The President has received, through Sir Dighton M. Probyn, the following gracious message from His Majesty the King:

Privy Purse Office,
Buckingham Palace.

28th June, 1901.

Sir,

I have the honour to inform you that I have submitted to The King your letter of the 19th instant, and, in reply, I am commanded to say that His Majesty is pleased to accede to the request contained in it to continue his patronage to the Royal Microscopical Society.

I am, Sir,
Your obedient Servant,

(Signed) D. M. PROBYN,
General,
Keeper of H. M.'s Privy Purse.

The President of
The Royal Microscopical Society.

His Majesty's message will be formally communicated to the Society at the next Ordinary Meeting on October 16th.

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

A. W. BENNETT, M.A. B.Sc. F.L.S.

Lecturer on Botany at St. Thomas's Hospital

Instruction to Binder.

The Message from the King, the Plate facing page 353 in the August Part, should be inserted as a *Frontispiece* to the Volume for 1901.—EDITOR.

1901

TO BE OBTAINED AT THE SOCIETY'S ROOMS,

20 HANOVER SQUARE, LONDON, W.

MESSRS. WILLIAMS & NORGATE; AND OF MESSRS. DULAU & CO.

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WITH THE ASSISTANCE OF THE PUBLICATION COMMITTEE AND

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Minimis partibus, per totum Naturæ campum, certitudo omnis innititur
quas qui fugit pariter Naturam fugit.—*Linnæus.*

FOR THE YEAR

1901

TO BE OBTAINED AT THE SOCIETY'S ROOMS,
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THE

Royal Microscopical Society.

(Established in 1839. Incorporated by Royal Charter in 1866.)

The Society was established for the promotion of Microscopical and Biological Science by the communication, discussion, and publication of observations and discoveries relating to (1) improvements in the construction and mode of application of the Microscope, or (2) Biological or other subjects of Microscopical Research.

It consists of Ordinary, Honorary, and Ex-officio Fellows of either sex.

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PROCEEDINGS OF THE SOCIETY.

F.W.Millett del.ad nat

West, Newman lith.

FORAMINIFERA OF MALAY ARCHIPELAGO.

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JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

FEBRUARY 1901.

TRANSACTIONS OF THE SOCIETY.

I.—*Report on the Recent Foraminifera of the Malay Archipelago collected by Mr. A. Durrand, F.R.M.S.—Part X.*

By Fortescue William Millett, F.R.M.S.

(*Read February 20th*, 1901.)

Plate I.

Sub-family **Cassidulininæ**.

Cassidulina d'Orbigny.

Cassidulina lævigata d'Orbigny.

Cassidulina lævigata d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 282 (No. 1), pl. xv. figs. 4, 5;—Modèle No. 41. *C. lævigata* (d'Orb.) Brady, Parker, and Jones, 1888, Trans. Zool. Soc., vol. xii. p. 221, pl. xliii. fig. 11. *C. lævigata* (d'Orb.) Terrigi, 1889, Mem. R. Accad. Lincei, ser. 4, vol. vi. p. 111, pl. v. fig. 9. *C. lævigata* (d'Orb.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol.

EXPLANATION OF PLATE.

Fig. 1.—*Mimosina affinis* sp. n. × 90.
In fig. 11*a*, plate IV. the inferior aperture is wrongly depicted; the present figure is intended to correct it.
" 2, 3.—*Chilostomella ovoidea* Reuss. Fig. 2 × 60; fig. 3 × 75.
" 4.—*Seabrookia pellucida* Brady. × 135.
" 5.—*Lagena ampulla-distoma* Ry. Jones. × 75.
" 6. " *rudis* Reuss. × 75.
" 7. " *variata* Brady. × 75.
" 8. " *costata* Williamson sp. var. × 100.
" 9. " *spumosa* sp. n. × 100.
" 10. " *lævis* Montagu sp., var. *distoma* Silvestri. × 100.
" 11. " *Chasteri* sp. n. × 100.
" 12, 13. " *pannosa* sp. n. Fig. 12 × 110; fig. 13 × 90.
" 14. " " var. × 100.
" 15. " *foveolata* Reuss. × 100.

xviii. p. 302, pl. vii. figs. 47, 48, 54–56. *C. lævigata* (D'Orb.) Goës, 1894, K. Svenska Vet.-Akad. Handl., vol. xxv. p. 43, pl. viii. figs. 418–420. *C. lævigata* (d'Orb.) A. Silvestri, 1896, Mem. Pontif. Accad. Nuovi Lincei, vol. xii. p. 103, pl. ii. fig. 10.

This is a very rare form in the Malay Archipelago, and has been observed only at Station 10, in Area 1.

Cassidulina crassa d'Orbigny.

Cassidulina crassa d'Orbigny, 1843, Foram. Amér. Mérid., p. 56, pl. vii. figs. 18–20. *C. crassa* (d'Orb.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 303, pl. vii. figs. 35, 36. *C. crassa* (d'Orb.) Goës, 1894, K. Svenska Vet.-Akad. Handl., vol. xxv. p. 43, pl. viii. figs. 421, 422. *C. crassa* Egger, 1895, Jahresbericht xvi. Naturhist. Ver. Passau, p. 19, pl. ix. fig. 19. *C. crassa* (d'Orb.) A. Silvestri, 1896, Mem. Pontif. Accad. Nuovi Lincei, vol. xii. p. 104, pl. ii. figs. 11, 12. *C. crassa* (d'Orb.) Morton, 1897, Proc. Portland Nat. Hist. Soc., vol. ii. p. 116, pl. i. fig. 12. *C. crassa* (d'Orb.) Flint, 1899, Rept. U.S. Nat. Mus. for 1897 (1899), p. 292, pl. xxxviii. fig. 3. *C. crassa* (d'Orb.) Wright, 1900, Geol. Mag., dec. 4, vol. vii. p. 100, pl. v. fig. 11.

This is less rare than *C. lævigata*, and is found at Stations in both Areas.

Family *CHILOSTOMELLIDÆ.*

Chilostomella Reuss.

Chilostomella ovoidea Reuss, plate I. figs. 2, 3.

Chilostomella ovoidea Reuss, 1850, Denkschr. k. Akad. Wiss. Wien, vol. i. p. 380, pl. xlviii. fig. 12. *C. ovoidea* (Reuss) Sherborn and Chapman, 1889, Journ. R. Micr. Soc., p. 485, pl. xi. fig. 12. *C. ovoidea* (Reuss) Dreyer, 1891, Jenaische Zeitschr. für Naturwiss., vol. xxvi. p. 271. *C. ovoidea* (Reuss) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 305, pl. ix. figs. 1, 2. *C. ovoidea* (Reuss) Silvestri, 1893, Atti e Rendic. Accad. Sci. Lett. e Arti dei Zelanti e P.P. dello Studio di Acireale, vol. v. p. 201, pl. vi. fig. 2. *C. ovoidea* (Reuss) Goës, 1894, K. Svenska Vet.-Akad. Handl., vol. xxv. p. 53, pl. ix. figs. 512–516.

In the robust form, fig. 2, the shell is dense and opaque, with a granular surface. The more attenuated specimens, fig. 3, are sufficiently transparent to allow of the internal chambers being seen, and the shell-wall is smooth, with a few opaque white dots scattered over its surface.

The principal variation is in the relative length of the successive chambers, and on this depends the comparative stoutness or attenuation of the contour of the test.

It is not uncommon at Station 25, in Area 2, but has not been observed at any other locality in the region.

Seabrookia Brady.

Seabrookia pellucida Brady, plate I. fig. 4.

Seabrookia pellucida Brady, 1890, Journ. R. Micr. Soc., p. 570, figs. 60, 1*a–c*, 2. *S. pellucida* (Brady) Wright, 1891, Proc. R. Irish Acad., ser. 3, vol. i. p. 476, pl. xx. fig. 5.

About twelve years ago Mr. W. H. Harris, then of Cardiff, obtained from the late Captain Seabrook some dredgings from the Java Seas. These were distributed amongst various rhizopodists, and excited much attention from the number of interesting forms contained in them. It was from these dredgings that Mr. Harris procured the specimens of the new genus *Seabrookia* which formed the subject of a paper by the late Dr. H. B. Brady, published in this Journal in the year 1890.

The differences between *Seabrookia* and *Chilostomella* are so slight that it is questionable if they are of generic value; quite as much variation exists amongst the forms assigned by common consent to the genus *Lagena*. The chief difference is in the form and position of the aperture; whilst in *Seabrookia* these are remarkably uniform, in *Chilostomella* they vary very much, as shown in the specimens figured by Sherborn and Chapman, Rzehak, Franzenau, and Silvestri. This is, however, a question which must be decided by future researches.

The Malay specimens vary so slightly that it is difficult to distinguish one individual from another.

It occurs at several Stations in both Areas, but is nowhere numerous.

The localities named by Brady and Joseph Wright are, off Cebu, 120 fathoms, Java Sea, 45 fathoms, and 'Challenger' material from Station 33, off Bermudas, 435 fathoms.

Family *LAGENIDÆ*.

Sub-family **Lageninæ**.

Lagena Walker and Boys.

Group of *Lagena globosa*.

Lagena globosa Montagu sp.

Serpula (*Lagena*) *lævis globosa* Walker and Boys, 1784, Test. Min., p. 3, pl. i. fig. 8. *Vermiculum globosum* Montagu, 1803, Test. Brit., p. 523. *Lagena globosa* (Montagu) Brown, 1844, Illustr. Rec. Conch. Gt. Brit., p. 126, pl. lvi. fig. 37. *L. globosa* var. *major* Uhlig, 1886, Jahrb. k. k. Geol. Reichs., vol. xxxvi. p. 167, fig. 1. *L. globosa*, (Montagu) Sherborn and Chapman, 1886, Journ. R. Micr. Soc., p. 744, pl. xiv. fig. 11. *L. globosa* (Montagu) Haeusler, 1887, Neues Jahrb. für Min., vol. i. p. 181, pl. iv. figs. 1–18. *L. globosa* (Montagu) Brady, 1888, Geol. Mag., dec. 3, vol. v. p. 481, pl. xiii. figs. 1–3. *L. globosa* (Montagu) Mariani, 1889, Boll. Soc. Geol. Italia, vol. vii. p. 285, pl. x. figs. 3, 4. *L. globosa* (Montagu) Terrigi, 1889, Mem. R. Accad. Lincei, ser. 4, vol. vi. p. 111, pl. v. fig. 10; pl. vi. figs. 4–6. *L. globosa* (Montagu) Burrows, Sherborn, and Bailey, 1890, Journ. R. Micr. Soc., p. 555, pl. ix. figs. 1, 4. *L. globosa* (Walker and Boys) Haeusler, 1890, Mém. Soc. Pal. Suisse, vol. xvii. p. 84, pl. xiii. figs. 5–9. *L. globosa* (Montagu) Terrigi, 1891, Mem. R. Com. Geol. Italia. vol. iv. p. 77, pl. ii. fig. 1. *L. globosa* (Montagu) Mariani, 1891, Boll. Soc. Geol. Italia, vol. x. p. 725, pl. xxi. fig. 7. *L. globosa* (Montagu) Chapman, 1893, Journ. R. Micr. Soc., p. 579, pl. viii. fig. 1. *L. globosa* (Montagu) Mariani, 1893, Ann. Istit. tecn. Udine, ser. 2, vol. xi. (p. 22) pl. i. fig. 7. *L. globosa* (Montagu) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 323, pl. x. fig. 69. *L. globosa* (Montagu) Haeusler, 1893, Abhandl. schweiz. pal. Gesell., vol. xx. p. 11, pl. i. figs. 1–13. *L. globosa* (Reuss) Grzybowski, 1894, Rozprawy Wydz. Mat.-Przyr. Akad. Umiej-Krakowie, vol. xxix. p. 189, pl. i. fig. 15. *L. globosa* (W. and J.) Goës, 1894, K. Svenska Vet.-Akad. Handl., vol. xxv. p. 77, pl. xiii. fig. 741. *L. globosa* (Montagu) Jones, 1895, Paleont. Soc., p. 177, pl. i. fig. 32 (1866). *L. globosa* (Montagu) Perner, 1897, Česka Akad. Césare Františka Josefa (Paleont. Bohemica, No. 4) p. 19, pl. vii. figs. 4, 6, and fig. 17 in text. *L. globosa* (Montagu) Morton, 1897, Proc. Portland Sci. Nat. Hist., vol. ii. p. 116, pl. i. fig. 1. *L. globosa* (Montagu) Egger, 1899, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xxi. p. 102, pl. v. fig. 3. *L. globosa* (Montagu) Flint, 1899, Rep. U.S. Nat. Mus. for 1897 (1899), p. 306, pl. liii. fig. 4. *L. globosa* (W. and B.) Kiær, 1900, Rep. on Norwegian Fishery and Marine Investigation, vol. i. No. 7, p. 39, pl. fig. 17. *L. globosa* (Montagu) Silvestri, 1900, Mem. Pontif. Accad. Nuovi Lincei, vol. xvii. p. 244, pl. vi. figs. 30, 40.

Williamson, in his 'Recent Foraminifera of Great Britain,' having regard to the resemblance in contour of the tests, associates *L. lineata* with *L. globosa*; Brady, in his 'Challenger' Report on the Foraminifera, attaching greater importance to surface ornamentation, places it with *L. striata*. There are advantages and disadvantages connected with each method, but on the whole the *Lagenæ* seem to fall into more natural groups when arranged in accordance with the general shape of the test, than when the character of the surface is taken as the basis of classification.

There are usually assigned to *L. globosa* two distinct forms; in one of these the test is thin and inflated, inclined to be opaque, and possessing a well developed internal tube. In the other the test is very thick and transparent, the shape pyriform, and the aperture surrounded with radiating striæ. Amongst these latter are doubtless included many specimens which are nothing more nor less than arrested growths of *Nodosaria* and *Polymorphina*.

Both forms are to be found in the Malay Archipelago, and they are evenly distributed over the whole of the region, although nowhere abundantly.

Lagena apiculata Reuss.

Oolina apiculata Reuss, 1851, Haidinger's Naturw. Abhandl., vol. iv. Abth. 1, p. 22, pl. i. fig. 1. *Lagena apiculata* Reuss, 1862, Sitzber. k. Akad. Wiss. Wien, vol. xlvi. (1863) p. 318, pl. i. figs. 1, 4–8, 10, 11. *L. apiculata* (Reuss) Sherborn and Chapman, 1886, Journ. R. Micr. Soc., p. 744, pl. xiv. fig. 14. *L. apiculata* (Reuss) Haeusler, 1887, Neues Jahrb. für Min., vol. i. p. 182, pl. iv. figs. 19–30. *L. apiculata* (Reuss) Mariani, 1889, Boll. Soc. Geol. Ital., vol. vii. p. 285, pl. x. fig. 5. *L. globosa* (Montagu) Burrows, Sherborn, and Bailey, 1890, Journ. R. Micr. Soc., p. 554, pl. ix. fig. 2; and *L. apiculata* (Reuss), p. 555, pl. ix. figs. 6, 7, 9–11. *L. globosa* (Montagu) Haeusler, 1890, Mém. Soc. Pal. Suisse, vol. xvii. p. 84, pl. xiii. figs. 3–10; and *L. apiculata* (Reuss) p. 85, pl. xiii. figs. 11, 12, 14, and pl. xv. fig. 43. *L. apiculata* var. *odontostoma* de Amicis, 1893, Boll. Soc. Geol. Italia, vol. xii. p. 352, pl. iii. fig. 9. *L. apiculata* (Reuss) Haeusler, 1893, Abhandl. schweiz. pal. Gesell., vol. xx. p. 14, pl. i. figs. 25–27, 34, 35. *L. apiculata* (Reuss) Chapman, 1893, Journ. R. Micr. Soc., p. 581, pl. viii. figs. 2, 3. *L. apiculata* (Reuss) Goës, 1894, K. Svenska Vet.-Akad. Handl., vol. xxv. p. 80, pl. xiii. fig. 747. *L. apiculata* (Reuss) Jones, 1895, Paleont. Soc., p. 179, pl. i. fig. 27 (1866). *L. apiculata* (Reuss) Egger, 1899, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xxi. p. 103, pl. v. fig. 32. *L. apiculata* (Reuss) Chapman, 1900, Quart. Journ. Geol. Soc., vol. lvi. p. 258, pl. xv. fig. 3.

Bearing in mind that most, if not all, of the *Lagenæ* have their apiculate condition, it seems unnecessary to endow each with a separate name; but pending an entire reform of the classification, it may cause less inconvenience for the present if these names be retained.

The form is rare in the Malay Archipelago, but is widely distributed.

Lagena ampulla-distoma Ry. Jones, plate I. fig. 5.

L. vulgaris var. *ampulla-distoma* Ry. Jones, 1872, Trans. Linn. Soc., vol. xxx. p. 63, pl. xix. fig. 52. *L. ampulla-distoma* (Ry. Jones) Brady, 1884, Chall. Rept., p. 458, pl. lvii. fig. 5.

This is a form of *L. globosa* which is not only apiculate, but roughened on the surface.

