nephridial Cells of Leech.§—L. Fage has studied the nephridial cells of *Hirudo medicinalis* in various stages of activity. He finds that the active cell is the seat of "ergastoplasmic" formations, which are localised in the basal part of the cell. The nucleus appears to have a role in connection with the "ergastoplasm," the nucleolus probably serving as an intermediary between the chromatin and the cytoplasm.

Metamerism of Nervous System of Hirudinea.‖—N. Livanow, in a second paper on the morphology of the Hirudinea, deals with the metamerism of the anterior end of the body, and the innervation of the head region. He observes that in *Hirudo* there has been much somite reduction, which is manifested almost exclusively in the disappearance of the outer ringing; the main parts of the nervous system remain unreduced. The second pre-clitellar segment consists of four rings, the first of which is seen from its innervation to be equal to the first and second ring of the typical 5-ringed somite. The first pre-clitellar has only three rings, the hinder one corresponds to the fourth and fifth, and the front one to the first and second. The fourth somite, which is innervated by the sub-œsophageal ganglion, is 3-ringed, with the charac-

* Bull. Mus. Zool. Harvard, xliii. (1904) pp. 91–4 (1 pl.).
† Annot. Zool. Japon., v. (1904) pp. 23–9 (1 pl.).
‡ Liverpool Marine Biol. Committee Memoirs, xl. (1904) 118 pp., 8 pls.
§ Comptes Rendus, cxxxviii. (1904) pp. 1450–2.
‖ Zool. Jahrb., xx. (1904) pp. 153–226 (3 pls.).

teristic nerve supply of the 5-ringed type. The third somite of the sub-œsophageal ganglion has dorsally three rings, while ventrally there are only two. The second somite of this group consists of two rings, the anterior of which corresponds to three, and the posterior to two, annulations. The first consists of a single ring, which is equal to five. Details concerning other Hirudinea are given.

Nematohelminthes.

Filaria Bancrofti.*—N. Taniguchi describes four cases of the occurence of this parasite in Japan. He distinguishes two forms of larva, one shorter and thicker than the other, enclosed in a loose transparent envelope. The second has no envelope, and has a sharply pointed tail. It is found within the body of the mother, in hydrocœle fluid, in accumulations of lymph, and in swollen lymph-glands, while the former type is found only in the blood. Both types arise from the same female; the one in the blood is to be regarded as a modified form, which has undergone degenerative alteration due to the chemical and mechanical stimulation of the circulation, and which ultimately dies, if not removed from the host.

Nematode associated with Decay in Plants.†—Haven Metcalf has studied *Rhabditis brevispina*, or a closely related form which is commonly and widely associated with decay in certain plants, such as *Crocus*, *Petunia*, *Coleus*, and *Geranium*. The nematodes seek wounded places on the underground parts of these plants, probably in order to feed on the plant juices. If they bear spores of pathogenic organisms they necessarily inoculate the plants, and readily transfer the disease from plant to plant.

Structure of Filaria loa.‡—A. Loos gives an account of the minute structure of this nematode. He investigated a male and female obtained from the human eye on the Gold Coast. The internal structure has not hitherto been studied in any detail.

Peculiar Structure of Epithelial Cells of Ovarian and Spermatic Tubes of Ascarids.§—L. Sala directs attention to the previously observed fact that these elongated epithelial cells exhibit what appear as internal fibres running parallel to one another. What he has discovered, by using Heidenhain's iron-hæmatoxylin, is that a definite filament extends up the middle of each fibre, sometimes straight, sometimes zigzag. These filaments are homogeneous and of uniform diameter. There is much probability that they represent an endocellular contractile apparatus.

Platyhelminthes.

A Diœcious Cestode.‖—O. Fuhrmann describes from the gut of *Podiceps dominicus*, a remarkable cestode with separate sexes. A special peculiarity is that it occurs in pairs, a male and a female, and for the

* Centralbl. Bakt. Parasitenk., xxxv. (1904) pp. 492–500 (3 pls.).
† Trans. Amer. Micr. Soc., xxiv. (1903) pp. 19–102 (1 pl.).
‡ Zool. Jahrb., xx. (1904) pp. 549–74 (1 pl.).
§ Rend. R. Ist. Lombardo, xxxvii. (1904) pp. 874–87 (1 pl.).
‖ Zool. Anzeig, xxvii. (1904) pp. 327–31.

most part only one pair in the gut of a single host. The author suggests that the larva forms two heads only, one of which gives rise to a female, and the other to a male. Another reproductive peculiarity is that the spermatozoa do not reach maturity save in the receptaculum of the female.

Epithelium of Trematodes.*—W. Hein has re-investigated this question, which has been the subject of so much discussion—perhaps more than its importance warrants. He finds in *Distomum lanceolatum*, and in *D. isostomum*, a distinct homogeneous cuticula, and a strongly developed ramification of processes from the epithelial cells with abundant anastomoses. In *Distomum hepaticum* and in *Amphistomum conicum* there is an epithelial cell-complex with somewhat less ramified processes, without observed anastomoses, but with a radial striation of the cuticle which is due to very fine processes from the epithelial cells. It seems certain that the four forms investigated exhibit a true epithelium and a cuticle in the strict sense.

Determination of Human Entozoa.†—Henry B. Ward has written a very useful paper entitled "Data for the Determination of Human Entozoa." Thirty years ago, Leuckart listed thirty species which had been found in man; Braun's more recent work (1902) discusses 15 Trematodes, 20 Cestodes, 38 Nematodes, besides 30–40 Protozoa. In less than a year after Braun's list, the author added two species to the roll. The first table gives a list, showing the organ infested, the stage of the parasite, the type of parasitism, the geographical distribution, the frequency of occurrence. A second table sums up the embryos of common Nematodes, as to form, size, surface, head, tail, sheath, and parts infected. The paper is full of useful hints, and should be widely circulated.

Incertæ Sedis.

Notes on Rhabdopleura Normani.‡—G. H. Fowler publishes some notes in reply to the criticisms of Conte and Vaney on his views regarding the insertion of the peduncle, the subdivisions of the cœlome and the notochord. The author substantiates his earlier views, giving a further account of the stalk of the adult, and the anatomy of a bud. Two main conclusions follow from his observations. The notochord in the bud is of ectodermal origin, and the gymnocaulus contains all three embryonic layers.

Revision of Palæozoic Bryozoa.§—E. O. Ulrich and R. S. Bassler give an account of the genera and species of Palæozoic Ctenostomata,—a first instalment of a revision of the Palæozoic Bryozoa.

Rotatoria.

New Rotifera.‖—Charles Linder, having studied the Pelagic fauna of the small Lac di Bret, between Lausanne and Vevey in Switzerland,

* Zeitschr. wiss. Zool., lxxvii. (1904) pp. 546–85 (3 pls.).
† Trans. Amer. Micr. Soc., xxiv. (1903) pp. 105–38 (4 pls.).
‡ Quart. Journ. Micr. Sci., (xlviii.) (1904) pp. 23–31 (1 pl.).
§ Smithsonian Misc. Collections, xlv. (1904) pp. 256–94 (4 pls.).
‖ Revue Suisse de Zool., xii. (1904) pp. 149–258 (1 pl.).

found fifteen species of Rotifers, four of which he erroneously describes as new. The new names with which science has been burdened are the following :—*Gastropus Cretensis* (= *Notops hyptopus*), *Notops falcipes* (= *Furcularia forficula*), *Mastigocerca Blanci* (= *Diurella Stylata*, according to Jennings' new nomenclature), *Cœlopus inermis* (= *Diurella Dixon-Nuttalli*).

New Rotifer of Genus Drilophaga.*—P. de Beauchamp figures and describes *Drilophaga Delagei*, sp. n., which he found living parasitically on the common fresh-water leech *Herpobdella octoculata*, near Paris. It is distinguished from *D. fucephalus*, of Vejdovsky, the only previous representative of the genus, by its shorter and broader body, devoid of annulations, and its shorter toes.

Echinoderma.

New Gonad in Holothurians.† — G. Polara finds in *Holothuria tubulosa* and *H. poli* that a group of germinal cells persists at the side of the ordinary genital organ, and gives origin to several genital cæca which are perhaps used to replace those which have liberated their sexual products. The cellular strand in question is regarded as analogous to the genital strand in Ophiuroids and Asteroids and to the "dorsal organ" ("genital stolon," "organo assile") in Crinoids.

Palæodiscus and Agelacrinus.‡— W. K. Spencer has investigated the structure and affinities of these two rare but very important Palæozoic Echinoderms, using the sectioning method. The fossils were ground at uniform distances of $\frac{1}{40}$ mm., and each successive surface photographed. From tracings of the photographs wax models were constructed. On the results of these investigations views are brought forward as to the relationships of some of the groups of Echinoderma. Thus: "We must conclude, therefore, that whilst a double series of plates, namely, an outer series peculiar to the Echinoid, perhaps derived from the adambulacrals of Asteroids, and an inner series homologous with the plates of an Asteroid, occur in the ambulacrum of all the Echinoids, a complete double series occurs in *Palæodiscus*, which is therefore entitled to be placed at the base of the Echinoid stem. It is not alone in the structure of the ambulacra that *Palæodiscus* shows itself to be the most primitive of Echinoids, for we have seen that the inter-ambulacral areas present many ideally primitive Echinoid structures. That the transition must have been from Asteroid to Echinoid, and not *vice versa*, the possession of a lantern of Aristotle by the latter forms is quite sufficient proof."

Function of Tube-Feet in Ophiuroids.§ — Hj. Östergren has made the interesting observation that representatives of various families of Ophiuroids, e.g. *Amphiura chiajei*, *Ophiopholis aculeata*, and *Ophiura albida*, can use their tube-feet to adhere to vertical glass plates, and can

* Bull. Soc. Zool. de France, xxix. (1904) pp. 157–60 (3 figs.).
† Anat. Anzeig., xxviii. (1904) pp. 33–7 (4 figs.).
‡ Proc. R. Soc. London, lxxiv. (1904) pp. 31–46 (1 pl. and 12 figs.).
§ Biol. Centralbl., xxiv. (1904) pp. 559–65 (2 figs.).

climb up these. The respiratory function is perhaps the primary one, and a sensory function is indubitable, but there can no longer be any denial of a considerable locomotor role. Thus another of the distinctions between Ophiuroids and Asteroids disappears.

Cœlentera.

American Hydroids.*—C. C. Nutting has completed the second part of his magnificent monograph on American hydroids. It deals with the Sertularidæ, and it may be noted that while not more than 20 species of Sertularians from American waters had been previously mentioned in any one publication, the author has found no fewer than 130 species which should be included in the American fauna. More than 30 new forms have passed through his hands, and many others have been discovered in scrutinising foreign publications.

Medusæ of the Bahamas.†—A. G. Mayer gives the results of an expedition to the Bahamas. The medusa fauna of this region is poor compared with that of the Tortugas, Florida, the number of species found in the two regions being forty-three and ninety respectively. These differences in two regions upon the same latitude and only 300 miles apart the author correlates with different physical conditions, e.g. relation to the Gulf Stream. The paper gives a detailed description of all the forms found, as well as notes on the post-embryonic development of *Cubaia* and *Olindias*, from which it appears that *Gonionemus*, *Cubaia*, *Vallentinia*, *Olindioides*, and *Olindias*, are closely related genera which may be grouped into one family, the Olindiadæ. Observations were made on the phenomenon of asexual budding. In *Eucheilota paradoxica*, the only known Leptomedusa producing an asexual generation of medusæ by a direct process of budding, the daughter-medusæ are derived from both endoderm and ectoderm of the gonad of the parent. Two new species have been established, one of which, *Parvanemus degeneratus*, is the most degenerate free-swimming hydromedusa yet described. It lacks tentacles, sense-organs, and peripheral vascular system. The velum is exceptionally large and provided with powerful muscles; the medusa swims with great activity, but is short-lived.

Regeneration and Non-Sexual Reproduction in Sagartia davisi.‡ Harry Beal Torrey and Janet Ruth Mery describe in this sea-anemone: (1) aboral-oral fission by constriction and rupture, with subsequent regeneration; (2) a strikingly irregular rupturing-process, which appears to differ from the basal fragmentation of *Metridium*, only in so far as each fragment retains a bit of the œsophagus and a few tentacles; and (3) the rare occurrence of aboral-oral division by constriction, which was never seen completed in a *normal* individual.

The authors also discuss the *causes of fission*. Fission of the first two types (1 and 2) depends to such a degree upon active movements of different areas of the foot disk in opposite directions that the idea

* Smithsonian Institution, Special Bulletin (1904) 325 pp., 41 pls.
† Mus. Brooklyn Inst., i. (1904) pp. 1–33 (7 pls.).
‡ Univ. California Publications (Zoology) i. No. 6, pp. 211–226 (7 figs.).

readily suggests itself that the establishment of some sort of physiological discontinuity between these areas may be the key to the causal problem. It seems to be clear from experiments, that an interruption of the physical continuity of two portions of a polyp by means of a cut parallel with the course which would be taken by a normal fission plane, tends to interfere with the physiological interaction of the separated regions and to initiate the process of fission. Finally, the authors give interesting proof of the occurrence of heteromorphoses; more than 50 p.c. of the anemones operated upon gave positive results.

Habits and Reactions of Sagartia davisi.* — H. B. Torrey describes this sea-anemone, the Pacific representative of *Sagartia luciæ* of the Atlantic coast, and discusses its habits. It occurs clustered on the valves of *Chione* or any object which can give it a foothold out of the sand. It can move freely by means of multicellular amœboid processes of the foot-disk, and may creep more than an inch in an hour. It has a marked tendency to assume as erect a posture as its situation will permit. Its locomotor geotropism is especially interesting from the fact that the major axis of the animal is not parallel with the direction of locomotion. It is not stimulated by light in any way.

The entire surface, with the possible exception of a small zone between mouth and tentacles, responds to mechanical stimulation, and the tentacles show very definite adaptive reactions, which are described at some length. The animal can discriminate between mechanical and chemical stimuli, and can make certain "choices" in its quest for food. Torrey shows how the movements of the tentacles, and the beating of the cilia of the lips and œsophagus, are adapted to swallowing what is useful and disgorging non-nutritious bodies. The phenomena of swallowing and disgorgement are carefully analysed.

Variation in Sagartia luciæ.†—G. C. Davenport has studied the question of the number of stripes on this sea-anemone. There is a range from 0 to 20, but this has been found to be due to the fact that longitudinal fission takes place in this animal with unequal apportionment of the stripes. The individuals are always tending by means of regeneration in the direction of twelve stripes and forty-eight mesenteries, though division may occur before the state of twelve stripes is attained.

'Albatross' Corals.‡—Emil von Marenzeller reports on the Madreporaria and Hydrocorallinæ of the 'Albatross' explorations in 1891, conducted by Alexander Agassiz. Of the former, he discusses *Bathyactis symmetrica*, *Cladocora arbuscula*, *Madrepora* (*Amphihelia*) *oculata*, *Caryophyllia diomedeæ* sp. n., another species of *Caryophyllia*, a species of *Flabellum*, *Desmophyllum crista galli*, and a new genus or species of Oculinidæ. Of the Hydrocorallines, he discusses *Errina macrogastra* sp. n., *Stylaster divergens* sp. n., *Stenohelia profunda*, and *Cryptohelia pudica*.

* Biol. Bulletin, vi. (1904) pp. 203–16.
† Mark Anniversary Vol., 1903, Art. vii., pp. 137–46 (1 pl.).
‡ Bull. Mus. Zool. Harvard, xlii. (1904) pp. 75–87 (3 pls.).

Modification of Tentacular Apparatus in Madrepora.*—Armand Krempf refers to a strange condition observed by Fowler in *Madrepora durvillei* in 1886, and re-observed by the author in three other species. A portion of the buccal disk has been converted by a fusion of two tentacles into a U-shaped tunnel, and insinuated into the body of the polyp. Analogous modifications have been observed by Vaillant in Oculininæ.

Systematic Relationships of Antipatharia.†—Louis Roule has made a study of *Stichopathes richardi* sp. n., and has been led from this to general reflections on the position of Antipatharians. As Brook indicated (1889) these have relationships with Ceriantharia; and E. van Beneden (1897) regarded Ceriantharia and Antipatharia as two tribes of the order Ceriantipatharia, which along with Rugosa and Scyphomedusæ form the class Scyphactiniaria, comparable to the classes Octactiniaria and Zoanthactiniaria within the group Scyphozoa.

Roule maintains that the class Anthozoa should be kept distinct from Scyphomedusæ, that the Antipatharia represent nowadays the simplest Anthozoa, that the Ceriantharia come nearer to the Antipatharia than do any other extant Anthozoa, but that the Rugosa were nearer still. Rugosa, Ceriantharia, and Antipatharia may be ranked together as a sub-class "*Protanthozoaria*," and opposed to the "*Metanthozoaria*," namely the Octactiniaria and the Zoanthactiniaria.

Protozoa.

Handbook of Fish-Diseases.‡—Bruno Hofer has done a useful and welcome piece of work in compiling a handbook of the diseases of fishes. He discusses (1) general infectious diseases, (2) special diseases of particular organs, (3) the crustacean-pest (*Bacterium pestis astaci*), and (4) the more important precautionary measures to be taken in regard to various diseases, such as salmon-disease.

Mitosis in Flagellata.§—B. Grassi and A. Foà describe with striking figures the remarkable process of division in *Joenia annectens* Grassi. The behaviour of the large spindle which develops tangentially to the nucleus and passes through remarkable changes is especially interesting, and may, as the authors suggest, supply some important data for cytological discussion.

Basal Corpuscles in Connection with Cilia.‖—P. Mitrophanow supports the view that the minute corpuscles found at the base of the cilia of *Paramœcium*, *Vorticella*, etc., and the "*Basalkörperchen*" of ciliated cells in Metazoa, are of mechanical importance as bases of insertion ("*points d'appui*") for the vibratile organs.

Chlamydomonas in Water-supplies.¶—F. S. Hollis describes two growths of *Chlamydomonas* in water-supplies in Connecticut. These

* Comptes Rendus, cxxxviii. (1904) pp. 1518–21. † Tom. cit., pp. 1621–2.

‡ Handbuch der Fischkrankheiten, Verlag. der Allgem. Fischereizeit. (München, 1904), 18 coloured plates and 22 figs. in text). See for review, Verh. Zool.-Bot. Ges. Wien, liv. (1904) pp. 358–61.

§ Atti (Rend.) R. Accad. Lincei, xiii. (1904) pp. 241–53 (17 figs.).

‖ Arch. Zool. Expér., xxxii. (1904) Notes et Revue, No. 10, pp. clxvii.–ix. (2 figs.).

¶ Trans. Amer. Micr. Soc., xxiv. (1903) pp. 13–16.

growths, although comparatively infrequent, have in several cases been studied, and the presence of an unpleasant odour in the water has been proved to be associated with their presence. Some description of the forms observed is given.

Trichocysts of Paramœcium.*—P. Mitrophanow interprets the trichocysts as an excretory apparatus. By contraction of the ectoplasm they squirt out their contents, and this hardens in the water into a thread. The material for the trichocysts is formed as granular or irregular bodies in the endoplasm, in the neighbourhood of the nucleus and with its assistance.

Nucleus of Paramœcium.†—P. Mitrophanow has made sections of *Paramœcium*, and has discovered details regarding the structure of the macronucleus. There are rows of chromatin granules arranged transversely with achromatin between. What look like chromatin rods are tubular folds packed with chromatin granules. His scholars, P. A. Chainsky and B. Petschenks, also contributed to this intricate study.

Stalk of Vorticella.‡—E. Fauré has made a study of the intimate structure of the stalk of *Vorticella convallaria*, which consists of an internal contractile axis, and an external elastic sheath. The contractile central cord includes (*a*) the essentially active part, composed of united myonemes, the tubular "*spasmonema*" disposed in a long spiral; (*b*) a plasmic cord formed of minute granules, doubtless united by a hyaloplasmic network, and describing a spiral parallel to that of the spasmonema, and (*c*) an enveloping sheath. A physiological interpretation of the contraction is attempted, but it all seems highly problematical.

Note on Klossiella muris, g. et sp. n.§—H. M. Woodcock reinterprets some of the observations of Smith and Johnson on this parasite. They described as the sporogonic cycle a stage characterised by the development of twelve to fourteen spherical spores, each containing thirty to thirty-four banana-shaped sporozoites. According to the author, their figures leave no doubt that the stage which they have described as sporogonic is nothing more nor less than merogony or schizogony, while the other part of the cycle regarding which they give no decided opinion, is in all probability the commencement of gametocyte formation.

Trypanosome of Rabbit.‖—G. F. Petrie records the occurrence of a trypanosome in the blood of rabbits. It does not appear to be of frequent occurrence, and artificial infection is not easily produced, although experiments seem to indicate that trypanosoma blood is toxic to certain uninfected rabbits. The parasite is not essentially different from that of the rat trypanosome, although it is smaller.

* Arbeit. Zool. Lab. Univ. Warschau, xxxii. (1903) pp. 1–18 (9 figs.), Russian. See Zool. Centralbl., xi. (1904) pp. 510–11.

† Op. cit., xxxi. (1903) pp. 1–48 (31 figs.) Russian. See Zool. Centralbl. xi. (1904) pp. 509–10.

‡ Comptes Rendus, cxxxviii. (1904) pp. 994–6.

§ Quart. Jour. Micr. Soc., xlviii. (1904) pp. 153–63.

‖ Centralbl. Bakt. Parasitenk., xxv. (1904) pp. 484–6.

Piroplasma of Dog.*—B. Galli-Valerio has found in dogs, chiefly in hunting dogs, an endoglobular Hæmosporidian, *Piroplasma canis*, which produces a sickness characterised by high fever, icterus, and hæmoglobinuria. It is peculiar in being pathogenic for dogs only. It increases in the blood by division and sporulation, and it is probable it has a sexual cycle in the body of a tick, which serves as intermediate host. When seen free in the plasma, the parasite exhibited appearances resembling the flagella of the hæmosporidian of human and bird malaria. The sickness has been observed in Italy, France and Africa, and probably exists in other countries.

Myxosporidia of Flat-fish.†—H. M. Woodcock reviews the recorded instances of these sporozoa in the flat-fishes in the light of several recently discovered cases which he describes. There appears to have been some doubt as to the identity of the species occurring. The writer concludes that there are only three forms known to infest these fishes—viz. *Glugea stephani*, in gut-wall of flounder, plaice, and *Pseudopleuronectes americanus* ; *Sphærospora platessæ*, sp.n. in otic capsule of plaice ; and a species of *Pleistophora* in the liver of *Rhombus triacanthus*.

* Centralbl. Bakt. Parasitenk., xxxiv. (1904) pp. 367–71.
† Rep. Lancashire Sea Fisheries Lab. (1904), pp. 46–62, 1 pl.

BOTANY.

GENERAL,

Including the Anatomy and Physiology of Seed Plants.

Cytology,

including Cell-Contents.

Observations on Reduction-division.*—Strasburger has published a short account of his present views on this division and the formation of the reduced number of the chromosomes. He states that when the network of the microspore-mother-cell of *Thalictrum purpurascens* has collected at one side of the nucleus, the chromatin separates from the linin threads and forms a number of granules. These then collect round a number of centres corresponding to the number of the future chromosomes, in this case twelve. These centres he terms gamocentra. The granules then form definite bodies at these points, in which they are with difficulty to be individualised. These bodies then become stretched out somewhat, and clearly divided in the middle; the individual granules of the two halves then separate into two portions, and with the help of the linin become arranged in threads. A single continuous thread is thus formed, and the synapsis stage is over. The longitudinal splitting of the thread then follows.

Recent Work on Cytology.†—M. Koernicke gives a very useful account of all the more important botanical work on the protoplasm and nucleus published during the last few years.

Heterotypic Division.‡—J. Berghs has studied this division from the spireme stage onwards, in the development of the microspores of *Allium* and *Lilium*. He agrees neither with Dixon nor with Farmer and Moore as to the origin of the chromosomes, but believes that they are produced from the spireme thread by mere shortening and thickening, and that the two halves of the chromosome are produced by longitudinal splitting.

Function of the Nucleolus.§—H. Wager has studied nuclear division and the relation of the nucleolus to the process of karyokinesis in the root apex of *Phaseolus*. He concludes that the nucleolus contains chromatin more or less combined with plastin; and that the chromatin passes into the chromosomes. Further evidence in support of this view is supplied by a study of the reconstruction of the daughter-nuclei, towards the formation of the nucleoli of which the chromatin contributes. The author considers that the nucleolus is possibly concerned with the

* SB. K. Akad. Wiss. Berlin, xviii. (1904) pp. 587–615 (9 figs. in text).
† Ber. Deutsch. Bot. Gesell., xxi. (1904) Generalversamml.-Heft, pp. 66–134.
‡ La Cellule, xxi. (1904) pp. 171–86, pl. 1.
§ Ann. Bot., xviii. (1904) pp. 29–55 (1 pl.)

production of the spindle, while part of it may, in some cases, be extended into, and disappear in the cytoplasm. He contests the view of Němec that the nucleolus of the daughter-nuclei originates from the spindle fibres.

Reconstitution of the Nucleus and Formation of the Chromosomes.*—V. Grégoire and A. Wygaerts have investigated these questions in the meristematic cells of *Trillium*, and in the second (homotypic) division of the microspore-mother-cells of that plant. They believe that the chromosomes produce the network of the resting nucleus by a process of vacuolation or alveolisation. In the prophase of the next division the phenomena are repeated in a reverse direction to that of the telophase. It is very probable that the chromosomes which appear in the prophase are identical with those that disappeared in the telophase, having become in the meanwhile invisible, but without losing their individuality.

Formation of the Achromatic Figure in Pellia.†—V. Grégoire and J. Berghs have investigated again the developing spores and also the maturation division of the spores in *P. epiphylla*. Their observations agree neither with those of Farmer, Davis, nor Chamberlain. They state that the centrospores described in this plant have no claim to be definite organs, for the whole achromatic figure is produced by a rearrangement of the ordinary cytoplasmic reticulum. They point out that their observations contradict several of the theories which have been put forward to explain the mechanism of karyokinesis.

Inorganic Phosphates in Plant Seeds and in Seedlings.‡—E. Schulze and N. Castoro have tested the seeds of species of *Lupinus*, *Lens*, *Vicia*, *Zea*, *Picea* and *Pinus*, for inorganic phosphates, and find these to be absent except for a negligible quantity in the case of *Pinus Strobus*. These results confirm those of Hart and Andrews. On the other hand, etiolated seedlings of *Lens esculenta*, *Vicia Faba*, and *Zea Mays*, when examined by the same method, were found to contain appreciable amounts of inorganic phosphates.

Structure and Development.

Vegetative.

Centripetal Wood in Leaves of Conifers.§—Ch. Bernard describes the results of his examination of the histology of the vascular bundle-system in the leaves of a large number of species of the genera of the older tribes of Coniferæ (Taxodieæ, Taxeæ, Podocarpeæ, Araucarieæ) from the point of view of the character and distribution of the transfusion tissue. He regards this tissue as merely centripetal wood; the conifers are "diploxylées" in the same sense as the Cycads, but their centripetal wood accentuates the reduction which is already manifest in

* La Cellule, xxi. (1904) pp. 7–76, pl. 2. † Tom. cit., pp. 193–239, pl. 2.
‡ Zeit. Physiol. Chem. xli. (1904) pp. 477–84. See also Journ. Chem. Soc., lxxxvi. (1904) II. pp. 506–7.
§ Beiheft. z. Bot. Centralbl., xvii. (1904) pp. 241–310 (1 pl. and 88 figs. in text).

the series of higher Cryptogams, especially in fossil forms. The so-called transverse parenchyma found in *Podocarpus* and *Cycas*, which may be physiologically the continuation of the centripetal wood, often plays the part of support, and must be kept absolutely distinct from the centripetal wood, from a morphological point of view; to accentuate this difference, the author suggests the term *transverse hydrostereome*. The author also gives a *résumé* of previous work, and a critical discussion of the whole subject.

Cupressinoxylon Hookeri.*—E. A. N. Arber describes, under this name, a large silicified trunk of coniferous wood from the Macquarie Plains, Tasmania, preserved in the Natural History Museum. A full description of the internal structure, which is in excellent preservation, is given by the author.

Cycadeoidea Reichenbachiana.†—Lester F. Ward gives a detailed account of the history and geological position, and a careful description of the external characters of this fossil. The specimen, which is in the Museum of Mineralogy and Geology at Dresden, has been known for more than two centuries and a half. It is a petrified trunk of a Cycad, and the type and only known specimen of the species which it represents. It has hitherto always been figured in an inverted position. The author expresses regret that the internal structure of so fine and classic a specimen should never have been investigated.