The process at the base of the acuminate *Lagenæ* may be either solid, or, as in the present instance, tubular. Whether or not the difference is worthy of varietal distinction is very doubtful.

It is by no means a rare form in the Malay Archipelago, and the specimens are well developed. It occurs in considerable abundance all over the Region.

Rymer Jones procured it from ten miles south of Sandalwood Island, in the Java Seas, 1080 fathoms. The 'Challenger' Station is Raine Island, Torres Strait, 155 fathoms. There seems to be no other record of its occurrence.

Lagena hispida Reuss.

"Sphærulæ *hispidæ*" Soldani, 1798, Testaceographia, vol. ii. p. 53, pl. xvii. V, X. *Lagena hispida* Reuss, 1858, Zeitschr. deutsch. geol. Gesell., vol. x. p. 434. *L. hispida* (Reuss) Haeusler, 1887, Neues Jahrb. für Min., vol. i. p. 185, pl. v. fig. 7–11. *L. hispida* (Reuss) Haeusler, 1890, Mém. Soc. Pal. Suisse, vol. xvii. p. 88, pl. xiii. figs. 21–24. *L. hispida* (Reuss) Chapman, 1893, Journ. R. Micr. Soc., p. 582, pl. viii. figs. 9, 10. *L. hispida* (Reuss) Haeusler, 1893, Abhandl. schweiz. pal. Gesell., vol. xx. p. 16, pl. i. figs. 36–47. *L. hispida* (Reuss) Flint, 1899, Rep. U.S. Nat. Mus. for 1897 (1899), p. 307, pl. liii. fig. 8.

This variety occurs in considerable abundance, and is widely distributed in the Malay Archipelago. The specimens have all the usual variations of form and structure, and comprise hispid conditions of *L. globosa*, *L. acuminata*, and *L. lævis*.

Lagena aspera Reuss.

Lagena aspera Reuss, 1861, Sitzungsber. k. Akad. Wiss. Wien, vol. xliv. p. 305, pl. i. fig. 5. *L. aspera* (Reuss) Balkwill and Millett, 1884, Journ. Micr., vol. iii. p. 78, pl. ii. fig. 1. *L. aspera* (Reuss) Balkwill and Wright, 1885, Trans. R. Irish Acad., vol. xxviii. (Sci.) p. 337, pl. xiv. figs. 10–12. *L. aspera* (Reuss) Haeusler, 1887, Neues Jahrb. für Min., vol. i. p. 185, pl. v. figs. 14–18. *L. aspera* (Reuss) Haeusler, 1890, Mém. Soc. Pal. Suisse, p. 89, pl. xiii. figs. 25, 26. *L. aspera* (Reuss) Terrigi, 1891, Mem. R. Com. Geol. Italia, vol. iv. p. 77, pl. ii. fig. 3. *L. aspera* (Reuss) Haeusler, 1893, Abhandl. schweiz. pal. Gesell., vol. xx. p. 15, pl. i. figs. 52–59. *L. aspera* (Reuss) Woodward and Thomas, 1893, Final Rept. Geol. and Nat. Hist. Survey of Minnesota, vol. iii. p. 35, pl. D, fig. 1. *L. aspera* (Reuss) Chapman, 1893, Journ. R. Micr. Soc., p. 582, pl. viii. fig. 8. *L. aspera* (Reuss) Egger, 1899, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xxi. p. 106, pl. v. fig. 10.

This form is widely distributed in the Malay Archipelago, although more rare than *L. hispida*. The examples have the like variation of form, the most common being that of *L. lineata*.

Lagena rudis Reuss, pl. I. fig. 6.

Lagena rudis Reuss, 1863, Bull. Acad. Roy. Belgique, sér. 2, vol. xv. p. 145, pl. i. fig. 17. *L. rudis* Reuss, 1862, Sitzungsber. k.

Akad. Wiss. Wien, vol. xlvi. (1863) p. 336, pl. vi. fig. 82. *Entosolenia rudis* (Reuss) Möbius, 1880, Meersfauna Insel Mauritius, p. 90, pl. viii. fig. 10.

Viewed by reflected light the surface appears, as described by Reuss, to be bedecked with knobs, between which lie weak and irregular dimples. By transmitted light these dimples are resolved into a reticulate system, which is continued over the entire test beneath the protuberances.

It is a very rare form, and has been noticed only in Area 2.

Lagena variata Brady, plate I. fig. 7.

Lagena variata Brady, 1881, Quart. Journ. Micr. Sci., vol. xxi. n.s. p. 61. *L. variata* Brady, 1884, Chall. Rept., p. 461, pl. lxi. fig. 1.

This variety is not uncommon at Station 22, and occurs also at Station 10. The examples are rather feeble.

The only 'Challenger' Station is off East Moncœur Island, Bass Strait, 38 fathoms.

Lagena lineata Williamson sp.

Entosolenia lineata Williamson, 1848, Ann. and Mag. Nat. Hist., ser. 2, vol. i. p. 18, pl. ii. fig. 18. *Lagena lineata* (Will.) Reuss, 1862, Sitzungsber. k. Akad. Wiss. Wien, vol. xlvi. p. 328, pl. iv. fig. 48. *L. caudata* (d'Orb.) Balkwill and Millett, 1884, Journ. Micr. vol. iii. p. 78, pl. i. fig. 9. *L. lineata* (Will.) Balkwill and Wright, 1885, Trans. R. Irish Acad., vol. xxviii. (Sci.) p. 336, pl. xiv. figs. 13–16. *L. lineata* (Will.) Brady, Parker, and Jones, 1888, Trans. Zool. Soc., vol. xii. p. 222, pl. xliv. fig. 33. *L. lineata* (Will.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 326, pl. x. figs. 29, 30.

The examples of this variety are typical, and are widely distributed in the Malay Archipelago, but are nowhere abundant.

Besides various localities on the west coast of Europe, it has been recorded from the Abrolhos Bank, Tristan d'Acunha, Kerguelen Island, and West Australia.

Lagena costata Williamson sp., plate I. fig. 8.

Entosolenia costata Williamson, 1858, Rec. Foram. Gt. Britain, p. 9, pl. i. fig. 18. *E. costata* (Will.) Dawson, 1859, Canad. Nat., vol. iv. p. 29, figs. 6, 7. *Lagena costata* (Will.) Reuss, 1862, Sitzungsber. k. Akad. Wiss. Wien, vol. xlvi. (1863) p. 329, pl. iv. fig. 54. *L. costata* (Will.) Wright, 1877, Proc. Belfast Field Club (App.), p. 103, pl. iv. figs. 11–13. *L. costata* (Will.) Terquem, 1882, Mém. Soc. Géol. Fr., sér. 3, vol. ii. p. 27, pl. ix. fig. 11. *L. costata* (Will.) Balkwill and Wright, 1885, Trans. R. Irish Acad. vol. xxviii. (Sci.) p. 338, pl. xiv. figs. 3–5. *L. costata* (Will.) Haeusler, 1887, Neues Jahrb. für Min., vol. i. p. 184, pl. v. fig. 5 ; and *L. striata* (d'Orb.)

p. 184, pl. v. fig. 6. *L. costata* (Will.) Haeusler, 1890, Mém. Soc. Pal. Suisse, vol. xvii. p. 88, pl. xv. fig. 42. *L. gracilis* (Will.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 328, pl. x. fig. 33.

This form varies very much in the character of the sculpture of its surface. The figured specimen resembles the *L. mucronulata* of Reuss.*

It is not very numerous in the Malay Archipelago, but occurs at several Stations in both Areas.

Lagena acuticosta Reuss.

L. acuticosta Reuss, 1861, Sitzungsber. k. Akad. Wiss. Wien, vol. xliv. p. 305, pl. i. fig. 4. *L. sulcata* var. *acuticosta* (Reuss) Brady, Parker, and Jones, 1888, Trans. Zool. Soc., vol. xii. p. 222, pl. xliv. figs. 26, 31. *L. acuticosta* (Reuss) Chapman, 1893, Journ. R. Micr. Soc., p. 583, pl. viii. fig. 11. *L. acuticosta* (Reuss) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II., vol. xviii. p. 329, pl. x. figs. 47, 48, 82, 83. *L. acuticosta* (Reuss) Jones, 1895, Paleont. Soc., p. 188, pl. i. figs. 42, 43 (1866). *L. acuticosta* (Reuss) Egger, 1899, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xxi. p. 106, pl. vi. fig. 62.

This variety, which can hardly be separated from *L. costata*, has in the Malay Archipelago the same distribution, and occurs in about equal quantities.

Lagena melo d'Orbigny sp.

Oolina melo d'Orbigny, 1843, Foram. Amér. Mérid., p. 20, pl. v. fig. 9. *Lagena melo* (d'Orb.) Jones, Parker, and Brady, 1866, Paleont. Soc., p. 38, pl. i. fig. 35. *L. melo* (d'Orb.) Brady, Parker, and Jones, 1888, Trans. Zool. Soc., p. 222, pl. xliv. figs. 21, 24. *L. melo* (d Orb.) Jones, 1895, Paleont. Soc., p. 192, fig. 20.

This variety is but poorly represented, the examples being few and insignificant.

Lagena hexagona Williamson.

Entosolenia squamosa var. *hexagona* Williamson, 1848, Ann. and Mag. Nat. Hist., ser. 2, vol. i. p. 20, pl. ii. fig. 23. *Lagena hexagona* (Will.) Jones, 1895, Paleont. Soc., p. 193, pl. vi. fig. 7, and w.c. fig. 21. *L. hexagona* (Will.) Wright, 1900, Geol. Mag., dec. 4, vol. vii. p. 100, pl. v. fig. 15.

In the Malay Archipelago this is the best represented of the reticulated forms. The specimens are well grown, abundant, and are distributed all over the Region.

Lagena reticulata Macgillivray sp.

Lagenula reticulata Macgillivray, 1843, Hist. Moll. Animal. Aberdeen, &c., p. 38. *Lagena reticulata* (Macgill.) Reuss, 1862,

* Sitzungsber. k. Akad. Wiss. Wien, vol. xlvi. 1862 (1863) p. 329, pl. iv. fig. 52.

Sitzungsber. k. Akad. Wiss. Wien, vol. xliv. p. 335, pl. v. figs. 67, 68. *L. hexagona*? (Will.) var. Balkwill and Millett, 1884, Journ. Micr., vol. iii. p. 79, pl. i. fig. 10. *Entosolenia squamosa* (Montagu) Dawson, 1886, Handb. Zool., p. 44, fig. 33. *L. hexagona* (Will.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 326, pl. x. fig. 60. *L. hexagona* (Will.) Goës, 1894, K. Svenska Vet.-Akad. Handl., vol., xxv. p. 80, pl. xiii. fig. 746. *L. reticulata* (Macgill.) Jones, 1895, Paleont. Soc., p. 195, pl. iv. fig. 7 (1866). *L. hexagona* (Will.) Silvestri, 1896, Mem. Pontif. Acad. Nuovi Lincei, vol. xii. p. 117, pl. ii. fig. 19.

This variety, distinguished by the irregularity of its meshes, is very rare in the Malay Archipelago, and the examples are by no means well developed.

Lagena squamosa Montagu sp.

Vermiculum squamosum Montagu, 1803, Test. Brit., p. 526, pl. xiv. fig. 2. *Lagena squamosa* (Montagu) Brown, 1827, Illustr. Rec. Conch. Gt. Brit., pl. i. fig. 32. *L. squamosa* (Montagu) Balkwill and Wright, 1885, Trans. R. Irish Acad., vol. xxviii. (Sci.) p. 340, pl. xiv. fig. 9. *L. squamosa* (Montagu) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 326, pl. x. figs. 58, 59. *L. squamosa* (Montagu) Goës, 1894, K. Svenska Vet.-Akad. Handl., vol. xxv. p. 79, pl. xiii. fig. 745. *L. squamosa* (Montagu) Jones, 1895, Paleont. Soc., p. 196, w.c. fig. 19.

Although not abundant, the examples are pretty evenly distributed over the whole of the Region, and have all the characters of the species, with little or no variation.

Lagena spumosa sp. n. plate I. fig. 9.

Test pyriform; shell substance a thick covering of vesicular matter overlying a dense internal layer. Aperture a conical transparent tube situated at the apex of the test. Length 0·25 mm.

This is a very interesting form, having the shell substance in two distinct layers, and differing from all the other species of the genus in its spongy outer coating.

It is very rare, and has been found only at Station 25 in Area 2.

Group of *Lagena lævis*.

Lagena lævis Montagu sp.

"Serpula (*Lagena*) lævis ovalis" Walker and Boys, 1784, Test. Min., p. 3, pl. i. fig. 9. *Vermiculum læve* (W. & B.) Montagu, 1803, Test. Brit., p. 524. *Lagena lævis* (W. & J.) Williamson, 1848, Ann. and Mag. Nat. Hist., ser. ii. vol. i. p. 12, pl. i. figs. 1, 2. *L lævis* (W. & J.) Jones, 1884, Quart. Journ. Geol. Soc., vol. xi. p. 769, pl.

xxxiv. fig. 3. *L. vulgaris* Gümbel, 1885, Geol. Bayern, Th. 1, Lief. 2, p. 422, fig. 266[6]. *L. lævis* (Montagu) Haeusler, 1887, Neues Jahrb. für Min., p. 181, pl. iv. figs. 31–38. *L. lævis* (Montagu) Malagoli, 1887, Atti Soc. Nat. Modena (Rend.), ser. 3, vol. iii. p. 109, pl. i. fig. 7. *L. lævis* (Montagu) Brady, 1888, Geol. Mag., dec. 3, vol. v. p. 482, pl. xiii. figs. 6–10. *L. lævis* (Montagu) Fornasini, 1889, Minute forme Rizopod. Retic., pl. fig. 8. *L. lævis* (Montagu) Haeusler, 1890, Mém. Soc. Pal. Suisse, vol. xvii. p. 86, pl. xiii. fig. 20. *L. lævis* (Montagu) Fornasini, 1890, Mem. R. Accad. Sci. Ist. Bologna, ser. 4, vol. x. p. 466, pl. fig. 1. *L. lævis* (Montagu) Mariani, 1891, Boll. Soc. Geol. Italia, vol. x. p. 725, pl. xxi. fig. 9. *L. lævis* (Montagu) Fornasini, 1893, Mem. R. Accad. Sci. Ist. Bologna, ser. 5, vol. iii. p. 431, pl. ii. fig. 1. *L. tubulifera* Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II., vol. xviii. p. 324, pl. x. figs. 6, 7. *L. lævis* (Montagu) Mariani, 1893, Ann. R. Ist. Udine, ser. 2, vol. xi. p. 22, pl. i. fig. 8. *L. lævis* (Montagu) Chapman, 1893, Journ. R. Micr. Soc., p. 581, pl. viii. fig. 5. *L. lævis* (Montagu) Haeusler, 1893, Mém. Soc. Pal. Suisse, vol. xx. p. 13, pl. i. figs. 14–16. *L. lævis* (Montagu) Goës, 1894, K. Svenska Vet.-Akad. Handl., vol. xxv. p. 74, pl. xiii. figs. 719–722. *L. lævis* (Montagu) Egger, 1895, Jahresbericht xvi. Naturhist. Ver. Passau, p. 24, pl. ii. fig. 11. *L. lævis* (Montagu) Jones, 1895, Paleont. Soc., p. 181, pl. i. fig. 28 (1866). *L. lævis* (Montagu) Fornasini, 1898, Mem. R. Accad. Sci. Ist. Bologna. ser. 5, vol. vii. p. 210, pl. fig. 19. *L. lævis* (Montagu) Egger, 1899, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xxi. p. 102, pl. v. fig. 2; and *L. clavata* (d'Orb.) p. 103, pl. v. fig. 16. *L. lævis* (Montagu) Flint, 1899, Rep. U.S. Nat. Mus. for 1897 (1899) p. 306, pl. liii. fig. 6. *L. lævis* (Montagu) Chapman, 1900, Quart. Journ. Geol. Soc., vol. lvi. p. 258, pl. xv. fig. 2. *L. lævis* (Montagu) Wright, 1900, Geol. Mag., dec. 4, vol. vii. p. 100, pl. v. fig. 12. *L. lævis* (Montagu) Silvestri, 1900, Mem. Pontif. Accad. Nuovi Lincei, vol. xvii. p. 244, pl. vi. fig. 56.

This ubiquitous form occurs in great profusion at nearly all the Stations, and exhibits the usual variations of form between *L. globosa* and *L. apiculata*.

Lagena lævis var. *distoma* Silvestri, plate I. fig. 10.

Lagena lævis (Montagu) Silvestri, 1900, Mem. Pontif. Accad. Nuovi Lincei, vol. xvii. p. 244, pl. vi. figs. 74, 75.

This apiculate variety is by no means uncommon at Station 25, and has been observed at other Stations. Some of the examples are very finely striated, indicating an affinity with *L.* (*Amphorina*) *Lyellii* Seguenza.*

Prof. Silvestri's examples are from a neogene deposit, supposed to be miocene, in the Alta Valle Tiberina.

* Foram. Monotal. Mioc. Messina, 1862, p. 52, pl. i. fig. 40.

Lagena Chasteri sp. n., plate I. fig. 11.

Test flask-shaped; rounded at the base. Shell substance consisting of a mass of vesicular matter enclosed between two layers of dense clear substance. Surface smooth and polished. Length 0·28 mm.

That this is closely allied to *L. spumosa* is shown by the tendency of the two forms to coalesce.

The vesicular matter sparkling through the transparent outer layer causes the test to resemble the mineral avanturine.

It has been observed only at Station 25, where it is not uncommon.

Lagena pannosa sp. n., plate I. figs. 12–14.

Test flask- or decanter-shaped, with usually a constriction at the place where the neck joins the body. Shell substance composed of an inner layer of hard matter, on which rests a thick coating of opaque granular substance, which exhibits a strong tendency to disintegrate. Between the middle and base of the body are two zones of irregular indentations. Length 0·30 mm.

This interesting member of the compound-wall series is well marked by the tendency of the granular portion to disintegrate and expose portions of the internal layer: to a less extent this feature is apparent also in *L. spumosa*.

In the variety fig. 14 the disintegration is more irregular, and the zones are not produced.

The *L. tubifero-squamosa* Parker and Jones,* fossil from Grignon, with its "decaying outer layers," appears to be a member of this group.

It occurs at many Stations in both Areas, but is most abundant at Station 25, which appears to be the headquarters of the compound-wall series.

Lagena foveolata Reuss, plate I. fig. 15.

Lagena foveolata Reuss, 1862 (1863) Sitzungsber. k. Akad. Wiss. Wien, vol. xlvi. p. 332, pl. v. fig. 65. *Lagena* No. 25, Von Schlicht, 1870, Foram. Septarienthones von Pietzpuhl, p. 10, pl. iii. fig. 25.

This is a very beautiful form, the minuteness and regularity of the sculpture causing the test to shine with great lustre.

The cells are smaller, and have less space between them than in the example figured by Reuss.

It occurs, very sparingly, at Station 25, and has not been observed elsewhere.

* Phil. Trans., 1862, p. 354, pl. xviii. fig. 7.

SUMMARY OF CURRENT RESEARCHES

RELATING TO

ZOOLOGY AND BOTANY

(PRINCIPALLY INVERTEBRATA AND CRYPTOGAMIA),

MICROSCOPY, Etc.*

ZOOLOGY.

VERTEBRATA.

a. Embryology.†

Experiments on Telegony.‡—Mlle. Barthelet has made experiments with white and grey mice (*Mus domesticus*), in regard to which it is known that if white females are crossed by grey males, the offspring are in the great majority of cases grey.

Four white virgin females were paired with as many grey males; the (25) young were all grey. The females were then paired with white males; the (28) young were all white.

A white virgin female was paired thrice with a grey male; the (17) young were all grey. The female was then paired with a white male; the (6) young were all white. Further experiments yielded similar results; there was no hint of telegony.

Sex in Pigeons.§—L. Cuénot points out the error of the common opinion that the two offspring in pigeons are ordinarily of opposite sexes. In 65 clutches the results were—17 cases of two males, 14 cases of two females, 34 cases of opposite sexes. Nor is it the case that the first laid egg usually becomes a male. Out of 30 clutches, the first laid egg gave rise to a male in 15 cases, and to a female in the other fifteen. The normal proportion of the sexes in the carrier pigeon is 115·87 male to 100 females—a notable hyperandry—as Darwin also remarked in regard to the adults.

Histogenesis of Ovary in Rana temporaria.‖—M. Bouin finds that the primordial genital organ in the tadpole consists of small germinative cells, and of large primordial genital cells which are filled with yolk-plates. The primordial genital cells arise from the peritoneal and mesenchymatous cells in the vicinity of the genital zone, and the same

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

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

‡ Comptes Rendus, cxxxi. (1900) pp. 911–2.

§ Tom. cit., pp. 756–8.

‖ Arch. Biol., xvii. (1900) pp. 201–381 (4 pls.).

cells also give rise to germinative cells. The formation of primordial genital cells is due to the absorption by the cells named above of a large amount of yolk, and the gradual assimilation of this yolk. During the process there is no division of the primordial cells, their increase in number being due to the transformation of the peritoneal and mesenchymatous cells. When the yolk is completely assimilated, however, the primordial genital cells, which may now be called the primordial ova, are surrounded by small germinative cells, and begin to divide by mitotic division. This division, which is synchronous with changes in the ovary itself, is associated with a remarkable degeneration and expulsion of a certain number of primordial ova into the body-cavity; a phenomenon more striking in future males than in the females. At the same time certain of the small germinative cells are converted into primordial ova. At the same stage the mesenchymatous Wolffian tissue grows into the developing ovary, and forms the medullary cords in which the cavities of the ovary appear. These cavities are therefore the homologues of the tubules of the testis in the male, and are more numerous in the tadpole than in the adult. The corpora adiposa develope at the expense of a part of the genital organ which contains no primordial ova, and are homologous with the interstitial cells of mammals. The primordial ova give rise by repeated division to nests of oogonia, each nest lying within the primordial follicle formed by the germinative cells. The nuclei of the oogonia then undergo remarkable changes, suggesting the approach of division; but this does not occur, the nuclei are reconstituted, and the oocytes are thus differentiated from the oogonia. Thus the oocytes each arise from a single oogonium (contrast Goette, Nussbaum, &c.). All the oogonia do not give rise to oocytes, for a certain number degenerate and disappear, but in each nest of oogonia several oocytes are generally formed. The author has not carried his researches beyond this point.

Defences of the Ovum.*—Dr. G. Loisel has published an interesting essay on the various ways (by reserves, envelopes, &c.) in which the ovum may be protected against drought, extreme humidity, heat, cold, microbes, and other injurious influences. The protection enables the ovum to survive in its struggle for existence, which is particularly keen in the period between liberation from the ovary and the beginning of development. All the ova of the same age are not identical; they vary partly in the adequacy of their protection; those that succeed are, often at least, the most effectively protected. In short, there is important selective action and also modification in the earliest stages of life.

Alleged Amœboid Movements of Germinal Vesicle.†—A. Giardina is entirely sceptical as to the occurrence of active amœboid movements in the germinal vesicle. The apparent movements are passive, and are due to differences of concentration in the surrounding substances.

Abnormal Eggs of Tropidonotus natrix.‡—G. Wetzel describes three cases of abnormality in developing eggs of this snake. In one of

* Journ. Anat. Physiol., xxxvi. (1900) pp. 438–63.

† Rivista Sci. Biol., ii. (1900) pp. 1–11 (2 figs.). See Zool. Centralbl., vii. (1900) pp. 786–7.

‡ Anat. Anzeig., xviii. (1900) pp. 425–40 (5 figs.).

these, four germinal discs were present in the egg, two quite distinct from each other, and two connected. The author believes that this must have been the result of the presence of four germinal vesicles in the egg. The other two eggs were in the gastrula stage, and showed two invaginations instead of a single one. From the appearances presented, the author believes that the spreading of the blastoderm over the yolk during the process of invagination arises not only from a direct conversion of the material at the spot into protoplasm, but also by an extension of the already formed blastoderm, due to a spreading-out of elements originally near together.

Periodicity in Spermatogenesis.*—Dr. Gustave Loisel finds, from a study of spermatogenesis in the sparrow, that periods of spermatogenetic activity alternate with periods of testicular repose. The latter are at first associated with cellular regression and partial or total absorption of the formed elements. As maturity approaches the periods of repose are shorter. It may be, the author suggests, that we have here to seek for an interpretation of sexual precocity and periodicity in mammals and man.

"Nebenkern" of Sperm-cells.†—Dr. Friedr. Meves has studied, in the male cell of *Paludina vivipara* and *Pygæra bucephala*, the structure called by von la Valette St. George the *Nebenkern*. Meves believes that this term should lapse, and himself employs for the separate granules Benda's term *mitochondria*, and for the *Nebenkern* which may be formed by their union, the term *mitochondrial corpuscle*. In *Paludina*, as is well known, there are two kinds of spermatozoon, the difference being first obvious during the growth-period of the respective spermatogonia. In the spermatogonia from which the "hair-like sperms" ultimately arise, there are a number of minute scattered mitochondria, which at the approach of the first maturation division arrange themselves first in filaments and then in rings. At first small, the rings increase in size, and are as it were pulled out lengthwise, so that they form double threads. At the division equal numbers of those double threads pass into the daughter-cells, and this is repeated at the second division. As the spermatozoon is formed, the threads unite into little vesicles, at one stage four in number, which are the equivalents of the *Nebenkern*. These vesicles surround the middle-piece of the developing sperm, and by fusion form a complete envelope for it. In the development of the "vermiform sperms" the mitochondria do not fuse, but remain throughout in the granular form. They accumulate about the middle-piece of the developing sperm as granules, and give rise to the appearance of cross-striping.

In *Pygæra bucephala* there are also two kinds of spermatozoon. The development of the sperms is described, but in the absence of figures it may be sufficient to note the chief point of importance—that the mitochondria after the second maturation division fuse to form a single corpuscle, which is the *Nebenkern* in von la Valette St. George's sense. In an exhaustive survey of the literature the author points out how these results aid in the interpretation of the more or less isolated observations of other authors on granules and so forth in the sperm.

* Comptes Rendus, cxxxi. (1900) pp. 725–7.

† Arch. Mikr. Anat., lvi. (1900) pp. 553–606 (2 pls. and 2 figs.).

Especially he notes that the spiral thread of the mammalian sperm is formed of mitochondria, and is therefore the equivalent of the envelope of the middle-piece, and so of the *Nebenkern* of Invertebrates. He figures various structures liable to be mistaken for mitochondria or mitochondrial corpuscles, notes that they may both occur in other cells besides spermatozoa, e.g. in Sertoli's cells in the testes of Vertebrates, and discusses the question whether the mitochondria are to be regarded as identical with the microsomata of tissue-cells. This last point, as well as the question of function, is left undecided.

Fertilisation in Petromyzon fluviatilis.* — Dr. Karl Herfort has studied the maturation and (artificial) fertilisation of the eggs of the lamprey, and gives his general results as follows. In all stages of the egg foam-structure of the cytoplasm in Bütschli's sense was clearly detected. The same structure was made out in the spheres and their radii, while no indication of contractile threads in the sense intended by Van Beneden, Boveri, &c. was observed. The sperm-head, before it is reconstructed as a pronucleus, consists of a group of small vesicles which are identical with Platner's karyosomata. The sperm-sphere seems to arise from the cytoplasm of the egg. The sphere lies in the egg behind the sperm-head, and when the latter becomes a pronucleus, the sphere becomes elongated and spindle-shaped, and the central corpuscle divides, a division which is followed by that of the sphere. The two spheres form the poles of the first segmentation spindle, and at the metaphase increase greatly in size, probably constituting the coarsely alveolar area which surrounds the daughter-nuclei. The author believes that the daughter-spheres are new formations here as elsewhere, while the central corpuscles are to be regarded as permanent organs. As a remarkable and as yet inexplicable fact, the author notes that the male pronucleus is at one stage surrounded by a clear area into which the female pronucleus also migrates. He believes that it is not an artefact, but can say nothing of its origin, fate, or relations.

Fœtal Membranes of Dasyurus. † — Mr. J. P. Hill has found that *Dasyurus viverrinus* will live and breed in captivity, and he has therefore been enabled to study the placentation and process of parturition in great detail. The present note contains a preliminary account of his results. The period of gestation appears to be about eight days, which agrees with Selenka's observations in the case of the opossum. As in other Marsupials the wall of the embryonic vesicle is divided into three zones:—(1) The bilaminar omphalopleure—forming here the larger part of the wall; (2) the true chorion; and (3) the trilaminar omphalopleure. An important point is that the proamnion, transitory in the Australian forms hitherto described, is here, as in *Didelphys*, persistent, and invests the embryo up to the fore-limbs. In regard to size, the allantois is well developed, but the shape is peculiar, being band-like with no definite stalk, and the vessels are degenerate, a large part of the area even in the early stage showing no trace of blood-supply. Nevertheless the allantois makes an abortive attempt to fuse with the chorion. The yolk-sac placenta is somewhat complex, and consists of two parts

* Arch. Mikr. Anat., lvii. (1900) pp. 54–95 (3 pls.).
† Anat. Anzeig., xviii. (1900) pp. 364–73 (1 fig.).

associated respectively with the vascular and non-vascular parts of the omphalopleure. It would seem that the former possibly serves mainly for gaseous interchange, while the latter is concerned with the absorption of nutriment. In the non-vascular region the omphalopleure is attached to the uterine epithelium by large pseudopodia-like processes arising from the cells, and ultimately producing degeneration of the uterine epithelium, so that maternal and fœtal tissues become very closely connected. As in *Perameles*, the yolk-sac placenta is contra-deciduate in type. Further, as in *Perameles*, delivery takes place through a median passage, formed at birth by a rupture of the connective-tissue between the median vagina and the urinogenital sinus. This was demonstrated clearly in animals killed during parturition, and it was also found that the passage rapidly closes up after birth, and must be formed anew at each parturition.

Chondrocranium of Chick.*—W. Tonkoff states that the development of the skull in the common fowl has hardly been studied at all since the publication of Parker's work in 1869. In devoting himself to the task, he has begun with the study of the chondrocranium, and finds that it attains its fullest development in the chick at the age of ten days eighteen hours, while at the same time the foundations of the membrane bones have been laid. He sectioned the skull at this stage, and reconstructed a model from the sections. The present instalment of his work is taken up with a description of the model, and a comparison with Gaupp's model of the chondrocranium of *Lacerta*. Among the points of special interest may be noticed the fact that that part of the squamosal which unites with the quadrate arises from a cartilage which is histologically indistinguishable from the cartilage of the chondrocranium, and that the vomer has a paired origin.

Air-sacs of the Chick.†—Prof. D. Bertelli gives an account of the development of the air-sacs, which he proposes to call cervical, interclavicular, anterior intermediate, posterior intermediate, and posterior, and discusses the morphological nature of the bird's oblique septum as distinguished from a true diaphragm.

Development of Excretory Organs in Turtles.‡—Miss Emily Ray Gregory has studied embryos of *Aromochelys* and *Platypeltis*, chiefly the latter, with reference to the development and relations of pronephros, mesonephros, and metanephros. She finds that the pronephros arises from outgrowths of the posterior regions of somites 4–10, and that it displays such variations in development as might be expected in a rudimentary organ. The posterior tubules are more or less fused with mesonephric elements, and function as excretory organs. The mesonephros may extend anteriorly over much of the pronephric region, and its tubules fuse with those of the latter organ. The metanephros arises at the point where the ureter branches from the upper side of the Wolffian duct, and in the blastema surrounding the ureter. It is independent of the mesonephros, save for the connection at the Wolffian duct, and perhaps the participation of a few cells from the mesonephric blastema.

* Anat. Anzeig., xviii. (1900) pp. 296–304 (1 fig.).
† Atti Soc. Toscana, xvii. (1900) pp. 145–66 (1 pl.).
‡ Zool. Jahrb. (Abt. Anat.), xiii. (1900) pp. 683–714 (6 pls.).

The tubules of the metanephros arise independently in the blastema surrounding the ureter, and probably also as branches from it. It would seem therefore that pronephros, mesonephros, and metanephros are heterodynamous organs only connected by their relations to the Wolffian duct. The glomus of the pronephros is distinct in origin, character, position, and extent, from the glomerulus of the metanephros.

Blastopore of Frog.*—Prof. H. V. Wilson has studied the history of the blastopore of the frog, especially *Corophilus feriarum* Baird. Yolk-cells adjacent to the dorsal lip of the blastopore gradually disappear under that lip, and this is interpreted as due to outgrowth on the part of the dorsal lip. The same happens ventrally, and is similarly interpreted. Ectoderm cells close to the dorsal lip and close to the ventral lip gradually disappear round their respective lips, and must, it would seem, become part of the archenteric lining.

After comparing his experiments, it seems to the author that his results are all explicable on the theory advanced by Assheton (1894), Whitman, and Eycleshymer (1895), that dorsal and ventral lips overgrow the yolk, from the places of their first appearance to the lower pole—the neural plate hence being formed in part on the black hemisphere, and in part by the backward growth of the dorsal lip over the white hemisphere, as Pflüger (1883) thought was possibly the case.

Thymus-Element in Spiracle of Raia.† — Dr. J. Beard has been able to prove that the structure named by Van Bemmelen the "ventral vesicular follicle of the spiracle," is really a rudimentary thymus-element. He finds that it arises as a placode of the gill-pouch, and with the rupture of the latter comes to be epiblastic in position. It later acquires a covering of ordinary epiblast, is penetrated by blood-capillaries, and divided by connective-tissue septa, and its epithelium gives origin to leucocytes. At a later stage it becomes more or less constricted off from the branchial epithelium, but apparently the separation is not complete, as in the case of an ordinary thymus-element.

Regeneration of Lens.‡ — Herr A. Fischel vindicates against G. Wolff's criticism his previously stated result that the iris—especially the lower half—is able to form lens-fibres, and a small but indisputable lens. Cases where lens-lesions had occurred were rejected.

b. Histology.