Observations on Mamillaria elongata.‡—O. V. Darbishire gives an account of the anatomy of the various members of this cactaceous plant, which is taken as a type of the family, and a general discussion of its physiological characters, and of their relation to the conditions under which the plant grows in its native habitat in Mexico. He concludes that the spines by which the tubercles are crowned form a structure which acts as a screen to protect the underlying tissues of the tubercle from the strong sunlight. Such an organ may be called a *paraheliode*. A similar function is played by the set of hairs found at the top of the leaf of *Mesembryanthemum stellatum*. He finds that the development of palisade-tissue is regulated by the influence of the light on the processes of photosynthesis; while the depth, but not the extension of the air-spaces, is dependent on the conditions favourable or otherwise to transpiration. The tubercle of *Mamillaria* represents morphologically the leaf-basis, with perhaps a portion of the stem. The sp nes are modified portions of the leaf-blade. There is only one bud in connexion with each tubercle, and that is axillary to it. The author insists that the guiding principle which underlies the adaptation of plants, and the production of plant forms, is physiological. There is no evidence to show that direct protection against attacks by animals influences the development of any plant-form.

Germination and Formation of the Primary Root in Palms.§—C. L. Gatin has studied germination in species of *Phœnix* and *Archontophœnix*

* Geol. Mag., dec. V., i. (1904) pp. 7–11 (1 pl. and 2 figs. in text).
† Amer. Journ. Sci., xviii. (1904) pp. 40–52 (1 fig.).
‡ Ann. Bot., xviii. (1904) pp. 375–416 (2 pls.).
§ Rev. Gén. Bot., xvi. (1904) pp. 177–87 (7 figs. in text).

and a few other palms. He points out that with considerable differences in the form of the embryo, manner of germination, formation of the primary root, etc., certain characters are constant. The radicle is always composed of a central cylinder, a cortex distinct but not limited by an endodermis, a piliferous layer, and a cap which is in close relation with the root-sheath of which it forms the inner part. The piliferous layers always appear late, after the external growth of the cotyledon has been completed. We can recognise two phases in the germination of Palms: (*a*) a phase of preparation, in which the plantlet in course of differentiation is carried into that medium in which it will develop; (*b*) a phase of development or germination properly so called. In this respect the author refers to the view expressed by Karsten that the great elongation of the petiole of the cotyledon in certain species is an adaptation which allows the young plant to find below the surface of the soil, dried by a hot climate, a medium more favourable for its development. On the other hand, Palms developing in a forest, that is to say a damp environment, develop at the surface of the soil. Thus of the two phases, the length and importance of the first are a measure of the degree of adaptation.

Adventitious roots are formed at the base of the root cone. In some types (*admotive*) one of these roots, situated in the same straight line as the axis of the plumule, may play the part of the principal root, at least during the first months of the life of the plant.

EBERWEIN, R.—**Zur Anatomie des Blattes von Borassus flabelliformis.** (Anatomy of the leaf of *B. flabelliformis.*)

[Describes the structure of the stomata and other epidermal formations, including the large cells containing secretions of silica.]

SB. K. Akad. Wiss. Wien., cxii. (1903) pp. 67–76 (1 pl.).

TONDERA, FR.—**Das Gefässbundel System der Cucurbitaceen.** (The vascular bundle system of the Cucurbitaceæ.) *Tom. cit.*, pp. 23–59 (5 pls.).

Reproductive.

Ovule and Seed of Cycadeæ.*—Marie C. Stopes has examined a number of species in various stages of the ovules of *Cycas*, *Zamia*, *Macrozamia*, *Ceratozamia*, *Encephalartos*, *Bowenia*, and *Dioon*. She finds that the usual description of the integument as a single one, differentiated into two layers, an outer fleshy and inner stony, does not hold good. In all the above-mentioned genera there is also a soft inner integumentary layer, which is sometimes greater in diameter than the outer fleshy layer; frequently it and the nucellus are crushed together by the growing prothallium, but this is by no means always the case: sometimes it remains fresh quite late.

Two series of vascular bundles run in the ovule, and it is proved that the inner series, frequently described as "nucellar," belong to the soft inner layer of the integument. These bundles do not invariably die out at the region where the nucellus becomes free from the integument, as hitherto supposed, but in more than one species are found continuing in the inner layer of the integument almost to the micropyle. The bundles running in the outer flesh are mesarch, centripetal xylem sometimes being

* Flora, xciii. (1904) pp. 436–82 (37 figs. in text).

developed in great quantity. The presence of this primitive type of bundle in the ovules is in itself of interest, as is the comparison of these bundles with the mesarch ones in the free fleshy "cupule" of *Lagenostoma*.

The view is brought forward, chiefly on anatomical grounds, that the inner fleshy layer with its system of bundles represents an inner integument. The stony layer is considered as a differentiation of the outer flesh, and with its distinct system of bundles forms the second or outer integument. The two are completely grown together, as in the case in some genera of Rosaceæ, and others.

On the basis of the arrangement of the bundles in the ovule and the supply bundles of the sporophyll, the genera may be placed in a series of which *Cycas* is not the most primitive, but the least primitive of the group. All the genera have approximately radial symmetry but *Cycas*, which is bilateral and shows distinct traces of an original radial symmetry.

Fructification of Neuropteris Heterophylla.*—R. Kidston describes specimens preserved in small ironstone nodules from the South Staffordshire coal measures, containing seeds of *Rhabdocarpus* Göpp. and Berger, each attached to a pedicel which bears the foliage of *Neuropteris heterophylla* Brongn. Great interest attaches to these specimens, as it is the first instance in which the foliage of one of the Cycadofilices has been found actually in continuity with a seed. This discovery confirms the conclusion already reached by Professor Oliver and Dr. Scott from the consideration of other evidence, that the seed-bearing habit existed among members of this group. The specimens, which are not petrified, are of the radio-spermic type, oblong, and about 3 cm. long. The outer surface shows numerous longitudinal ribs, formed by bands of sclerenchymatous tissue in the outer seed-envelope. Some of the pinnules, which do not differ in form or nervation from the ordinary foliage pinnules of *Neuropteris heterophylla*, show a slight widening of the base, and seem to be attached to a basal expansion somewhat of the nature of a cupule. This semi-cupule like structure does not seem to completely surround the seed as in *Lagenostoma Lomaxi*, but is more in the form of a subtending bract, and probably served to protect the seed during the early stages of development.

Small bodies of doubtful structure, apparently split into four arms or valves, and borne at the ends of the dichotomously divided branches of another specimen, are regarded by the author as the pollen-bearing organs of the same species.

Gametophyte and Embryology of Cryptomeria Japonica.*—A. A. Lawson finds that the reduction division which leads to the formation of the tetrads in the course of development of the microspore, takes place in October, while pollination occurs in the following March. At the time of pollination the spore contains a tube-cell and a generative cell; the vegetative tissue of the male gametophyte is not represented. At the time of penetration the generative nucleus divides, so that the young pollen-tube contains the tube-, stalk-, and body-nuclei. The body-nucleus soon enlarges and becomes surrounded with a dense zone

* Phil. Trans. Roy. Soc., ser. B, cxcvii. (1904) pp. 1–5 (1 pl. and fig. in text).
† Ann. Bot., xviii. (1904) pp. 417–44 (4 pls.).

of cytoplasm and starch-grains, round the periphery of which a membrane is formed. After the tip of the tube has reached the depression above the archegonium complex, the body-cell divides to form two male cells, which enter separate archegonia.

From twelve to sixteen macrospores are formed, but only one germinates and forms the female gametophyte. No distinct tapetum is present. In the formation of the prothallium the wall becomes lined with a parietal layer of primary prothallial cells, which become multinucleate, and by their inward growth the large central vacuole becomes ultimately filled up. The cell-walls are formed as the result of a peculiar method of free-cell formation. The archegonium-initials appear as peripheral cells just before the prothallial tissue is thoroughly organised. There are four neck cells, and a ventral canal-nucleus is cut off before fertilisation. The archegonia are arranged as in the Cupresseæ, in a single group at the apex of the prothallium. They are surrounded by a common layer of jacket-cells, which are multi-nucleate, their characters suggesting that they are sterile archegonia.

A single male cell enters the egg; the first segmentation spindle is organised in the centre just about the place where the fusion of the sex-nuclei occurred. After the second division the four free nuclei pass to the base of the archegonium, become arranged in two tiers, and undergo a third division, and an embryo consisting of two tiers of cells and one of free nuclei is organised. The middle tier forms long tortuous suspensors, which carry down the embryo-cells at their tips. One or several embryos may be developed from a single archegonium.

As nearly as could be estimated, there are nine or ten chromosomes in the nucleus of the gametophyte, and eighteen or twenty in that of the sporophyte. The gametophytes and embryo of *Cryptomeria* are distinctly of the Cupresseæ type.

Gametophyte and Development of the Seed-coats in some Papaveraceæ.*—C. H. Shaw gives the results of his examination of some quantity of material of *Sanguinaria*, *Chelidonium* and *Eschscholtzia*. He finds that in *Sanguinaria* the microspore mother-cells are formed in the season preceding blooming, but their division and the formation of the ovular integuments and of the embryo-sac occur after renewal of growth in the spring just before blooming. In all genera an open canal extends from the carpellary cavity to the exterior. The antipodal cells are very prominent, especially in *Eschscholtzia*, and the adjacent cells of the nucellus are thick-walled and rich in contents.

In formation of the seed-coat in *Sanguinaria* and *Eschscholtzia*, the secundine eventually disappears, and the inner cell-layer of the primine constitutes the most important element of the testa. In *Chelidonium* both primine and secundine persist and take part in the formation of the testa.

Physiology.

Nutrition and Growth.

Sources of Nitrogen to Fungi.†—J. H. Kastle and E. Elvove find that a nutritive solution containing ammonium thiocyanate as the

* Bull. Torrey Bot. Club, xxxi. (1904) pp. 429–33 (1 pl.).

† Amer. Chem. Journ., xxxi. (1904) pp. 550–7. See also Journ. Chem. Soc. lxxxvi. (1904) II., pp. 504–5.

nitrogenous food substance, can support the growth of *Penicillium glaucum*, but that a similar solution in which the thiocyanate is replaced by thiocarbamide cannot do so; the thiocarbamide is, however, not poisonous to the fungus. Potassium thiocyanate is equally ineffective; hence, in the case of the ammonium salt, it is the nitrogen of the radicle which is available for food. Similar results were obtained with the various micro-organisms of putrid cheese, and also with yeast. Thiocarbamide, although unable to supply the nitrogen required for the growth and reproduction of the yeast, does not prevent alcoholic fermentation. Ammonium thiocyanate slowly undergoes nitrification by the organisms of the soil, whilst thiocarbamide is either acted on very slowly or not at all.

Transpiration.* — A. Burgerstein contributes what he terms a "physiological monograph" on the subject of transpiration. It is a useful account of the work which has been done, and should prove invaluable to students. The author has brought together in a comparatively small volume the results of work spreading over many years, and embracing the contributions to knowledge of very various workers. He also includes observations, hitherto unpublished, of his own. The chapter on methods of investigation contains useful sketches of apparatus. At the end of the book is a bibliography occupying more than thirty pages.

Accumulation of Water in the Leaf-sheath of Musa Ensete.†— P. Baccarini describes the accumulation of an amount of water in the lacunar system in the leaf-sheath of a cultivated specimen of this species of *Musa* (a native of Abyssinia). It recalls the similar water accumulation in another member of the Musaceæ, *Ravenala madagascariensis*. The accumulation which occurred at the close of the vegetative season evidently represented the difference between the amount of water absorbed by the roots, and that lost by transpiration during the previous season of growth. The limpid solution was without colour, taste or smell, did not reduce Fehling's solution, but responded to reaction for nitrates.

Chemical Changes.

Germination of Oily Seeds.‡ — Maurice Nicloux has previously demonstrated the remarkable lipolytic action of the cytoplasm in the castor-oil seed, which alone of all the other cell-contents has the power of saponifying. This action of the cytoplasm is comparable to a diastatic action, and the author proposes the name *lipaseidin* for the lipolytic substance, of which the cytoplasm is probably only the carrier. An essential condition of the process is the presence of a small quantity of mineral or organic acid, and the author suggests that the carbon-dioxide known to be present in the cell in association with water fulfils the condition. This is proved by performing the lipolytic process *in vitro*; the cytoplasm of the seed of *Ricinus*, when isolated in the presence of oil and

* Die Transpiration der Pflanzen. By Dr. Alfred Burgerstein. 8vo., x. and 253 pp., 24 figs. in text. Fischer, Jena, 1904.

† Bull. Soc. Bot Ital., 1904, pp. 276–80.

‡ Comptes Rendus, cxxxix. (1904) pp. 143–5.

carbonic anhydride, is able to effect saponification ; hence the intervention of some other acid need not be assumed.

General.

Determination of Sex in Plants.*—R. P. Gregory has investigated this question in connexion with the suggestion of Castle (put forward in relation to animals only), that sex is an inherited character which exhibits the Mendelian phenomena of segregation and dominance, and is not subject to direct control by environment. Accepting the view that the chromosomes contained in the germ-cells are the factors concerned in the transmission of inherited characters, and also the hypothesis that the segregation of characters in accordance with Mendelian laws is provided for in the reduction division, it was important to observe the occurrence of that division. Spore-formation and divisions in the prothallia were observed in *Osmunda regalis*, and it was found that a true (qualitative) reduction takes place at the time of spore-formation. The problem of sex-determination is complicated in the higher plants by alternation of generations ; and in the higher Cryptogams and in Phanerogams (where heterospory is, of course, present) the gametophyte is diœcious. In many of the Archegoniatæ the gametophyte, however, is hermaphrodite. It was observed that the prothallia of *Osmunda* were hermaphrodite, and that they were capable of self-fertilisation. It must be thus concluded that the reduction division in a hermaphrodite sporophyte does not bring about a segregation of sex-characters. There is also no doubt that the form of gametes produced from the gametophyte may be influenced, within limits, during the independent existence of gametophyte, by the environment. Also the form of gamete produced by any gametophyte is independent of the sex-character transmitted through that gametophyte to the sporophyte of the next generation.

Replacement of Stamens by Carpels in Wallflower.†—C. Gerber has studied the anatomical structure of the supernumerary carpels which replace the stamens in that cultivated form of the wallflower styled by De Candolle *Cheiranthus Cheiri* var. *gynantherus*. He finds that, whereas a normal stamen receives only a single meristele from the central cylinder, there is in addition in the staminal carpels a reversed bundle such as characterises the false septum of the pistil. It is not therefore correct to say that the stamens are transformed into carpels in this form of the wallflower, but rather that the carpellised stamen differs from the ordinary stamen by the addition to the vascular system of the latter of the reversed vascular system characteristic of the pistil of Crucifers.

Attraction of Colours and Scents for Insects.‡—J. Pérez, in a second contribution to this subject, criticises the conclusions of Felix Plateau on the same subject, and gives an account of his own observations on the visits of insects to flowers, and to other coloured objects. He conceives the relation between insect and flower to be as follows. Insects are guided to masses of flowers at a distance only by the scent

* Proc. Camb. Phil. Soc., xii. (1904) pp. 430-40.
† Comptes Rendus, cxxxix. (1904) pp. 219-21.
‡ Mém. Soc. Sci. Phys. et Nat. Bordeaux, sér. 6, iii. (1903) pp. 1-36.

which is carried by air currents. At a sufficiently close range the short sight of the insect intervenes to direct it precisely to the seat of the nectar. Isolated flowers are in general brought to the notice of an insect by their colour ; the scent intervenes at a short distance to confirm or correct the original impression. In cases where a petaloid perianth is absent, the smell alone seems to guide the visitor.

As to whether a bee keeps to one particular species, the author concludes that such fidelity is not absolute, but very frequent. It appears in relation with the collecting of pollen and not of honey, and only rarely exists in the case of the males. It is hardly ever observed in other Hymenoptera, though certain species show a marked preference for definite groups of plants.

Plant-Geography upon a Physiological Basis.*—It is a matter for congratulation that the late A. F. W. Schimper's great work, "Pflanzen-Geographie auf physiologischer Grundlage," has been issued in English form. The book, which is already well known in its German form, is an excellent exposition of the modern development of plant study known as œcology. Its usefulness is much enhanced by the numerous excellent illustrations. An additional feature is an appreciation of the author by one of the editors, Percy Groom.

Forest Vegetation in Southern Switzerland.†—B. Freuler supplies a number of photographic representations of the vegetation of Soltoceneri, or that portion of the Canton Tessin which lies to the south of Monte Ceneri. Of this district M. Freuler, who is a forest inspector, remarks that hardly anywhere in Switzerland is there an area of similar size which is so rich and interesting from the point of view of forest vegetation. This variety is due to the mountainous character of the area, extending from 230 to 2,226 metres above sea-level, to the climatic conditions, and also to the great diversity in geological conditions. The views, which depict groups of trees, single trees or more general aspects of vegetation, are accompanied by a full description in the text, which is written in German.

Completion of Chinese Flora.‡—The completion of the enumeration of the Grasses by A. B. Rendle brings to a close the account of the Chinese Flora which, initiated by F. B. Forbes and W. B. Hemsley, has been brought to a conclusion under the editorship of the last-named. The elaboration of the grasses includes a number of new species and forms, chiefly contained in the collections of Henry from Western China and Formosa, of Faber from Szechuen, and of Hugh from the province of Shensi. The Bamboo tribe (Bambuseæ) is represented by 43 species, 12 of which are here described for the first time.

Flora of Norfolk Island.§—J. H. Maiden gives an account of the flora of this island based on previously published accounts and on the

* Plant-Geography upon a Physiological Basis. By Dr. A. F. W. Schimper. Translated by W. R. Fisher, revised amd edited by Percy Groom and J. Bayley Balfour. Large 8vo, xxx. and 839 pp. Clarendon Press, 1904.

† Atti d. Soc. Elvet. Sci. Nat. in Locarno, sess. 86, 1903 (1904) pp. 269–92.

‡ Journ. Linn. Soc. (Bot.) xxxvi. (1904) pp. 377–49.

§ Proc. Linn. Soc. New South Wales, xxviii. (1904) pp. 692–785 (1 pl.).

results of his own investigations. He records 161 monocotyledons and dicotyledons, 1 gymnosperm (*Araucaria excelsa*, the Norfolk Island pine), 52 ferns, 3 lycopodinæ, 18 mosses and hepaticæ, 23 lichens, 13 fungi, and 10 algæ (an incomplete list). He also gives a list of introduced plants, economic and otherwise, and makes suggestions as to the extermination of weeds, and other points of agricultural interest. At the close of his paper extracts are given from accounts by Captains Cook and King on the primæval vegetation of the island; and also a bibliography of works and papers dealing with its vegetation, and an account of the relation between Ferdinand Bauer and the island.

Icelandic Fodder Plants.* — St. Stefánsen and W. G. Söderbaum give the results of their analysis of the fodder plants of Iceland. Of the 360 flowering plants known in the island, 25 per cent. are grasses or sedges. Analyses are given of 25 of the most important plants, collected in July or early in August. As regards the grasses, the results show higher percentages of ash and nitrogenous matter and lower percentages of cellulose than the corresponding Swedish plants, and the digestibility of the nitrogenous matter is also relatively higher. Except for a greater digestibility of the nitrogenous matter, the composition of the sedges did not differ essentially from those analysed in Sweden.

Philippine Rubber Plants.† —The last report of the Superintendent of the Government Laboratories in the Philippine Islands contains an exhaustive report of the Secretary of the Interior on the sources of gutta-percha and rubber in the Islands. The most important rubber-producing trees are several species of *Palaquium* and *Payena Leerii*, members of the order Sapotaceæ. Photographic reproductions of leafy and in some cases flower-bearing shoots are given, as well as plates indicating the various methods of tapping, and maps illustrating the known geographical distribution of rubber plants in the Philippines. Notes are also given on the chemical properties of the latter, the cultivation of the plants, etc., with suggestions as to the value of the islands from a rubber-producing point of view.

Timbers of Commerce and their Identification.‡—In this book Herbert Stone gives a description of the wood of nearly two hundred and fifty species, comprising all those met with upon the British market, and those which he has received from the Colonies as being useful and abundant, and also a few which, though at present unknown in the market, commend themselves to the writer as timbers of good quality, which are likely to be heard of in the future. The special portion of the book is preceded by an introduction, in which the author gives a general account of the growth of a tree, and the formation and structure of the wood. This is followed by some practical hints to those wishing

* Medd. k. Landtbruks. Akad. Exper., No. 77, Stockholm, 1903. See also Journ. Chem. Soc., lxxxvi. (1904) II., pp. 509–10.

† Report of the Superintendent of Government Laboratories in the Philippine Islands for the year ending September 1, 1903. (From fourth annual report of the Philippine Commission.) Bureau of Insular Affairs, War Department, pp. 394–411, with numerous plates.

‡ The Timbers of Commerce and their Identification. By Herbert Stone. 8vo, xxxviii. and 311 pp., 186 pls. Rider, London, 1904.

to study woods from practical and economic points of view. The special portion comprises a systematically arranged description of the woods. The arrangement is that of Bentham and Hooker's *Genera Plantarum*. In each case the common and the botanical names of the wood are followed by the name of the natural order. A few synonyms are cited, the source of supply is given, and also a number of "alternative" common names. The physical characters, the grain and bark are described; its uses are mentioned, and references are given to various authorities. Then follows a more detailed description of the anatomical characters of the wood in transverse, radial, and tangential section, so far as they are visible to the naked eye, or an ordinary hand lens. All the genera mentioned are with few exceptions represented by photomicrographs, which have been prepared by Mr. Arthur Deane. The scale of magnification is three times the actual size, and is designed to show the appearance of the transverse section as seen by means of an ordinary hand lens.

Carlo Allioni.*—In commemoration of the centenary of the death of this Italian botanist (born 1728, died 1804) O. Mattirolo gives a systematised account of his works, both published and manuscript, followed by an enumeration of the genera and species published by him. Allioni was the author of several important works on the botany of northern Italy, including the *Flora Pedemontana*, comprising three large volumes and 92 plates. He also published a small work on palæontology entitled "*Oryctographiæ Pedemontanæ specimen, exhibens corpora fossilia terræ adventita*," besides various medical and a few zoological works. The paper is accompanied by photographic reproductions of a portrait and a bust at Turin.

Alexis Millardet.†—U. Gayon and C. Sauvageau give an account of the life and work of this French botanist (1838–1902), who for five and twenty years occupied the chair of botany at Bordeaux. Millardet's work falls into two categories; that of pure botany, chiefly cryptogamic and cytological, and that of viticulture. To the latter he contributed invaluable researches on the relation of the Phylloxera to the vine, and the possibility of establishing disease-resisting varieties in Europe, and also on the fungal diseases of the plant. The notice concludes with a chronologically arranged list of his papers, 141 in number.

CRYPTOGAMS.

Pteridophyta.

BERNARD, C.—**A propos d'Azolla.** (Concerning Azolla.) *Rec. Trav. Bot. Néerland.*, i. (1904) pp. 10–14 (1 pl. and figs.).

BOODLE, L. A.—**On the occurrence of secondary Xylem in Psilotum.** *Ann. Bot.*, xviii. (1904) pp. 504–17 (1 pl. and figs. in text).

BURCK, W.—**Sur quelques formes du Polystichum aculeatum de l'Archipel Malais et sur un caractère spécial et peu connu de cette espèce.** (On some forms of *P. aculeatum* in the Malay Archipelago and on a special and little known characteristic of this species.) *Rec. Trav. Bot. Néerland.*, i. (1904) pp. 33–49.

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* Malpighia, xviii. (1904) pp. 213–92 (2 pls.).

† Mém. Soc. Sci. Phys. et Nat. Bordeaux, sér. 6, iii. (1903) pp. ix.–xlvii. (with ograph).

CHRIST, H.—**Filices Faurieanæ.** (Ferns collected by Faurie.)
Bull. Herb. Boissier, iv. (1904) pp. 609–18.

" " **Primitiæ Floræ Costaricensis. Filices et Lycopodiaceæ.** III. (First-fruits of the Costa-rican flora, Ferns and Lycopods. Continuation.)
Tom. cit., pp. 936–51, 957–72.

CLUTE, W. N.—**The Star Fern, Hemionitis palmata.**
Fern Bull., xii. (1904) pp. 71, 72 (1 pl.)

" " **A new form of the Christmas Fern.** (*Polystichum acrostichoides* forma *recurvatum.*) *Tom. cit.*, p. 79.

" " **Raising prothallia of Botrychium and Lycopodium.**
[A suggestion that these prothallia to reach maturity require to be associated with a symbiotic fungus just as the seedlings of orchids do. For artificial culture use should be made of soil from the rootlets of mature plants.]
Tom. cit., pp. 83, 84.

" " **Concerning forms and hybrids.**
[A protest against some instances of denoting hybrids by binomial names as if they were true species.]
Tom. cit., pp. 85, 86.

EATON, A. A.—**The Californian Gold Fern.** (Gymnogramme.)
Tom. cit., pp. 77, 78.

" " **Is Asplenium lanceum American?**
[An account of how an error arose from a change of labels in a fern-dealer's garden.] *Tom. cit.*, pp. 79, 80.

" " **Isoetes Amesii.** (A correction.) *Tom. cit.*, p. 89.

GREGORY, R. P.—**Spore-formation in Leptosporangiate Ferns.**
[Investigations of eight genera of ferns, with special reference to reduction-phenomena.] *Ann. Bot.*, xviii. (1904) pp. 445–58 (1 pl.).

HAHNE (BONN)—**Ueber Farnhybriden.** (On Fern-hybrids.)
Allg. Bot. Zeit., 1904, pp. 102–6.

" " **Ueber Gabelung der Farnwedel.** (On bifurcation of fern-fronds.)
[Contains list of more than 80 species in which it has been observed by the author.] *Tom. cit.*, pp. 106–8.

HOPE, C. W.—**The Ferns of North-western India.**
Journ. Bombay Nat. Hist. Soc., xv. (1904) pp. 415–29.

HOUSE, H. D.—**Some rare ferns of central New Jersey.**
Fern Bull., xii. (1904) pp. 80–2.

LE GRAND, A.—**Lettre à M. Malinvaud.** (*Scolopendrium officinale* abnormal.)
Bull. Soc. Bot. France, xlviii. (1901) pp. 420–1 (1 fig.).

LINDMANN, C. A. M.—**Regnellidium novum genus Marsiliacearum.** (Regnellidium, a new genus of Marsiliaceæ.)
Arkiv Bot. Stockholm, 1904, 14 pp. (10 figs.).

LINSBAUER, L.—**Ueber das Vorkommen von Botrychium rutæfolium A. Br. in Niederösterreich.** (On the occurrence of *B. rutæfolium* in Lower Austria.)
Oesterr. Bot. Zeit., liv. (1904) pp. 332–3.

LOTSY, J. P.—**Photographies de plantes interessantes. 1. Pflanzen des javanischen Urwaldes. Nephrodium callosum Bl.** (Photographs of interesting plants. 1. Plants of the Javan jungle.)
Rec. Trav. Bot. Néerland., i. (1904) pp. 131–4 (3 pls.).

MARQUAND, E. D.—**Additions to the Flora of Alderney.**
[Records the occurrence of *Isoetes Hystrix.*]
Guernsey Soc. Nat. Sci. Rep., 1902 (1903) pp. 144–8.

MAXON, W. R.—**A new fern, Goniophlebium Pringlei, from Mexico.**
Proc. U S. Nat. Mus., xxvii. (1904 pp 953–4.

MAXON, W.—**Two new Ferns of the genus Polypodium, from Jamaica.**
[Reprinted.] *Bull. Dept. Agric. Jamaica*, ii. (1904) pp. 176–8.

PARISH, S. B.—**Additions to the Californian Fern flora.**
Fern Bull., xii. (1904) pp. 82, 83.

PRICE, SADIE F.—**Contribution toward the Fern flora of Kentucky.**
[An annotated list of 42 ferns, published after the writer's death.]
Tom. cit., pp. 65–70.

PRINCE, S. FRED.—**Some ferns of the cave region of Stone County, Missouri.**
[A list of 17 species and 4 varieties from the remarkably eroded southern side of the Ozark Range.] *Tom. cit.*, pp. 72–7.

SCOTT, D. H.—**On the occurrence of Sigillariopsis in the lower coal-Measures of Britain.** *Ann. Bot.*, xviii. (1904) pp. 519–21.

Bryophyta.

Monoclea.*—D. S. Johnson discusses the development and relationship of *Monoclea*, founded on a study of material from Jamaica. In an historical résumé he gives a clear account of the observations of previous authors, and their views as to the systematic position of the genus—at first near *Anthoceros*, then near *Pellia*, and then in the Marchantiaceæ. He also describes his own researches, and draws a series of conclusions from them. The male receptacle resembles that of *Corsinia* and *Fimbriaria* rather than that of *Fegatella*. The development and structure of the antheridia are clearly Marchantiaceous. The archegonia are Marchantiaceous in development and structure, and not Jungermanniaceous. The long-stalked sporogonium with cylindric capsule is more of a difficulty ; but the monostromatic capsular wall is Marchantiaceous, not Jungermanniaceous. The presence and direction of the two kinds of rhizoids is a thalline character of the Marchantiaceæ, among the lower members of which order the author places the genus.

Revision of Lophozia.†—V. Schiffner has made a careful study of *Lophozia Muelleri* and its allies, examining very many specimens. This group of species is well marked off from the rest of the genus by the following characters : (1) leaves always two-lobed ; (2) amphigastria mostly well developed even on the sterile stem ; (3) involucral bracts subsimilar to the leaves ; (4) perianth cylindric or conical, not plicate (or only at the apex), contracted into a tubular apiculus ; (5) perigonial bracts, always with a third dorsal tooth. The author gives a chronological list of 19 species which have been described in this group, and, criticising them in detail, reduces them to 7 species : *L. Muelleri*, *Hornschuchiana*, *badensis*, *turbinata*, *heterocarpa*, *Schultzii*, *Kaurini*. As an appendix he adds a long list of the original specimens and specimens in published sets, which he has examined critically, giving them their corrected names.