Comparative Histology of Vertebrata.§ — Dr. A. Oppel has published the third instalment of this immense work. Two previous parts dealt with the gullet, stomach, and intestines; this deals with the mouth, the tongue, the salivary glands, the liver, and the pancreas. The method of treatment is in great part historical, and there is much physiological as well as histological information. Various authorities have already spoken highly of this work of reference.

Structure of Human Epidermis.‖—Dr. Ludwig Merk finds that the horny cells of the human skin contain three distinct substances:—(1) a

* Anat. Anzeig., xviii. (1900) pp. 209–39 (16 figs.).

† Tom. cit., pp. 359–63. ‡ Tom. cit., pp. 324–6. Cf. this Journal, 1898, p. 406.

§ 'Lehrbuch der vergleichenden mikroskopischen Anatomie der Wirbeltiere,' iii. Teil, Jena, 1900, 8vo, x. and 1180 pp., 679 figs., and 10 pls.

‖ Arch. Mikr. Anat., lvi. (1900) pp. 525–35 (2 pls.).

skeleton of epidermal fibrils, which form a peripheral network at the surface, and a series of internal fibrils running almost at right angles to these; (2) a substance which is apparently horn and which controls the form of the cell; (3) the cell-contents, apparently protoplasmic in nature. The author strongly contests the current view that the horny cells are dead, and believes that all layers of the epidermis—even the outermost—are living. By suitable methods he has succeeded in demonstrating nuclei in horny cells.

Fine Structure of Glandular Cells.* — Herr C. Golgi reports on A. Negri's observation that in the pancreatic and parotid cells of the cat it is possible, by means of Veratti's mixture (indirect method), to demonstrate a complex network in the portion of the plasm facing the lumen of the alveolus. The filaments anastomose and form a beautiful feltwork which is not connected with the nucleus. Fine branches seem to be connected with the efferent canals of the gland.

Structure of Gastric Epithelium.†—Prof. Martin Heidenhain finds that in the stomach of *Triton tæniatus* it is possible to study the first origin of the mucus-plug of the epithelial cells. In the first stage the cells show a striated margin composed of isolated protoplasmic rods (*Bürstensäume*). This peripheral "brush" increases in height, and its elements secrete a connecting mucoid substance. Later on mucus is secreted within the cell beneath this striated margin, the rods of the margin being continued into the subjacent layer. They are there less numerous, so that the superficial rods appear like the branches of candelabra. At a later stage the protoplasmic rods disappear, the basal first, and the peripheral last. Of the peripheral rods those at the sides of the cell appear to persist, probably because they remain in connection with the subjacent protoplasm.

Classification of Epithelial Cells.‡— P. Vignon discusses the variation in structure of the margin of epithelial cells, with special reference to the so-called "motionless cilia" of insects and other invertebrates. He suggests that epithelial cells generally should be arranged in three categories:—(1) those with a united wall and with or without cuticle or vibratile cilia; (2) those with striated margin, whether cuticle or cilia be present or absent; (3) those with a margin made up of hollow prisms, which, as before, may be ciliated or furnished with a cuticle. The second group includes all cells in which the kinoplasm forms trabeculæ, usually in the shape of cylindrical rods, placed perpendicularly to the cell-margin. Such are the cells of the intestine and the Malpighian tubes in the larva of *Chironomus*, the intestinal cells of *Ascaris*, and so on. The third group have been described in *Amphioxus*, in *Petromyzon*, and in the larvæ of Amphibians. Needless complications, as the author believes, have been introduced by the failure to recognise the fact that the cytoplasmic reticulum frequently tends to form trabeculæ. When cilia or peripheral striation is present, these trabeculæ have received special names, as "roots of cilia," &c., but they may exist when there is neither striation nor cilia. Among the other questions

* Verh. Anat. Ges., xiv.; in Anat. Anzeig., xviii. (1900) Erg. Hft., pp. 178–81.
† Anat. Anzeig., xviii. (1900) pp. 417–25 (4 figs.).
‡ Arch. Zool. Expér., viii. (1900) pp. 3–15 (7 figs.).

discussed by the author is the one whether the "basilar granulations of the cilia" cause the movement of the cilia—a question he is disposed to answer in the negative. Generally, he believes that the vibratile apparatus of cells in itself is a simple matter, and it is the condition of the parietal apparatus which must be employed as a basis of classification of the cells.

Anastomoses of Gland-tubules.*—Prof. K. W. Zimmermann finds that in the serous glands of the tongue in man anastomoses of the tubules are of frequent occurrence. Their presence can be demonstrated by reconstructions from serial sections. A list of glands in which similar anastomoses occur is given by the author.

Skin-Glands of Monotremes.†—Herr H. Eggeling corroborates the view of Gegenbaur as to the homology of mammary glands and sweat-glands in Monotremes. They are derived from perfectly similar rudiments in the embryos. Another noteworthy point is the absence of distinctly recognisable sebaceous glands in all the stages examined in the region of the pouch, where they are abundant in the adult.

The author contrasts sebaceous with sudorific glands, laying emphasis on the presence in the latter of a well-defined sharply contoured lumen extending into the finest branches of the glands. The secretion of the sudorific glands is formed by a vital metabolic process, while that of the sebaceous glands is necrobiotic, the cell being sacrificed in the process of secretion. All sudorific glands and the mammary glands of higher mammals are permanently canaliculate, vitally secreting integumentary glands, while the sebaceous glands and the peculiar skin-glands of reptiles are temporarily canaliculate and necrobiotic in their mode of secretion.

Luminous Organs of Selachians.‡—Prof. R. Burckhardt finds that luminous organs, similar to those described by Johann (1899) in *Spinax niger*, and observed in *Isistius brasiliensis* by Bennett (1840), occur in many Spinacidæ and Læmargidæ, nine cases having been observed.

Structure of Nucleus of Trapezoid Body.§—Prof. Livio Vincenzi has succeeded in obtaining successful preparations of the calices of Held in the nucleus of the trapezoid body in various animals, and finds that the calix consists of two parts, (1) a pericellular capsule, and (2) a fibre which forms a more or less closely woven network on the surface of the capsule. The calix at times has a smooth surface, and at other times shows numerous filiform prolongations straight or curved, radiating outwards for a greater or less distance. These prolongations the author finds arise exclusively from the pericellular capsule. In a concluding note the author criticises Veratti's observations on the same subject.

Canaliculi of Nerve-cells.‖—Dr. Emil Holmgren finds that the ganglion-cells of the nerve-collar in *Helix pomatia* are admirably suited

* Anat. Anzeig., xviii. (1900) pp. 373–6 (1 fig.).
† Verh. Anat. Ges., xivth Vers.; in Anat. Anzeig., Erg. Hft., xviii. (1900) pp. 29–42 (6 figs.).
‡ Ann. Nat. Hist., vi. (1900) pp. 558–68 (8 figs.).
§ Anat. Anzeig., xviii. (1900) pp. 344–8 (6 figs.).
‖ Tom. cit., pp. 290–6 (4 figs.).

for the study of the canaliculi, and show clearly that prolongations of the surrounding stellate interstitial cells penetrate into the cytoplasm, and there ramify to form a network. These prolongations are hollow, and their ramifications therefore constitute a network of canaliculi, which open externally into the meshes of the interstitial tissue. Such a system of canaliculi also occurs in the axis-cylinders of nerves, but a notable difference in the latter is the absence of the "tigroid" substance found in nerve-cells. The author's preparations showed the inter-relation of nerve-cells and interstitial cells so clearly, and shed so much light on his other previous preparations, that he considers that the cells of the Metazoa generally may be divided into two sets, according to the nature of the canaliculi. The two main categories of cells are then as follows:—(1) Cells of high physiological significance, which are not simple but of complex organisation, and consist of central cells provided with a trophic mechanism presided over by subsidiary cells. Examples are nerve-cells, muscle-cells, reproductive cells, certain gland-cells. (2) Cells of lower physiological importance, which may possess canaliculi, but have not a trophic mechanism dependent upon subsidiary cells. The distinction he believes to be of primary importance. The paper is illustrated by some striking figures of the nerve-cells of the snail.

Structure of Human Neuroglia.*—Dr. A. J. Aguerre has confirmed the Ranvier-Weigert view as to the minute structure of the neuroglia, and has further made some novel observations on the nuclei of the glia-cells. While Weigert speaks only of two kinds of nucleus, large vesicular forms with granular chromatin, and small rounded forms with homogeneous chromatin, the author's preparations showed pronounced polymorphism of the nuclei. All possible shapes were present, e. g. spindle-shaped forms, three-cornered, hourglass-like, &c., the most interesting perhaps being curved forms not unlike the nuclei of certain leucocytes. There was also a considerable variation in size, the range being from 3–14 μ. Further, some of the nuclei showed clear indications of increase by amitotic division, which the author regards as proof that the glia-cells increase in number. He holds strongly that the neuroglia is actively functional, and is not merely a passive supporting substance.

Islands of Langerhans in Pancreas.†—Walter Schulze briefly reviews the literature of these structures, and points out that the real question in regard to them is whether they are to be considered as modified parts of the pancreas, or as structures *sui generis*. He made a series of experiments on guinea-pigs by isolating a small fragment of the pancreas with a ligature, the object being to determine whether or not the "islands" and the other portions of the pancreatic tissue would behave alike. In all cases he found that while the ordinary pancreatic tissue underwent progressive atrophy, the islands remained unaffected. This points to the conclusion that the islands are independent structures, not related to the duct system of the pancreas proper. Again, reasoning from such pathological phenomena as pancreatic diabetes leads to the conclusion that the islands are blood-vessel glands of the

* Arch. Mikr. Anat., lvi. (1900) pp. 509–25 (1 pl.).

† Tom. cit., pp. 491–509 (1 pl.). Cf. this Journal, 1900, pp. 25, 308.

same type as the hypophysis, and that their function in all probability is the regulation of the amount of sugar in the blood.

c. General.

Symbiosis.* — Dr. F. Fedde shows, in an interesting lecture, that intimate partnerships or vital co-operations between organisms are of frequent occurrence. He uses the term symbiosis widely, to include commensalism and antagonistic symbiosis (= parasitism), as well as that intimate internal co-operation illustrated by Radiolarians and their partner algæ, to which, as it seems to us, there is good reason for restricting the term. He distinguishes what may be called, zoo-symbiosis, phyto-symbiosis, and zoo-phyto-symbiosis. It is interesting to compare this lecture with a well-known one by Oscar Hertwig, for the comparison shows that many fresh illustrations have come to light.

Genesis of Mid-Pacific Faunas.† — Dr. H. A. Pilsbry discusses the hypothesis of a late palæozoic or early mesozoic mid-Pacific continent, upon the sunken heights of which the present island masses, volcanic or coral, have been superposed. The hypothesis is advanced to account for the constitution of Polynesian land-snail faunas, which are shown to be :—(1) nearly homogeneous over vast areas ; (2) composed of ancient types, with no admixture of the great series of modern families ; and (3) not derivable from any tertiary or modern continental fauna or faunas in the sense in which Atlantic island faunas have been derived. The molluscs, land and marine, supply no evidence that this Pacific continent was ever connected with or faunally affected by America (North or South), but are against any such connection.

Power of Flight in Vertebrates.‡—Prof. L. Döderlein notes that if the known species of animals be estimated at 420,000, then some 62 p.c. of these possess the power of flight in some form. If from the total there be subtracted such groups as the Protozoa, Cœlentera, &c., where the method of life excludes the possibility of flying organs, the proportion of flying animals in the remaining terrestrial forms is so large as to lead to the conclusion that flying is the ideal method of locomotion for land animals, and gives the possessors of the power an enormous advantage in the struggle for existence. In Vertebrates the flying-organs may be divided into two sets, true wings which can produce movements of the body in air without the aid of a fixed starting-point, and parachutes which cannot be flapped, do not produce independent movements, but can be utilised in supporting the body during leaping. Such parachutes are found in two genera of fishes, in a frog, in two groups of lizards, and in four groups of mammals, and are theoretically capable of being used in two ways. They may be used in taking leaps from the ground, a possible use of which there is no example in land-vertebrates; or they may be employed during leaping from heights, so as to produce oblique instead of vertical descent. The latter is the use exemplified in land-vertebrates, and is necessarily associated with the power of climbing, by means of which the animal may attain the height required, and therefore with the possession of climbing organs. True

* Jahresber. Schles. Ges., lxxvii. (1900) pp. 2–15.
† Proc. Nat. Sci. Philadelphia, 1900, pp. 568–81.
‡ Zool. Jahrb. (Abt. Syst.), xiv. (1900) pp. 49–61.

wings occur only in the Pterosauria, the Chiroptera, and in birds, among Vertebrates, and in each case the hand has in different ways been modified in connection with the organ. Nevertheless, the conditions seen in *Galeopithecus*, where the hand supports the patagium, shows that the distinction between the latter and a true wing is not absolute, and wings must be supposed to have arisen from patagia. If this be so, all winged vertebrates must have had climbing ancestors. To this statement birds seem to form an exception, but the claws and climbing habit of the hand of the young hoatzin (*Opisthocomus*), and the claws of *Archæopteryx*, show that birds may be regarded as descendants of climbing animals, who have lost their claws owing to the acquisition of the power of flight. Another important point is that while parachutes may occur as it were sporadically in animals which still display many characters in common with allied forms without parachutes, true flying animals form sharply demarcated independent groups, distinguished by their wealth of species. The last fact is due in part to the fact that, while the deep-seated modifications associated with the development of wings are slow, patagia are such recent modifications that differentiation has not had time to act, and partly to the fact that the power of true flight gives the possessors such an advantage in the struggle for existence that the formation of new species must be rapid.

Relation of Dinosaurs to Birds.* — Prof. H. F. Osborn discusses the evidence for a common dinosaur-avian stem in the Permian. We do not summarise the paper, but its ending. If bipedalism subsequently proves to be a common dinosaur character, it would naturally strengthen the dinosaur-avian stem hypothesis. The presence of a free quadrate in birds may be explainable as a secondary character, like the secondarily free quadrate of certain Lacertilia and Ophidia, due to degeneration of one of the cranial arches. The passage from a quadrupedal to a bipedal type would also mark the transition from the Proganosauria to the Dinosauria; and in this bipedal transition, with its tendency to form the tibio-tarsus, the avian phylum may have been given off from the dinosaurian. Thus, the author submits that the dinosaur-avian stem hypothesis should be very seriously reconsidered in future research among birds and dinosaurs.

Pneumaticity of Skull in Mammals.† — Dr. Simon Paulli gives details of his results in regard to this point in various orders of Eutheria, and also sums up the general conclusions obtained from his completed research. He finds that the degree of pneumaticity depends upon the size of the species, and increases with the increase in size of the species. The most general significance of the pneumaticity is that it affords a means whereby the characteristic shape of the skull may be attained with the minimum expenditure of osseous tissue; i.e. it is entirely an adaptive phenomenon. In consequence it is not possible to directly homologise the pneumatic cavities of the skull in Mammalia generally, except in regard to their point of origin, that is their position in regard to the wall of the nasal cavity. In other words, there are no pneumatic spaces of fixed morphological value, and such phrases as the "sinus frontalis" or "sinus sphenoidalis" have no significance in comparative anatomy.

* Amer. Nat., xxxiv. (1900) pp. 777-99 (12 figs.).
† Morph. Jahrb., xxviii. (1900) pp. 483-564 (3 pls. and 36 figs.).

Orbital Glands of White Rat.*—Prof. N. Loewenthal finds that in addition to the infraorbital, there is in the white rat another gland which has a connection with the orbital cavity. This new gland he calls the *glans orbitalis externa*. It lies beside the parotid, but nevertheless opens with the infraorbital by a common duct in the vicinity of the external angle of the eye.

Variation in Vertebral Column in Man.†—C. R. Bardeen notes that the vertebral column and ribs in man show frequent deviation from the normal. In fifty-nine cases, thirty only were perfectly normal as regards these structures. The commonest variation is the reduction of the twelfth rib to the rudimentary condition, and this, and other more pronounced illustrations of a tendency towards the shortening of the vertebral column, occurred in twenty-three cases. In six cases the vertebral column showed a tendency to lengthen, and in two of these there were thirteen rib-bearing vertebræ.

Integument of Erethizon dorsalis.‡—Dr. Theodor Loweg concludes, from a study of the skin of fœtus and adult of this rodent, that its ancestors must have been covered with scales, and that the characteristic bristles and spines developed beneath the posterior free border of these scales. The arrangement of the spines shows that the scales were the primitive structures to which the spines have adapted themselves. Further, in the fœtus the skin is marked by warts and quadrilatera areas which are to be regarded as the last remnants of the ancestra scales, and are most developed on the dorsal surface. The fine soft hairs which in the adult fill up the gaps between the spines develope late, are quite irregularly arranged as contrasted with the regular spines, and occupy the spaces left by the disappearing scales. Sweat-glands are absent, and the author regards it as not improbable that the luxuriant growth of soft hair is lost in the summer-time. The structure of the spines and bristles is described in detail. The true spines have dark strongly barbed tips, while barbs are at best only slightly developed on the bristles. Near the axilla, but towards the dorsal surface, there is at either side of the body a conical skin-papilla surrounded by a furrow. These papillæ, in spite of the fact that they are small and lie among the bristles, the author believes to be the teats, which, according to Brehm, the North American Indians declare to be absent. The author believes that during the lactation period they become turgid and elongated, so that they can be reached by the young. Their position is perhaps due to the fact that the animals are climbers, and the mother would be more hampered in the act of climbing if they were placed elsewhere. The illustrations include a striking photograph of the fœtus, showing the arrangement of the fœtal bristles.

Variation in Didelphys virginiana.§—Mr. C. F. W. McClure finds that opossums from the neighbourhood of Princeton show an extraordinary range of variation in regard to the venous system. He describes in detail the variations in regard to the posterior tributaries of the vena cava posterior of twenty-six specimens. The details are outside our

* Arch. Mikr. Anat., lvi. (1900) pp. 535–52 (1 pl.).
† Anat. Anzeig., xviii. (1900) pp. 377–82.
‡ Jen. Zeitschr. Naturwiss., xxxiv. (1900) pp. 833–66 (2 pls.).
§ Anat. Anzeig., xviii. (1900) pp. 441–60 (21 figs.).

range, but the general interest is twofold. In the first place a comparison with Hochstetter's account of the development of the vena cava posterior of *Echidna aculeata* suggests that the course of development of the vein is substantially the same in the two forms, and that the variations in *Didelphys* are produced by an arrest of development at various stages. In the second place, it is of interest to note that Mr. Oldfield Thomas believes that *D. virginiana* is merely a variety of the very variable *D. marsupialis*, and states that the variability of the opossums generally is such that specimens even from the same locality show "an entire absence of constancy in any character or set of characters." The reference in the quotation is of course to the external characters.

Respiration in Lungless Salamanders.*—Miss A. I. Barrows has a brief note on the respiratory organs of *Desmognathus fusca*. She finds that the skin contains a network of capillaries, and similar networks are present in the mouth and pharynx. Further, the entire wall of the œsophagus is furnished with a network of capillaries, which lie in the epithelium, and are probably of great respiratory significance in this lungless form.

Forked Tails in Amphibians.†—Dr. G. Tornier has studied many cases, and draws a number of conclusions. The degree of super-regeneration in a region depends on the size of the wound. Forked tails in natural conditions may be legitimately regarded as the results of wounds, since exactly analogous states can be induced experimentally. When regenerative processes set in, the basal parts of the integumental structure are the first to be laid down in rudiment, and the apical regions later on; but with the skeletal parts the process works in the opposite direction. Because of this there arise two-pointed lizard-tails in which the skeleton of one of the points seems to wane away towards the axis. That growth at first abnormal may be corrected is due not to "self-regulation," but to inequalities of growth.

Abnormalities in Lepidosiren.‡—Mr. H. H. Brindley describes partial duplicity of the limb or sudden tapering into a sharp tip, abnormalities in all probability of regenerative growth after injury. In the repair of an injury there is a special proliferation at one point, and the epidermis makes haste to cover the exposed subjacent tissues. Thus the trophic events of growth proceed otherwise than in normal development, and extremely slight circumstances may affect the direction of growth. In the absence of the co-ordination of growth which obtains in normal development, external interference may in some cases mould the regenerating structure in a special form.

Teeth and Breathing Valves of Fishes.§—Mr. E. Phelps Allis, jun., has investigated the structure of the mouth-cavity in *Polypterus bichir*, with special reference to such questions as the homologies of the teeth and the parts of the palate in Fishes and Amphibians. Of the two rows

* Anat. Anzeig., xviii. (1900) pp. 461–4 (2 figs.).
† Zool. Anzeig., xxiii. (1900) pp. 233–56 (12 figs.).
‡ Proc. Cambridge Phil. Soc., x. (1900) pp. 325–7 (1 pl.).
§ Anat. Anzeig., xviii. (1900) pp. 257–89 (3 figs.).

of teeth usually stated to occur in Fishes, the pterygo-vomerine row and the premaxillo-maxillary row, he believes that the former alone is present below the Teleostean-like Ganoid *Amia*. The so-called maxillary teeth of *Lepidosteus* and *Polypterus* he believes to be dermo-palatine in origin, and he therefore considers that there is in these fish a new arch, formed by the premaxillary and dermo-palatine teeth, which is apparently the arch found in Amphibians and higher Vertebrates. Further, he states that maxillary and mandibular breathing valves are very generally found in all fishes which have a premaxillary bone, and that in *Polypterus* bones related to teeth are developed in what are apparently the homologues of both breathing valves. "The maxillary breathing valve bone, so developed, forms a second superficial bony layer on the roof of the mouth-cavity, and it and the valve itself seem to foretell the secondary palate of the higher vertebrates."

Nephrostomes and Segmental Canals in Selachians. * — Frédéric Guitel, following up his discovery that Flemming's liquid differentiates nephrostomes from the peritoneum, has made a series of observations on Selachians in the hope of finding these structures. In a female of *Squatina angelus*, females of *Scyllium canicula*, and young males of the same species, females and young males of *Scyllium catulus*, and young females of *Centrina salviani*, he has succeeded in demonstrating the occurrence of ciliated nephrostomes opening into distinct segmental canals. The number of these varies within the limits of the species, and generally speaking both organs degenerate, especially in the males, as age increases. This process of degeneration attacks the segmental canals first, beginning at the renal end, and travelling outwards towards the nephrostome. Nevertheless, in adult females of *Scyllium canicula* the organs were found to be large, and seemed to be of functional importance, as is indicated by the fact that the segmental canals took up sepia introduced into the cœlom. In a number of other Selachians no nephrostomes could be made out.

New Abyssal Fish. † — M. Louis Dollo describes as *Cryodraco antarcticus* g. et sp. n. a fish taken by the Belgian Antarctic Expedition, which appears to be a member of the Trachinidæ adapted for life at great depths. Among its remarkable adaptive characters are, the characters of the skin, which is scaleless, colourless, and transparent; the great elongation of the body; the spathulate snout; the great size of the eyes; and especially the remarkable characters of the ventral fin, which has two united rays of great extent, spathulate at their extremities. This last character is also present in other unrelated abyssal fish, e. g. *Bathypterois* and *Photostomias*. Another point of importance about the capture is that it is a new proof of the frequency of the Trachinidæ within or in the vicinity of the Antarctic Polar Circle, while the family is hardly known from the Arctic region.

Development of Pigment.‡—S. Prowazek finds that in young fish the different pigment-cells appear in a definite order, first the black, then the red, finally the yellow. Also, the pigment-cells tend to take up

* Arch. Zool. Expér., viii. (1900) pp. 33–40.
† Bull. Acad. Sci. Belg., 1900, pp. 128–37.
‡ Zool. Anzeig., xxiii. (1900) pp. 477–80.

positions determined by the lines of least histological resistance, but their course is not directly influenced by the position of the blood-vessels or capillaries. The author believes that the pigment is produced by a katabolic modification of the cell-substance.

Structure of Amphioxus.*—Eugen Burchardt has had very abundant material of this much-investigated form, and has been able to make out some new points. In regard to the cœlom he finds that the complexity of its relations is accentuated by the occurrence of individual variation. The transverse canals, which are cœlomic in nature, constitute a regular means of communication between the cœlomic canals of the pharynx and the liver-cœlom, and serve to equalise the pressure in the two sets of spaces. They do not afford a means of communication between blood-system and body-cavity, as suggested by various authors. The author succeeded in finding Lankester's "brown funnels," and in addition two paired septa which form a chamber corresponding to the 28th segment. The septa must be regarded as persistent splanchnocœlic septa, and are the only regions in which true connective-tissue originates. The limited area in which this tissue is formed the author ascribes to the fact that *Amphioxus* is to be regarded as degenerate. He finds that the pharyngeal bars may contain cysts due to a coccidium named by him *Branchiocystis amphioxi*, which is apparently a common parasite. In the cœlom of one specimen of *Amphioxus* an "encapsuled organism" was obtained, whose affinities remain wholly doubtful, while in the food-canal of other specimens an apparently new Radiolarian—*Prismozoon neapolitanum*—was obtained. The paper contains a copious bibliography.

Osmosis between Hæmolymph and Sea-Water.†—R. Quinton gives a series of tables for starfish, lug-worm, *Sipunculus*, crab, lobster, *Aplysia*, *Sepia*, &c., showing (*a*) the approximate equality of the salinity in the internal fluids and in the surrounding medium; (*b*) the rapid change of the internal salinity when the external salinity is altered; and (*c*) that this is due to osmosis. There is no direct communication (except in the starfish); the weight of the animal increases in a hypotonic medium, diminishes in a hypertonic medium, and remains constant when equilibrium is established. This must be due to osmosis, and it is shown that salts as well as water pass through the body-wall.

Osmotic Pressure in Internal Fluids of Selachians.‡—E. Rodier finds that the blood-serum, the pericardial, the peritoneal, and the uterine fluids, freeze at almost the same temperature as the sea-water. As their saline composition is notably different from that of the sea-water, the uniformity of congelation temperature is ascribed to the organic substances (urea, &c.) in the body-fluids, and points to osmotic equilibrium between outside and inside.

L'Année Biologique.§—We have received the preface, table of contents, and index of the fourth volume of this valuable record, which deals with researches in general biology for the year 1898.

* Jen. Zeitschr. Naturwiss., xxxiv. (1900) pp. 719-832 (9 pls.).
† Comptes Rendus, cxxxi. (1900) pp. 905-8, 952-5.
‡ Tom. cit., pp. 1008-10.
§ Paris, 1900, xxvii. and 842 pp.

Tunicata.

Morphology of Tunicata.*—Maynard M. Metcalf has examined an extensive series of simple and compound Tunicates with special reference to the intersiphonal organs and their significance. He describes the various forms which these organs assume in representatives of almost all the families, and sums up as follows. The ciliated funnel (dorsal tubercle) is present in all species of Tunicates (except rarely in *Phallusia mammillata*), and receives innervating fibres from the brain; but in some cases these latter were made out only in connection with the duct in the vicinity of the funnel. The funnel may receive the duct of the neural gland, but this is not invariably the case, and it cannot be regarded as merely the aperture of the gland. Anatomically the evidence as to the sensory function of the funnel is complete, but the nature of the sense subserved is entirely obscure. The development of the ciliated funnel shows that it is the modified neuropore. The neural gland in some form is present in all species of Tunicates, but is absent from the Phorozooid of *Doliolum.* It arises from the central neural tube, and the anterior part of this tube forms its duct, usually opening by the modified neuropore into the pharynx. The secretion of the gland originates by the disintegration of cells proliferated from the endothelium of its wall. There are great differences between the different species in the degree of development of the gland and the character of its rapheal prolongation, but there is no great variability within the limits of a species. In regard to function the author's results are chiefly negative; and while he favours the suggestion that the gland is the homologue of the hypophysis of Vertebrates, he considers that this suggestion has been too hastily accepted as established, in view of the many difficulties which still exist.

In addition to the account of the intersiphonal organs, the paper includes discussions on various other points. Among these may be noticed the discovery that *Salpa cylindrica* is protandrous and not protogynous like other species; the confirmation of Brooks' description of the granular bodies within the blastomeres of embryos of *Salpa* as ingested follicular nuclei; an account of the anatomy of *Octacnemus patagoniensis*; a description of a new species of *Bostrichobranchus*; and so on. The author dissents from Herdman's view that *Octacnemus* is related to *Salpa*, and believes that it should be placed among the simple Ascidians near the Clavelinidæ.

Magellan Ascidians.†—Dr. W. Michaelsen gives an account of a rich collection of holosomatous Ascidians, including the new genus *Agnesia*, from the Magellan and South-Georgian region.

Follicular Cells of Salpa.‡—Herr Todaro describes the remarkable way in which the follicular cells—which he calls trophic or lecithin cells—become associated with the blastomeres, and multiply among them, first by karyokinesis and then amitotically. The body composed of blastomeres plus lecithin cells is hardly an embryo; it is a special

* Zool. Jahrb. (Abt. Anat.), xiii. (1900) pp. 495–602 (10 figs. and 7 pls.).

† Zoologica (Chun), Heft 31, Bd. xii. (1900) pp. 1–148 (3 pls.).

‡ Verh. Anat. Ges., xiv. Vers.; in Anat. Anzeig., xviii. (1900) Erg. Hft., pp. 194–202 (3 figs.).

arrangement for the nutrition and multiplication of the blastomeres, which only after a long period become differentiated into the germinal layers.

Development of Heart in Ciona intestinalis.* — Marc de Selys Longchamps finds that the pericardium has a paired symmetrical origin, intimately united with the ventral endoderm of the pharynx. The pericardium is quite independent of the epicardium both in time and in mode of origin. The two pericardial vesicles increase in size and embrace one another, forming a vesicle divided into halves by a double septum. Willey's account of the origin of the heart-cavity by a separation of the components of the double septum is confirmed.

INVERTEBRATA.

Metazoa of Salt Lakes.†—Prof. P. Butschinsky previously gave an account of the Protozoa of the Chadjibej-Liman and the Kujalintzky-Liman at Odessa, and now gives lists of the higher forms found in the lakes. The salinity in the former lake varies from 5–7° Beaumé, and in the latter from 9–9½° B.; but while the water of the Chadjibej-Liman differs from sea-water only in its concentration, that of the Kujalintzky-Liman contains no sulphate save that of lime. As might be expected, the Metazoa are few in number, not only absolutely but also relatively to the Protozoa, and are fewer in the dense waters of the Kujalintzky-Liman than in those of the Chadjibej-Liman. For the same lake the number of Metazoa varies with varying salinity, *Daphnia brachiata* appearing when this falls to 5° B., and *Artemia salina* disappearing when it approaches saturation point. Generally, the fauna may be said to consist of fresh-water, marine, and saline forms, and of these the marine forms live chiefly on the banks. The greatest adaptability to varying conditions among the representatives of the Metazoa is displayed by the Crustacea, as is shown by their occurrence in water of very varying salinity.

Fauna of Salcombe Estuary.‡—Messrs. E. J. Allen and R. A. Todd, with the assistance of W. Garstang, W. J. Beaumont, T. V. Hodgson, and R. H. Worth, have given an account of the fauna of this estuary, which was the hunting ground of Montagu. As the authors say, "It is only by a large number of detailed records of this kind, where all possible information is given as to the exact localities and conditions in which each species is found, that we can hope to ascertain the general principles which underlie the distribution of the animals which live in the sea."

Tentaculites and Nowakia. § — Herr G. Gürich discusses these Silurian fossils, and emphasises especially the importance of the embryonic vesicle or nucleus in *Nowakia*, which points to the relationship of this genus with Molluscs (Pteropods), while *Tentaculites ornatus*, *T. schlotheimi*, *T. sandbergeri*, *T. tenuicinctus*, &c. seem to be genuine worm-tubes.

* Bull. Sci. Acad. Belg., 1900, No. 6, pp. 432–41 (6 figs.).
† Zool. Anzeig., xxiii. (1900) pp. 495–7. Cf. this Journal, 1897, p. 300.
‡ Journ. Mar. Biol. Ass., vi (1900) pp. 151–217 (1 chart).
§ Jahresber. Schles. Ges., lxxvii. (1900) pp. 32–5.

Indian Ocean Dredging.*—Dr. A. F. McArdle reports on the dredging season 1899–1900, and notes some of the most interesting finds:—e.g. a very large (12 in.) adult male of *Bathynomus giganteus*, the strange crab *Trichopeltarium ovale*, the Atlantic fish *Hoplostethus atlanticum*, 28 specimens of *Glyphocrangon investigatoris*, *Pleurotoma symbiotes* encrusted with *Epizoanthus*.

Mollusca.

α. Cephalopoda.

Effect of Reagents on Segmenting Eggs.† — Wl. Schimkewitsch has made a series of experiments as to the effect of concentrated sea-water, sulphate of manganese, sodium bromide, potassium iodide, and other substances, on the meroblastic eggs of *Loligo vulgaris*. He finds that the effect of any solution is twofold, the mechanical effect due to changes of pressure being distinct from the chemical effect. It would appear that of the two the former has the greater influence, as is seen from the fact that two compounds very different chemically may produce the same effect on the ovum. The most obvious effect produced is usually the formation of outgrowths of the egg or furrows on its surface, which produce notable changes in the growth and relations of the germinal layers. At certain stages in the development the ectoderm, under the influence of certain reagents, exhibits a teloblastic mode of increase, comparable to that seen, e.g. in primitive mesoderm cells, which suggests that the teloblastic method, when it occurs normally, may be due to special conditions of pressure. Again, certain reagents result in the shell-gland arising by a process of delamination instead of the normal invagination process. But while the author in this way points to various artificially produced phenomena which cast light upon normal processes, it would seem that the complete interpretation of the new conditions is not as yet possible.