Dispersal of Moss-spores.‡—A. Pfaehler publishes a biological and morphological study of the dissemination of the spores of mosses. After describing the general structure of the sporogonium, he sums up previous work, mainly that of Hutton (1874), who held the wind to be the prime agent in spore-dispersal in proportion to the length of the fruit-stalk, and the peristome to be an apparatus which prevents too rapid

* Bot. Gazette, xxxviii. (1904) pp. 185–205 (2 pls.).
† Verh. k. Zool. Bot. Ges. Wien, liv. (1904) pp. 381–405.
‡ Bull. Soc. Vaudoise, xl. (1904) pp. 41–132 (9 pls.).

dispersal. Goebel's views are similar. Pfaehler then details his own observations extended to all the groups of stegocarpous mosses; and finally gives a résumé showing how the different parts of a moss may contribute towards the emission and protection of the spores—pedicel, capsule, peristome (simple or double), operculum, columella, and even the spores themselves. The dominant biological principle is regulation in the spore-dispersal by means of the peristome, columella, upright position of capsule, etc. A second dominant principle is the protection of the spores from water, by means of the peristome, by the formation of a watery pellicle across the mouth of the capsule, etc. For in nearly all the mosses spore-dispersal does not take place during rain.

BOUVET, G.—**Muscinées du département de Maine et Loire. Supplément No. 2.** (Muscineæ of the department of Maine and Loire.)
Bull. Soc. Études Sci. Angers. N.S., xxxii. (1902) 1903, pp. 171–8.

BRITTON, E. G.—**Hyophila: a new genus to the United States.**
[*Pottia riparia* Austin, 1870, New Jersey, is now shown to be a species of the tropical genus *Hyophila*. It is known in Switzerland as *Trichostomum Warnstorfii*. It is remarkable for the gemmiferous paraphyses in its perichætia.] *Bryologist*, vii. (1904) pp. 69–71 (1 pl. and fig.).

" " **When doctors disagree.** (Controversy as to *Plagiothecium Groutii*.)
Tom. cit., p. 78.

CAMUS, F.—**Une anomalie du Phascum cuspidatum.** (An abnormal form of *P. cuspidatum*.) *Bull. Soc. Bot. France*, xlviii. (1901) pp. 421–2.

CARDOT, J.—**An answer to Mrs. E. G. Britton's last article, "Notes on Nomenclature."** *Bryologist*, vii. (1904) pp. 80, 81.

CLARKE, CORA H.—**Curbstone Mosses.**
[On the interest of common species of the pavement.] *Tom. cit.*, p. 74.

COKER, W. C.—**Chapel Hill Liverworts.**
Journ. Elisha Mitchell Sci. Soc., xx. (1904) pp. 35–7.

CORBIÈRE, L.—**Le Jolis.**
[Notice of Auguste Le Jolis, b. 1823; d. 1904.]
Revue Bryolog., xxxi. (1904) pp. 96–7.

DÉPALLIÈRE, C.—**Essai sur les muscinées de l'Ain.** (Essay on the Muscineæ of the Ain department.)
[Catalogue of 259 species.] *Bull. Soc. Sci. Nat. Ain*, 1904, 16 pp.

DISMIER, G.—**Muscinées nouvelles, rares ou peu connues pour la flore Parisienne.** (Muscineæ new, rare or little known for the Parisian flora.)
Bull. Soc. Bot. France, li. (1904) pp. 182–6.

EVANS, A. W.—**Notes on New England Hepaticæ.**
[Critical and descriptive notes on thirteen species, which are new to New England or have been imperfectly described. *Lepidozia sylvatica* is new to science.] *Rhodora*, vi. (1904) pp. 165–74, 181–91 (1 pl.).

FRIREN, A.—**Promenades bryologiques en Lorraine.** (Bryological excursions in Lorraine.)
[Third series.] *Bull. Soc. Hist. Nat. Metz*, 1904, 25 pp.

" " **Nouveau Supplément au catalogue des mousses et des hépatiques de la Lorraine.** (New Supplement to the Catalogue of the Mosses and Hepatics of Lorraine.) *Op. cit.*, 11 pp.

GROUT, A. J.—**Mosses with hand-lens and Microscope.**
Part ii. pp. 87–166. Brooklyn, 1904 (numerous figs.).

GUINET, A.—**Henri Bernet.**
[B. 1850; d. 1904. Memorial notice.]
Revue Bryolog., xxxi. (1904) pp. 97–8.

HAMILTON, W. P.—**Mosses.**
[List of 197 mosses and 14 hepatics gathered in the neighbourhood of Church Stretton in Shropshire.]
Church Stretton. Ed. by Hyslop and Cobbold. Shrewsbury, 1904, vol. ii. pp. 137–49.

HERZOG, TH.—**Die Laubmoose Badens. Eine bryogeographische Skizze.** (The Mosses of Baden. A bryogeographic sketch. Continuation.)
Bull. Herb. Boiss., iv. (1904) pp. 918–35, 1035–50.

INGHAM, W.—**Mosses and hepatics of the Buckden District.**
Naturalist, 1904, pp. 309–12.

KELLER, R.—**Beiträge zur Kenntnis der Laubmoosflora des Kantons Unterwalden.** (Contributions to a knowledge of the moss-flora of Canton Unterwalden.)
[List of 102 species gathered at Beckenried, Buochs, etc., on the Lake of Lucerne.] *Bull. Herb. Boiss.*, iv. (1904) pp. 952–6.

LAMPA, E.—**Untersuchungen an einigen Lebermoosen.** (Researches on some liverworts. Part II.)
Sitzb. K. Akad. Wiss. Wien., cxii. (1903) pp. 779–92 (4 pls.).

LETT, H. W.—**A new Hepatic.**
[Description and figures of *Adelanthus Dugortiensis* Donin and Lett, gathered in Achill Island, Co. Mayo, in 1903.]
Irish Naturalist, xiii. (1904) pp. 157–9 (1 pl.).

" " **Notes on Hypopterygium.**
[Describes a new species, *H. immigrans*, found in an Irish greenhouse; and redescribes 14 other species mostly preserved in Trinity College, Dublin.]
Journ. Bot., xlii. (1904) pp. 249–53 (1 pl.).

LOESKE, L.—**Erster Nachtrag zur "Moosflora des Harzes."** (First supplement to the "Moss-flora of the Harz.")
[Contains one species new to Germany and nine new to the Harz mountains.]
Festschr. zu P. Ascherson's siebzigstem Geburtstage, 1904, pp. 280–95.

LLOYD, F. E.—**Liverworts in dry regions.**
Plant World, Washington, vii. (1904) pp. 185–7.

MARQUAND, E. D.—**Further Additions to the Flora of Alderney.**
[Contains a list of 13 mosses, raising the total of species in Alderney to 106.]
Guernsey Soc. Nat. Sci. Rep., 1903 (1904) pp. 266–71.

" " **The Mosses and Hepaticæ of Sark.**
[A list of 60 mosses and 22 hepatics, 14 of which are not found in Alderney.] *Tom. cit.*, pp. 223–6.

MASSALONGO, C.—**Appunti intorno alle specie Italiane del genere Radula Dumort.** (Notes on the Italian species of *Radula*.)
[Having studied the native species in detail, the author arranges them in two groups; (1) Communes (*R. complanata*, *R. ovata*, and *R. Lindbergi* with var. *germana* = *R. commutata* Gott.); (2) Abnormes (*R. visianica*).]
Bull. Soc. Bot. Ital., 1904, pp. 260–1.

MCARDLE, D.—**Bryophyta.**
[A list of 84 mosses and 56 hepatics collected in Sligo and Leitrim, with a photograph of a large growth of encrusted calcicolous mosses.]
Irish Naturalist, xiii. (1904) pp. 208–13 (1 pl.).

PARIS, E. G.—**Index Bryologicus.** Ed. II., ii. fasc. 3, 4 (Paris, 1904) pp. 129–256.

" " **Quelques nouvelles pleurocarpes japonaises et tonkinoises.** (Some new pleurocarpous mosses from Japan and Tonkin.)
[Descriptions of 7 new species.]
Revue Bryolog., xxxi. (1904) pp. 93–5.

PAUL, H.—**Einige interessante Moosfunde aus Oberbayern.** (Some interesting moss records from Upper Bavaria.)
Festschr. zu P. Ascherson's siebzigstem Geburtstage, 1904, pp. 128–37.

PÉTERFI, M.—**Beiträge zur Kenntniss der ungarischen kleistocarpen Moose.** (Contributions to a knowledge of the Hungarian cleistocarpous mosses).
[A list of 13 species mostly from Siebenbürgen.]
Math. Naturw. Ber. Ungarn., xix. (Leipzig, 1904) pp. 352-6.

ROTH, G.—**Die Europäischen Laubmoose beschrieben und gezeichnet.** (The European Mosses described and figured.)
Band ii. Lief. ix. (Leipzig, 1904) pp. 385-512, pls. xxxi.-xl.

SCHIFFNER, V.—**Bryologische Fragmente.** (Bryological Fragments.)
[Six notes on *Cephalozia* and other subjects.]
Oesterr. Bot. Zeitschr., liv. (1904) pp. 251-6, 292-4.

" " **Revision einiger kritischer Laubmoose aus dem Herbarium F. v. Höhnel.** (Revision of some critical mosses from F. v. Höhnel's herbarium.)
[Four of von Höhnel's novelties from the Sierra Nevada of Spain, described by him in *Sitzb. k. Akad. Wiss. Wien.*, 1895, pp. 297-336, are here criticised with a few others. *Grimmia Dornaji* is shown to be a synonym of *G. anodon*; and *Hypnum Alcazabæ* is *H. Vaucheri* var. *cœlophyllum* Mol.]
Hedwigia, xliii. (1904) pp. 425-7.

" " **Ueber Dumortiera.** (On Dumortiera.)
[A reply to W. C. Coker's article in *Bot. Gaz.*, xxxvi. (1903) p. 225, etc., on the presence of air-chambers in the frond of *Dumortiera*.] *Tom. cit.*, pp. 428-9.

" " **Ueber die Variabilität von Nardia crenulata (Sm.) Lindb. und N. hyalina (Lyell) Carr.** (On the variability of *N. crenulata* and *N. hyalina*.)
[The former of these is the most variable of all hepatics. Three new varieties of the former and two of the latter are established. Notes on *N. scalaris* and *N. minor* are added.] *Verh. k. Zool. Bot. Ges. Wien*, liv. (1904) pp. 410-22.

S[HEPPARD], T.—**Yorkshire Naturalists at Dent.**
[Contains lists of mosses and hepatics determined by W. Ingham.]
Naturalist, 1904, pp. 299-304.

STEPHANI, F.—**Species Hepaticarum.**
[Monograph of the genus *Plagiochila*, continued; descriptions of 29 species.]
Bull. Herb. Boiss., iv. (1904) pp. 973-88.

STOW, S. C.—**Lincolnshire Mosses.**
[A few new records for the county.] *Naturalist*, 1904, p. 312.

TORKA, V.—**Moose des Kreises Züllichau-Schwiebus.** (Mosses of the district Züllichau-Schwiebus.) *Helios*, xxi., 1903.

Thallophyta.

Algæ.

Algæ of Central Europe.*—W. Migula has reached the Algæ in his Cryptogamic Flora of Germany, Austria, and Switzerland. He begins with a few introductory remarks on algæ in general, and then proceeds to describe the search for, collection and determination of these plants. Useful hints and instructions are given on all these points, as well as on methods of mounting for microscopic examination of both Cyanophyceæ and Diatomaceæ. Details as to the cultivation of green algæ are also given, and in a manner calculated to interest both the professional and the amateur botanist. Under Schizophyceæ there is a key to the seven

* Flora v. Deutschland, Thomé, v. (1904) pp. 1-16 (6 pls.).

families of that order. The first, Chroococcaceæ, is shortly defined, and then follows a key to the fifteen genera it contains. Diagnoses are given of the first few species of *Chroococcus*.

Algæ of Alderney.*—E. D. Marquand publishes additions to the flora of this island, in the first of which he gives a list of 62 marine algæ, and in the second a list of 14 marine and 63 fresh-water species, as well as 9 Desmidiaceæ. Each species-name is followed by the name of the locality where it occurs.

New Algæ from Java and the Philippines.†—W. Schmidle describes four new species, one of which is the type of a new genus, *Myxobaktron*. They are *Phormidium Usterii*, *Lyngbya Usterii*, *Pleurocapsa Usteriana* and *Myxobaktron Usterianum*. They are all named after the collector.

Marine Algæ of the Caroline Islands, etc.‡—K. Okamura publishes an interesting list of algæ collected in the Caroline Islands, Australia, Tasmania and New Zealand. He enumerates 16 Chlorophyceæ, 25 Phæophyceæ, 40 Florideæ, and 2 Schizophyceæ. Among the algæ are specimens of *Cystoseira articulata* Kütz., and the author adds an interesting and instructive note on its structure, synonymy and allies. He doubts whether *Hormophysa articulata* Kütz. is really a synonym of *Cystoseira latifrons* Kütz., as De Toni suggests in his Sylloge Algarum. He puts forward the question whether *Hormophysa articulata* is distinct from *Hormosira* (?) *articulata* Zan., and whether the latter is the same as *Cystoseira prolifera* J. Ag., or *C. triquetra* J. Ag. He also describes the anatomical differences between *C. articulata* and *Hormosira Banksii*. Figures of portions of *C. articulata* add to the interest of his remarks. Separate short lists of the species collected at each locality complete the paper.

American Algæ.§—F. S. Collins publishes a note on a small collection made by a sailor with no special knowledge of Algæ. The localities range from Newfoundland and Bay Chaleur to Yucatan. The only fresh-water algæ are specimens of *Stigeoclonium* and *Ulothrix* which were found on pine logs coming down the river to some port in Florida. Among the marine species are several which enlarge the geographical distribution hitherto recorded. The most interesting plants, however, are luxuriant specimens of *Caulerpa prolifera* Lam., *Codium tomentosum*, Stackh., *Bryothamnion Seaforthii* Kütz., and *Eucheuma isiforme* J. Ag., from Progreso, Mexico. Hitherto it has been supposed that the coast of Mexico was barren, but the presence of these algæ indicates that this theory is not well-founded.

Two Algæ from the Malay Archipelago.‖—A. Weber van Bosse makes some interesting observations on two algæ in her collection made on the Siboga Expedition to the Dutch East Indies. One is a new species, forming the type of a new genus, *Tapeinodasya Borneti*. The

* Guernsey Soc. Nat. Sci., 1902–3, pp. 145–8; 1903–4, pp. 266–71.
† Hedwigia, xliii. (1904) pp. 414–5.
‡ Bot. Mag. Tokyo, xviii. (1904) pp. 77–96 (4 figs. in text).
§ Rhodora, vi. (1904) pp. 181–2.
‖ Recueil des travaux bot. Néerl., i. (1904) pp. 1–10.

thallus is dorsiventral, with sympodial branching, and the plant resembles in appearance a minute cauliflower. Cystocarps and tetraspores are described. The carpospores are pyriform, like those of *Dasyopsis*, but it differs from that genus in having pericentral cells. The other species referred to in this paper is *Gelidium rigidum* Vahl., which should be placed in *Gelidiopsis*. It agrees with *Gelidiopsis* in having a fan-like disposition of the apical cells, while *Gelidium* has one large apical cell. The hyphæ which characterise *Gelidium* are wanting in *G. rigidum*, and the structure of the tetrasporous branches is identical with those of *Gelidiopsis variabile*.

Florideæ of the Gulf of Spezia.*—This is the first part of a paper by A. Preda, on the algal flora of the Gulf of Spezia. Seventy-three species are given, and among them *Bornetia secundiflora*, which is recorded as growing on a rhizome of *Posidonia*.

Genicula of Corallineæ.†—K. Yendo publishes the results of his study on the genicula of the Corallineæ, a subject which has lately received attention from another botanist. After a short introduction, he opens his paper with a description of the external appearance of the genicula, and gives diagrammatic figures which make his meaning clear. He considers that the genicula may be classified according to five different types, distinguishable by the naked eye. These differences are due to a diversity in the method of development in the early stages of the plant. He discusses the position of genicula, both normal and abnormal; the relative position of the genicular and articular cells; the structure of the genicular cells, and comparison with articular cells; the formation and development of the geniculum; the difference in the properties of the cell-wall of articular and genicular cells; and lastly, the value of the geniculum as a systematic character. The subject is worked out in great detail, and the genicula of several genera are figured.

British Fresh-water Algæ.‡—G. S. West embodies in a Treatise on the British Fresh-water Algæ, the results of his studies on this group. Many new facts and suggestions concerning their life-histories, development and relationships are here brought forward. A short preface explains the lines on which the book is written and the necessity for such a book. The contents are divided into two sections. The first is an Introduction, which gives a short historical sketch of the principal works hitherto published on the subject; and information on the Occurrence, Collection, Preservation and Cultivation of Fresh-water Algæ. In the second section the author shortly diagnoses the six classes of Algæ in general, and then turns to Fresh-water Algæ in particular; describing their Vegetative multiplication, Asexual reproduction, Sexual reproduction, Polymorphism, and Phylogeny and Classification. To the latter subject thirteen pages are devoted, and diagrams represent the views of the author on this subject. The algæ are then dealt with under their various orders. Each genus is fully described, with short

* Malpighia, xviii. (1904) pp. 76–93.
† Journ. Coll. Sci. Tokyo, 1904, Art. 14, 44 pp., 1 pl.
‡ Cambridge Biol. Ser. (1904) 8vo, xv. and 373 pp., 166 figs. in text.

notes on the British species. The book is illustrated by 166 text-figures, most of which are original, and as a rule the localities are mentioned where the specimens figured were collected. Accurate measurements are given for the most abundant and widely distributed species. Peridineæ and Characeæ are not included in the volume, as being outside the group of fresh-water algæ. A frontispiece shows a reproduction of two photomicrographs of plankton material from Loch Ruer, Sutherland, and Lough Neagh, Ireland.

British Desmidiaceæ.*—W. West and G. S. West have brought out the first volume of their Monograph of the British Desmidiaceæ. The preface contains a short historical account of past work. The last book published on the subject appeared in 1887, since which time 400 species and 402 varieties have been added to the British Desmid flora. A full bibliographical list is followed by an Introduction, in which a general description of Desmids is given, and their minute structure is dealt with under the headings of cell-wall, cell-protoplasm, chloroplasts and nucleus. Other subjects discussed are Variation, Locomotion, Vegetative Reproduction, Asexual Reproduction, Sexual Reproduction, Phylogenetic Relationships of the Desmidiaceæ, Occurrence and Distribution, Collection and Preservation, Examination, and Specific Determination. A diagram illustrates the views of the authors on the phylogeny of the genera. In the systematic treatment, the arrangement of the genera is based upon the scheme of evolution already published by one of the authors, and upon certain recent investigations of Lütkemüller. An analytical key is given to all known genera of Desmids, of which five have not been recorded from Great Britain. This first volume includes twelve genera, ending with *Tetmemorus* in Cosmarieæ. One new species is described, *Mesotænium truncatum*, and thirteen new varieties of species already known. Keys are given to several genera, including *Penium* and *Closterium*. Under each species name stands a short list of synonymy, the diagnosis, a list of British localities, the general geographical distribution, and generally some critical remarks. The volume is illustrated by thirty-two plates, some of which are coloured. Most of the figures are original.

West Indian Fresh-water Algæ.†—G. S. West describes a collection of fresh-water species found by A. Howard in the islands of Barbadoes, Dominica, and Trinidad. The author finds nine new species among them, three of which are epiphytic on *Pithophora Cleveana* Wittr. Of the remainder, there were several of special interest, notably *Glæotænium Loitlesbergerianum* Hansg., which was remarkable on account of the extraordinary deposition of black pigment in its integuments; and *Cosmarium bireme* Nordst. var. *barbadense*, because of its minute size. The most interesting of the diatoms were *Achnanthes Hörmannii* Gutw., *Cerataulus lævis*, var. *thermalis* Grun., *Tropidoneis Van Heurckii* Cleve, and *Terpsinoë musica* Ehrenb.

* Monograph of the British Desmidiaceæ, i. (London, Ray Society, 1904) xxxvi. and 224 pp., 32 pls. † Journ. Bot., xlii. (1904) pp. 281–294 (1 pl.).

Biology of Diatoms.*—Matteo Lanzi makes some interesting biological observations on Diatomaceæ. He points out the use of these plants in purifying fresh- and salt-water, in the composition of the so-called guano, and in the nutrition of animals. At the end of his remarks the author gives two lists of Diatoms; the first enumerates thirty-nine species found in the stomach and intestines of a fresh-water fish caught near Domodossola, and the second is a list of fifty-eight species found in a fish from the Mediterranean.

Micrasterias.†—J. A. Cushman records ten species and five varieties of this genus from south-eastern Massachusetts, of which three varieties are new. He finds the genus is almost wholly confined to ponds and lakes, but few occurring in streams. In ponds and lakes there are many species present, and usually an abundance of specimens. Critical notes are appended to the species names.

Development of Cocconema.‡—C. Turner has found developmental stages of *C. Cistula*, which he describes and figures. The earliest stage seen by him consists of a minute spore, which is brown in colour and contains four dark brown nuclei. The spore increases in size, and four diatoms are formed within the protoplasm, the frustules being gradually secreted and deposited around the four nuclei. The spore may contain one, two or three young diatoms, instead of four.

Diatoms of Koh Chang.§—E. Oestrup publishes a list of 274 species of marine diatoms contained in 74 samples of material collected by the Danish Expedition to Siam in 1899–1900. The genera which characterise the material as a whole are *Cocconeis* and *Mastogloia*. Fresh-water species occur singly, especially in samples from mangrove swamps. Plankton forms are rare, and occur only as fragments. Taken as a whole, the material is rich both in individuals and in species, but it is uniform. The marine diatoms of Siam have a tropical character, but do not occupy a peculiar position among the East-Indian marine diatoms, such as might have been anticipated.

Dutch Plankton.‖—H. C. Redeke publishes the result of his investigations during the years 1897-1901, made on the plankton of the Zwanewater, a small lake in the North Sea dunes near Callantsoog. On account of the shallowness of the water, the plankton corresponds with that of the littoral zone of a larger lake. In the number of forms and of individuals, the zooplankton exceeds the phytoplankton.

North Sea Plankton.¶—H. C. Redeke and P. J. van Breemen give a list of phyto- and zoo-plankton collected in the southern waters of the North Sea between 52° and 54° N. lat., 0° and 4° E. long. Triposplankton occurred principally in the north of the region examined, being

* Atti Pont. Accad. Nuov. Lincei, lvi. (1903) pp. 129–41.
† Bull. Torrey Bot. Club, xxxi. (1904) pp. 393–7 (3 figs. in text).
‡ Rep. and Trans. Manchester Micr. Soc., 1903, pp. 88–91 (1 pl.).
§ Botanisk. Tidsskrift., xxvi. (1904) pp. 115–61 (2 pls.).
‖ De erven Loosjes. Haarlem, 1903, 5 pls.
¶ Tijdsch. Nederl. Dierk. Vereeng. (2) viii. (1903) pp. 118–47.

less common in the south. Remarks are made on the occurrence, geographical distribution, etc., of the most important species. No novelties are mentioned.

BALSAMO, F.—**Primo elenco delle Diatomee del Golfo di Napoli.** (First list of Diatoms from the Gulf of Naples.)
Bull. Soc. Nat. Napoli, xvii. (1903) pp. 228–41.

DAVIS, B. M.—**Oogenesis in Vaucheria.**
Bot. Gazette, xxxviii. (1904) pp. 81–99 (2 pls.).

DROST, A. W.—**Pleurococcus vulgaris Menegh. als endophytisch levende wier.** (*P. vulgaris* as an endophytic alga.)
[The author finds small wart-like swellings on the needles of *Abies Pinsapo* and *Picea excelsa*, caused by colonies of *Pleurococcus vulgaris*, which push up the epidermis.]
Tijdschrift over Plantenziekten, x. (1904) pp. 71–3 (1 pl.).

ERNST, A.—**Zur Kenntniss des Zellinhaltes von Derbesia.** (On the cell-contents of Derbesia.)
[The author finds very large crystals of calcium oxalate of regular shape in *D. tenuissima*.]
Flora, xciii. (1904) pp. 514–32.

" , **Die Stipularblätter von Nitella hyalina (D.C.) Ag.** (The stipulary leaves of *N. hyalina*.) *Vierteljahrschr. Natur. Gesell. Zurich*, xlix. (1904) pp. 64–114 (1 pl.).

FALCON, R. C.—**Los misterios de la naturaleza: investigaciones sobre el microplankton de la ria de Arosa.** (The mysteries of nature: investigations into the microplankton of the Arosa River.) *La Coruna*, 1904, 175 pp. (1 map, 293 figs.).

FIRTH, W. A.—**Diatomaceæ.**
[A note on five species of Diatoms encrusting some molluscs (*Planorbis*) dredged in a pond near Kilmacowan, Co. Sligo.]
Irish Naturalist, xiii. (1904) p. 214.

FOURNIER, ABBÉ—**L'étude des Algues.** (The study of Algæ.)
Bull. Soc. Bot. Deux-Sèvres, Bull. xv. [1903] 1904, pp. 173–8.

FRANK, THEODOR—**Cultur und chemische Reizerscheinungen der Chlamydomonas tingens.** (Culture and chemical stimulus-phenomena in *C. tingens*.)
Bot. Zeitschr., lxii. (1904) pp. 153–88 (1 pl.)

GRAN, H. H.—**Diatomaceæ from the Ice-Floes and Plankton of the Arctic Ocean.**
In F. Nansen's The Norwegian North Polar Expedition, 1893–96, iv. (London, 1904.)

" " **Die Diatomeen der Arktischen Meere. I Teil. Die Diatomeen des Planktons.** (Diatoms of the Arctic Ocean. Part I. Diatoms of the Plankton.) *Fauna Arctica*, iii. (1904) pp. 511–54 (1 table and 6 figs. in text).

HIRN, K. E.—**Zur Kenntnis der Desmidiaceæ Finnlands.** (Contribution to a knowledge of the Desmids of Finland.) *Act. Soc. Faun. et Fl. Fenn. Helsingfors*, 1903, 24 pp. (2 pls.).

KJELLMAN, F. R.—**Om Alvegetationen i Skelderviken och angränsande Kattegattsonwåde.** (On the algal vegetation in Skelderviken and the neighbouring parts of Kattegatt.)
[Mentions a new species of *Phlœospora*, but gives no description.]
Medd. fr. Kgl. Landbruksst, ii. (1902) pp. 71–81.

KUCKUCK, P.—**Bericht über eine botanische Reise nach Marokko** (Account of a botanical journey to Morocco.) *Wiss. Meeresunters. Kiel und Biol. Anst Abt Helgoland*, v. (1904) pp. 107–15.

LANGERON—**Note sur le rôle phytostatique et la floculation naturelle des eaux limoneuses.** (Note on the phytostatic character and natural flocculation of muddy waters.) *Bull. Soc. Bot. France*, li. (1902) pp. xxvii–xl

LANZI, M.—**Diatomee contenute nel canale alimentare di Oloturie del Mediterraneo.** (Diatoms contained in the alimentary canal of Holothurians of the Mediterranean.)

[The author enumerates 28 species in Holothurians collected at Civita Vecchia, and 89 in others collected at Naples.]

Atti Pont. Akad. Rom. Nuov. Lincei, lvii. (1904) pp. 172–9.

MOESZ, G.—**Brassó vidékénck levegön és folyovizben étö moszatjai.** (Algæ from the neighbourhood of Brasso living in air or running water.)

Jahresb. Staats-Ober-R.-schule, Brasso, xix., 1904 (11 pls.).

LARGAIOLLI, V.—**Notizie fisiche e biologiche sul lago di Cepich in Istria.** (Physical and biological notes on the lake of Cepich in Istria.)

Programm R. Gymnasium Pisino (Parenzo, 1904).

,, ,, **Le Diatomee del Trentino, xvi., xvii., Laghi Corvo.** (The diatoms of the Trentino, Corvo lakes.)

Ann. Soc. Alpinisti Tridentini, xxiii. (1904) Trento.

OSTENFELD, C. H.—**Phalocystis Pouchettii (Hariot) Lagerh., and its zoospores.**

Arch. f. Protistenkunde, iii. (1904) pp. 295–302 (figs. 1, 2).

PORSILD, MORTON P., & H. G. SIMMONS—**Om Faeroernes Havalgevegetation og dens Oprindelse. En Kritik.** (On the marine flora of the Faeroës and its origin.)

[M. P. Porsild writes 20 pages on the origin of the Faeroë marine flora, giving a reduced facsimile of Ryder's map of the currents of the North Atlantic. H. G. Simmonds writes 13 pages on the ecological unities in the same flora; to be continued.] *Bot. Notiser*, 1904, pp. 149–80.