Plague of Octopus.‡—Mr. W. Garstang reports that until the spring of 1899 the true or common Octopus (*O. vulgaris*) was comparatively rare in the neighbourhood of Plymouth, since the opening of the Plymouth Laboratory in 1888. But in 1899 and 1900 the numbers have enormously increased, on both shores of the English Channel—probably in association with the warmth of recent summers—and the result has been serious loss to crab and lobster fisheries. Mr. Garstang suggests the advisability of temporarily suspending all fishing for crabs and lobsters, and of employing a number of men to fish for octopus, e.g. with unbaited pots.

γ. Gastropoda.

Locomotion of Fulgur.§—Mr. W. S. Wallace observed the manner and rate of locomotion in *Fulgur carica* up the glass side of an aquarium. He says that the progression of the foot-surface over the smooth glass is accomplished by two devices:—(1) the pedal secretion is adhesive; and (2) the foot, when not in motion, becomes a vacuum-cup of considerable efficiency. But these cannot account for *progression*.

* Ann. Nat. Hist., vi. (1900) pp. 471–8.
† Zeitschr. wiss. Zool., lxvii. (1900) pp. 491–528 (4 pls.).
‡ Journ. Mar. Biol. Ass., vi. (1900) pp. 260–73.
§ English Mechanic, lxxii. (1900) p. 244 (4 figs.).

The rate was about $3\frac{1}{4}$ in. per minute on a smooth glass set vertically in water; almost equivalent to a refutation of the time-honoured saying, "as slow as a snail."

Development of Aplysia.*—D. Carazzi criticises Georgevitch's account of this development. In the first place he states that that author has mistaken the species, and that his specimens must have been eggs of *A. punctata* Cuv. and not of *A. depilans* as stated. Second, he criticises the method employed; and finally states that Georgevitch has inverted his eggs, placing the anterior region below, the posterior above, so that he has called the small blastomeres A and B, instead of C and D as they should be called. This cardinal error, according to Carazzi, vitiates the whole research.

Tectibranchs.†—J. Guiart gives a description of the structure of *Aplysia depilans* and *Philine aperta*, and discusses the affinities (*a*) between Bulleidæ and Aplysiidæ; (*b*) between Tectibranchs and Nudibranchs; (*c*) between Tectibranchs and Prosobranchs. His general views as to the phylogeny are expressed in this scheme:—

Dermatobranchs

Aplysiidæ

Pleurobranchs

Acera

Bulleidæ

Acteon

Prosobranchs

Arthropoda.

α. Insecta.

Metamorphosis of the Blow-fly.‡—Dr. F. Supino has made a fresh study of the post-embryonic development of *Calliphora erythrocephala*. We cite two conclusions:—(*a*) the supposed phagocytes of Kowalevsky, Viallanes, Rees, and others do not appear to act as such; the destruction of the larval adipose cells does not seem due to leucocytes; or, in any case, these elements are not indispensable in the process; (*b*) the imaginal adipose tissue is not developed at the expense of the muscle-nuclei, but from mesenchyme cells, which, though at first scattered, come to be regularly disposed as the foundation of the said tissue.

* Anat. Anzeig., xviii. (1900) pp. 382–4 (2 figs.). Cf. this Journal, 1900, p. 666.
† Causeries Scient. Soc. Zool. France, 1900, No. 4, pp. 77–132 (4 pls. and 35 figs.).
‡ Bull. Soc. Entomol. Ital., xxxii. (1900) pp. 192–216 (2 pls.).

Pupal Histolysis in Diptera.*—C. Vaney has studied this in artificially reared larvæ of *Gastrophilus equi* and in species of *Chironomus*, and gives an account of the various stages in the process. In Œstridæ, as in Muscidæ, the destruction of the tissues is due to phagocytes, which are no other than the cellular elements of the blood. In the blood of *Chironomus*, however, there are no elements which can act thus, and the phagocytosis is due to individualised cells of the adipose tissue.

Rôle of "Phagocytes" in Insect Metabolism.†—Prof. Antonio Berlese publishes a brief note on this subject. He considers that the term phagocyte is totally inapplicable to the amœbocytes or leucocytes of larval insects; for not only have these no destructive action on the larval tissues, but also they are incapable of digesting the detritus when these tissues have broken down. Their function is twofold:—they serve to transport elaborated food-material to areas in which formative processes are going on, and they are also capable of giving rise to new mesodermal tissue by direct transformation into its elements. Elements of the fatty body in the newly-hatched larva, and muscular elements, may arise in this way from leucocytes. When these convey food-material, they do not alter it in any way, so can have no digestive properties. In general they may be said to be the exact opposite of phagocytes.

Histolysis in Muscidæ.‡—Prof. F. Henneguy agrees with Berlese that the cells of the fatty body (in *Calliphora vomitoria* and *Lucilia cæsar*) are never attacked by phagocytes. As Berlese says, these cells are *trophocytes*,—elements which elaborate the substances necessary for the nutrition of the tissues of the nymph. Henneguy does not, however, deny that it may be otherwise; e.g. as Vaney describes, in Œstridæ.

Freezing of Body Fluids in Insects.§—P. Bachmetjew has continued his observations on the "critical point" in insects cooled below freezing-point. His previous results showed that, as is the case with water in capillary tubes, the body-fluids can be cooled considerably below their freezing-point before solidification occurs, and when it does occur there is an instantaneous rise of temperature to the normal freezing-point. His present results show that the exact point at which the solidification occurs (the critical point), depends, among other causes, upon the rate of cooling, but this dependence is by no means of a simple kind. Thus, a certain rate of cooling gives the critical point its minimum value in *Vanessa atlanta* and *Papilio podalirius*, and its maximum value in *Pieris rapæ* and *Aporia cratægi*. Again, the critical temperature differs in different species, though it may perhaps be said generally that the larger the pupa the higher is the critical temperature, i.e. the nearer it is to the freezing-point. The behaviour of para-nitrotoluol and benzol, when subjected to temperatures lower than those of their normal points of solidification, showed a striking analogy to that of the fluids of insects.

Silk of the Procession-Caterpillar.‖—Prof. R. Dubois notes the interesting fact that this caterpillar—*Cnetocampa processionæa*—spins

* Comptes Rendus, cxxxi. (1900) pp. 758–61.
† Zool. Anzeig., xxiii. (1900) pp. 441–9.
‡ Comptes Rendus, cxxxi. (1900) pp. 908–10.
§ Zeitschr. wiss. Zool., lxvii. (1900) pp. 529–50 (3 figs.).
‖ Ann. Soc. Linn. Lyon, xlvi. (1900) pp. 125–7.

a thread of silk as it goes, and that this, attached by the leader to the objects crept over, forms the clue which the others follow.

Alleged Termitophily.*—Herr C. Berg doubts the accuracy of the conclusion drawn by Wasmann and Horn as to the termitophilous life of certain Cicindelids (*Cratohæra bruneti*, *Cicindela cyanitarsis*, and *Chilonycha auripennis*). Berg thinks that the cases should be described as "*termitariophilous*," not termitophilous. The Cicindelids select the termitaries as sunny places well suited for play and for hunting (for flies, spiders, &c.), and also affording some protection from lizards. As the Cicindelids feed by day they have little to do with the nocturnal termites.

Aphis of the Sugar-Beet.†—P. Doerstling finds, in Oregon, a disease of the sugar-beet due to the ravages of an aphis. It attacks the root first of all, proceeding thence to the leaves, and causes a large reduction in the produce of sugar by converting it into glucose and free acid.

Colour-Changes in Locusts.‡—J. Künckel d'Herculais shows that in the American *Schistocerca paranensis* Burmeister, as in the Old World *Sch. peregrina*, red coloration characterises the hibernating period and yellow that of pairing and egg-laying. He gives an account of the various changes in the course of life, and regards the pigment as zoonerythrin.

Habits and Metamorphoses of Beetles.§—Captain Xamben has published the tenth of his memoirs on this subject. He deals especially with the Clytridæ (*Clytra*, *Labidostomis*, *Gynandrophthalma*, *Coptocephala*, *Lachnæa*) and Cryptocephalidæ (*Cryptocephalus stylosomus*, and *Pachybrachys*). There are interesting general notes on the behaviour of the larvæ and adults.

German Species of Aspidiotus.‖—Dr. L. Reh has an interesting note upon this point. It has been generally supposed that there is one species of *Aspidiotus* in Germany, the *A. ostreæformis* of Curtis. The author found recently that specimens from North Germany differed in various respects from the (by hypothesis) typical *A. ostreæformis* of South Germany. Curtis' original description is not of great assistance; but from English entomologists the author learnt that the traditional *A. ostreæformis* of England is the North German form, while he finds that the South German form hitherto called by that name by the Agricultural Bureau is apparently *A. pyri* Lichtenstein. The distribution is interesting; for while the one is typically a northern form and the other a southern, they overlap in Mid-Germany, where one fruit-tree may be infested by the two species. Again, in America there is also a northern (*A. ancylus*) and a southern (*A. perniciosus*) form, and the two show respectively marked affinities with *A. ostreæformis* and *A. pyri* respectively.

Parasites of Oaks.¶—L. G. Seurat gives an account of the more destructive parasites of *Quercus suber* and *Q. mirbecki* in Tunis. The

* Comun. Mus. Nac. Buenos Aires, i. (1900) pp. 212–5. See Zool. Centralbl., vii. (1900) pp. 701–2.

† Zeitschr. f. Pflanzenkrankheiten, 1900, p. 21. See Bot. Centralbl., lxxxiv. (1900) p. 329.

‡ Comptes Rendus, cxxxi. (1900) pp. 958–60.

§ Ann. Soc. Linn. Lyon, xlvi. (1900) pp. 1–72.

‖ Zool. Anzeig., xxiii. (1900) pp. 497–9.

¶ Ann. Sci. Nat. (Zool.), xi. (1900) pp. 1–34 (10 figs.).

most dreaded parasite in the case of the cork-oak is the ant *Cremastogaster scutellaris*, which constructs its nests in the corky layer, and by means of its formidable mandibles works great destruction, rendering the cork quite useless. Again the valuable wood of *Quercus mirbecki* is attacked by the larvæ of *Cerambyx mirbecki*, whose habits the author was unable to study. In addition, the wood after felling is liable to the attacks of a large number of insects, whose structure and habits are noted.

New Genus of Flies.* — G. Wasmann records four species of an interesting new genus of flies found in nests of Termites. The point of interest is the external resemblance to the physogastric Aleocharinæ, so that the author did not at first doubt the label "Staphylinid beetle" which accompanied the first specimen sent to him from Natal. Later he found that the insects in reality belong to the order Diptera, family Stethopathidæ, and he describes four species all belonging to *Termitoxenia* g. n. From the somewhat lengthy diagnosis the following, as illustrating the most important characters, may be quoted :—"Labium biarticulatum, longe productum instar stili vel rostri, art. 2° fisso, apicibus acutis, sub-corneis. . . . . Prothorax angustus, oblongus, convexus, sub angulo basali externo utrimque appendice mobili (plerumque erecto), vel stiliformi vel hamiformi, munitus. Meso- et metanotum sub abdominis basi occulta. Abdomen infra recurvatum, ano antrorsum directo, peramplum in ♀, modice inflatum in ♂." It is the shape of the abdomen especially which renders the resemblance to such beetles as *Corotoca* and *Spirachtha* so striking. The remarkable thoracic appendages are believed by the author to function as transporting organs, enabling the flies to attach themselves to the hosts. Further, he believes that from the characters of the mouth-parts the flies must be regarded as ectoparasites of the Termites. Further details, especially in regard to histology, are to follow.

Structure of Insect Testes.†—Herr N. Cholodkowsky maintains the view that the giant cell or Verson's cell is to be regarded partly as a "rhachis"—a residue of the division process with nutritive significance for the developing spermatozoa—and partly as a primitive sperm-cell, for it may exhibit mitoses. The varied occurrence of the "rhachis" in different types is discussed.

Bees as Reflex Machines.‡—Abraham Netter directs attention to the numerical and geometrical regularities illustrated in the life and labours of bees, and indicates a number of facts, such as the result of shifting the hive, which point to the conclusion that they are automatic reflex machines. He also asks a number of curious questions, e.g. whether the hexagonal mosaic of the eye may not be associated with the plan of the combs.

β. Myriopoda.

Volatile Poison of Iulus terrestris.—C. Phisalix § has studied the yellowish secretion which escapes from the cutaneous glands of this

* Zeitschr. wiss. Zool., lxvii. (1900) pp. 599–617 (1 pl.).
† Trav. Soc. Imp. Nat. St. Pétersbourg, xxx. (1900) 5 pp. (Russian, with German summary). See Zool. Centralbl., vii. (1900) p. 699.
‡ Comptes Rendus, cxxxi. (1900) pp. 976–8. § Tom. cit., pp. 955–7.

millipede. It has a pungent odour and is certainly poisonous. It is not an albuminoid and it is markedly volatile.

A subsequent paper by Behal and Phisalix * details the chemical evidence which has led these authors to the conclusion that the poison includes a quinone, and very probably the ordinary quinone. They point out that although the production of analogous substances by other invertebrate animals is unknown, Beyerinck has shown that the saprophytic *Streptothrix chromogenes* found about the roots of various trees produces quinone which has an important rôle in helping to form humus. It is interesting therefore to recall that *Iulus* feeds on vegetable debris. The penetrating odour of the quinone is probably protective to the millipede.

Poison of Scolopendra morsitans.† — Prof. S. Jourdain recalls his observations of thirty years ago, in which he showed that the poison of this centipede is fatal to small mammals and birds, but, as he points out, this is a very different affair from that which Phisalix has discovered.

δ. Arachnida.

Kœnenia mirabilis in Texas.‡ — Prof. W. M. Wheeler announces this very interesting discovery. The remarkable animal which he describes is a primitive synthetic form, found by Grassi in Sicily, and established by him as a type of the distinct arachnid order of Microthelyphonida. In Europe it was found associated with *Iapyx*, *Campodea*, *Pauropus*, and *Scolopendrella*; in Texas it was associated with the same series, excepting *Pauropus*; it perhaps feeds on the eggs of *Campodea* or *Iapyx*. It is probably a relict of an ancient widely distributed fauna, analogous to *Projapyx stylifer* from Liberia and the Argentine Republic.

Accessory Chromosome in Sperm-cells of Spider.§ — Miss L. B. Wallace notes that the "chromosome nucleolus" or "accessory chromosome," known to occur in the testicular cells of various insects, is to be seen in the late spermatogonia and in the prophase of the first spermatocyte in an Agalenid spider.

Is there Polymorphism and Parthenogenesis in Gamasidæ? ‖ — Dr. Anna Foa has investigated these two questions. There is no polymorphism, though there is admittedly specific variability. The forms which Berlese regarded as within the species *Gamasus coleoptratorum* include two other distinct species — *G. pusillus* Berl. and *G. crassus* Kr. The same is true of the alleged polymorphism of *Holostaspis*. Nor is there any definite evidence of parthenogenesis. At the proper seasons the males of all the species are always discoverable.

ε. Crustacea.

Patagonian Cladocera.¶ — Sven Ekman describes a collection of Cladocera obtained in ponds, &c. in Patagonia. The collection includes many new species. In collections made from the end of February

* Comptes Rendus, cxxxi. (1900) pp. 1004–7. † Tom. cit., pp. 1007–8.
‡ Amer. Nat., xxxiv. (1900) pp. 837–50 (4 figs.).
§ Anat. Anzeig., xviii. (1900) pp. 327–8 (5 figs.).
‖ Bull. Soc. Entomol. Ital., xxxii. (1900) pp. 121–49 (13 figs.).
¶ Zool. Jahrb. (Abt. Syst.), xiv. (1900) pp. 62–84 (2 pls.).

to the end of March, males and winter eggs were found. The season corresponds to the late autumn of Europe, and the fact indicates that, as in European forms, an autumnal breeding season occurs.

Fresh-water Ostracods of Germany.* — Herr G. W. Müller completes his monograph, dealing with Cypridæ, Cytheridæ, Darwinulidæ.

Development of Leptodora hyalina.†—Max Samter has undertaken the study of this development, in the hope of settling some of the controversies in regard to the phylogeny of the Cladocera. The present instalment of the work includes an account of the development up to the time when the embryo quits the vitelline membrane and begins life on its own account. Like Weismann the author was unable to stain the nucleus of the unsegmented egg deeply, and found that it appeared as a light spot in all his preparations. From the characters of the egg and the nature of the gastrulation process, the author believes that the yolk in the egg is a recent acquisition which has produced remarkable modifications of the process of development. In the unsegmented egg there is a nearly central mass of protoplasm containing the segmentation nucleus, and sending out protoplasmic prolongations through the envelope of yolk in all directions to a peripheral layer of protoplasm. The polar body was not clearly made out, though the author noted appearances similar to those observed by Weismann in Daphnids. The first and second segmentation furrows are internal, but at the eight-cell stage the products of division approach the surface and fuse with the superficial protoplasm. As division proceeds, the egg-surface shows scattered cells connected by protoplasmic processes lying on a field of yolk, and the internal yolk shows no sign of segmentation. A blastosphere in the ordinary sense is therefore not formed before gastrulation begins. This process takes place in the following way. The surface of the egg is covered with cells which are only loosely connected, and show numerous intracellular chinks and fissures through which the yolk-spherules appear. At one spot these fissures are larger than elsewhere, and this spot marks the origin of the endo-mesodermic primordium. Round this area the smaller ectoderm cells proliferate, and at the same time a movement of the endoderm cells begins, so that the endo-mesodermic disc gradually diminishes in size. The inwandering of endoderm cells is most pronounced in the posterior region of the disc, the cells of which ultimately take up a position on the ventral surface and form a closed cell-layer. Others of the endoderm cells are merely overgrown by the proliferating ectoderm, so that generally it may be said that the method of gastrulation is, as it were, intermediate between invagination of the ordinary type and the immigration of isolated cells. The relations of this method of gastrulation to other types found in Crustacea, and the conclusions as to the position of *Leptodora* to be drawn from its occurrence in this type, the author intends to discuss in the general part of his work. He believes that the invagination of the endoderm primordium is prevented by the resistance of the newly acquired yolk, and therefore that the modified process of gastrulation is accomplished in part by active movements of the separate cells, in part by passive overgrowth by the ectoderm cells.

* Zoologica, Heft 30, ii. (1900) pp. 49–112 (4 pls.).
† Zeitschr. wiss. Zool., lxviii. (1900) pp. 169–260 (6 pls.).

Arthropod Vision.*—Dr. Em. Rádl considers that those who have discussed this subject have not realised the importance of a study of the nerve-centres of the eye, as well as of the dioptric apparatus itself. His belief that the key to the problem of Arthropod vision is to be sought in the central rather than in the peripheral organs, has led him to make an exhaustive examination of the optic tract in *Squilla mantis*, as well as of the eye itself. He briefly describes the external appearance of the eye, and gives a very comprehensive account of the occurrence of the phenomenon of "double eyes"—well known to occur in *Squilla*—in other Arthropods, both aquatic and terrestrial. He then somewhat briefly describes the eye itself, and gives a full account of the structure of the eye-ganglia. Each ommatidium gives off seven nerve-fibrils which unite in a bundle, and as these bundles cross the space between the basal membrane of the eye and the first ganglion (ganglion retinæ), those from neighbouring ommatidia unite to form larger bundles. In the first ganglion these bundles break up into their constituent fibrils. This first ganglion, like the eye itself, is made up of two halves, which are connected by a thick bundle of vertical nerve-fibres. The ganglia have a complicated structure, an especially important element being the granular layer, which contains darkly staining bodies, the "nerve-nodes" (*Nervenknoten*), corresponding in number to the ommatidia. These consist of neuroglia-fibrils, of a homogeneous substance with the staining reactions of neuroglia-fibrils, and especially of a group of nerve-fibrils, to whose presence the node is due. It would seem that each node contains fibrils from several ommatidia, but the fibrils apparently do not end at the node, but pass on through this first ganglion to the other ganglia behind. As the fibrils leave the first ganglion to pass to the second, they cross so that those at the right side become left, and *vice versa*. The importance of this crossing the author believes lies in the varying lengths of the fibres, for he thinks that this variation in length has a direct physiological significance. This significance he explains as follows. Suppose the eye to be stimulated in such a way that a certain set of retinulæ receive an equal impulse. These impulses travel down the fibrils to, e.g. the second ganglion, but as the lengths of the paths they have to travel vary, they will not arrive simultaneously, but one after the other according to the relative lengths of the fibrils. In general terms it may be said that every adequate stimulus will produce a periodic cycle of changes in the receptive organ. Even if we suppose a stimulus to affect one ommatidium only, there would be set up a successive series of changes in the nerve-centres, for each ommatidium, as noticed above, has seven nerve-fibrils, and each of these has (apparently) a course of different length from those of its neighbours. This theory of Arthropod vision was reached by the author as the result of a process of induction, but he believes that it receives confirmation from the theories of other authors, e.g. Exner, who have based their conclusions on theoretical grounds.

Variations in Crest of Daphnia hyalina.† —Miss M. M. Enteman discusses the variability in the cephalic crest of this species. Every kind of crest displayed in the genus may be observed in the species,

* Zeitschr. wiss. Zool., lxvii. (1900) pp. 551–98 (1 pl.).
† Amer. Nat., xxxiv. (1900) pp. 879–90 (6 figs.).

which at the same time remains relatively constant in other distinguishing characters. The varieties may be classed under five types, three of which are quite the same as those described for Europe under the names *pellucida*, *galeata*, and *gracilis*, while two are peculiar to the American lakes. The interest of the communication is increased by the fact that the range of variation described is confined to the summer forms, which are parthenogenetic.

Nervous System of Crayfish.*—Ph. Owsiannikow has investigated the minute structure of the nerve-elements in *Astacus fluviatilis*, and the general structure of the nervous system. He finds that the nerve-cells possess a membrane, and contain primitive fibrils of varying calibre. The smaller fibrils form a network about the nucleus, the larger, which lie nearer the cell-periphery, unite to form a thick bundle which passes out of the cell into the axis-cylinder. The nucleus possesses a firm membrane, and contains one or two corpuscles. Almost all the nerve-cells are unipolar, and give rise usually to one nerve only. In the ganglia white and grey matter can be distinguished, and there are two kinds of nerve-cells, the large and the small. The large cells give rise to broad processes which become the fibres of the longitudinal commissure. These fibres may cross so that the right becomes the left and *vice versa*. With the small nerve-cells are connected fibrils belonging chiefly to the first pair of nerves in each ganglion. These fibrils are also, owing to the branching of their processes, connected with the grey substance of the right and left half of the chain, and in addition send fibrils to the longitudinal commissure. The last-named fibrils, during their passage through the ganglion, may give off branches which lie chiefly in the grey substance of the same side. The nerve-fibrils which enter the ganglia from the second pair of nerves mostly branch in the grey substance without coming into connection with nerve-cells, but a few unite with the small nerve-cells, and form fibrils which go to the longitudinal commissure. In consequence of these relations, the first pair of nerves in the crayfish must be homologised with the anterior roots of the Vertebrate nerves, the second with the posterior roots. The so-called third pair of nerves in the crayfish consists almost exclusively of blood-vessels. Besides the connection indicated above between the grey substance of the two sides of the ganglia, certain specially large cells give off processes which connect the grey matter of the two sides.

Annulata.

Sipunculus nudus.†—S. Metalnikoff has made an exhaustive study of the anatomy and histology of this Gephyrean. Among the points of interest made out, the following may be noticed. Pigment-cells occur in varying numbers, not only in the skin but in all the organs of the body except the muscles. The cells disappear during starvation, when the body becomes perceptibly paler. They vary greatly in size and in the number of their nuclei, and appear to possess considerable power of locomotion. The author is disposed to regard them as parasitic amœbæ or rather plasmodia; in not a few cases he found that they were entirely absent. He finds that the diverticulum of the gut is large in young and

* Mém. Acad. Impér. Sci. St. Pétersbourg, x. (1900) pp. 1–29 (1 pl.).
† Zeitschr. wiss. Zool., lxviii. (1900) pp. 261–322 (6 figs.).

small individuals, but degenerate in large ones, and believes that its function is to increase the secretory surface in the small individuals which have a relatively short gut. In the brain four types of nerve-cells were made out in addition to neuroglia-fibres and cells. The author makes no suggestion as to the affinities of *Sipunculus*.

Study of English Channel Polychæts.*—Mr. T. V. Hodgson brings into compact form the records of those Amphinomidæ, Aphroditidæ, Polynoidæ, and Sigalionidæ, known to occur in the Channel, and gives descriptions of species and synoptical tables which will be of service to other workers. The section dealt with is that treated of by M'Intosh in the recently published part of his monograph, to which Mr. Hodgson acknowledges his indebtedness.

Arenicola.†—Dr. P. Fauvel gives an account of the structure and habits of lob-worms, and discusses their distribution and systematic relations. There is only one genus constituting the family Arenicolidæ; *Branchiomaldane* and *Arenicolides* are not justifiable genera. The family shows no transitions towards the Maldanidæ. The most primitive species is *A. ecaudata*, one of the most evolved is *A. claparedii*, while *A. vincenti* is degenerate.

Anatomy and Classification of Arenicolidæ.‡—Messrs. F. W. Gamble and J. H. Ashworth find that there are three British species of *Arenicola*, *A. marina*, *A. ecaudata*, and *A. grubii*. In addition there are two other species, *A. claparedii*, Mediterranean and Pacific, and *A. cristata*, Mediterranean, Florida, and Jamaica. The American forms described as *A. natalis* Gir. and *A. arenata* both belong to the species *A. marina*. Audouin and Milne-Edwards' species *A. branchialis* was possibly founded on specimens of *A. grubii*; but as the type specimens are lost, and the descriptions insufficient, the species should lapse. The five recognisable species fall into two groups, *A. ecaudata* and *A. grubii* differing from the other three in the absence of a tail, the simple prostomium and brain, the shape of the nephridia, and some other points. In regard to specific characters, the authors find that the most reliable are founded on the characters of the otocysts, prostomium, and nephridia taken together, and they give diagnoses depending on these points. The external characters are subject to great variation in all the species. The authors have also made a number of observations on the anatomy of the different species, and on the post-larval stages. Among the most striking of their results are the following. Giant-fibres and segmentally arranged giant-cells occur in the nerve-cord of all the species except *A. claparedii*. All the species possess eyes during at least the immature stages; they are superficial in the larva, but sink in until in the adult they are found among the ganglionic cells of the brain. The Arenicolidæ show most affinity with the Maldanidæ, but nevertheless form a well-defined group. Special mention should be made of the figures, which are numerous and clear.

Affinities of Procerastea (Langerhans).§—Ch. Gravier obtained four specimens of a new species of this genus in the Bay of La Hougue,

* Journ. Mar. Biol. Ass., vi. (1900) pp. 218–59.
† Mém. Soc. Sci. Nat. Cherbourg, xxxi. (1898–1900) pp. 101–86 (11 figs.).
‡ Quart. Journ. Micr. Sci., xliii. (1900) pp. 419–569 (8 pls.).
§ Ann. Sci. Nat. (Zool.), xi. (1900) pp. 35–50 (1 pl.).

and in describing his species discusses the position of the genus. It was founded by Langerhans for a Syllid without dorsal cirri. The author's species, *P. perrieri*, is larger than that of Langerhans, and shows well-marked differences. The four specimens were all males, and consisted each of a stock and a sexual stolon. As to the genus, the condition of the parapodia shows that it is to be regarded as including the simplest of the Syllids. It is nearest to the genera *Virchowia* and *Autolytus*, both more highly specialised forms, and the relations of the four genera of the *Autolytus* group are indicated by the author as follows :—

Procerastea

Virchowia *Autolytus*

Myrianida

A Viviparous Syllid.*—Mr. E. S. Goodrich notes the discovery, in a tank at the Naples zoological station, of a Syllid which is apparently *Syllis vivipara* Krohn. Krohn's description is somewhat vague, and his statement that his worm is viviparous has been doubted by later authors. Goodrich's specimens, whether specifically identical or not, place the occurrence of viviparity in the Syllidæ beyond a doubt, and he figures adults showing well-developed embryos within the cœlom. He is however entirely unable to solve the problem as to how the eggs are fertilised, if they are fertilised. The fact that there is no obvious path by means of which sperms from another individual could reach the ova, seems to leave only two possibilities ; (1) that the eggs develope parthenogenetically ; (2) that the animals are hermaphrodite and self-fertilised. Of the latter suggestion no proof in the shape of ripe spermatozoa could be obtained ; so the question remains undecided.

Spermiducal Glands of Australian Earthworms.†—Miss Georgina Sweet has investigated the structure of these glands and the associated parts in 32 species of earthworms from Australia and Tasmania. She finds that in the species examined it is possible to show that a complete series exists connecting the simplest tubular form of the gland with the complex lobular condition. To this statement, however, the spermiducal gland of *Acanthodrilus sydneyensis* forms an exception, for it cannot be referred to any position in the series afforded by the other forms.

Regeneration in Lumbriculus variegatus Gr.‡— Dr. Franz von Wagner finds that in this worm the process of regeneration depends firstly on the formative activity of the epidermis, which under special circumstances is capable of producing a mass of regeneration-cells, and secondly on the capacity which the gut epithelium displays for producing new elements without disturbance of its existing organisation. Except for the food-canal, all regenerated organs and parts of organs originate from the

* Journ. Linn. Soc., xxviii. (1900) pp. 105–8 (1 pl.).
† Tom. cit., pp. 109–39 (2 pls.).
‡ Zool. Jahrb. (Abt. Anat.), xiii. (1900) pp. 603–82 (4 pls.).

ectoderm; but the food-canal, with the exception of a small buccal region, has an endodermic origin. There is no special mesoderm primordium, nor do the regeneration-cells arrange themselves in special masses for the different organs. Two periods can be distinguished in the process of regeneration:—the first is the organogenetic period, when the foundation of the organs is laid down; and the second the growth period, when the new organs acquire their normal relative size. The nervous system is the first structure to be regenerated in all cases, and of its parts the brain developes first, then the gullet ring, and finally the ventral chain. The first indication of segmentation in the regenerated region occurs in the ventral nerve-chain, which divides up into metameric ganglia. Later the dissepiments are formed, and finally the bristles appear and the segmentation becomes visible externally.

The author's observations were made on worms artificially mutilated, but he finds that *Lumbriculus* exhibits transverse division under normal conditions as a form of asexual reproduction. He distinguishes generally artificial regeneration as *reparation*, from the true regeneration which follows on normal asexual reproduction, but notes that in *Lumbriculus* there is virtually no distinction between the two processes. Except for the extreme head and the tail, the power of regeneration is very great at all parts of the body.

Egg of Allolobophora fœtida.*—Miss K. Foot and E. C. Strobell publish a series of photomicrographs of this egg, which they have taken in order to illustrate the following points:—(1) the effect on the cytoplasm of the different fixatives in common use; (2) the characters of the fertilisation cone; (3) the position of the middle piece in the male aster; (4) the origin of the sperm-granules; (5) the early stages in the development of the pronuclei; (6) the presence of osmophile granules in the nucleoli of the germinal vesicles. The photographs have been taken at two magnifications, 660 and 950, and the authors believe that they furnish objective proof of some of Miss Foot's previous conclusions, e.g. in regard to the cytoplasmic origin of the centrosome of the male aster. The paper is the first of a series of illustrated studies in which the authors hope to treat the first point especially in detail.

Structure of Leech Somite.†—Mr. J. Percy Moore notes that in his recent paper ‡ on a new biannulate leech, he made no mention of Oka's § leech (*Ozobranchus mendiesi* ?), as the description had escaped his notice. In the present communication he points out the resemblances and differences between his own and Oka's biannulate form. The resemblances he regards as striking, the somite in each case consisting of a large and a small annulus. Further, he believes that they are such as to confirm his view that the large annulus is the equivalent of the neural annulus plus its predecessor in *Pontobdella*, and therefore that the neural annulus is morphologically the middle ring of the 3-annulate leech somite.

Protonephridia of Leeches.‖—Boris Sukatschoff has studied these structures in embryos of *Nephelis vulgaris* and *Aulastomum gulo*, with special reference to Bergh's views as to their relation to those of *Poly-*

* Journ. Morph., xvi. (1900) pp. 601–18 (3 pls.).
† Zool. Anzeig., xxiii. (1900) pp. 474–7 (1 fig.).
‡ Cf. this Journal, 1900, p. 585. § Zool. Mag., vii. (1895) pp. 1–7.
‖ Zeitschr. wiss. Zool., lxvii. (1900) pp. 618–39 (2 pls. and 3 figs.).

gordius. With some modifications of detail, his results strongly resemble those of Bergh. He finds that abnormalities at times occur in the protonephridia of *Nephelis* which bring these closer to those of *Polygordius* than Bergh thought. The protonephridia of *Nephelis* strongly resemble these of *Aulastomum*, but the latter are more complex, and suggest comparisons with the permanent excretory organs of the adult or of related simpler forms. The author agrees with Bergh that the protonephridia of leeches are derived from those of such a form as *Polygordius*, but are phylogenetically highly specialised structures.

Nematohelminthes.

Mode of Filarial Infection.*—Sigg. B. Grassi and G. Noè first of all corroborate Bancroft's suggestion that the Filariæ pass from mosquito to man only in the act of biting. Secondly, in the case of *Filaria immitis* in *Anopheles*, they show that the embryos develope in the Malpighian vessels, pass into the cavity of the body, and reach the prolongation of this in the labium. They explain in detail the very interesting way in which the larvæ pass from the labium in the act of biting.

Development of Sclerostomum equinum.†—A. Conte describes the ovoid eggs with their delicate shells, the formation of the blastula with two large initial endoderm-cells, the embolic gastrulation, and the appearance of the two initial mesoderm-cells, the formation of two ventral mesoderm-bands and of four longitudinal rows of endoderm-cells, the beginning of the stomodæum and the nervous system, the endodermic origin of the primitive intestine, and its strange subsequent replacement by a non-endodermic secondary intestine. The retrogression of the primitive endoderm recalls what Heymons and Lecaillon have described in certain insects.

Platyhelminthes.