ROSEN, F.—**Die Frage von der Sexualität der Diatomeen, in Studien ueber das naturliche System der Pflanzen.** (The question of the sexuality of diatoms in studies on the natural system of plants.)

Cohn's Beiträge z. Biologie der Pflanzen, chaps. v., vi. (1904);
Jahresb. Schles. Gesell. Vaterl. Cultur., Abt. ii. Zool.-Bot., 1904, p. 11.

SAUVAGEAU, C.—**Remarques sur les Sphacélariacées.** (Remarks on the Sphacelariaceæ.)

[A continuation of the author's work on the subject.]

Journ. de Bot., 1903, pp. 332–53, 378–422;
1904, pp. 88–104 (figs. 48–68).

SCHRÖDER, B.—**Ueber den gegenwärtigen Stand der schlesischen Algenforschung.** (On the present condition of the investigation of Silesian algæ.)

Jahresb. Schles. Gesell. Vaterl. Cultur., Abt. ii., Zool.-Bot., 1904, pp. 27–30.

TECKET, K.—**Verhalten einiger mariner Algen bei Aenderung des Salzgehalles.** (Reaction of some marine algæ to change of salinity.) To be continued.

Oesterr. Bot. Zeit., liv. (1904) pp. 313–18 (9 figs. in text).

WILLE, N.—**Ueber die Gattung Gloionema Ag. Eine Nomenklaturstudie.** (On the genus Gloionema. A study in nomenclature.)

Festschrift f. P. Ascherson, pp. 439–51.

Fungi.

Plasmopara cubensis in Austria.*—Ludwig Hecke records the appearance of this dangerous parasite of cucumber. It has long been known in America, but not yet recorded for Austria or Germany. The leaves are attacked and very soon wither and fall, so that the health of the plant and the development of the fruit are seriously affected. He describes the fungus in detail, and gives an account of the methods employed for its eradication.

* Ann. Mycol., ii. (1904) pp. 355–8.

Spore-development in Aphanomyces.*—Rothert confirms De Bary's work on *Aphanomyces*, and adds further observations. He describes the formation of the sporangia and the spores: the latter characterised by a circular massing of the plasma, which takes at the same time a foam-like formation. When the spores are fully formed, there remains a plasma thread forming a bridge between them. The connection accounts for the grouping of the non-motile spores after leaving the sporangium.

Sexual Reproduction in the Mucorineæ.†—A. F. Blakeslee presents us with the extended paper, a summary of which has already appeared. In a long introduction he discusses the points of interest in connexion with the formation of zygospores. He finds that the conjugating gametes do not grow towards each other, but are the ends of branches in close contact, and that as they swell and grow, they push apart the supporting hyphæ. He explains the distinction between homothallic or bisexual and heterothallic or unisexual strains, and gives an historical review of the many theories held by workers as to the causes inducing the formation of zygospores in this group of fungi. An account is also given of all the species in which zygospores have been recorded. He finds that there are two main groups of Mucorineæ, homothallic and heterothallic, the latter largely outnumbering the former. In the heterothallic group zygospores are only formed between the hyphæ of different plants or "strains." Given these two strains, the other conditions of nutrition and moisture are unimportant, except that where the substratum is too dry no fusion takes place. Moisture, he finds, though not a determining factor, has a decided influence on zygospore formation. The stimulus to the formation of progametes becomes operative through the osmotic activity of the hyphal contents; and if the surfaces of the two membranes are dry, there will be no osmotic influence between the fluids contained in them. The author records several instances of successful hybridisation between different species, but always between the (+) strain of one and the (−) of another. Mature zygospores are not formed, however; the process goes no further than the formation, or the cutting off, of the two gametes. A complete bibliography of the subject is appended.

Development of Mucorini.‡—J. Dauphin has tested the influence of various carbohydrates on the growth of *Morierella polycephala*. He finds that glucose, levulose, and galactose favour the appearance of sporangia and induce the formation of zygospores hitherto unknown in this fungus. Lactose and saccharose give only sporangia and chlamydospores; with maltose and mannite chlamydospores alone are produced. The author considers that he has gained some knowledge of the conditions favourable to the formation of zygospores, a subject which is still enveloped in obscurity.

Conidial Form of Morchella esculenta.§—Marin Molliard produced a conidial growth from the ascospores of *Morchella*, and he finds it identical

* Flora, xcii. (1903), pp. 293–301. See also Centralbl. Bakt., xii. (1904) p. 502.
† Proc. Amer. Acad. Arts and Sci., xl. (1904) pp. 205–319 (4 pls.).
‡ Comptes Rendus, cxxxix. (1904) pp. 482–4.
§ Rev. Gén. Bot., xvi. (1904) pp. 209–18 (1 pl.).

with the Hyphomycete *Costantinella cristata*. He thinks that it might be included in the genus *Botrytis*. The conidial form is produced where there is a high condition of moisture. Conidiophores and conidia are colourless. Sclerotia were also developed from the *Morchella* mycelium, hard brown bodies up to 7 mm. in diameter. If grown in a more liquid substratum, a crust of similar texture was formed on the surface.

Capnodium maximum.*—A fungus that K. Giesenhagen found on the sori of *Polypodium crassifolium* in tropical America, was described by him as new, and placed in a new genus, *Sorica*. He learned later that it had already been described by Berkeley and Curtus as *Capnodium maximum*. The fungus, however, belongs rather to the Pyrenomycetes than to the Perisporiaceæ, and thus the more recent name is retained. The fungus finds entrance into the leaf either through the young sorus or through wounds at the edge of the leaf caused by the bites of animals.

Karyokinesis in the Ascomycetes.†—A. Guillermond has investigated nuclear division in this group, paying attention chiefly to divisions in the ascus. He has observed in the ascus of *Pustularia vesiculosa*, *Peziza catinus* and *Ascobolus marginatus*, divisions which are of the type described by Harper. In *Peziza rutilans*, however, the division is of quite a different type, the karyokinesis having no centrosomes but all the characters of nuclear division in Phanerogams. The number of chromosomes is 12 in *P. catinus*, 8 in *P. vesiculosa*, and 6 in *P. rutilans*; the generalisation of Dangeard that all the ascomycetes have 4 chromosomes at this stage is thus not supported. The author was unable to solve the problem of the reduction in number of the chromosomes.

Erysiphe Graminis.‡—In this paper, Part I., E. Salmon discusses the adaptive parasitism of *Erysiphe graminis* within the genus *Bromus*. He shows that there exists not only a high degree of specialisation of the fungus, but that each species of the host-plants possesses constitutional characters existing concomitantly with the specific morphological characters. As a rule this holds good for all examples of the species wherever grown. In one case he found a biologic form of the host-plant which resisted infection, though morphologically it was exactly similar to the form on which the fungus grew readily. This fact has great economic importance, as pointing to the possibility of breeding races that would be immune to disease.

In another case, *Bromus arduennensis*, the species has been considered by some systematists to possess generic differences that would separate it altogether from this genus. Salmon found that it was markedly susceptible to attacks of the fungi that are parasitic within the genus, and thus its affinity was very strikingly indicated.

In Part II., he gives an account of his inoculation experiments with the conidia of *E. graminis* on species of *Bromus*. The *Oidium* was taken from several species, and a very large number of experiments were made, with very varying results, according to the affinities and physiological

* Ber. Deutsch. Bot. Gesell., xxii. (1904) pp. 355–8.
† Rev. Gén. Bot., xvi. (1904) pp. 129–43 (2 pls.).
‡ Ann. Mycol., ii. (1904) pp. 255–67, 307–43.

characters of the host-plants. In the species *B. commutatus*, he found that there were two races that showed a different reaction to the same fungus. In other cases, plants that were immune when young and vigorous, became susceptible after being kept for some time in the laboratory. Extended tables are given of the experiments, and diagrams illustrating the text.

Growth of Yeast in Mineral Solutions.*—A. Kossowicz found that very small quantities of yeast failed to increase in the usual sugar and mineral solutions. An increased quantity showed some growth, though no visible fermentation, while the introduction of a large quantity induced at once cell production and fermentation. He found also that an addition of calcium (as phosphate or chloride) increases yeast formation and fermentation. Sulphate and chloride of iron, in excess only, aid fermentation.

Saccharomyces Anomalus.†—Under this name, K. Saito describes a yeast that occurs on *Sake*. He made artificial cultures, and describes the morphology and physiological properties of the cells. Endogenous spores were easily obtained. The writer is uncertain as to the role of this special yeast in the brewing of saké. He thinks probably the peculiar odour is to be traced to it.

Contributions to the Morphology of Saccharomyces.‡—A. Osterwalder has studied the forms of yeast that are to be found in the must of cider. He isolated several species, and found that they belonged to races that could not be distinguished from *Saccharomyces Cerevisiæ*. He found also that the culture medium exercised a great influence on the form of the yeast-cell. He gives an account of spore formation, and a detailed account of the 12 races that he succeeded in isolating.

Aposphæria violacea, sp. n.§—Rud. Bertel detected a large patch of reddish-violet mycelium growing on the walls of a conservatory at Prague. The hyphæ were thickly interwoven and appressed to the substratum. Here and there seated on the hyphæ were small pycnidia, which became dark-brown when mature. The pycnidial spores were small, colourless, elliptical bodies. No further fructification was observed by the author, who considers that it would probably prove to be near *Chætomium*. He cultivated the fungus in artificial media, and tested the colouring matter with various reagents.

Cercosporella compacta, sp. n.‖—J. B. Traverso describes a disease of *Acanthus* leaves caused by the above fungus. The leaf was covered with brown spots 3–8 mm. broad. The fungus consists of tufts of colourless conidiophores, which rise from a Pseudostroma within the tissue; the elongate, septate conidia are borne singly at the tips of the fertile hyphæ. The author gives an account of other fungal parasites on *Acanthus* leaves.

* Zeitschr. Landw. Versuchsw. Oesterr., vi. (1903) pp. 731–7. See also Ann. Mycol., ii. (1904) p. 385.

† Journ. Coll. Sci. Imp. Univ. Tokyo, xix. (1904) 14 pp.

‡ Landw. Jahrb. der Schweiz, 1903. See also Centralbl. Bakt., xii. (1904) pp. 486–7. § Oesterr. Bot. Zeitschr., liv. (1904) pp. 205–209, 233–7 (1 pl.).

‖ [illegible], xliii. (1904) pp. 422–4 (2 figs.).

Hyphomycetes.*—G. Lindau continues in this third part the decription of the Aspergilleæ begun in Part II. Under *Aspergillus* he includes the genus *Sterigmatocystis*, with *Septromyces opizii* as a monstrous form of *S. nigra*. *Citromyces* and *Penicillium* are also described. The latter genus, he remarks, is in great need of revision.

Uredineæ.—D. McAlpine† corrects misconceptions that have arisen concerning the uredospores of *Puccinia Pruni*. A number of observers have described them as being of two kinds. McAlpine disproves this. The uredospores are all alike, but sometimes the two cells of the teleutospore fall apart, and the lower has been figured and described as a second kind of uredospore.

H. and P. Sydow ‡ describe a series of new or critical species from Japan, Africa, Mexico, etc.

C. A. J. A. Oudemans § writes a note on *Puccinia veratri*, which has been erroneously described as a *Uromyces*.

A. Trotter ‖ gives an account of *Uromyces giganteus*, a species found on the stalks of *Suaeda maritima* ; he finds a variety on *S. fruticosa* also, growing on the stalks and deforming them.

Fr. Bubak ¶ gives a list of seven forms of Uredineæ, in which he has conducted successful inoculation experiments. He notes that in *Sedum boloniense* the æcidium mycelium of *Puccinia longissima* is perennial.

Fertilisation, Alternation of Generations, and General Cytology of the Uredineæ.**—V. H. Blackman has published the full paper, a short account of which appeared in the *New Phytologist*, iii. 1904, pp. 24–27. He reviews the history of research and opinion as to the sexuality of this group of fungi, describes the methods he employed, and then gives the results arrived at by himself. After describing the morphology, cytology and germination of the teleutospores of *Phragmidium violaceum* and *Gymnosporangium clavariæforme*, he passes on to a consideration of the spermogonia of these forms. They arise from a uninucleate mycelium. The spermatia are also uninucleate, and, when mature, are extruded and lie on the leaf surface, where many of them seem to undergo a process of degradation : they took no part in æcidium formation, and were never observed to germinate. The æcidium of *Phragmidium*, which the writer takes next in order, also arises from a uninucleate mycelium. The cells of the æcidium immediately below the epidermis of the hosts elongate, and cut off a sterile cell at the tip, the nucleus of which becomes disorganised ; the cell below is the fertile cell that gives rise to the æcidiospores ; at first uninucleate, it becomes binucleate from the passing into it of the nucleus of a neighbouring cell, usually the one immediately below. The migrating nucleus passes through the cell wall. The paired nuclei then divide by conjugate division, and binucleate æcidiospores are cut off from the fertile cell. The migrating process was not observed in *Gymnosporangium*, but the development proceeds in the same way from uninucleate mycelium to binucleate æcidiospores.

* Rabenhorst's Kryptogamen-Flora, viii. Lief. 94, pp. 129–76.
† Ann. Mycol., ii. (1904) pp. 344–8. ‡ Tom. cit., pp. 349–51.
§ Tom. cit., p. 358. ‖ Tom. cit., pp. 359–60 (1 fig.).
¶ Tom. cit., p. 361. ** Ann. Bot., xviii. (1904) pp. 323–73 (4 pls.).

The æcidiospores give rise to binucleate uredospores mycelia and finally to binucleate teleutospores; as these latter mature, the two nuclei in each cell become fused, and produce on germination the uninucleate sporidia and uninucleate mycelium of the early æcidium stages. The author considers that the migration of nuclei observed in the æcidium is a reduced form of fertilisation; though conjugation does not take place, there is association which give the necessary sexual stimulus to further growth. The spermogonia are male organs, that have become functionless; the nature of the spermatia proves this to be the case. Comparing the development with that of the higher plants, he finds a clear alternation of generations; the sexual or gametophyte bearing spermogonia and æcidia, and characterised by a single nucleus, and the sporophyte or asexual stage, bearing asexual spores, æcidiospores, uredospores and teleutospores. Finally in the teleutospore there is the return to the oophyte, fusion of the nuclei, and reduction of the chromatin masses. The teleutospore represents the spore mother-cell, and undergoes a process of tetrad division to form the four cells of the promycelium. These four cells are really spores, and are easily recognised as such in forms like *Coleosporium*. The absence of the æcidium in the life-cycle corresponds to the cases of apogamy observed in the higher plants. Apospory is found in *Endophyllum*, where the æcidiospores behave on germination like the teleutospores, and produce sporidia. Blackman has given full accounts of the cytology throughout. He compares the fusion of nuclei in the basidiospore with fusion in the teleutospore, but he would consider the Basidiomycetes, while closely related, to be reduced apogamous forms of the Uredineæ.

Nuclear Phenomena in Coleosporium Sonchi-arvensis.*—R. J. Holden and F. J. Harper selected this form, parasitic on various compositæ, as favourable for the study of nuclear division and nuclear phenomena. The authors consider the uredospores of this fungus to be really æcidiospores—thus regarding *Coleosporium Sonchi-arvensis* as monœcious. All other forms investigated have been found to be heterœcious. They discuss the work already done by Sappin-Trouffy, Dangeard, Poirault, etc., on this subject, and give in detail the results arrived at in their own investigations. They lay special stress on the fusion of the nuclei in the teleutospore, which has, they consider, "the essential characteristics of a sexual fertilisation in the origin of the nuclei, and in the behaviour of the teleutospores after fusion." In this genus the teleutospore germinates at once, and sporidia are produced, which are at first uninucleated. The nucleus divides in the sporidium, and the cells of the fungus, according to these writers, are thenceforth bi-nucleated until the teleutospore is again reached. Poirault and Raciborski found in the division stages of the nucleus that there were two chromosomes. Holden and Harper have evidence that there are from six to ten.

Witches'-Broom caused by Puccinia.†—P. Magnus has followed the development of *Puccinia Rübsaameni* on *Origanum vulgare*, where

* Trans. Wiss. Acad. Sci. Arts and Letters, xiv. (1904) pp. 63–80 (2 pls.).
† Ber. Deutsch. Bot. Gesell., xxii. (1904) pp. 344–7 (1 pl.).

it grows only in the stalk, causing an abnormal branch development with a dwarfing of the leaves. The fungus produces only teleutospores ; the mycelium is very abundant in the pith, and passes out to the cortex chiefly at the leaf bases where the sori are usually found, though they also extend up the internodes. The intercellular spores are filled with hyphæ, and haustoria penetrate the cells. The hyphæ were found to have penetrated the youngest branches. Magnus made a careful search for mycoplasma, but was unable to find any evidence of its presence in the tissues.

Infection of Cereals by Smut.*—L. Hecke has been testing the effects of copper sulphate treatment of seeds to destroy any spores of *Ustilago* adhering to them. He has come to the conclusion that the fungus infects the seed before it is ripe, and is thus contained within it when it is sown the following year. He experimented with corn that was artificially infected when flowering, and of which some of the seeds ripened and seemed healthy. These seeds protected from further infection were sown, and produced smutted heads.

Copulation of Conidia in Ustilago Tragopogi-pratensis.† — H. Federley has observed the copulation of the conidia of this fungus and the fusion of the nuclei. He noted some remarkable differences in material gathered at different seasons. In autumn material the spores would not germinate in any nutritive solution : they germinated only in pure water. Fusion took place between the conidia, and long hyphæ were formed. The spores from fungi collected during the summer germinated either in water or in nutritive media ; the promycelium gave rise to numerous conidia, which multiplied by budding, but copulation was never observed, and the addition or exhaustion of nutrition had no effect in inducing fusion.

North American Polyporaceæ.‡—W. A. Murrill continues his work on this group. He revises the two genera *Hapalopilus* and *Pycnoporus* ; the former to contain forms with an "anoderm surface and fleshy-tough context" ; the latter for the two species *Polyporus cinnabarinus* and *P. sanguineus*. His new genera are *Abortiporus*, *Cyclomycetella*, *Cycloporus*, *Globiformes*, *Nigroformes* and *Poronidulus*, all of them so far monotypic, and founded on various speeies of *Polyporus*.

Dry-rot.§—B. Malenkovié finds that the infection of dry-rot is due to the spores of the fungus rather than to the mycelium. He thinks that calcium carbonate, which is found on wood near the walls, offers a favourable medium for the growth of the fungus. He recommends light and air as the best means of preventing the growth of *Merulius*. In another paper ‖ the same author gives results of his work on the ger-

* Zeitschr. landw. Versuchsw. Oesterr., 1904. See also Ann. Mycol., ii. (1904) pp. 376-7.

† Finska. Vetensk.-soc. Förh., xlvi. (1903-4) No. 2. See also Bot. Zeit., lxii. (1904) pp. 171-2.

‡ Bull. Torrey Bot. Club, xxxi. (1904) pp. 415-28.

§ Centralbl. Ges. Forstw., xxxix. (1903) pp. 281-96. See also Centralbl. Bakt., xii. (1904) pp. 511-2.

‖ Naturw. Zeitschr. Land und Forshw., ii. (1904) pp. 100-9, 160-3. See also Centralbl. Bakt.. xii. (1904) pp. 512-3.

mination of the spores. He made artificial cultures, and found that any invasion of bacteria or moulds hindered the development of the Merulius, and that the finest growth was obtained in acid solutions that were unfavourable to bacteria. Wood itself was less advantageous than artificial media. He found, however, that bacteria did not readily develop on wood.

J. Beauverie * has written a lengthy treatise on the same subject. He gives a scientific account of the fungus, discusses the conditions favourable to growth, the influence of different media in artificial culture, and the chemical products of growth. He then takes up the technical side of the question; the woods that are specially liable to attack, and the conditions that favour development. He gives various methods of detecting the presence of the hyphæ, and advises as to the means of combating the fungus when it has gained an entry into a house; above all, proper ventilation must be secured. Various antiseptics are also of use to sterilise the wood.

New Species of Microfungi.†—G. Cocconi describes a new *Absidia*, which grows on horse-dung. The sporangiophores grow in groups of 3 to 5, and are often branched. The spores are somewhat echinulate. Lack of nutrition induces the formation of zygospores, which are almost globose. If the sexual hyphæ fail to fuse together, azygospores are formed, which germinate like the zygospores.

Cocconi also describes ‡ a species of *Chætomium*; the spores are ovate, with a colourless papilla at one end. The author describes the various cultures that he made.

Teratology of Fungi.§—Ferdinand Filarszky describes the cases of anomalous growth or malformation among the higher fungi. He includes among these the cases of cohesion between different individuals, proliferation, abnormal growth of the stalk at the expense of the pileus, excessive development of stalk or head, malformation of the hymenophore, and either dwarfing or overgrowth of any of the plants.

Production of Citric Acid by Citromyces.‖—The species of fungi belonging to the genus *Citromyces* produce citric acid in sugar solutions, and have been used commercially for the production of the acid. P. Mazé and A. Perrier have studied the process, and give their results. They find that these moulds (nearly allied to *Penicillium*) grow freely on organic acids. They have isolated four different species, which they call *Citromyces citricus*, *C. tartaricus*, *C. oxalicus*, and *C. lacticus*. They consider the acid formed by the fungus to be an accidental product of "disassimilation," when nitrogen is exhausted in the culture, and sugar, glycerine or alcohol are still present in abundance. They give details of the different experiments, and the chemical results arrived at.

* Ann. Soc. Linn. Lyon, l. (1904) pp. 1–63 (9 figs.).

† Mem. Acad. Bol., viii. ser. 5, pp. 85–90 (1 pl.). See also Centralbl. Bakt., xii. (1904) p. 738.

‡ Tom. cit., pp. 683–88 (1 pl.). See also Centralbl. Bakt., xii. pp. 738–9.

§ Math. Naturwiss. Ber. Ungarn, xix. (1904) pp. 357–62.

‖ Ann. Inst. Pasteur, xviii. (1904) pp. 553–75.

Diseases of Ficus.* — R. Farneti describes two fungi that attack and damage figs. The first, *Alternaria Fici*, attacks the young fruit and causes deformation. The mycelium burrows among the cells of the growing tissue. As the fruit ripens and becomes soft, conidiophores and conidia are produced. The second, *Cladosporium sicophilum*, also attacks the fruit. A layer of cork underneath the part affected is formed, and brown spots appear on the outer skin of the fig. The fungus spores are of a clear brown colour.

White Mildew of Citrus Limonum.† — G. Briosi and R. Farneti have worked out this disease of the lemon tree. It attacks the fruit, leaves, and leaf-stalks. The first form of the fungus observed is *Cladosporium Citri*; other forms observed were *Hormodendron*, *Ovularia*, *Haplaria*, and *Rhynchodiplodia*. The authors followed the different stages throughout, and watched the development of one form to another. Artificial infection of healthy fruits caused either hypertrophy (outgrowths of the fruit), or atrophy (formation of crusts). The oil glands are the most favourable regions of infection. A cork layer invariably forms under the area attacked.

Diseases of Citrous Trees and Fruits.‡—P. H. Rolfs records a fungous disease which works much havoc in all places where citrous fruits are grown, and is known by the name of wither-tip. The fruit, leaves, flowers, or twigs may be attacked by the fungus *Colletotrichum glœosporoides*. It causes spots on the fruit, especially of the lemon, and these do not show until after the fruit is shipped, and much loss is caused. The writer recommends methods of cure.

Mycodomatia of Myrica cerifera.§—J. W. Harshberger has given an account of the nodules on the root of this plant. He found them to be filled with fungus mycelium. The hyphæ grew in the interior of the cells and also in the intercellular spaces. The larger hyphæ were brown in colour. The root structure was found to be more or less abnormal in the nodules.

Formation of False Heart-wood in the Red Beech.‖ — The false heart-wood is characterised by its dark colour. It takes rise from wounds caused by decaying or broken branches, and spreads above and below the place of origin. Johan Tuszon finds that it differs from the neighbouring sap-wood, in the cells being filled by reddish-brown gummy contents and in the tylosis of the vessels. He finds also that there are always fungal hyphæ in the tissue, especially towards the centre. He considers the special formation to be a protective structure against the attack of the fungus. It is only the functionless heart-wood that is thus transformed, and the fungus enters through some deeply penetrating

* Atti Ist. Bot. Pavia, viii. (1903) 5 pp., 1 pl. See also Ann. Mycol., ii. (1904) p. 375.

† Op. cit. n.s., x. (1904) 60 pp., 11 pls. See also Ann. Mycol., ii. (1904) pp. 374-5.

‡ U.S. Dep. Agric. Bur. Plant Industry, Bull. lii. (1904) 20 pp. See also Bot. Centralbl., xcvi. (1904) pp. 116–7.

§ Proc. Acad. Nat. Sci. Philadelphia, lv. (1903) pp. 352–62. See also Bot. Centralbl., xcvi. (1904) p. 274.

‖ Math. Naturwiss. Ber. Ungarn, xix. (1904) pp. 242–82 (22 figs.).

wound such as would be caused by a decaying branch. The fungi causing the formation are *Stereum hirsutum* and possibly *Xenodochus* (?) *ligniperda*. The latter consists of stout coloured hyphæ, of which the fructification is unknown. The author gives an account of various other fungi that attack beech wood, and recommends suitable remedies.

Influence of Growth Products of Fungi on their Further Development.*—Jacob Nikitinsky has studied this question in regard to the growth of species of *Penicillium*, *Mucor*, *Aspergillus* and *Saccharomyces*. He gives the solutions used as culture media, and the different salts employed to vary these media. He found, in all the culture conditions tested, that changes were induced by the growth of the fungus that had a considerable influence on its later growth. These results can be counteracted by the addition of neutralising agents such as ammonia, salts, etc. A deterrent of growth is produced by an acid condition of the culture solution, the acidity being due to the production of inorganic acids or free oxalic acid extruded in the metabolism of the hyphal cells. Other hurtful products arise by the splitting of glucosides. There are also unknown products that are harmful to continued growth, and some fungi are more susceptible than others to these influences. Extended tables are given of the different culture experiments.

Conditions of Colour Formation in Fusarium.†—Ernst A. Bessey gives an historical review of previous work on this subject; his object has been to verify the results already published by various workers, and to advance further our knowledge of the subject. The colours produced by the different fungi tested are chiefly red and orange. The red colour he found to be an acid which with different bases formed blue or violet salts insoluble in alcohol. Under the influence of light the same species of *Fusarium* produced an orange colour, of which the exact chemical nature is unknown. *Fusarium culmorum* forms a yellow pigment in an acid medium, and reddish-violet if the medium gave a neutral or alkaline reaction. The acid form appears to be a weak organic acid with difficulty soluble in water or alcohol. The alkaline form dissolved in alkaline solutions. The author gives the conditions other than the media in which these colours were formed, and also the conditions that hinder their production.

Seed-fungus of Lolium temulentum.‡—This fungus is of universal occurrence in Europe. G. Lindau has also found it in seeds of extra-European origin. He secured some old seeds from Egyptian tombs, and in all cases he found the fungus in them in great abundance. He examined recent seeds from the same locality with the same result. He gives an account of the microscopic appearance of the fungus.

BUCHNER, E., & J. MEISENHAMMER—**Die chemischen Vorgange bei der Alkoholischen Gärung.** (The chemistry of alcoholic fermentation.)
Ber. Deutsch. Chem. Gesell., xxxvii. (1904) p. 417. See also *Ann. Mycol.*, ii. (1904) pp. 385–6.

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* Jahrb. Wiss. Bot., xl. (1904) pp. 1–93.
† Flora, xciii. (1904) pp. 301–33.
‡ SB. K. Preuss. Akad. Wiss., xxxv. (1904) pp. 1031–6 (2 figs.).

BUFFA, EDMOND—**Note sur un Mucor parasite végétal du cuir chevelu de l'homme** (The mucor found growing on the hair of a child's head resembled *Mucor corymbifer.*) *Nord. Med. Arkiv.*, 1904, Afd. ii. Haft. 2, No. 6, 9 pp. (2 pls.).

COOKE, M. C.—**Fungoid pests of the garden.** (Descriptions of the parasites that attack greenhouse plants.) *Journ. Hort. Soc.*, xxviii. (1904) pp. 313–37.

HEINZE, B., & E. COHN—**Ueber Milchzucker vergärende Sprosspilze.** (The yeast fungi that cause fermentation of milk.)
Zeitschr. Hyg. Infectionskrankh., xlvi. (1904) pp. 286–366.
See also *Ann. Mycol.*, ii. (1904) pp. 380–5.

HENNINGS, P.—**Fungi amazonici iii. a cl Ernesto Ule collecti.**
[A large number of new species of microfungi are included in the list, the new genera are *Perisporina* and *Zukaliopsis* (Perisporiaceæ); *Asteropeltis* and *Phæoscutella* (Microthyriaceæ); *Metadothella* (Pseudophacidiaceæ); *Cicinnobella*, *Diplodiopsis* and *Septodothideopsis* (Sphæropsideæ); *Poropeltis*, *Peltistroma*, *Seynesiopsis* and *Phragmopeltis* (Leptostromataceæ); and *Bactridiopsis* (Tubercularíaceæ.)]
Hedwigia, xliii. (1904) pp. 351–400
(1 pl. and 46 figs.).

" " **Cudoniella Milbrædii sp. n.** (An Ascomycete described at length; it has a smooth stalk and a reddish-brown convex head.)
Tom. cit., pp. 430–1 (3 figs.).

" " **Einige von Herrn G. Feurich, Göda, im Konigreich Sachsen gesammelte Sphæropsidaceen.** (Description of six new species parasitic on herbaceous plants.) *Tom. cit.*, pp. 432–3.

HINSBERG & ROOS—**Ueber einige Bestandteile der Hefe.**
[The authors found among other constituents of the yeast-cell a chloresterin and an ethereal oil: The latter had the odour of hyacinth.]
Zeitschr. Physiolog. Chem., xxxviii. (1903) p. 1 ff. See also
Centralbl. Bakt., xii. (1904) pp. 478–9.

HOLLOS, LADISLAUS—**Neue Gasteromyceten-Arten aus Ungarn.**
[Diagnoses and descriptions of eight new species of *Geaster*, *Calvatia*, *Lycoperdon* and *Bovista.*) *Math. Naturwiss. Ber. Ungarn*, xix. (1904) pp. 82–8.

KUSENO, S.—**Notes on Japanese Fungi.**
[An account of Uredineæ found on *Sophora japonica.*]
Bot. Mag. Tokyo, xviii. (1904) pp. 1–6. See also
Ann. Mycol., ii. (1904) p. 371.

LESAGE, PIERRE—**Contribution à l'etude des mycoses dans les voies respiratoires. Rôle du régime hygrométrique dans le genèse de ces mycoses.** (Study of the development of fungi in the tracheæ of birds and in respiratory canal of man.)
Arch. Parasit., viii. (1904) pp. 353–443 (14 figs.). See also
Bot. Centralbl., xcvi. (1904) pp. 301–2.

MCALPINE, D.—**Australian Fungi, new or unrecorded. Decades vii.–viii.**
[There is one new genus, *Amphichæta*, and seventeen new species.]
Proc. Linn. Soc. N.S. Wales, xxix. (1904) pp. 117–27.

PAX, F.—**Cordiceps sphecophila von Gorkan am Zobten.**
[A record of the *Isaria* form of this fungus rare in Silesia found on a wasp.]
Jahres. Ber. Schles. Ges., lxxx. (1904) Abt. ii. p. 10.

PANTANELLI, ENRICO—**Su le regolazioni del Turgore nelle cellule delle volgari muffe.** (On the regulation of turgescence in the cells of the common moulds, *Aspergillus niger*, and others.) *Nuovo Giorn. Bot. Ital.*, xi. (1904) pp. 333–55.

REHM, H.—**Ascomycetes Americæ borealis.**
[Notes on twelve species of Ascomycetes. Three of these are new species.]
Ann. Mycol., ii. (1904) pp. 351–4.

SACCARDO, P. A., & G. B. TRAVERSO—**Micromiceti Italiani nuovi o interessanti.**
[A list of new or interesting species parasitic on leaves or branches.]
Bull. Soc. Bot. Ital., v. (1904) pp. 207–21 (9 figs.).

SACCARDO, P. A.—**Le relique dell' Erbario micologico di P. A. Micheli.**
[A list of the fungi of Micheli's herbarium.]
Bull. Soc. Bot. Ital., v. (1904) pp. 221–32.

SAITO, K.—**Tieghemella japonica sp. n.**
[Morphological account of a new mucor obtained from the floating spores in a brewing cellar.]
Journ. Coll. Sci. Imp. Univ. Tokyo, xix. (1904) 8 pp. (1 pl.).

SHEAR, C. L.—**The black Fungi.**
[Popular account of some Pyrenomycetes in America.]
Plant World, vii. (1904) pp. 172–4.

SPAULDING, PERLEY—**Two fungi growing in holes made by wood-boring insects.**
[The fungi were *Flammula sapineus* and *Claudopus nidulans*. They grew on logs of Pine.] *Report Miss. Bot. Garden*, xv. (1904) pp. 73–7. See also *Bot. Centralbl.*, xcvi. (1904) pp. 119–20.

STARBÄCK, KARL—**Ascomyceten der ersten Regnellschen Expedition, iii.**
[The list of Discomycetes and Pyrenomycetes includes several new species.]
Arkiv für Botanik, ii. No. 5, 20 pp. (2 pls.).

YOUNG, A., & W. J. YOUNG—**Gärversuche mit Presssaft aus obergäriger Hefe.**
[Research on fermentation processes.]
Ber. Deutsch. Chem. Ges., xxxvii. (1904) p. 1052. See also *Ann. Mycol.*, ii. (1904) p. 36.

Lichens.

ALVTHIN, NILS—**Bidrag tell kännedom om Skänes lafflora.**
[A list of Lichens from Scandinavia.]
Arkiv fur Botanik, ii. No. 6 (1904) 30 pp.

BRITZELMAYR, M.—**Uber Cladonien-Abbildungen.**
[An account of the published drawings, photographs, etc., of the different species of *Cladonia*.] *Hedwigia*, xliii. (1904) pp. 401–13.

STEINER, J.—**Flechten, auf Madeira und den Kanaren gesammelt von J. Bornmüller in den Jahren 1900 und 1901.**
[A list of species with their habitats, with descriptions of *Pyrenopsis Palmana* and *Usnea submollis*, sp. n.]
Oesterr. Bot. Zeitschr., liv. (1904) pp. 333–6.

Mycetozoa.

Nuclear Changes in the Plasmodium of Myxomycetes.*—J. Proweizek finds in the plasmodium of *Physarum* a nucleus rich in chromatin with a dark-staining body. At certain stages this body moves to the periphery of the nucleus, and passes out into the surrounding protoplasm, leaving a clear, somewhat empty nucleus behind. He discusses the nature of these inner dark bodies, and compares the structure of this nucleus with that of other organisms. He gives an account of nuclear fusion in the plasmodium. Such fusion may or may not have a sexual signification, but he thinks that sexual fusion does take place, as in *Plasmodiophora*, before spore-formation.

Schizophyta.

Schizomycetes.

Etiology of Rat-Plague and other Infectious Rat Diseases.†—E. Klein, in a report on this subject, suggests that there are at least two definite types of *B. pestis*—viz. (1) a virulent type, bred in the human

* Oesterr. Bot. Zeitschr., liv. (1904) pp. 278–81.
† Rep. Med. Off. Local Government Board, 1902–3, pp. 399–420.

subject, which on gelatin exhibits raised colonies with filmy irregular margins, and the bacilli of which are cylindrical in shape when taken from recent cultures; and (2) a less virulent type, bred in the rat, exhibiting rounded translucent colonies on gelatin, with coccus-like forms on culture. He regards the rat-bacillus of Edington as belonging to the latter type. With regard to the supposed flea agency in the spread of plague among rats, the author, from the results of experiment, negatives it. He emphasises the prevalence of wounds, abrasions, ulcers, etc., in the majority of sewer rats, making ready inoculation possible. From the fact that the bloodvessels and uriniferous tubules of the kidney in a plague-infected rat contain *B. pestis*, he considers the urine as a possible source of infection. He has found the sanguineous mucus of the intestine very virulent, and also, in the sub-acute form, the oral and pharyngeal mucus. Feeding with infected material gave negative results. The author discusses four rat-diseases other than plague: (1) that described by Danysz, caused by a microbe shown to be a variety of *B. coli*; (2) one caused by a microbe related partly to *B. coli* and partly to *B. lactis cerogenes*, and named by him *Bact. Bristolense*; (3) Pseudotuberculosis; and (4) a disease caused by a micro-organism apparently morphologically identical with Klebs-Löffler's *B. diphtheriæ*, which is uninfluenced by diphtheria anti-toxin.

Nitrifying Organisms in Sewage Filters.*—Schultz-Schultzenstein has carried out a research with the object of isolating and studying the nitrifying bacteria in sewage filters, and comparing them with the nitrifying organisms present in the soil of cultivated fields. His conclusions are as follows: (1) on the coke of biological filters Winogradsky's nitrifying organisms are present; (2) for their isolation the silica jelly media of Winogradsky is strongly recommended; (3) the micro-organisms isolated by Winogradsky are introduced into the filters by the sewage itself; (4) no nitrifying organisms other than those discovered by Winogradsky were found upon the coke of biological filters; (5) sterilised sewage containing ammonium salts may be kept indefinitely without losing ammonia. If such sewage be inoculated with the nitrite- and the nitrate-formers, the ammonia is soon oxidised; (6) unsterilised sewage kept without inoculation loses its ammonia in time. Nitrites and nitrates make their appearance, and these disappear after some time (denitrification); (7) the optimum temperature for the nitrifying organism lies between 28° C. and 30° C.; (8) slight amounts of organic acids up to 0·1 p.c. interfere but little with the growth of the nitrifying organisms; they retard their nitrifying activity only. Commercial chloride of lime and phenol up to 0·1 p.c. act similarly; (9) 0·5 p.c. solutions of organic acids, of phenol, chloride of lime and inorganic acids, completely prevent growth and nitrification; (10) free ammonia entirely prevents the growth and activity of the nitrifying organisms.

Role of Streptococci in the Course of Scarlatina.†—Besredka and Dopter have endeavoured to demonstrate specificity as regards the streptococci commonly found in the throat and heart's blood of cases of

* Technology Quarterly, xvii. (1904) pp. 186–203.
† Ann. Inst. Pasteur, xviii. (1904) pp. 373–7.

scarlatina. Having previously failed to obtain a specific agglutinating reaction, they attempted to demonstrate a *sensibilisatrice* for the streptococci. Serum obtained from scarlatina patients was heated to 56° C. 20 drops of this were then mixed with 4–7 drops of serum of the guinea-pig, which supplied the necessary alexine. 10–20 drops of a culture of the streptococcus were added, and after five hours sensitised red blood corpuscles (*globules sensibilisés*) of the rabbit. The reaction showed itself very soon. The results of the experiments were that in none of the sera employed did there appear to be a *sensibilisatrice* either for streptococci isolated from the heart's blood in fatal cases, or for their proper streptococci isolated from the throat. The authors are of opinion that the streptococcus met with in scarlatina is not specific to this disease.

Antistreptococcic Serum and its Mode of Action.*—Besredka has prepared antistreptococcic serum by sowing and preserving different varieties of streptococci in a mixture of horse serum, heated for half an hour at 56° C., and bouillon (Martin) in equal parts. From these cultures are made, in Roux's flasks, on agar to which 1–1·5 c.cm. horse serum, heated, has been added one hour before inoculation. Each injection into the horse contains a mixture of cultures of 6–8 streptococci. Of this mixture all varieties save one are from a human source; this one has been caused to acquire a heightened virulence by a series of passages through animals. It is inferred that this virulent streptococcus may serve as an indicator of the state of immunity of the horse against the totality of the streptococci. Serum obtained from a horse so treated is preventive. It, unlike Aronson's serum, contains *fixateur*. A serum is then able to be active without containing *fixateur*, and is able to contain *fixateur* without on that account being active. The action of the serum is apparently to stimulate the leucocytes.

Fatal Infection by a Hitherto Undescribed Chromogenic Bacterium: Bacillus aureus fœtidus.†—Under this name M. Herzog describes a micro-organism obtained from the body of a Filippino who had died rather suddenly. It is a non-sporing, non-motile, encapsulated short rod. It tends to polar staining, and is negative to Gram. On solid media it produces golden yellow pigment. It liquefies gelatin. It develops under either aerobic or anaerobic conditions, and the cultures have a very fœtid, cheesy and somewhat cadaverous smell. In animal experiments it was not found to be very highly pathogenic. The author concludes that *Bacillus aureus fœtidus* is ordinarily a saprophyte.

Role of Microbes in Alcoholic Fermentation which Stoklasa attributes to the Zymase isolated from Vegetable or Animal Tissues.‡—From experiments on this subject, P. Mazé and A. Perrier conclude that the results obtained by Stoklasa are accurate, if one only considers the nature of the fermentations which appear in solutions of glucose to which vegetable or animal extracts have been added; but the origin of the diastases so acting is quite other than that which they indicate, being bacterial.

* Ann. Inst. Pasteur, xvii. (1904) pp. 363–72.
† Rep. Bureau Gov. Lab., Manila, 1904.
‡ Ann. Inst. Pasteur, xviii. (1904) pp. 382–4.

Loss of Colour in Red Wines.*—R. Greig Smith considers the los of colour stage of *vin tourné* to be due to the action of an acetic organism which does its work by means of oxidase. From two samples of decolorised red wines he isolated a bacterium, apparently a race of *Bact. ascendens* Henneberg. It forms a delicate film, which creeps high up the sides of the culture flasks; it is easily broken, and falls to the bottom of the wine as a flocculent precipitate. The cells are not stained by iodine; they are non-motile, and are not arranged in threads, but occur singly, in pairs, and in masses. When contained in wine it is killed by an exposure to 43° C. for ten minutes.

Bacerium teutlium, sp. n.†—H. Metcalf describes the parasite which causes the rot of sugar beets. It is a rodlet without flagella or capsule; does not form spores or pigment; occurs singly, in pairs, and in chains; is readily stained, and is positive to Gram; does not liquefy gelatin; is a potential anaerobe; does not form gas; produces acid in all media; inverts cane-sugar; and is not sensitive to acid or alkalis. It grows freely on sugar beet, but less copiously or not at all on other media.

Influence of Shaking on the Development of Cultures.‡—B. Galli-Valerio finds that shaking is rather more favourable than unfavourable to the development of cultures of bacteria and yeasts. Also the production of spores and of pigment is unaffected. The morphological aspect is only slightly modified, and then only in the case of the longer forms, which seem a little more bent; micrococci, sarcinæ, and saccharomycetes not being altered in shape or in arrangement.

WRIGHT, A. E., & S. R. DOUGLAS—**Action exerted upon the Staphylococcus pyogenes by human blood fluids, and on the elaboration of protective elements in the human organism in response to inoculations of a staphylococcus vaccine.** *Proc. Roy. Soc.*, lxxiv. (1904) pp. 147–59.

" " " **Action exerted upon the tubercle bacillus by human blood fluids, and on the elaboration of protective elements in the human organism in response to inoculations of a tubercle vaccine.** *Tom. cit*, pp. 159–80.

TCHITCHKINE, A.—**De l'influence de l'ingestion des bactéries et des produits bactériens sur les propriétés du sérum sanguin.** (Influence of the ingestion of bacteria and of bacterial products on the properties of blood serum.) *Ann. Inst. Pasteur*, xviii. (1904) pp. 576–86.

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* Proc. Linn. Soc. N.S.W., xxix. (1904) pp. 213–6.
† Centralbl. Bakt. 2te Abt., xiii. (1904) pp. 28–30.
‡ Op. cit., 1te Abt. Orig., xxxvii. (1904) pp. 151–3.

MICROSCOPY.

A. Instruments, Accessories, &c.*

(1) Stands.

Exhibition Microscope.†—B. J. Howard, of the Bureau of Chemistry, U.S.A. Department of Agriculture, gives a description of the Microscope used in connection with the exhibit at the St. Louis Exposition.

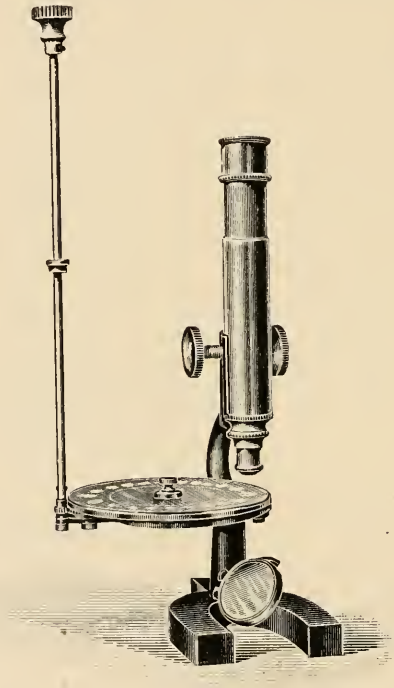


Fig. 102.

The chief feature is a specially devised stage which carries three cog-wheels so arranged that for each half revolution of the small pinion the large one is driven forward $\frac{1}{20}$ revolution. The large wheel carries a circular plate-glass disk of 5 in. diameter, attached to it by means

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

† Journ. App. Micr., vi. (1903) p. 2727 (1 fig.).

of a thumb-screw passing through a hole in the centre of the disk. The specimens are carefully mounted, so that their centres are at an equal distance from the centre of the disk, and are covered with ½-in. slips. In this way each disk will carry twenty specimens. On the shaft carrying the hard rubber button by which the small pinion is turned is an intermittent gear arrangement which drives a dial with figures or names on it, indicating the specimens as they come under the objective. The whole instrument (fig. 102), with the exception of the ocular and the hard rubber button, is inclosed in a glass case, the focussing being accomplished by raising or lowering the ocular ; a set-screw preventing its being removed from the draw-tube.

Société Genevoise Second Large Model Microscope.* — This instrument (fig. 103) is of similar but lighter construction to the Microscope previously described and figured in this Journal.†

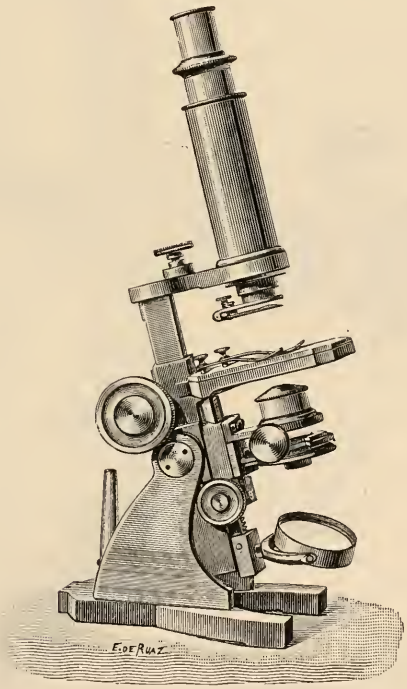


Fig. 103.

Culmann's Monocular Image-Erecting Prism-Microscope.‡—This instrument (fig. 104), constructed by the Zeiss firm, has been designed

* Cat. Soc. Genevoise pour la Construction d'Instr. de physique et de mécanique, 1900, p. 99. † See this Journal, 1884, pp. 281–2, figs. 30 and 31.
‡ Zeitschr. wiss. Mikr., xx. (June 1904) pp. 416–20 (1 fig.).

by P. Culmann to serve the combined purposes of a preparation, an observation, and a drawing Microscope. The stand is fitted with Zeiss'

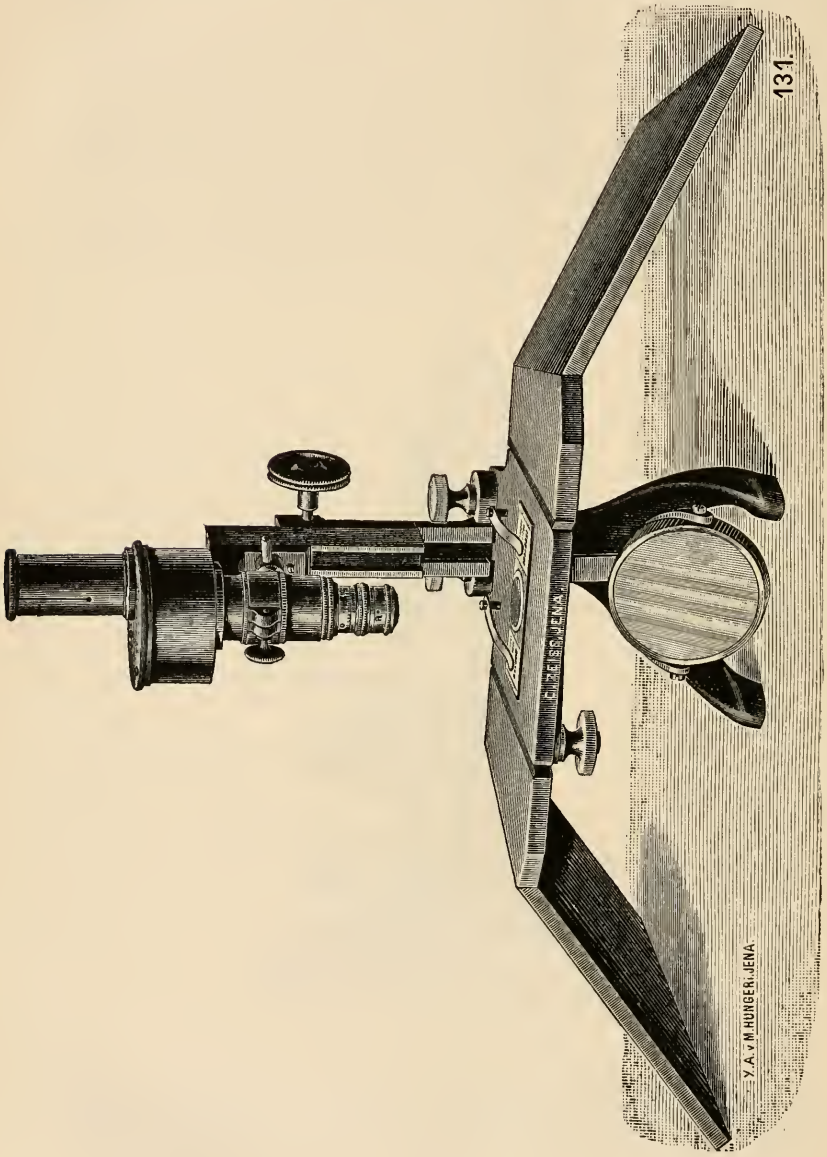


Fig. 104.

objective *a** with changeable magnifying power, and the object is placed at about 10 cm. distance. The stage opening and mirror are

of correspondingly large dimensions. The underside of the stand resembles Zeiss' binocular preparation Microscope. The mirror is plane one side, concave the other, 7 cm. diameter, and has universal movement. Over it there extends a frame: this can be placed upon a sheet of white paper for affording diffused illumination. By means of the frame black paper diaphragms can be fastened over the mirror, if required, for stopping down the light-cone. The 10 by 10 cm. stage has an aperture of 4 cm., which can be reduced to 2 cm. by a diaphragm. Under the stage is a rotatory disk half-black, half-white, so that, if one is working with reflected light, a black or a white background can be had, as desired. The rotation axis of the disk which, in the binocular stand is placed on the right, is here placed on the left, so as to leave the right side quite clear for the drawing-paper. The entire upper part of the stand is fastened by two screws to the lower part. The bent arm bearing the optical system can be moved vertically up and down in two different ways: first, in the ordinary way by rack-and-pinion; secondly, by push-movement in a swallow-tailed groove. A screw provided with a short lever clamps the arm in the groove. The second movement is intended to lengthen the rack-range and to increase the object distance beyond 10 cm. The reversal system is in a drum with two tube-unions; the upper one bears an ordinary Microscope ocular; the lower has the English objective thread and can take either a revolver or a single objective. The construction is so arranged that the tube-length without the revolver is 145 mm.; with it, 160 mm., so that even medium-power objectives can be used with the stand. An extension ring of 15 mm. length allows of stronger systems to be used even without the revolver. The author gives full details of objectives and oculars.

Ortner's Pocket-Loup.*—This instrument (fig. 105) is fitted with two lenses; one, an aplanatic, has a magnification of twenty; the

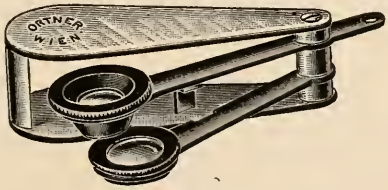


Fig. 105.

other, an achromatic, has a magnification of ten, the combination giving a magnification of 30 diameters. By pressing the projection or handle to the right the aplanat only comes out, while by pressing it to the left both loups are simultaneously extruded from the mount, and by a special contrivance are accurately centred.

Ortner's Loup-Stand.†—This loup-stand or lens-holder (fig. 106) which is chiefly intended for the use of entomologists, consists of a firm

* Ortner's Katalog No. 7 (Entomologie), 1904, p. 42.
† Tom. cit., p. 44.

pillar, supported on a circular base, and of two arms. One arm carries the lens, the other the object-holder. Both arms are fitted with a ball-and-socket joint. The lens arm has also vertical and horizontal move-

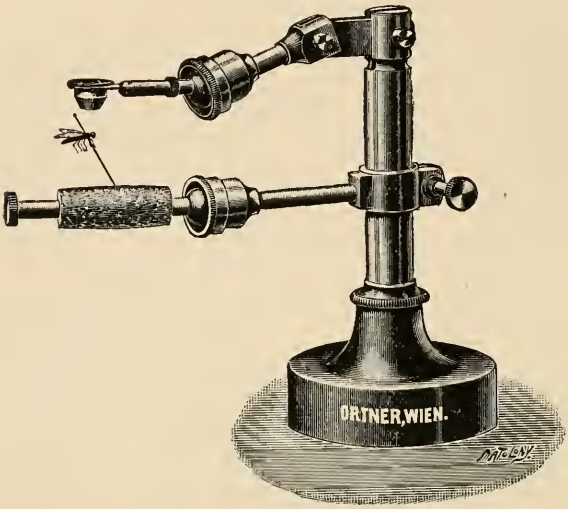


Fig. 106.

ments. This object-holder can be raised or lowered along the pillar, and its outer end is covered with cork ; this part of the apparatus can be rotated and also pushed to and fro. The apparatus can be supplied with lenses having magnifications of from 10 to 35 diameters.

(3) Illuminating and other Apparatus.

Artificial Light for the Microscope.* — C. J. Chamberlain states that excellent illumination is obtainable by means of a hollow sphere filled with liquid. The globe should be made of the finest flint glass, have a diameter of 6 in., and be mounted in a black frame. The liquid content mostly used is a weak solution of ammonia copper sulphate, made by adding 50 c.cm. of ammonia to 25 c.cm. of 10 p.c. solution of copper sulphate, and then adding enough distilled water to fill the globe. If the solution be milky more ammonia must be added.

The best source of light is an incandescent gas burner, so placed that the rays will be focussed on the mirror of the Microscope. With less powerful lamps a reflector is required.

Apparatus for Examination of Ultra-Microscopical Particles.†—(1) *In Solutions.*—The firm of Carl Zeiss have prepared the apparatus

* Journ. App. Micr., vi. (1903) pp. 2663–5 (2 figs.).

† Catalogue, Beschreibung der Einrichtungen zur Sichtbarmachung ultramikroskopischer Teilung, 1904

required for the investigations of Siedentopf and Zsigmondy on ultra-microscopical particles. Some of the results of these inquiries, more especially in regard to gold ruby glass and bacteria, were described by H. Siedentopf in a paper read before the Society.* It will be found, on reference to the paper, that the principle of the experiment consists (pp. 575, 576) "in illuminating only those particles which are to be made visible, by focussing an arc light upon a small spectroscopic slit; the light from this slit being focussed by a condenser upon those particles which are to be made visible. The size of the slit can be precisely controlled, and, with a knowledge of its width and of the condensing system employed, the exact thickness of the layer of illuminated particles can be regulated to a nicety."

The axis of the Microscope must be at right angles to the plane of

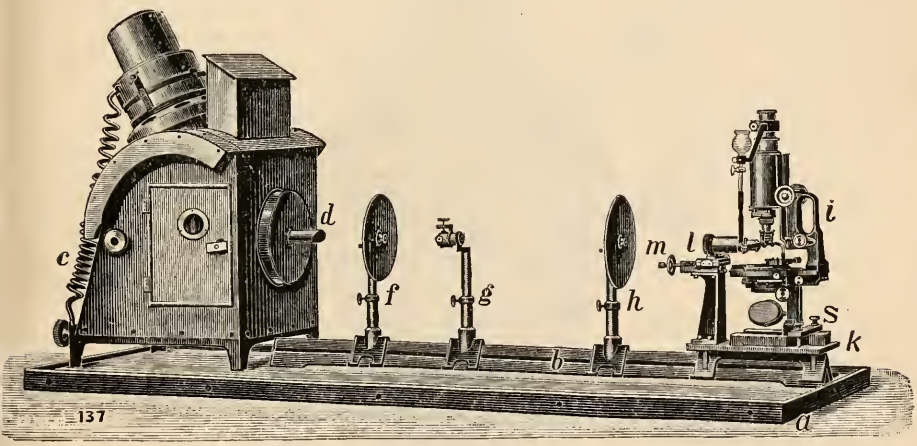


Fig. 107.

the beam, and the general arrangement of the apparatus is shown in fig. 107. On the stand *a*, an optical bench *b*, one metre long, is mounted. The stand is 34 cm. longer than the bench; the free part is unused, in case of sunlight, but serves for an arc lamp in case of artificial light. With sunlight a heliostat is indispensable. The figure shows at *c* a self-regulating arc lamp mounted on the stand. The lamp is so arranged that the axis of the narrow light beam emerging through the previously erected diaphragm *d* is parallel to the optical bench. A small projection objective *f* of 80 mm. focus, mounted on a rider, is arranged about 41 cm. from the beginning of the bench. The objective is surrounded by a circular diaphragm disk of 15 cm. diameter to keep off side light, and is chromatically and spherically corrected.

The next piece of apparatus *g* is a precision slit-head, and is also on a rider. It is moved along the optical bench until the projection objec-

* Journal R.M.S., 1903, pp. 573–8.

tive *f* throws on the slit a real image of the light source. With sunlight the distance of the slit from the objective is about 80 mm., and the sun's image is then 1 mm. in diameter. The slit-head is shown separately in fig. 108. The drum *c*, graduated on rim into 50 divisions, must always be on top: the entrance-slit is then horizontal. One complete rotation of the drum opens the slit about $\frac{1}{2}$ mm., so that the rotation of one division of the drum produces an aperture of $\frac{1}{100}$ mm. For the examination of fluids the most favourable slit-breadth is from 0·1 to 0·4 mm. The figure also shows the two slit-cheeks, one of which is secured by springs and is operated by the screw *a*. These cheeks limit the slit-length, which, with sunlight, should be about

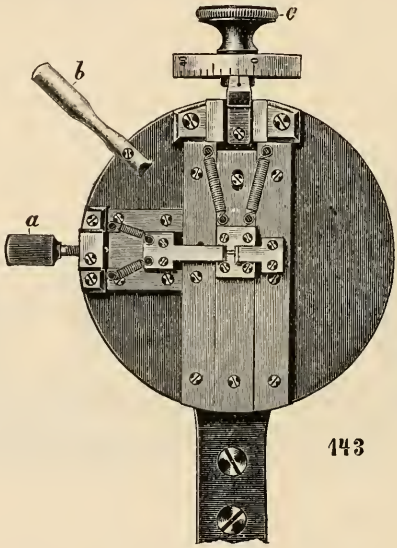


Fig. 108.

1 mm. The whole head can be rotated through 90° by the lever *b*. The effect is to make the slit vertical, which is of importance for gauging purposes. The slit answers a two-fold purpose: firstly, a measurable, illuminated volume is delimited in the preparation; secondly, the depth of this volume must be made as suitable as possible to the penetrating power of the Microscope objective used (in this case, the water-immersion D✱).

Details of the gauging process are given below. At *h* (fig. 107) there is a second projection objective of 55 mm. focus at a distance of about 14 cm. from the slit. Like the first objective, it is mounted on a rider with its front side directed towards the Microscope. It casts a real, about $1\frac{1}{2}$ fold reduced, image of the slit at a distance of 90 mm. from the lens. The function of this second lens is to bring the image

of the slit into the image plane of the Microscope objective A A. Quite at the end of the bench there is a Microscope stand *i*, with the base-plate *k* and cross-carrier *l*. The base-plate is clamped by the screw *s*, and the cross-carrier by two screws *m* (only one of which is visible in

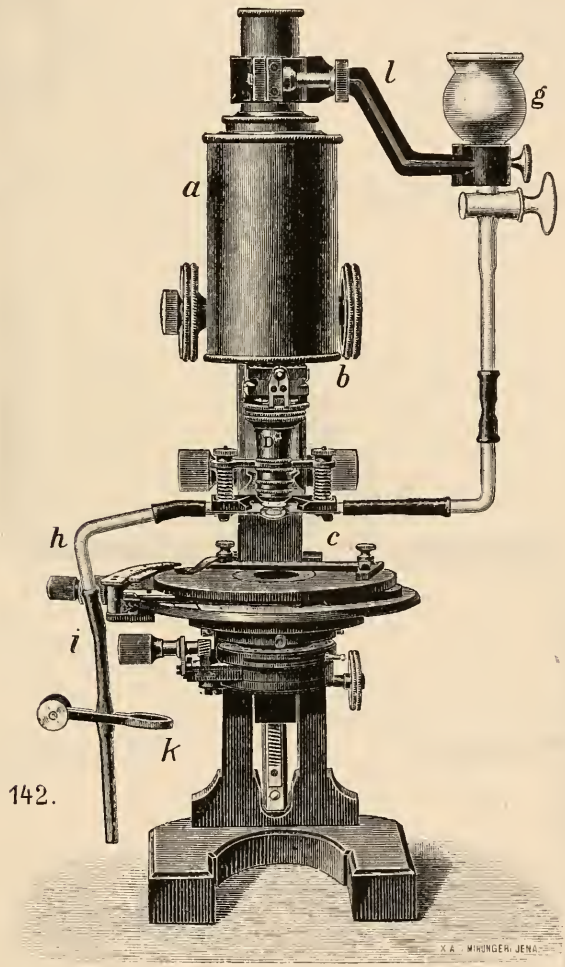


Fig. 109.

the figure), which move it micrometrically in two directions at right angles. The Microscope objective A A for the illumination is fastened to the carrier by a sleeve and moves with it, and thus the beam of light can be centred for the observation Microscope objective D*. When in

adjustment, the front lens of A A must be about 1 mm. from the mount of D*. On the tube *a* (fig. 109) of the Microscope stand the

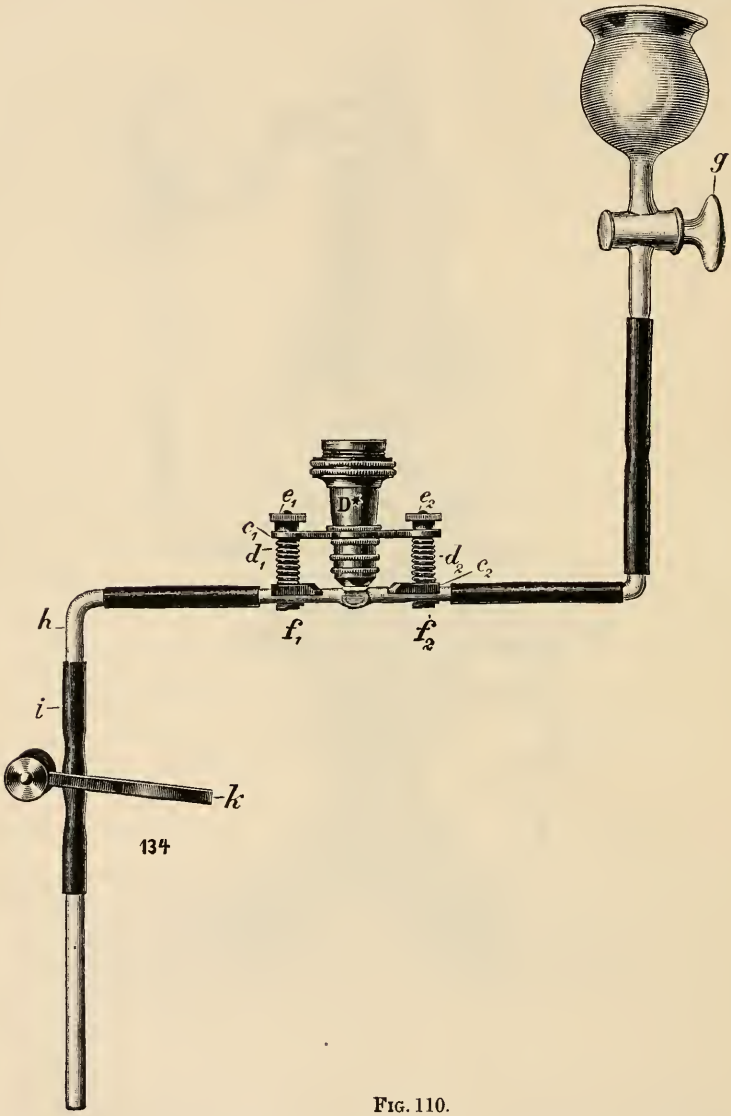


FIG. 110.

objective D* is fastened with a sliding objective change-piece. On this objective a special holder secures the cuvette used for observation.

The holder consists of an upper band c_1 (fig. 110), set round the objective mount, and a lower band c_2 encircling the back half only of the front lens mount; both these bands are held together by the springs d_1, d_2. The lower band can be moved upwards by means of the screws e_1, e_2. The cuvette is placed in two sections on the underside of the band c_2, and is then held fast by two springs secured by screws. The cuvette is again shown in fig. 111, and its two quartz windows must be so arranged, that one faces the light source and the other is parallel to the front lens of the objective. The screws e are

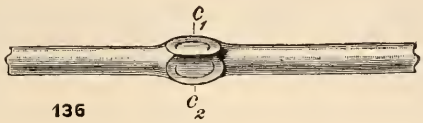


Fig. 111.

turned so as to bring cuvette and band to a position such that the quartz window is about 0·2 mm. from the front lens. The water-immersion is filled by injection, and the superfluous water carefully removed from the quartz window facing the light source. Quartz is recommended on account of its resistance to fluids, and as being in its molten state free from double refraction, and giving a sharp image of the slit. The ends of the cuvette are connected by indiarubber couplings with the thistle funnel g and the delivery tube h (fig. 109), the

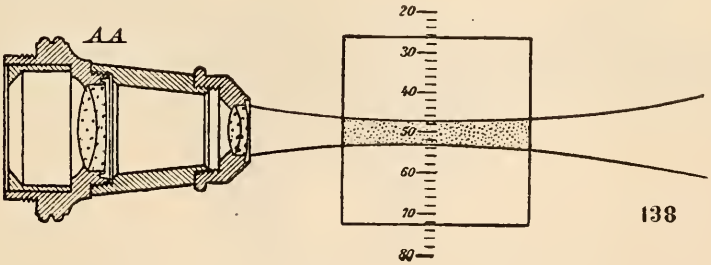


Fig. 112.

delivery tube being closed by a pinchcock k, and led away by a second coupling i to a final delivery tube. The pinchcock is only opened when it is desired to empty out the liquid in the funnel and cuvette. The attachment of the funnel by its holder l is made after the insertion of the objective.

The illuminated fluid is now gauged, so that its breadth is read off with an ocular micrometer as shown in fig. 112. The precision slit-head is next rotated 90° into its position, and the proper slit-breadth, corresponding to the depth of the observation, is then projected in the

microscopic image from left to right. The reading on the ocular micrometer now gives the depth. The slit-cheeks are brought as closely together as is suitable for the purpose.

It remains now to delimit forwards and backwards a portion of the light cone ; and this is done by rotation of the ocular micrometer into the position shown in fig. 113. The gauging can also be done by

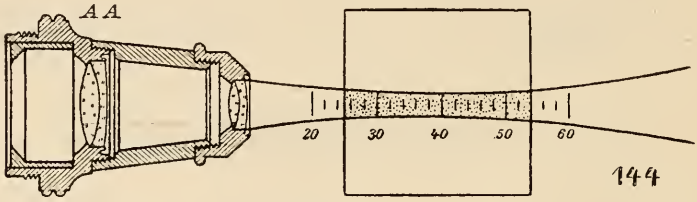


Fig. 113.

placing in the ocular quadratic fields, whose dimensions are known. Fig. 114 shows the network in Huyghens' ocular 4, which contains eighteen squares. The side-length of such a square has, in the combination of water immersion D✱ with a tube-length of 160 mm., a value of about 9 μ shown on the object. This arrangement suffices for approximate measurements ; but for accurate determinations the ob-

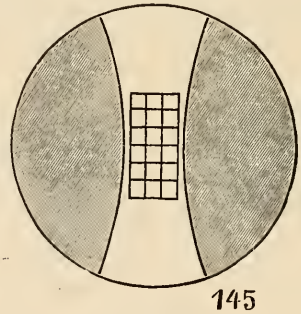


Fig. 114.

server must ascertain its value for his objective and ocular by comparison with an object micrometer.

Finally, for the observation of polarisation effects, an analyser is set up on the ocular. The particles show themselves the more polarised in proportion as they are more minute, according to the plane which passes through the axis of the illuminating and refracted beams. The analyser also serves for distinguishing the non-polarised fluorescent light from the refracted light.

(2) *For Ultra-microscopical Bacteria between Object-carrier and Cover-glass.*—The principle involved was described by Siedentopf in the above-mentioned paper,* as follows: "In the arrangement for this purpose the axis of the illuminating cone of light, and that of the rays diffracted by the object, are in a straight line, and not at right angles to each other, as in the other methods. Preparations of bacteria can therefore be mounted in the usual way." The general arrangement of apparatus is shown in fig. 115; and, on comparing it with fig. 107, it will be noticed that the base-plate, the optical bench, the heliostat (or arc lamp), and the projection objective have been retained. The objective of the Microscope is illuminated by the rear focus of its Abbe condenser, which itself receives the direct beam from the arc lamp through the diaphragm *d*. The observation Microscope is arranged at the end of the optical bench, and is secured on the stand *k* by means

140.

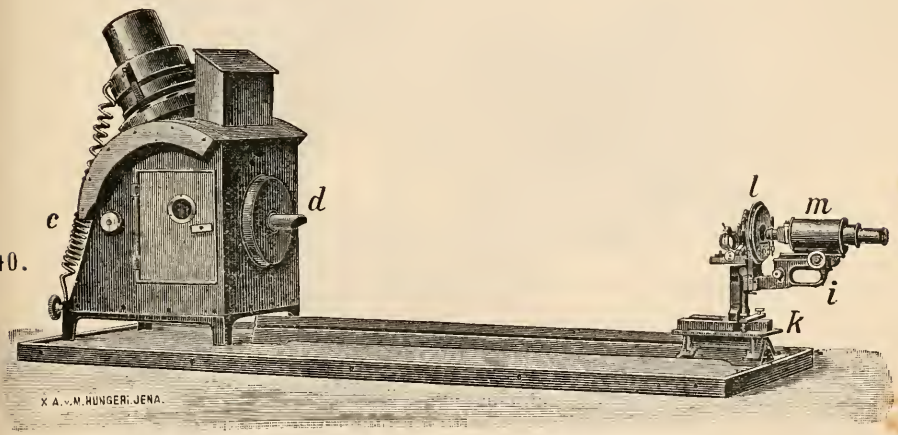


Fig. 115.

of clamps. It is set horizontally, so that its axis is parallel to that of the light cone: the object-stage is therefore vertical.

The illuminating apparatus consists of an exchange condenser (fig. 116) which permits of an easy alteration from ordinary illumination to dark-ground illumination. It includes the push-tube *a*, the three-lens condenser *b*, the special objective for dark-field illumination *c*, and the centring apparatus *d*. The tube *a* slides directly into the sliding collar of the illuminating apparatus, and, when fully pushed in, it engages with the clamp *h* of the condenser *b*. The iris diaphragm with ground-glass disk is then inserted from the side, and the illumination now takes place in the ordinary manner (fig. 117). The handle *m* serves for lateral movement of the iris. The objective used is the

* Journal R.M.S., 1903, pp. 577–8.

apochromat 2 mm. N.A. 1·30, with intense dark-field stop. This dark-field stop is after Prof. Abbe's suggestion, and has the front lens of the objective in its central part as far as aperture 0·33 mm. accurately cut away, and the corresponding plane face blackened. The only rays which enter the objective are those between apertures 0·3 and 1·3.

Among the advantages of the arrangement are: Firstly, absence of reflexions between the lenses; secondly, the tedious centring for dark-ground illumination is obviated; thirdly, a stop made like this cannot be decentred; and lastly, the objective remains available also for observation in the ordinary way without dark-ground illumination. If the illumination should now appear unequal, the inequality is due to

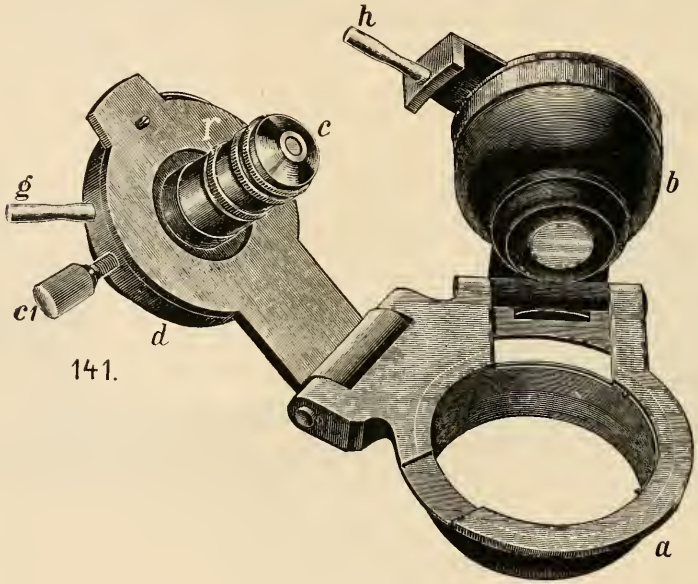


Fig. 116.

the fact that the reduced image of the light source of perhaps 0·1 mm. does not generally lie in the field of view of the observation objective. To correct this, two centring screws, c_1, c_2 (of which only one is visible in figs. 116 and 117), are provided, and must be so adjusted that the image of the light source appears in the preparation. This image is only indirectly visible, as only the particles which are encountered by the beams appear self-luminous through diffraction. The centring succeeds best with a not too high ocular (perhaps compensation ocular No. 4). The illumination can be increased or reduced by rotation of the ring *r*.

In the use of liquid films between object-carrier and cover-glass, care must be taken that the film thickness is neither too great nor too

small. The best is 1 to 3 μ. If the distance is much greater there is much disturbance from the indistinctness of the extra-focal parts of the

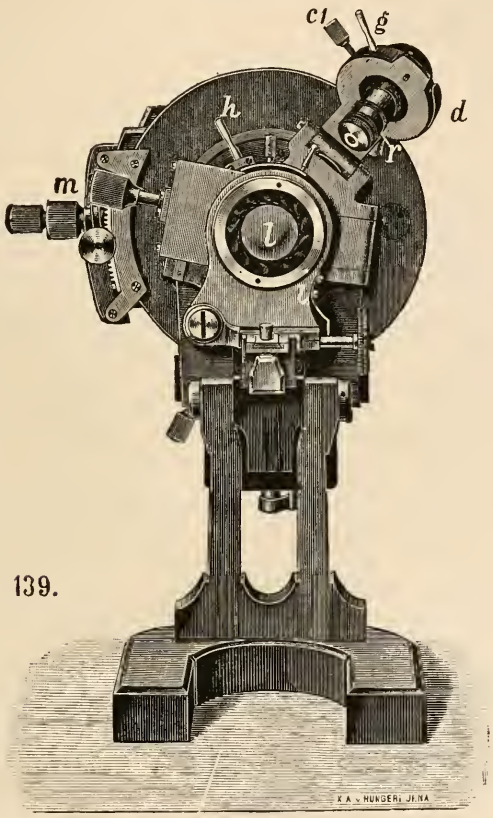


FIG. 117.

image; if the distance is less there is a very disturbing adsorption effect of the glass planes on the ultra-microscopical particles.

SIEDENTOPF, H.—**Ueber die physikalischen Principien der Sichtbarmachung ultramikroskopischer Teilchen.**

[This is substantially the same as Dr. Siedentopf's lecture before the Society, June 17, 1903, and printed in the Journal, October 1903.]

Berliner Klinischer Wochensch., 1904, No. 32; also reprinted as an extract, 7 pp.

(4) Photomicrography.

Grain in Photographic Plates.*—R. J. Wallace gives an account of the circumstances which control the size of the silver particles in a developed gelatino-bromide plate. Generally speaking, these particles

* Astrophysical Journal, Sep. 1904. See Nature, lxx. (1904) p. 571 (1 fig.).

were found to be spherical in ordinary plates, while isochromatic plates of several makes showed the peculiarity of having elongated or spicular grains at the surface of the film. These in passing downwards through the film gradually gave place to rounded particles, until close to the supporting glass these latter were the only ones found. Intensification increased the size of the particles, and these also varied with rapid and slow development. With rapid development the silver particles most nearly approached the size of the original particles of the silver salt from which they were produced. Prolonged development favoured enlargement of the particles by reason of the formation of "group particles" as well as by accretion.

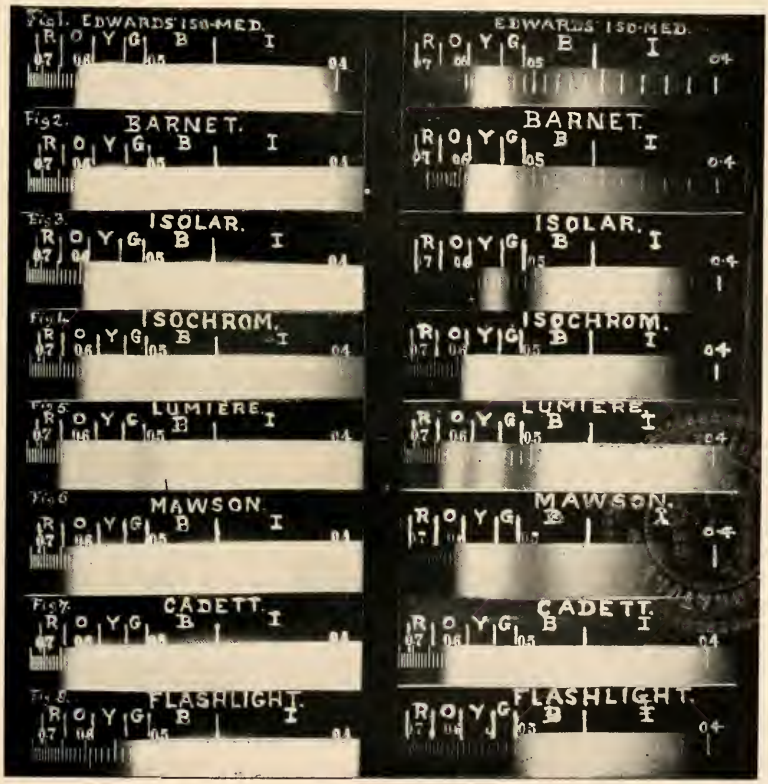
On Suiting Contrast Screens for the Photography of Bacteria.* E. J. Spitta commences his article by reminding his readers, that while the eye is sensible to differences of *colour*, the photographic plate can only perceive *contrast*. If, therefore, the images of two selected coloured objects of equal brightness are thrown upon a plate—provided it is specially prepared to be equally *sensitive* to both colours—their effect upon the emulsion is precisely the same, and their images appear similar within certain limits. But if it is desired to increase the contrast between two colours in photomicrography, one colour must be made less bright than the other. The object of the author's paper is to discover suitable screens for producing this effect. If the spectral colours of red, orange, yellow, green, blue, and violet are thrown upon an ordinary photographic plate (Plate XII.), it is at once seen that the emulsion is not sensitive to the entire range of the spectrum, and that the different colours which affect it do not do so equally with one another. This selective capacity may be called the "eye" of the plate. It is known that isochromatic or orthochromatic plates are those in which the sensitiveness of an ordinary plate has been extended by staining the film with some dye. Plate XII. gives a selection of "eyes" of several isochromatic plates. The wave-lengths in $\mu\mu$ are given the entire length of the spectrum, whilst little linear demarcation-limits are also placed (somewhat empirically chosen) where one colour may be said to merge into its neighbour. Inasmuch as all plates have a cumulative power, so with a long exposure (say 15 to 20 seconds) one part of the spectrum seems as it were to catch up the other parts; hence the final effect appears very similar in many cases, so far as relates to *density*, although differing in distribution *along* the spectrum, one part appearing to be affected more than another. This apparently equal density, as a matter of fact, is more apparent than real, for each emulsion, in reality, is more sensitive to one or two particular wave-lengths of light than to any others. This is the reason for supplying the extra column of exceedingly short exposures on the right hand of Plate XII., which shows at a glance where the chemical action in each case seems to have commenced. It will be observed (Plate XII.) that:

1. In the *Edwards Iso-medium* plate, action begins between wave-lengths 525 and 570, that is in the yellow; whilst with fairly long exposure its sensitiveness reaches to about 607 in the orange and to nearly the extreme end of the violet.

* Photography, xvii. (June 25, 1904) pp. 577–9 (4 plates).

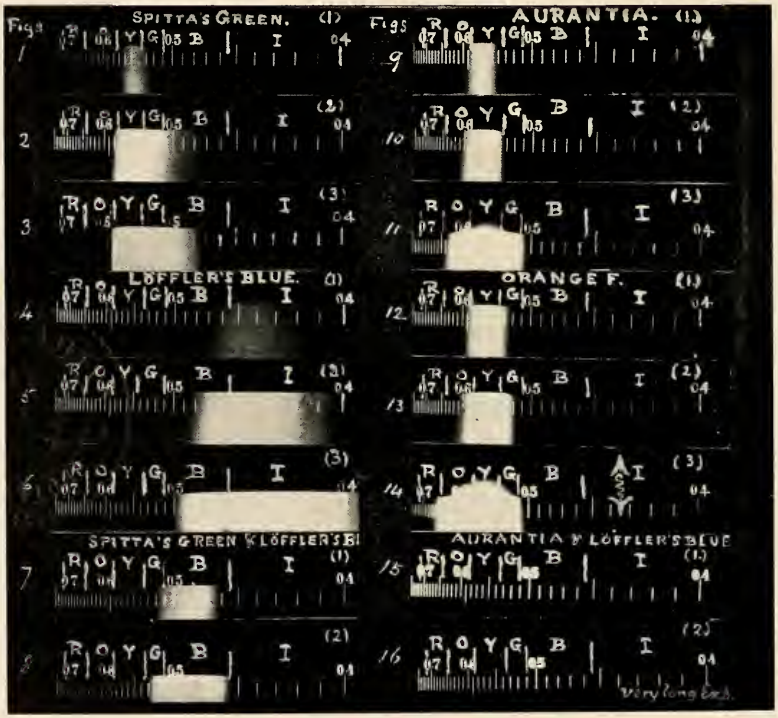
THE "EYE" OF DIFFERENT PLATES.

Long Exposure. *Very short Exposure.*



[*To face p.* 712.

LÖFFLER'S BLUE.



2. In the *Barnet* plate, action begins about the same place and extends somewhat further each way.

3. In the *Isolar*, action begins in the blue and indigo, where it is sharply sensitive, but is feeble in the yellow. With a prolonged exposure its sensitiveness reaches to about 596 in the orange.

4. In the *Isochrom*, a very rapid plate, fairly sensitive in the yellow, blue and indigo with a short exposure, action reaches to nearly 610 in the orange.

5. In the *Lumière Pantachromatic*, action starts away strongly and extensively in the blue and indigo, though faintly in the orange and yellow, and very weakly in the green. With exposure it reaches to nearly 650.

6. The *Mawson* plate is not unlike the Barnet, but it is a trifle quicker and a little more evenly sensitive.

7. In the *Cadett* plate we seem to have the greatest evenness of any isochromatic on the market. Action commences over nearly the entire range of the spectrum at one and the same moment, even with the exposure of half a second. It extends with a long exposure far into the ultra-violet, and to 650 at the red end.

8. The *Flashlight* plate is merely given as an example of the limited sphere of sensitiveness in the ordinary unstained plate. Action commences in the blue and violet nearly evenly, but no amount of reasonable exposure will produce effect much further than about 550.

Suppose that it is desired to photograph a blue-stained bacillus on a white ground. Then in order to increase contrast between the two colours in the photographic image, the brilliancy of one or the other must be weakened so as to affect the emulsion less. This can be done by staining the screen with such a colour that the blue is obliterated, i.e. that it becomes black to the "eye" of the plate—but the plate must be sensitive to the colour itself.

The three leading dyes for which we have to find contrasting screens are: Löffler's blue, gentian violet, and carbolfuchsin. Plate XIII. gives a spectrograph of Löffler's blue; and figs. 4, 5, 6 show the absorption bands peculiar to it, with short, medium, and long exposures. It will be seen that this dye transmits light as far as 500. If we now try and use a green pot-glass screen (much recommended for *general* use by the author, three exposures of which are shown in figs. 1, 2, 3, Plate XIII.), it will be seen that the glass transmits light from 474 to 580 or 590. There is, therefore, an overlap, through which a considerable amount of light passes (figs. 7 and 8). Such a combination of dye and screen is therefore useless.

Amongst the many dyes tried, Aurantia was found to be the best. Its absorption bands are shown in figs. 9, 10, and 11. In the longest exposure (No. 11) only light between 510 and 632 is transmitted, so that if this screen be used with the blue (fig. 15) there is just a margin of safety. Orange F is almost as good, but with a fairly long exposure there is a suspicious leakage at the position of the arrow.

Plate XIV. deals with gentian violet, figs. 1 and 2 showing its two spectrographs. A single thickness of green pot-glass (fig. 4) is not dense enough to cut off all the light; but two thicknesses make it a

safe screen to use (fig. 5). Plate XIV. also shows the spectrograph of carbolfuchsin (fig. 1). This dye passes much more indigo than red (as shown by the Edwards' plate—which was used for all these experiments). Although a fair photograph may be obtained without any screen, it is better to use the green pot-glass, which perfectly cuts off the light (fig. 2).

DOWDY, S. E.—**How to photograph crystals.**
Amateur Photographer, xl. (1904) pp. 93–5 (6 figs.).

HERTZSPRUNG, E.—**Ueber Tiefenschärfe.**
[The article is mainly concerned with the "penetration" attainable in ordinary photography; but the author also deals with the subject as affecting microstereoscopy.]
Zeitschr. f. wiss. Photographie (*Leipzig*), ii. (1904) pp. 232–44; also as an extract in pamphlet form.

JONES, C.—**Developments of three-colour photographic processes.**
Nature, lxx. (1904) pp. 553–5, 578–80.

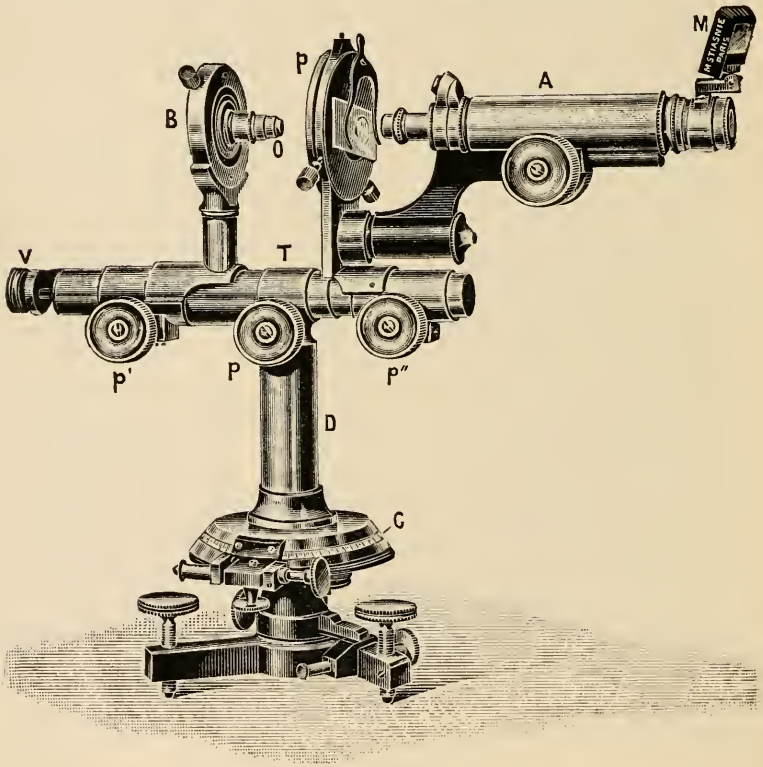


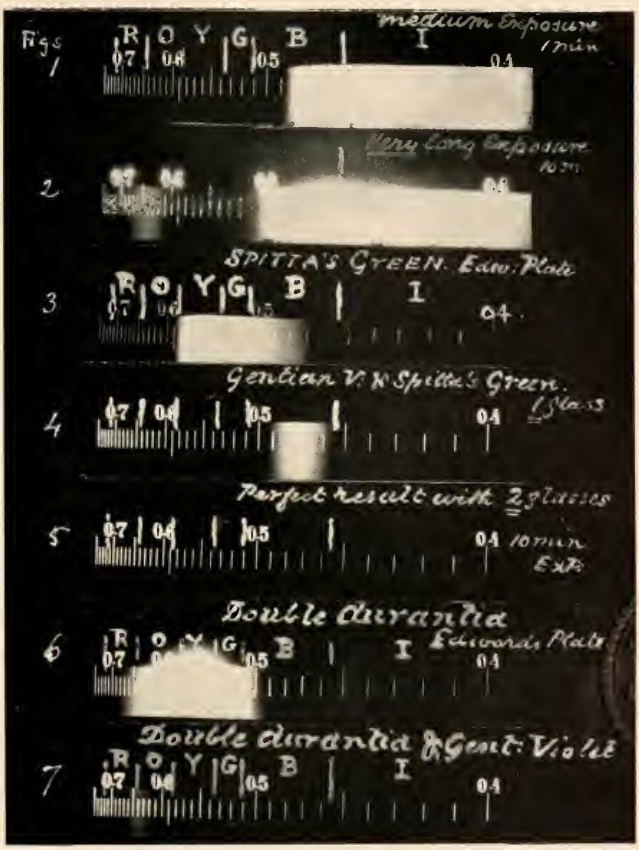
FIG. 118.

(5) Microscopical Optics and Manipulation.

Photogrammetric Focimeter for Microscopical Optics: an Instrument for Verifying Microscopes.*—This instrument (fig. 118), due

* Comptes Rendus, cxxxvii. (Aug. 3, 1903) pp. 314–6 (1 fig.).

GENTIAN VIOLET.



CARBOLFUCHSIN

[To face p. 714.

to the combined efforts of V. Legros and M. Stiassnie, is intended to bring into the regular practice of the workshop and of centres of microscopical instruction, the results which formed the subject of a previous communication * by M. V. Legros. The base C (fig. 118) is a divided circle from whose centre arises a vertical column D, terminated by a horizontal sleeve T. In this sleeve there glides, governed by a rack-and-pinion *p*, a rod on which move also under the action of pinions *p'*, *p''*, two other sleeves bearing the optical parts. These sleeves can ride one over the other, their displacements being measured by verniers. The sleeve manipulated by *p'* has also a slow movement governed by a screw with divided head V. The part A represents the body of an ordinary Microscope with its stage P : a slight displacement can be given by the revolver for purposes of parallax. The stage and substage are fitted with centring and rotating movements. Micrometers are fitted to both faces of P, and the orifice in the substage is provided with interlocking screw-jaws for receiving optical systems. Details are given of the methods for measuring (1) the focal length of an objective or ocular ; (2) the angle of aperture ; (3) distortion.

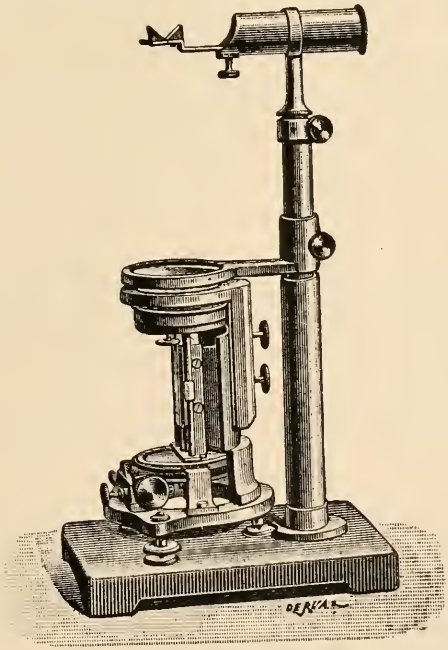


Fig. 119.

Desains' Apparatus.†—This instrument (fig. 119) is intended for measuring wave-lengths by Newton's rings.

* Comptes Rendus, cxxxvii., Jan. 29, 1900.

† Cat. Soc. Genevoise pour la Construction d'Instruments de Physique et de Mécanique, 1900, p. 111.

Chromatic Correction of Object-Glasses.* — A. E. Conrady, after drawing attention to the utter uselessness of Cauchy's dispersion formula, gives as an alternative

$$n_\lambda = n_0 + v_1 \lambda^{-1} + v_2 \lambda^{-\frac{7}{2}}$$

Next, he explains the method of trigonometrically tracing a ray through a spherical surface, and then shows that if d be the thickness of a lens at the axis, and D its thickness where traversed by an extra axial ray, and if δn be a small increment of the refractive index n, the equation for an achromatic condition will be

$$\Sigma\, \delta n\, (d - \mathrm{D}) = 0.$$

Finally, he points out that when a ray is near the axis the angles become so small that in the computation sufficient accuracy is obtained by writing $\frac{1}{2}$ (circular measure)^2 instead of the versed sine of the angles.

(6) Miscellaneous.

Ultra-microscopic Observations in Solutions of Pure Glycogen.† W. Biltz and Z. Gatin-Gruzewska used the apparatus of Siedentopf and Zsigmondy for their observations on glycogen. Similar observations had been made previously by Raehlmann and others, but the samples of glycogen used by these observers were not pure. The authors used A solutions of glycogen in water and B solutions, to which different reagents were added. The A set showed that in an aqueous solution of glycogen when examined ultra-microscopically there are corpuscles of different sizes; the size varying with the conditions of the solutions. The B set showed the progressive and regular course of the precipitation of glycogen under the influence of increasing quantities of certain precipitants.

Microscope and Expert Testimony.‡ — A. S. Osborn shows how useful the Microscope is for examining documents, especially in case of fraudulent additions, interlineations and erasures. The paper is furnished with excellent illustrations giving examples of retouched writing, forgeries, and lines showing the sequence of writing.

REED, L.—**The Microscope and food adulteration.**
Proc. and Trans. Croydon Nat. Hist. and Sci. Soc., 1904, pp. 41–4.

B. Technique.§

(1) Collecting Objects, including Culture Processes.

Detection of Nitrifying Organisms in Sewage Filters.‖—The following is the technique employed by Schultz-Schultzenstein (see p. 695): 100 c.cm. of Winogradsky's nutrient solutions for the nitrite-

* Monthly Notices Roy. Astron. Soc., lxiv. (1904) pp. 182–8 (2 figs.); pp. 458–60.
† Comptes Rendus, cxxxix. (1904) pp. 507–9.
‡ Journ. App. Micr., vi. (1903) pp. 2637–43 (8 figs.).
§ 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.
‖ Technology Quarterly, xvii. (1904) pp. 186–203.

and nitrate-forming bacteria were put in Erlenmeyer flasks. To these flasks were added coke from experimental contact beds, soil from irrigation field, etc., in quantities of a few grains. The solutions were kept at 25° C. to 26° C., and examined daily for ammonia, with Nessler's reagent; for nitrites, with sulphanilic acid and α naphthol; and for nitrates, with diphenylamine. After six days sub-cultures were made, and from these inoculations were made on silica jelly. By such means organisms were isolated agreeing completely with Winogradsky's *Nitrosomonas* and *Nitrobacter*.

Identification of the Bacillus typhosus in Stools.*—E. Klein and A. C. Houston, from a research on this subject, conclude that the Drigalski-Conradi medium in plates incubated at 37° C. is of value in assisting detection in a short time (24 hours) of the presence of *B. coli communis* and allied forms; the colonies of this microbe being noticeable by their red colour. Accordingly, in the search for the *Bacillus typhosus* in stools the above colour reaction permits of many colonies being excluded. The recognition of the typhoid colonies was found possible only in the plates made with high dilutions; and in these alone were the (red) colonies of *B. coli* sufficiently reduced in number to allow recognition of the typhoid (blue) colonies. Tests with sub-cultures are necessary. It follows, therefore, that where the typhoid bacilli are present in a stool only in small numbers the Drigalski plate is not able to demonstrate them with certainty, for the reasons that: the method does not alter the initial proportion of *B. coli* to *B. typhosus*; high dilution of the stools is necessary; all blue colonies are not those of *B. typhosus*.

Bacteriological Test for Estimating Pollution of Air.†—M. H. Gordon has undertaken an inquiry to determine whether it is possible to find a bacteriological test of the pollution of air by material given off from the human body, comparable to the *B. coli* (etc.) test for the pollution of water by material derived from a like host: a test capable of application as an index of the possible access of morbific virus to air in a manner similar to that in which the *B. coli* (etc.) test is an index of its possible access to water. Air is liable to be polluted by material given off from the human body in the acts of expectoration, coughing, sneezing and speaking, and such material consists of mucus derived from the respiratory passages. The procedure adopted was: (1) A bacterial analysis of a number of samples of saliva obtained from normal individuals was made, special attention being paid to the micro-organisms most abundant therein, with the object of determining whether any particular micro-organism is by the abundance and constancy of its presence characteristic in the way that *B. coli* is characteristic of fæces. The most abundant and constant organism in normal saliva was found to be *Streptococcus brevis* of Lingelsheim. The sparse occurrence of bacilli was noticeable. Neutral-red broth, for the reason that its colour is markedly changed by *S. brevis*, is, when incubated anaerobically for 48 hours at 37° C., a culture test whereby very minute

* Rep. Med. Off. Local Govt. Board, 1902–3, pp. 622–46.
† Tom. cit., pp. 421–71.

droplets of saliva may be readily detected. (2) A series of speaking experiments was made in a small and also in a large room, first with the artificial infection of the mouth with a living emulsion of *B. prodigiosus*, and afterwards with no artificial infection, culture plates being placed at different distances on the floor. By this means the presence in the air of a room of invisible droplets of ordinary saliva emitted from the mouth during the act of loud speaking was demonstrated at a distance of 40 feet in front of the speaker, and at a distance of 10 feet behind him. (3) The open air in several localities was examined both by exposing broth plates for definite periods, and by aspirating the air through a special apparatus. By these means twenty-two streptococci were isolated from the open air, three of which resembled *S. brevis* of the saliva. Virulent anaerobic bacilli resembling *B. enteritidis sporogenes* were isolated five times, and micro-organisms of the *B. coli* type thrice.

Simple Method for Cultivating Anaerobic Bacteria.* — B. R. Rickards recommends the following method (fig. 120) for solid media.

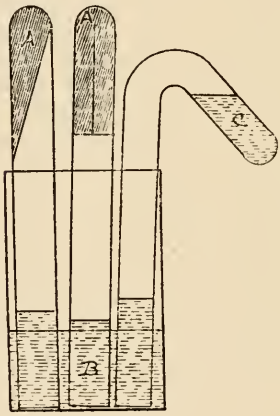
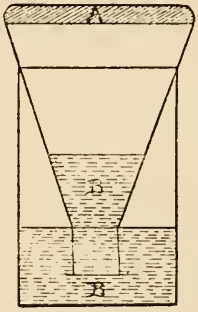


Fig. 120.



A Agar.
B Pyrogallol.
C Broth.

Fig. 121.

The tube of inoculated media is inverted into a tall vessel containing a layer of dry pyrogallol, to which is then added a strong solution of sodium hydroxide. As the oxygen is absorbed the solution rises in the tubes. For liquid media the same procedure is followed, but a tube is employed, the lower two inches of which is bent at an angle of 60°, and in this part is contained the liquid medium. For plate cultures an inverted Erlenmeyer flask answers well (fig. 121).

Symmers, W., St. C.—**Method of maintaining the virulence of a pathogenic micro-organism, Bacillus choleræ asiaticæ.**
Centralbl. Bakt., 1te Abt. Orig., xxxvii. (1904) pp. 23–4.

* Centralbl. Bakt. Orig., xxxvi. (1904) pp. 557–9 (2 figs.).

(2) Preparing Objects.

MARPMANN—**Ueber die Präparation der Diatomaceen, Foraminiferen, Polycystineen and Spongillen.** *Zeitschr. angew. Mikr.*, x. (1904) pp. 141–5.

(3) Cutting, including Imbedding and Microtomes.

Agar Method for Imbedding Plant Tissues.* — H. H. York recommends the following quick and simple method for fixing and imbedding plant tissues. 10 grm. of agar are boiled in 500 c.cm. of distilled water for 2 hours. The hot solution is poured into a tall cylindrical vessel. When cold, the clear upper portion is cut off and put into a glass jar. The jar is placed in a basin of hot water until the agar is melted, and then 1 part of formalin is added to 9 parts by volume of the melted agar. A 5 p.c. solution is prepared in a similar way. The fresh tissue is placed in hot 2 p.c. solution for about 2 hours, and is then transferred to the 5 p.c. solution for an hour or so, after which it is imbedded on wooden blocks. A layer of agar is smeared on the block, and allowed to cool; then the piece of material is placed thereon and covered with a sufficient amount of agar. When properly fixed to the block the whole mass is placed in 95 p.c. alcohol for 12 hours, after which it is sectioned on a sliding microtome.

Sectioning Wheat Kernels.† — B. J. Howard soaks the grains in 90 to 95 p.c. alcohol for 10 to 14 days, after which 90 p.c. glycerin is added to the alcohol in small proportions at intervals of a few days, until the proportions of alcohol and glycerin are about equal. The material is then allowed to stand until the grains have attained a firm cheesy consistence. When the softening has attained a satisfactory stage, the grains are placed in a shallow dish just covered with the fluid. When the alcohol has evaporated (2 to 3 days) the grains are treated (1) with 98 p.c. alcohol for 30 to 60 minutes; (2) with chloroform, 30 to 60 minutes; (3) chloroform and paraffin shavings, 60 to 90 minutes; (4) melted paraffin, changing 2 or 3 times, for 2 hours; (5) block; (6) sections.

Imbedding Medium for Brittle Objects.‡ — J. B. Johnston has found that rubber mixed with paraffin wax makes a satisfactory medium for imbedding brittle objects, such as amphibian embryos. Mix with hard paraffin about 1 p.c. of indiarubber cut up into very small pieces. Dissolve by heating to 100° C. (not more) for 24 to 48 hours, though several days at from 55° to 60° will serve the purpose. Filter or use the supernatant fluid. Keep a stock of the prepared mixture cold, as the rubber separates out after a few weeks if the mixture is kept melted. Use as ordinary paraffin, except that xylol and not cedar-wood oil must be used for clearing. The hardened block is light brown, and the melted solution is murky. This murkiness may be prevented by dissolving in the paraffin before the rubber is added enough "mineral rubber" (asphalt) to give the paraffin a light amber colour. This paraffin-asphalt solution is more transparent than simple paraffin, and so facilitates orientation of the object.

* Journ. App. Micr., vi. (1903) pp. 2591–2.
† Tom. cit., pp. 2498–9 (1 fig.). ‡ Tom. cit., pp. 2662–3.

Radais' Microtome with Vertical Slideless Carrier.* — This instrument, designed by Radais, belongs to the class of microtomes in which the histological object borne by a carrier receives a vertical movement. It is the knife which governs the adjustment and regulates the thickness of the section. The mechanical arrangements of the various parts are essentially different from the instruments hitherto in use; the results attained are marked by easy manipulation and an evenness of section, which remains uniform even in the weakest section-strengths.

Fig. 122 shows the apparatus arranged for celloidin sections. The

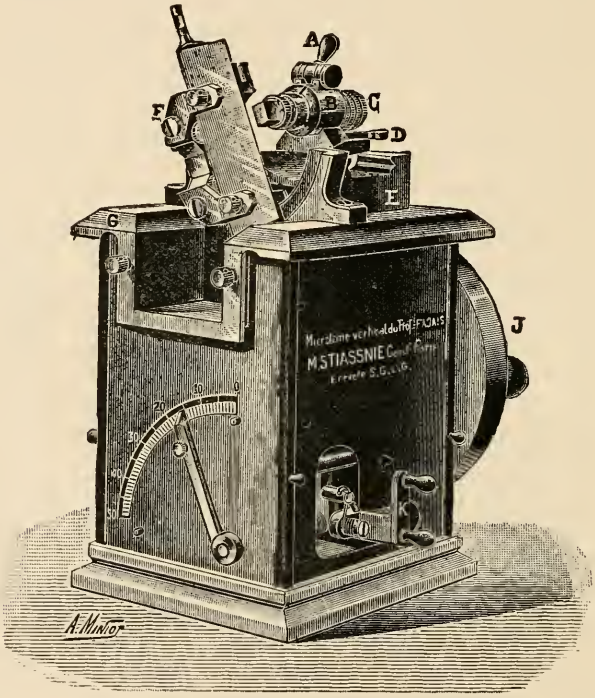


Fig. 122.

carrier is guided in a straight-lined course by means of two Watts' balance-wheels, movable between conical steel points. Such a kind of adjustment lends itself to a very exact control, and obviates the working-space required for the slides generally recommended. Indeed it is evident that in many machines the unequal pressure of the oil layer is the main cause of the irregularity of the section thickness, and, moreover, the fouling is very considerable. In the axle movements between the points the upper planes are in no wise exposed to the dust, the

* Zeitschr. angew. Mikr., ix. (1903) pp. 206–9 (2 figs.).

wear and tear is almost nil, and the accuracy is unlimited. The regularity of the carrier-track is also secured by means of the arrangement of the device which keeps the bearer of the histological object vertically over the engage-point of the driving-wheel. This orderly arrangement, to which constructors have hitherto paid too little attention, avoids all quivering which could influence the carrier. The orientation of the object to be cut is easily and quickly accomplished by the application of a special handle A B C, which is fastened in a circular-shaped groove of the carrier E. With the help of this groove and the rotation of the cylindrical object-holder C about its axis, the celloidin plug moves,

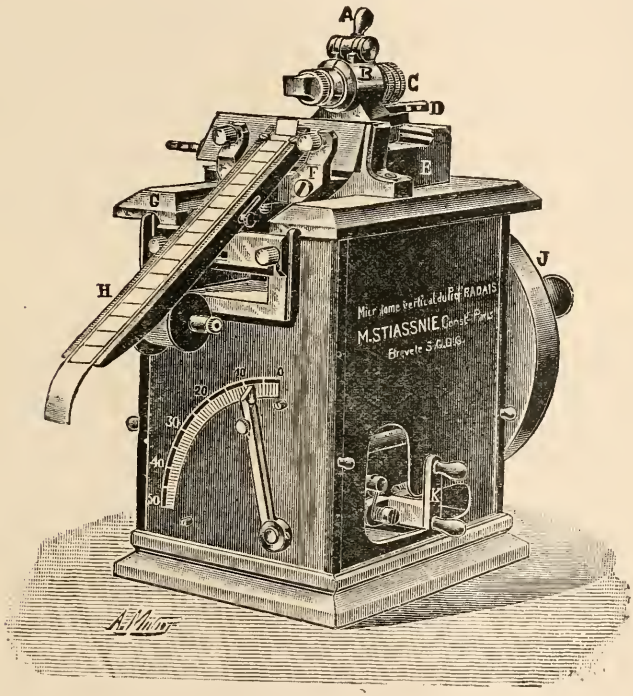


Fig. 123.

so that the object can be oriented without removal from the vertical line over the engage-point with the driving-wheel. The motive system of the micrometer screw removes all back-friction of the catch on the toothed wheel, and thus excludes any possibility of back-action. The female screw of the micrometer is movable, and of the ordinary type. A special form of screw-division permits, by a simple manipulation of the swing-piece of the handle K, the knife to approximate directly to the upper plane of the object to be cut. The automatic micrometric forward movement can then be immediately begun.

The apparatus will produce sections of thicknesses varying from 1 μ to 50 μ. A change may be made during operation by the application of a needle on the quadrant of a divided circle, and in this way the thickness may be quickly determined in the case of series sections at the beginning of the cutting. Fig. 123 shows the machine arranged for paraffin and series-cutting. The knife cuts horizontally or obliquely without any exchange, and the operator can therefore immediately change the section-angle with the carrier of the histological object. This carrier is united to the vertical diameter of a metallic semicircle F, which serves as a carrier to the knife. The edge of the section passes through the centre of this circle, which can rotate around itself in a circular track, or can be clamped fast. It therefore follows that the knife, in consequence of a rotation of 90°, can take every required position from the horizontal to the vertical. In each individual case the oblique setting of the section is arranged, as seems best, and serial sections are cut without changing any part of the apparatus. A paper-strip H can be applied, as shown in figure, for the more convenient reception of the serial sections. The gearing is inside the frame.

HANDLEY, W. S.—**Method of obtaining uniplanar sections with the ordinary rocking microtome.** *Journ. Anat. and Physiol.*, xxxvi. (1903) pp. 290–2.

(4) Staining and Injecting.

Staining Hyphomycetes in Horny Tissues.* — A. Kraus uses a methylen-azur solution prepared according to Michaeli's formula.† It is made by dissolving 2 grm. of medicinal methylen-blue in 100 c.cm. of water; 10 c.cm. of one-tenth normal caustic soda solution are added, and the mixture boiled for a quarter of an hour. When cold 10 c.cm. of one-tenth normal sulphuric acid are added, after which the solution is filtered.

The material (scales and crusts from the skin and hairs) is stained for 5 minutes or so, and is afterwards differentiated in 96 p.c. alcohol. Good results were obtained with *Pityriasis versicolor*, *Herpes tonsurans*, *Favus*, *Eczema marginatum*, *Erythrasma*. It is advisable to remove fatty matter with a mixture of ether and alcohol before staining.

Simple Method of Spore Staining.‡ — E. Thesing fixes the air-dried film in the flame, then covers it with 1 p.c. platinum chloride solution and heats it till it vaporises. The film is then washed with water and mopped up with blotting-paper, after which it is flooded with the staining solution (carbol-fuchsin or Loeffler's methylen-blue) and then heated again over the flame. The stain is poured off, and after having been treated with 33 p.c. alcohol the preparation is thoroughly washed. When dry it may be contrast-stained (Loeffler after carbol-fuchsin; safranin, vesuvin or fuchsin after Loeffler). The film is then treated in the usual way, and mounted in balsam.

* Centralbl. Bakt., 1te Abt. Orig., xxxvii. (1904) pp. 153–5.
† See this Journal, 1901, p. 602.
‡ Zeitschr. angew. Mikr., x. (1904) pp. 147–8.

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

Sticking of Celloidin Sections.* — K. v. Tellyesniczky suggests that, instead of using Mayer's glycerin-albumen as in Argutinsky's method, albumen simply diluted should be employed, as the white of one egg diluted to 100 c.cm. with distilled water and filtered. This he claims gives a much smoother and more uniform surface of coagulated albumen than Mayer's glycerin-albumen, and does not stain appreciably. He also advocates the use of mica plates for mounting celloidin sections.

(6) Miscellaneous.

Ink for Writing on Glass.†—Dissolve 20 parts resin in 150 parts of alcohol, then add, drop by drop, stirring all the while, a solution of 35 parts borax in 250 parts of water. Finally dissolve 1 part methylen-blue in the mixture.

METCALF, H., & G. G. HEDGCOCK—**New apparatus for phytopathological work. 1. A transferring "Oese." 2. Apparatus for growing seedlings and small plants under sterile conditions.** *Journ. App. Micr.*, vi. (1903) pp. 2493–5 (2 figs.).

DICKERSON, W. S.—**Useful modification of the life-box.**
[This consists in substituting for the ordinary cover-glass of the life-box, a thin glass perforated by a small opening near one margin.]
Tom. cit., pp. 2499–500 (1 fig.).

Metallography, etc.

Evolution of Structure in Metals.‡—M. G. Cartaud has been able by means of picric acid in acetone to etch the surfaces of soft metals such as lead, zinc and tin. He gives his reasons for thinking that the cellular surface structure so displayed is antecedent to the perfectly developed crystalline structure of the interior. The cellular structure is, as it were, embryonic; the crystalline, adult.

BEHRENS, H.—**Notes from the Microchemical Laboratory at Delft.**
[1. Movements in metals under annealing. 2. On tinning and soldering. 3. Etching by means of electricity.
Iron and Steel Mag., viii. (Aug. 1904) pp. 150–5.

CAMPBELL, W.—**Change of structure in the solid state.**
[A useful *résumé* of our present knowledge of changes in metallic structure during and after solidification.
Journ. Franklin Inst., clviii. (Sept. 1904) pp. 161–84 (34 figs.).

SHEPHERD, E. S.—**Some neglected details in the experimental study of alloys.**
Iron and Steel Mag., viii. (Sept. 1904) pp. 222–31 (6 photos).

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* Eine einfache und zuverlässige Methode Celloidinserien mit Wasser und Eiweiss aufzukleben. Arch. Mikr. Anat., Bd. lv. (1900). See also Anat. Anzeig., xxv. (1904) p. 182.

† Pharmaceutical Era, Sept. 1903. See Journ. App. Micr., vi. (1903) p. 2636.

‡ Comptes Rendus, cxxxix. (1904) pp. 428–30.

PROCEEDINGS OF THE SOCIETY.

MEETING

HELD ON THE 19TH OF OCTOBER, 1904, AT 20 HANOVER SQUARE, W.
THE PRESIDENT, DR. D. H. SCOTT, F.R.S., ETC., IN THE CHAIR.

The Minutes of the Meeting of the 15th of June, 1904, were read and confirmed, and were signed by the President.

The List of Donations to the Society since the last Meeting, exclusive of exchanges and reprints, was read, and the thanks of the Meeting were voted to the donors:

	From
S. Ramon y Cajal, Textura del Sistema Nerviosa del Hombre y de Los Vertebrados (2 vols, 8vo, Madrid, 1899–1904)	*The Author.*
Additional Portions of a Lucernal Microscope presented by Mr. F. Orfeur (Feb. 18, 1903)	*Mr. F. Orfeur.*

Mr. J. J. Vezey said that the Fellows would regret to hear of the death of Mr. Edward Dadswell, who had been connected with the Society since 1887, and was at one time a Member of the Council. Mr. Dadswell was also a member of the Quekett Club, and had always been greatly interested in Microscopical work. At one time he was President of the South London Society, and took the warmest interest in promoting its progress.

Mr. Dadswell possessed a trait which commended itself especially to the Treasurer, viz. that he proclaimed his belief on all suitable occasions that the Fellows of the Society should always endeavour to remember the Society when making their wills. Mr. Dadswell had carried this sentiment into practice, and had left a legacy of 50*l.*, free of duty, for the benefit of the Society. Mr. Vezey commended this to others to imitate, and he mentioned incidentally that a Member of the Council (Mr. J. M. Allen) had undertaken to draw up, without charge, the will of any Fellow wishing to copy such a good example.

Mr. Rousselet read a short description of the Adams Improved Lucernal Microscope, some further portions of which had recently been presented to the Society by Mr. F. Orfeur. The instrument, in its completed condition, was placed upon the table, together with the box of apparatus pertaining to it.

The Secretary called the attention of the Fellows to three microphotographic portraits which had been found in the Society's collection,

and were exhibited under Microscopes in the room. One of these was certainly a portrait of Prof. Quekett, but as there seemed some uncertainty as to the identity of the others, the Fellows were asked to look at them, and to name them in the event of their being recognised. They were subsequently identified as those of Dr. J. Millar, who was for many years a Member of the Council of the Society, and of Dr. Letheby.

A Note, entitled "The Antennæ of *Pulex irritans*, with remarks on a hitherto undescribed structure of the same," by Mr. W. D. Colver, was read by the Secretary, as follows: The object exhibited under the Microscope in the room this evening was of particular interest to entomologists, as it was believed to be the first time that the lamellated structure on the terminal joint of the antennæ of *Pulex irritans* had been demonstrated. It was discovered by Mr. William Jenkinson, of Sheffield, whilst studying the sense organs of insects, who had kindly lent two slides for exhibition, one of which showed the entire antennæ, whilst the other was of the terminal joint only, showing more clearly the particular structure referred to. Photographs of this were exhibited in the room and also upon the screen, the amplification being about × 400. In describing his observation, Mr. Jenkinson remarked, "that the antennæ of the common flea were a pair of appendages situated in immediate proximity to the eyes, formed externally of three distinct chitinous joints, and believed to have an olfactory function." The joint attached to the head was a simple structure, the second being circular in section and conical in shape, and perforated longitudinally for the passage of the nerve and trachea. The third, or terminal joint, was somewhat globular in shape, one half being divided into leaf-like appendages, or lamellæ, and it could readily be imagined that when the terminal of the large antennal nerve given off from the brain was distributed over the surface of these lamellæ, there would be an extensive area of highly sensitive surface for the reception of impressions. He had found a similar structure in several others of the Pulicidæ, and inferred, therefore, that it would be common to all members of the family.

The thanks of the Society were voted to Mr. Colver for his communication.

Part XVII. of the "Report on the Recent Foraminifera of the Malay Archipelago," by Mr. F. W. Millett, was taken as read.

Dr. Henry Woodward, having been asked to take the Chair *pro tem.*

The President gave a demonstration of "The Reconstruction of a Fossil Plant." The plant selected was *Lyginodendron oldhamium* Will., from the lower coal-measures of Lancashire and Yorkshire, and the growth of our knowledge of its construction was illustrated by a large number of the actual sections, shown upon the screen under various magnifying powers by means of the epidiascope. A few supplementary lantern-slides were also shown.

The first part discovered was the stem, described in 1866 by Binney, who referred it to the genus *Pinites* or *Dadoxylon*, thus recognising its gymnospermous affinities, though he compared the structure of its primary wood with that of a *Sigillaria*. A much more thorough investigation was made by Williamson (1874), who was at first in doubt whether the affinity with Lycopods or Ferns was the stronger. Later on, however (1890), he was able to show that the fern-like petiole, *Rachiopteris aspera*, belonged to *Lyginodendron*, and this led to the discovery that the foliage was identical with *Sphenopteris Höninghausi*, a well-known "Fern-frond." In the meantime the organisation of the stem had become more thoroughly understood, and proved to present a combination of Cycadean with Filicinean characters. Subsequently the fossil described as *Kaloxylon Hookeri* Will., turned out to be the root of *Lyginodendron*. Our knowledge of the vegetative organs now seemed to be complete, but as lately as 1902 Mr. Lomax showed that the stem was frequently branched, a fact not observed before.

The vegetative organisation indicated a position intermediate between Cycads and Ferns, but the fructification was still unknown. In 1903 Prof. F. W. Oliver noticed that certain seeds, named *Lagenostoma Lomaxi* Will., bore glands on their cupules identical with those on the leaf and stem of *Lyginodendron*. A detailed comparison of structure, supported by evidence from association, left no doubt that this seed was the female fructification of *Lyginodendron*. Whereas, however, the previous steps in the reconstruction of the plant were based on the direct proof of continuity, this last conclusion rested at present mainly on identity of structure. The reconstruction of the plant was still incomplete, for the male organs had not yet been identified with certainty. The position of *Lyginodendron*, as a seed-bearing plant, allied at once to Cycads and Ferns, was now established. Finally a picture of the reconstructed plant was exhibited, and its various features explained.

Interesting models of the seed of *Lyginodendron*, kindly lent by Prof. F. W. Oliver of University College, were also exhibited.

Dr. Woodward said that before leaving the Chair he would ask those who were present to give a very hearty vote of thanks to the President for his very interesting and instructive demonstration. He had shown that from the numerous sections of calcareous nodules out of the Halifax coal, he had puzzled out what appeared to be the remains of one and the same plant, and had been able to demonstrate the structure of the root, stem, leaves, and fruit, and to correlate these on good botanical grounds as organically related to one another. This demonstration had been a good object lesson how to use a fragmentary series of remains, and how to identify them under the Microscope in a clear and definite manner. He congratulated Dr. Scott on the great success he had achieved, and felt sure that he would be further rewarded in the efforts he was making in the study of fossil plant-structures under the Microscope, both in the Jodrell Laboratory at Kew, and at the British Museum (Natural History).

The thanks of the Meeting were cordially voted to Dr. Scott for his demonstration.

Dr. Scott, in responding, pointed out that the demonstration had necessarily been limited to *Lyginodendron* itself, as time had not permitted of any comparison with allied plants. He regretted that his explanations had been rather hurried, for he had not been able to dwell as long as he would have liked on each section, for fear of its being injured by heat, if exposed too long in the lantern.

The following Instruments, Objects, etc., were exhibited:—

The Society:—Microphotographs of Prof. John T. Quekett, Dr. Letheby and John Millar, L.R.C.P. Ed.; An Old Lucernal Microscope.

Mr. W. D. Colver:—One Lantern and Two Microscope Slides of Antennæ of *Pulex irritans*.

The President:—Sections of Fossils and Lantern Slides shown on the Screen, and Models illustrating his Demonstration of "The Reconstruction of a Fossil Plant."

MEETING

HELD ON THE 16TH OF NOVEMBER, 1904, AT 20 HANOVER SQUARE, W., THE RIGHT HON. SIR FORD NORTH, P.C., F.R.S., IN THE CHAIR.

The Minutes of the Meeting of the 19th of October, 1904, were read and confirmed, and were signed by the Chairman.

The List of Donations to the Society since the last Meeting (exclusive of exchanges and reprints), was read; these included a number of photomicrographs by Dr. Woodward, U.S.A., sent by Dr. Lionel S. Beale, for distribution to any Fellows of the Society who desired to have them.

	From
An Old Microscope by Dollond, after John Cuff's "New Constructed Double Microscope"	*Mr. C. L. Curties.*
An Old Microscope by Banks, 441 Strand, after Jones's "Most Improved Compound Microscope"	

The thanks of the Society were voted to the donors.

Mr. C. F. Rousselet called attention to the two old Microscopes which had been presented to the Society by Mr. Chas. Curties; one of which was a copy by Dollond, of Cuff's "New Constructed Double Microscope," first invented in 1744, and described by Henry Baker; the other being a copy of Jones's "Most Improved Compound Microscope," described by Adams, and made by Banks about 1815.

The original descriptions in each case were read to the Meeting.

The thanks of the Meeting were voted to Mr. Rousselet for his explanation.

Mr. C. L. Curties exhibited two new designs of electric lamps for Microscope use, fitted with ground-glass or blue-glass fronts, and mounted so as to be used at any height or angle required. Those exhibited were made for 100 and 200 volts respectively.

Dr. Hebb said he had been using one of these lamps at the Westminster Hospital for some weeks, and found that it worked very satisfactorily and gave a very powerful light.

Mr. Hugh C. Ross exhibited and described a small electric warm stage, formed by a coil of fine wire pressed into an ebonite plate and covered with a piece of mica. It could be slipped on or off the ordinary slide in an instant; it could be used with the highest powers of the Microscope; it would work on a mechanical stage, and required no attention when in use, maintaining a constant temperature for any length of time. The one exhibited was regulated to give a temperature of 37° C., and a small thermometer attached to the slide showed that this temperature did not vary during the evening. He invited the Fellows present to inspect the stage, and to make any suggestions for its improvement which occurred to them.

On the motion of the Chairman, a vote of thanks to Mr. Ross for his exhibit and description was unanimously carried.

Mr. A. E. Conrady gave a lengthy *résumé* of the contents of his paper entitled "Theories of Microscopical Vision: a Vindication of the Abbe Theory," illustrating his remarks by lantern slides and by mathematical formulæ worked out upon the board.

Dr. Johnstone Stoney, after referring to the lateness of the hour, which prevented his venturing to criticise Mr. Conrady's suggestive paper, requested permission to avail himself of this, the first opportunity open to him, to call attention to a passage in one of Sir George Stokes's earlier papers, of which he had only lately become aware.

The Abbe theory, as investigated by its author, relies upon experimental evidence; and when Dr. Stoney, some eleven years ago, made a special study of Prof. Abbe's important explanation of how microscopical images are formed, the inductive proof adduced by Abbe did not seem to him a satisfactory basis on which to rest a theorem of the kind, since, if accurately correct and susceptible of being generalised, it ought to follow deductively, as a necessary consequence of the laws under which the electromagnet waves which constitute light are propagated in uniform media. On a further study of the subject, he found that it is possible to obtain a complete deductive proof of Abbe's results, and to extend them to all optical images, by resolving the optical disturbance in the medium into components, each of which is an undulation of plane wavelets, and in which each of these wavelets is uniform throughout its extent. Dr. Stoney was then and remained until lately under the impression that he was the first to ascertain that every disturbance within a uniform wave-propagating medium is susceptible of being resolved in this way. But a scientific friend has directed his attention to a passage in one of

Stokes's early papers in which the resolution is distinctly enunciated. Stokes's words are : " . . . , for we may represent an arbitrary disturbance in the medium as the aggregate of series of plane waves propagated in all directions."* He does not give a proof of the theorem, nor a reference to where a proof may be found, from which the natural inference is, that the theorem could be referred to as a well-known theorem so long ago as 1845, when Stokes published the paper in which this incidental reference occurs. Dr. Stoney desired to call special attention to this, lest it should be supposed that he claimed the discovery of the theorem. What he did was only to re-discover it when it seemed to be forgotten, and to show its great value as a means of investigating optical problems.

It may be of special interest to some Fellows of the Society to know that it is possible to see resolved equidistant lines of which there are 140,000 to the inch. Grayson's second set of rulings consists of twelve bands of lines, of which the closest are 120,000 to the inch. By taking the seventh of these bands, which consists of lines 70,000 to the inch, and examining it with an objective of N.A. 1·35, used in conjunction with a condenser of N.A. 1·30—the admirable immersion condenser computed by Mr. Conrady—it was found possible to form a visible image of the band with its lines duplicated, so that the image as seen was an image of lines 140,000 to the inch. To accomplish this, all light of longer wave-lengths was excluded by admitting only light from the violet end of a solar spectrum, which formed by a two-inch lens of short focus an image of the sun, as the source of light. A slit was then placed under the condenser in such a position that the direct light from it was seen at the edge of the "concentration image"—i.e the image seen on looking down the tube of the Microscope—accompanied by the first and second spectra formed by the ruling. The first spectrum was then shut out by a narrow strip of copper foil placed over the objective, and in this way the direct light and the light of the second spectrum were alone allowed to pass up the tube and form the microscopic image near the top of the tube. Under these circumstances, as Abbe pointed out, the image of the band as seen had twice as many lines as are in the object on the stage.

To succeed in this experiment it was found necessary to adjust carefully the tube-length, and the distance between the condenser and the image of the sun, which was the source of light.

Nobert's celebrated nineteenth band was of lines 120,000 to the old Paris inch, which is the same as 112,594 to the English inch. It is, therefore, not as close a ruling as Grayson's twelfth band, and of course falls far short of being as fine as a ruling of lines 140,000 to the English inch.

Mr. Gordon spoke in answer to Mr. Conrady, and handed in the following note upon the mathematical part of Mr. Conrady's paper :—

The main position in Mr. Conrady's paper, the position by establishing which he proposes to re-establish the Abbe theory, is contained in the following sentence, which occurs on page 620 : "The first spectrum

* Stokes's Collected Papers, i. p. 102.

is always in phase with the direct light." The argument is indeed somewhat loose, for Mr. Conrady does not go on to show that this equality of phase affects the formation of the image in the image plane. On the contrary, when he comes to deal with that point, at the bottom of page 621, he gives the go-by to the spectra altogether, and argues from the principle of equal optical paths that since the diffracted beams leave the grating in equal phase with the direct light, they will arrive in equal phase at the conjugate image. This is a perfectly valid argument, but it is simply the old-fashioned "dioptric" theory, and has nothing whatever to do with the Abbe theory, or with the phase relations of the spectra *inter se*. The argument, therefore, has not even the merit of being coherent, but for some reason Mr. Conrady thinks it necessary to insist upon the equality of phase of the direct light and the spectra of the first order. The matter, therefore, must be examined again, although probably other Members of the Society as well as myself will think it strange that this question should now be brought up, and brought up in the form which it assumes in Mr. Conrady's paper. Only in June last Prof. Everett contributed a paper to our Proceedings in which he showed that the phase relation between the direct light and the two spectra of the first order is quite indeterminate, and goes through a complete cycle of change as the grating is made to move across the stage in a direction perpendicular to the bars through a distance equal to the distance from centre to centre of two contiguous bars. It is sufficiently surprising to find this result called in question, and still more surprising that Mr. Conrady, while denying Prof. Everett's conclusion, should not think it necessary even to allude to the argument by which that conclusion was reached.

By the Society's leave I propose, therefore, to examine Mr. Conrady's argument; and since Prof. Everett is no longer among us to defend his own position, I will venture to offer some observations in its defence.

First of all, to deal with Mr. Conrady's argument. This appears on page 617, and it is there shown, with the aid of a diagram, that the resultant phase in the diffracted beam of the first order is equal at any given time to the contemporary phase in the beam of direct light. With that conclusion nobody will quarrel. It might be extended to the beams of the second, third, and other orders. Mr. Conrady, indeed, thinks not. He says on page 620: "This is my great point, in this second cycle the sign of the resulting amplitude is reversed, i.e. the combined phase is in this case the opposite one to or is $\frac{1}{2}$ wave-length different from that given by indefinitely narrow slits." On looking for the proof of this proposition, one finds that it is due to a mere error in calculation. Mr. Conrady deduces quite correctly for the resultant disturbance due to the impulses from a pair of points, E and F, situated symmetrically on either side of the middle point of a slit, the following expression—

$$x_E + x_F = 2\,c\,.\,\cos\beta\,.\,\sin\alpha.$$

He then proceeds to obtain the whole result of the radiation from the slit by integrating this expression, and everything proceeds (so far as it goes) quite correctly except that he omits to observe the proper limits of

the integration. Since α is measured from the edge to the middle of the slit, it is plain that α is the limiting value of β, and the required integral is—

$$\int_{\beta=0}^{\beta=\alpha} 2\,c\,.\,\sin\alpha\,.\,\cos\beta\,.\,d\beta\,. = 2\,c\,.\,\sin^2\alpha.$$

This, therefore, is necessarily positive, and does not change its sign whatever value β may have. Mr. Conrady has tabulated the function $\frac{12}{\pi}\sin\beta$: a function which does not seem to have relation to anything in particular, but as it, of course, has a series of negative values, he infers that the resulting light phase will also change in the diffracted beam from a broad slit. We see, however, that Mr. Conrady's own postulates lead to a different conclusion, so we need not further discuss this proposition.

But to return to the spectra of the first order. Mr. Conrady, having seen the beams which are to form these spectra safely started on their way to the focal plane vibrating in unison with the direct light, assumes that they will be in equal phase in the focal plane itself. Now that depends entirely upon the lengths of the optical paths traversed by the direct beam and the diffracted beam respectively in passing from the grating to the focal plane. Mr. Conrady does not appear to have investigated this part of the problem. Prof. Everett did investigate it, and therein lies the explanation of his having arrived at the opposite conclusion. A short examination of this point will suffice to decide the controversy.

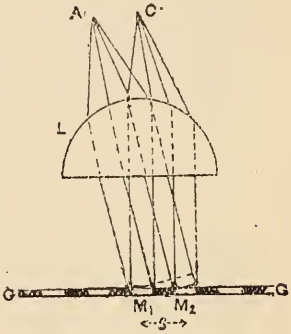

Fig. 124.

In the following diagram (fig. 124) let G . . . G be the grating on the stage of the Microscope, M_1 M_2 the middle points of two contiguous slits, s the distance between M_1 and M_2, L the lens, C the principal focal point, and A_1 the middle point of one of the spectra of the first order. I use, as far as possible, the symbols used by Prof. Everett in his paper, and accordingly $t =$ the optical distance from the grating to the principal focal point C, and $T = \lambda$. Therefore $\frac{t}{T}$ expresses this distance in wave-lengths. To express, in like manner, the optical distance from the point M_1 to the focal point A_1 we may write $\frac{t}{T} + a_1$ where a_1 stands for any quantity, integral or fractional, and might, if that were possible, stand for 0, so that the use of this expression does not commit us to any proposition concerning the relative optical paths of the direct and diffracted beams respectively. But if this path from

$$M_1 \text{ to } A_1 = \frac{t}{T} + a_1,$$

it follows that the path from

$$M_2 \text{ to } A_1 = \frac{t}{T} + \alpha_1 + \lambda.$$

Now Mr. Conrady wants the spectrum of the first order to be in phase with the image formed by the direct light, and as this is a perfectly possible condition of things, we will assume it for a starting point, and in order to express this clearly we will write for the optical paths

$$M_1 \text{ to } A_1 = \frac{t}{T} + n\lambda \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$M_2 \text{ to } A_1 = \frac{t}{T} + (n+1)\lambda \quad . \quad . \quad . \quad . \quad (2)$$

n being some positive integer.

Next, suppose the grating to be moved across the stage in the direction from C to A_1 through a distance $= s$. It is clear that in the new position it will give rise to the same phenomena in the focal plane as when it occupied the original position. The optical paths from M_1 and M_2 to A_1 will have been shortened by one whole wave-length, and the optical paths to C will be unchanged. Therefore the principal image and the first spectrum will still be in phase.

But the grating might have been moved through a less distance than s. Suppose it moved through x. Then the optical path from M_1 will become

$$M_1 \text{ to } A_1 = \frac{t}{T} + \left(n - \frac{x}{s}\right)\lambda \quad . \quad . \quad . \quad . \quad (3)$$

and similarly

$$M_2 \text{ to } A_1 = \frac{t}{T} + \left(n + 1 - \frac{x}{s}\right)\lambda \quad . \quad . \quad . \quad (4)$$

But the optical paths to C remain unchanged, and therefore in this new position of the grating there is a phase difference corresponding to $\frac{x}{s}\lambda$ between the direct light and the spectrum of the first order.

It is now evident that as x increases from $x = 0$ to $x = s$ the phase difference between the direct image and the first spectrum must run through a complete cycle of change, and that this relation, far from being determinate, in a general sense, is determined only by the accidental position of the grating on the stage of the instrument. This is the conclusion at which Prof. Everett arrived, and it appears to be irresistible.

Towards the end of Mr. Gordon's remarks the Chairman interposed, and suggested that as it was nearly half-past ten o'clock, Mr. Gordon might close the subject by simply stating that on other points he did not accept Mr. Conrady's conclusions. Mr. Gordon at once acquiesced, and concluded his remarks in that way.*

The Chairman said that the subject referred to in the paper read was no doubt of much interest to some of their number, but at that late hour he thought that the discussion could not be prolonged. He felt sure, however, that they would return their thanks to all who had addressed them, for the light they had thrown on the matter.

* For Mr. Conrady's rejoinder, see next page.

The **Chairman** also called attention to an exhibition of the palates of Mollusca from the Society's collection, which were shown under a number of Microscopes lent for the occasion by Messrs. Watson & Sons, to whom the thanks of the Meeting were unanimously voted for the use of these instruments.

New Fellows.—The following were elected *Ordinary* Fellows:—Mr. William Joseph Dibdin, Rev. William Earl, Messrs. Charles E. M. Fischer, Alfred G. E. Foster, John Ross MacKenzie, and Cecil Price-Jones.

The Following Objects, Instruments, &c. were exhibited:—

The Society:—An Old Microscope by Dollond, after John Cuff; an Old Microscope by Banks, after "Jones's Most Improved Compound Microscope"; a Selection of ten Slides of Palates of Mollusca from the Saunders Collection.

Mr. A. E. Conrady:—The following Experiments in illustration of his paper. I. Diffraction Spectra with Curved Wave-fronts. The condenser may be racked up or down as far as it will go, causing a variation in curvature of the waves passing through the grating from the maximum possible to practically plane waves (considering the smallness of the object) without *any* change being noticeable in the diffraction spectra. II. Diffraction Spectra with Critical Light-Opening and Closing of the Condenser-Iris cause the diffraction spectra to expand and contract in uniform circles, always retaining their distance from centre to centre, just as would be the case with diffused light. III. Dr. Johnstone-Stoney's Experiment. An apochromatic objective (Zeiss 16 mm., ·30 N.A.) is used as a condenser, carefully adjusted and focussed, the "Diffractions-platte" being placed upside down. According to the usual interpretation of the undulatory theory, diffraction spectra should be impossible in this case. It will be seen, as a matter of fact, that they are there, precisely like those in Experiment I.

Mr. J. W. Gordon:—Experiment referred to in Mr. Conrady's paper, to show the effect of shortening the radius of curvature of the diffracted wave-front where it passes the grating.

Mr. Hugh C. Ross:—An Electric Warm Stage.

Owing to the lateness of the hour Mr. Conrady was precluded from replying, but has kindly favoured us with the following rejoinder to Mr. Gordon's remarks:—

Mr. Gordon sent me a signed copy of the manuscript of his note a day or two before the meeting at which my paper was read.

In this note Mr. Gordon endeavours, *inter alia*, to show that I made a miscalculation in the treatment of a certain integral by which I prove an important new theorem applying to gratings. It was immediately apparent to me that Mr. Gordon had misunderstood or overlooked the carefully explained meaning of the two angles entering into

the problem, and had thus been led to a different solution which is, as a matter of fact, impossible, because devoid of physical meaning, as I shall show presently. I therefore wrote privately to Mr. Gordon, pointing this out, and repeating the essential parts of my argument; but as he does not, apparently, accept my explanation, and maintains his objection, it becomes necessary to publish my answer to his indictment.

A repetition of my proof of the theorem in question, carried out with more minute care as to definitions, will probably be the quickest way of stating my case, which is a very simple example of the application of Huyghens' principle.

The latter teaches us that the whole disturbance caused by coherent light from any given aperture at any point beyond that aperture is determined by the sum (or integral) of all the elementary disturbances produced by light from the component elements of the given area.

Referring to fig. 95 accompanying my paper, the wave-motion produced in the sufficiently distant reference-plane C D by the undulations from an element of surface, or strip, in the centre of the slit A of a grating was expressed by the formula

$$(1) \quad x_A = c \,.\, \sin \alpha ;$$

and I took great pains to clearly point out α as an angle uniformly increasing by 360° for every complete vibration or wave. I used the simple symbol α for this ever-increasing angle for the sake of brevity, as in the whole of this proof its sine only appears as a common factor of all the terms. Its value is mathematically to be stated as $2\,\pi\,\frac{v}{\lambda}\,t$; where π has the usual meaning, λ is the wave-length of the light under consideration, v the velocity of light, and t the time reckoned from the instant when the first undulation is assumed to have reached the plane C D. And it must of course be borne in mind that this meaning is to be permanently connected with my angle α, as otherwise the physical meaning of the various equations would be lost, owing to their no longer expressing light-vibrations.

I next considered two elementary strips of the slit, E and F, equidistant from the central strip A, and designated the *constant* difference of phase between the light reaching C D from those elements and that from A by an angle β, which, consequently, is *independent of time.* The wave-motion which light from E and F would produce in the plane C D contemporaneously with the light from A according to (1) would then be

$$(2) \quad x_E = c \sin (\alpha - \beta)$$

$$(3) \quad x_F = c \sin (\alpha + \beta).$$

I next added these two disturbances together by solving the sines, and obtained

$$\text{II.} \quad x_E + x_F = 2\,c \cos \beta \sin \alpha ;$$

and I tabulated the value of the amplitude: $2\,c \,.\, \cos \beta$ in column 2 of Table I.

Corresponding pairs of elementary strips are to be formed so as to cover the entire width of the slit. Let the number of pairs be n with

corresponding values x_1, x_{-1}, β_1 for the first pair, and so on to x_n, x_{-n}, β_n for the last pair; then we shall have n equations of the form of II., differing only in the value of the phase-difference β which grows proportionately to the distance of the strips from the centre of the slit. The sum to be formed is therefore composed of the terms

$$\begin{aligned} x_1 + x_{-1} &= 2\,c \cos \beta_1 \sin \alpha \\ x_2 + x_{-2} &= 2\,c \cos \beta_2 \sin \alpha \\ \vdots \qquad & \qquad \vdots \qquad \vdots \\ x_n + x_{-n} &= 2\,c \cos \beta_n \sin \alpha. \end{aligned}$$

All these terms have the common factor $2\,c \sin \alpha$, and the sum, or total disturbance, is therefore

$$\text{III.} \quad \sum_{m=1}^{m=n} (x_m + x_{-m}) = 2\,c \sum_{m=1}^{m=n} \cos \beta_m \,.\, \sin \alpha.$$

The successive values of the β being independent of time, and therefore constant for a spectrum of given order from a given grating, the sum on the right is also a constant, and combines with $2\,c$ to form the amplitude of the integral wave; and this amplitude has been tabulated in Table I., column 3, for the very coarse interval there adopted.

The step from the sum in III. to the integral, i.e. the corresponding sum taken with pairs of indefinitely narrow strips, is now exceedingly simple. We introduce a new constant, C defined by $c = \mathrm{C}\,d\beta$, $d\beta$ representing the infinitesimal difference of phase between the extreme edges of any one of the elementary strips, and we can then at once write down the integral expressing accurately the total effect of the light from the whole slit; putting the limiting value of the angle β for the extreme edges of the slit as β_ϕ and the integral disturbance as $\mathcal{H}$, we find

$$\text{IV.} \quad \mathcal{H} = 2\,\mathrm{C} \int_{\beta=0}^{\beta=\beta_\phi} \cos \beta\, d\beta \times \sin \alpha = 2\,\mathrm{C} \sin \beta_\phi \times \sin \alpha\,;$$

and, of course, β_ϕ being again a constant, we identify $2\,\mathrm{C} \sin \beta_\phi$ as the amplitude of the resulting wave, whilst $\sin \alpha$ again expresses the undulatory nature of light, inasmuch as it goes through its complete cycle of positive and negative values for every increase of α by $2\,\pi$. But the amplitude is the quantity of interest, and this is therefore tabulated in column 4 of the table, to show that it agrees closely with the result of the rough mechanical integration tabulated in column 3.

The important conclusions to be drawn from this table are contained in the original paper, and need not be again referred to.

It will now be clear that where Mr. Gordon errs is in claiming that α is *also* the value of the *phase difference* for the edges of the slit—which latter I have consistently designated by β. He gives no justification for this, and could not; for α is an angle ever growing with time at a tremendously quick rate and to enormous values, whilst the β are comparatively small differences of phase which are independent of time and limited to a moderate number of wave-lengths.

It is, therefore, no wonder that Mr. Gordon's "solution" of the integral, i.e. $\mathcal{H} = 2\,\mathrm{C} \sin^2 \alpha$, is of a form which—assuming that α retains

the meaning attached to it by me—does indeed represent a periodical disturbance, but of an unprecedented kind. Owing to $\sin^2 \alpha$ being always positive, with a period of π, the disturbances in the æther are *all* on the *same* side of the ray, with a period equal to *half* that of the light-waves causing this novel phenomenon ; and, stranger still, the amplitude is a constant, 2 C ; the influence of the width of the slit has therefore disappeared, or, in other words, slits of *all* widths cause the *same* disturbance, which, however, is *not* light. Other interpretations *may* be possible by making different assumptions as to the significance of Mr. Gordon's α, but if α were to be put forward as an angle *not* depending on time, say as my β, then the expression $2\ C \sin^2 \alpha$ would no longer represent any undulations of any kind, and would, therefore, become hopelessly absurd, as a permanent dislocation in the æther is quite unthinkable.

A large part of the preamble of Mr. Gordon's note falls to the ground through this proof that the error in the matter is on *his* side.

It remains to briefly deal with Mr. Gordon's reference to Prof. Everett's paper.

I am truly glad to see that Mr. Gordon now admits the value and validity of Prof. Everett's proof of the conjugate movements of object and image according to the method of treating the formation of microscopical images which Prof. Abbe has introduced. But that is precisely what I claimed in my paper and referred to, more particularly in the eleventh line on page 624. Mr. Gordon's attempt to prove me at variance with Prof. Everett is, therefore, completely unfounded. The changes in phase relations which take place when a grating is *moved* across the field of vision, and which Prof. Everett used in his elegant proof, have no connection whatever with the phase-law which I have established as holding for the light emanating from any one slit of a stationary grating, and which is due to interference of the light from different parts of each individual slit.

The further question raised by Mr. Gordon, as to whether my application of the well-established law of equal optical paths between geometrically conjugate points is reconcilable with the Abbe theory, arises from Mr. Gordon's views as to the scope and significance of that theory, which I do not share. I think the reasoning which I have given in my paper will appear both clear and conclusive to the majority of readers, and I do not consider it necessary to add to it.

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