Enterostoma mytili (v. Graff).‡—Herr H. Sabussow describes this Turbellarian from the gills of the edible mussel. One of the most remarkable features is the combination of the genital aperture with the mouth and the opening of the resulting porus communis at the posterior end of the body. Perhaps, like a form described by Böhmig from Lessina, it should be separated from the genus *Enterostoma*. A position between *Allostomina* and *Cylindrostomina* is suggested for both.

Two Large Species of Distomum.§—Herr H. v. Buttel-Reepen describes *D. ampullaceum* sp. n., 47 mm. in length by 22 mm. in breadth and 16 mm. in thickness, said to have come from a cetacean in the Indian Ocean, but more probably (according to the author) from a *Coryphæna* which seafarers sometimes call a dolphin. A second large form, *D. siemersii* sp. n., from the stomach of *Sphyræna barracuda* in the Atlantic Ocean, measured 31 by 12 by 10 mm.

New Genus of Distomidæ.‖—Herr Th. Odhner finds it necessary to establish a new genus—*Gymnophallus*—for *Distomum deliciosum* Olss.,

* Centralbl. Bakt., 1te Abt., xxviii. (1900) pp. 652–7.
† Comptes Rendus, cxxxi. (1900) pp. 846–8.
‡ Zool. Anzeig., xxiii. (1900), pp. 256–63.
§ Tom. cit., pp. 585–98 (9 figs.).
‖ Centralbl. Bakt., 1te Abt., xxviii. (1900) pp. 12–23 (4 figs.).

D. micropharyngeum Lühe, *D. somateriæ* Lev., and two new species, *Gymnophallus choledochus* and *G. bursicola*,—all from swimming birds such as gulls. The name refers to the absence of a cirrus-pouch, but the distinctive features are numerous. The nearest allies seem to be among the Cœnogoniminæ.

Distomum arcanum.*—Prof. W. S. Nickerson describes this new species, which lies hidden in cysts forming considerable swellings just at the pylorus of American frogs. It is closely related to several species (*D. medians*, *D. clavigerum*, *D. confusum*), which it resembles in its small size, compact form, spiny covering, rudimentary intestine, and laterally placed sexual aperture, as well as in being parasitic in the intestine of the frog.

Genus Podocotyle (Duj.) Stoss.†—M. Lühe discusses the value of this generic name, which was used by Dujardin as the name of a subgenus of *Distomum*, including those species with a stalked ventral sucker, and was erected into a separate genus by Stossich. Lühe has had an opportunity of examining *Podocotyle furcata* (= *Distomum furcatum* Brems.), and has made out various points which should aid in drawing up a generic definition. Thus he finds that, in addition to the stalked ventral sucker, there is a smaller sessile sucker which lies beside the genital atrium, but does not envelope it. It is probable that the stalked sucker is the homologue of the ordinary ventral sucker of other flukes, and that the sessile sucker is an accessory structure. The topography of the genital organs is also described, but the author notes that, as Stiles and Hassall have taken *D. angulatum* Duj. as the type of the genus *Podocotyle*, he cannot draw up a generic definition on the basis of his own observations on *D. furcatum*, for it is quite uncertain how far this species resembles *D. angulatum*. As Dujardin's description of his own species is brief and unsatisfactory, the deadlock must continue till the species be re-found and re-described, and forms an object-lesson illustrating the necessity for supreme care in the choice of type-species.

Genus Clinostomum (Leidy).‡—Prof. M. Braun sums up his various brief notices on this subject in a general account of the history, general characters, and species of the genus, with references and synonymy. The genus is defined by the form of the body, which shows a division into two regions, by the obliquely truncated anterior end of the body, by the absence of a true pharynx and the shape of the alimentary canal, and by the characters of the excretory and especially of the genital system, in which the presence of a large uterine diverticulum (the uterus-sac) is specially noteworthy. In the genus so defined the author includes nine species, which are all fully described. He also notes a number of young forms described by various authors, some of which can be referred to existing species, while the position of others remains uncertain.

Hydatid Fluids.§—E. Couvreur analysed the fluid of a huge cyst (*Cœnurus serialis*) in a rabbit. There was no albumin, globulin, or

* Amer. Nat., xxxiv. (1900) pp. 811–5 (1 fig.).
† Zool. Anzeig., xxiii. (1900) pp. 487–92.
‡ Zool. Jahrb. (Abt. Syst.), xiv. (1900) pp. 1–48 (2 pls.).
§ Ann. Soc. Linn. Lyon, xlvi. (1900) pp. 73–4.

peptone, but evidently a protoproteose, with traces of sugar. In acephalous cysts of *T. echinococcus* he found deuteroproteose and sugar. A non-parasitic pulmonary cyst contained sugar, traces of proteose, and a considerable quantity of urea.

New Cestodes.*—Prof. St. von Ratz describes from a species of *Varanus* three new tapeworms,—*Ichthyotænia biroi*, *I. saccifera*, and *Tænia mychocephala*; the special interest of the first two being that they add to the small list of cases where fish-tapeworms have been found in higher Vertebrates.

Incertæ Sedis.

Double Forms of Loxosoma.†—Mr. W. S. Nickerson describes five double monsters, united side to side and with a common foot, and interprets them as due to the incomplete separation of two masses of germinal tissue, destined under normal conditions to give rise to two distinct buds.

Echinoderma.

Antarctic Echinoids and Ophiuroids.‡—Prof. R. Kœhler makes a preliminary report on the Echinoids and Ophiuroids of the Belgian Antarctic expedition. They exhibit a very distinct facies "without any analogy with arctic and sub-arctic or with sub-antarctic forms." In short, the results are quite opposed to the theory of bipolarity.

Genital Organ of Larval Antedon.§—Achille Russo finds that the primary genital cells of *Antedon rosacea* are not, as is generally supposed, formed by a proliferation of the "genital stolon," but first appear in a mesenteric structure placed in the interradius C D. These primary sexual elements have a very brief existence, and have disappeared before the arms begin to bifurcate. The organ which becomes the "genital stolon" of the adult appears in the interradius A B, and completely replaces the earlier structure. These facts the author regards as being of great importance in connection with problems of Echinoderm morphology, and especially in regard to the affinities of Crinoids, Cystoidea, and Holothurians. Thus, in Holothurians the primary genital cells arise in the mesentery of interradius C D, the organ being apparently homologous with that of the larval *Antedon*. Again, in the Holothurian the formation of the genital organ is accompanied by the formation of the aboral lacuna and sinus, structures which are also indicated in the larval *Antedon*, though they atrophy with the primary genital organ. Further, the author believes that the larval genital organ of *Antedon* is homologous with that of the Cystoidea, which was also, as is seen from its aperture, placed in the interradius C D.

Cœlentera.

Mesenterial Filaments.||—Prof. J. Playfair M'Murrich has studied these in various Actinians, but especially in *Zoanthus sociatus* Ellis. In adults there is no histological continuity between the glandular streaks

* Centralbl. Bakt., 1te Abt., xxviii. (1900) pp. 657–60.
† Amer. Nat., xxxiv. (1900) pp. 891–5 (6 figs.).
‡ Comptes Rendus, cxxxi. (1900) pp. 1010–12.
§ Atti (Rend.) R. Accad. Lincei, ix. (1900) pp. 361–6 (2 figs).
|| Trans. Canadian Inst., vi. (1899) pp. 387–404 (11 figs.).

and the ciliated bands; in egg-embryos the glandular streaks develope before the ciliated bands make their appearance; in the same embryos the streaks make their appearance on mesenteries that are not connected in any way apparently with the ectoderm; and in bud-embryos the ciliated bands appear before the glandular streaks. Therefore it seems to the author that the ciliated bands must be regarded as being ontogenetically distinct from the glandular streaks. But although he is prepared to call the ciliated bands ectodermal in all cases, the glandular streaks seem to be endodermal in some mesenteries and ectodermal in others. But since every kind of cell—glandular, muscular, sensory, ganglionic, and even nematoblastic—which occurs in the ectoderm, may also occur in the endoderm, it seems to the author that in Cœlentera the two layers are hardly as yet differentiated from one another.

Anemones from Jamaica.*—Mr. J. E. Duerden publishes a second instalment of his work on this subject, containing descriptions of various members of the order Stichodactylinæ, and of three new species of *Parazoanthus.* He divides the order Stichodactylinæ into two new sub-orders:—(1) Heterodactylinæ, in which the tentacles are of two forms; and (2) Homodactylinæ, in which they are all of one kind. In regard to the genus *Parazoanthus*, the author notes that pigment-granules and zooxanthellæ are present in inverse ratio to one another, the granules of certain species appearing to replace the zooxanthellæ of other species. He finds that this is also the case in other families of Actiniaria, and suggests that the pigment-granules may perform the same function as the zooxanthellæ, and may be regarded as free chromoplasts.

Protozoa.

Sexual Zygosis in Protozoa.†—Prof. E. Ray Lankester points out that the microgametes in the Coccidiidæ and Hæmamœbidæ are similar to the spermatozoa of Metazoa both in appearance and in mode of development. He emphasises this point by a detailed comparison of the process by which the microgametes arise in those Protozoa, and the method of formation of spermatozoa in the earthworm, which shows how close the resemblance is. But it is remarkable that the zygote of the malarial parasite after fertilisation gives rise to *blasts* or *filiform young*, which in form and mode of development are identical with microgametes. In other organisms the fertilised egg-cell produces as fission-products cells which are similar to female cells (*oomorphous* or *gynæcomorphous* cells), but in the Hæmamœbidæ the fertilised zygote produces *andromorphous* or *spermatomorphous* cells. As these cells are capable of carrying on the life of the species without conjugation, the author believes that we have here parthenogenesis by means of male elements (*androcratic* parthenogenesis), and that the existence of these spermatomorphous blasts is "a distinct proof that the spermatozoon is, so far as its essential nature is concerned, capable of acting the part of the solely sufficient germ in a parthenogenetic reproduction or multiplication."

Karyokinesis in Vampyrella.‡—Prof. P. A. Dangeard describes the karyokinesis of *V. vorax.* The chromosomes seem to arise in the

* Trans. Roy. Soc. Dublin, vii. (1900) pp. 133–208 (6 pls.).
† Quart. Journ. Micr. Sci., xliii. (1900) pp. 581–8 (13 figs.).
‡ Le Botaniste (Dangeard), vii. (1900) pp. 131–58 (1 pl.).

nucleolus; the latter also furnishes the chromatin basis (*plancher*) of the equatorial plate; the spindle is formed at the expense of the nucleoplasm, which receives in this connection a certain quantity of chromatin from the nucleolus; there is at each pole of the spindle a corpuscle which may be compared to a centrosome; the cyst of *Vampyrella* is to be regarded as a sporangium within which the nuclear elements multiply.

Reaction of Amœba to Different Colours.*—Messrs. N. R. Harrington and E. Leaming find that the streaming movements occur in red light, but are delayed, inhibited, or reversed by rays from the violet end of the spectrum. In non-nucleated fragments violet and white rays inhibit the weak streaming.

Foraminifera from Singapore.†—Dr. R. J. Schubert has examined a specimen of white calcareous sand from Singapore, and finds that Foraminifera are present together with other organic remains, such as Molluscan shells, Ostracod shells, and fragments of coral. Of the Foraminifera, individuals of *Peneroplis pertusus* in the typical form and varieties formed about half of the total number of specimens. The remainder were chiefly Miliolidæ.

Cœlomic Coccidia in Insects.‡—Louis Léger notes that there are few cases described of cœlomic Coccidia in Insects. In the beetle *Olocrates abbreviatus* Ol. he has found, in the fatty body and the cells of the pericardium, the oocysts of what appears to be the previously described *Adelea akidium*. Many of the cysts were degenerate, having been transformed into a brown colloid substance which shone through the skin in the dorsal region, and made the infected insects appear pigmented. Others of the cysts showed undivided granular contents, or commencing sporulation, or 12–20 ripe sporocysts each containing two sporozoites. This is only the third case observed of cœlomic Coccidia in Insects.

Life-history of Hæmamœbidæ.§—Major Ronald Ross and Dr. R. Fielding-Ould publish, with a short description, a series of diagrams illustrating the life-history of the parasites of malaria. They state the life-history as follows. Minute amœbulæ occur in the red corpuscles of the Vertebrate hosts (man, monkeys, bats, birds), and become mature as (*a*) sporocytes or (*b*) gametocytes. The sporocytes arise by the division of the nucleus of the amœbulæ, each nuclear mass surrounding itself with a mass of protoplasm; the spores so formed escape from the corpuscles and infect other corpuscles of the same host. Where the amœbulæ become gametocytes nuclear division does not occur, but the gametocyte in the undivided state is taken up into the stomach of a gnat. Here the male gametocytes (distinguished by their larger nuclei) give rise to a number of motile microgametes, which unite each with a macrogamete. The resulting zygote becomes motile, forming the *vermicule*, and travels to the muscular coat of the stomach. Here it becomes motionless, grows rapidly, and divides into eight to twelve *meres*. Each mere becomes a spherical *blastophore*, bearing on its surface a number

* Amer. Journ. Physiol., iii. (1900) pp. 9–18. See Zool. Centralbl., vii. (1900) p. 748.
† Zool. Anzeig., xxiii. (1900) pp. 500–2.
‡ Arch. Zool. Expér., viii. (1900) pp. 1–3.
§ Quart. Journ. Micr. Sci., xliii. (1900) pp. 571–9 (2 pls.).

of spindle-shaped *blasts*, and ultimately the blastophores disappear and the capsule contains thousands of free blasts. These reach the salivary glands of the gnat, and are introduced into the blood of the Vertebrate host. The authors recognise two genera, *Hæmamœba*, in which the gametocytes resemble the sporocytes before the latter begin to divide, and *Hæmomenas* g. n. in which the gametocytes have a special crescentic shape.

Malaria and Natives.* — S. R. Christophers and Dr. J. W. W. Stephens show that in all native villages examined in Sierra Leone, from 59–90 p.c. of the children were infected with malaria, and that a considerable number of these contained crescentic bodies, which very rapidly took on the spherical and flagellating form requisite for the transmission of human malaria to the mosquito. In all the villages examined, mosquitos (*Anopheles*) were present; indeed, in all but rare cases each individual hut contained both infected children and infected mosquitos. Thus the native is the prime agent in the malarial infection of Europeans, and infection can be escaped by avoiding native villages and huts.

Zoochlorellæ of Paramœcium bursaria.† — Prof. P. A. Dangeard discusses this case of symbiosis which appears to be due to *Chlorella vulgaris* Beyerinck. He describes the occurrence of the algæ in the Infusorian, their structure, and their division (normally into four, but in nutritive culture-solutions into six).

Parasitic Infusoria.‡—Dr. Adolf Günther has continued his observations on *Ophryoscolex caudatus* from the stomach of Ruminants, and has investigated the minute structure of *Cycloposthium bipalmatum* from the cæcum of the horse. He finds that in both the macronucleus lies in the ectoplasm, but it appears at first sight to lie in the endoplasm, because it occupies a bay-shaped inturning of the ectoplasm, and is in consequence a considerable distance from the cell-periphery. The ectoplasmic position of the macronucleus was also demonstrated for other parasitic Infusoria. In both the Infusorians studied the author describes a layer of muscle-fibrils, or *myonemes*, more conspicuous than anything of the kind previously described in the Ciliata. The distribution of the myonemes is described in detail for the two forms. It would appear that the functions of the different groups differ; e.g. some move the cilia, some perhaps retract the peristome, and so on. In *Cycloposthium* the author describes in detail the structure called by Bundle the ridge (*Leiste*), and finds that it is a definite cell-organ, and not merely a junction-line as has been supposed. The function appears a little uncertain, but the author regards it as more than a simple supporting-rod. Conjugation, not hitherto observed, was noted in six cases in *Cycloposthium*. Mention should be made of the admirable figures of sections which illustrate the paper.

New Sporozoon in Dipterous Larvæ.§—Louis Léger found in the intestine of larvæ of *Ceratopogon* sp. n. a sporozoon, which exhibits

* Rep. Malaria Comm. Roy. Soc., Aug. 15, 1900, 22 pp., 1 pl., and 1 map.
† Le Botaniste (Dangeard), vii. (1900) pp. 161–91 (3 figs.).
‡ Zeitschr. wiss. Zool., lxvii. (1900) pp. 640–62 (2 pls.).
§ Comptes Rendus, cxxxi. (1900) pp. 722–4.

the general characters of a Gregarine, but has a schizogonic multiplication within its host. The name proposed is *Schizocystis gregarinoides*. Its life-history presents a striking analogy with that of *Ophryocystis*, and the two genera may be united as *Schizogregarines* in contrast to the *Eugregarines* (without endogenous multiplication). Both the genera named differ from Coccidia in being in great part, if not always, extracellular, and in having the sporogony preceded by isogamic conjugation of sporoplasts, whereas the Coccidia are intracellular during their whole period of growth, and exhibit heterogamic conjugation.

New Species of Ophryocystis.* — Louis Léger and Paul Hagenmuller have found in *Blaps magica* a parasite nearly allied to *Ophryocystis bütschlii*, which they call *O. schneideri*. The material was in sufficient quantity to enable them to make observations on both the endogenous and exogenous cycles of the parasite. In regard to the first, the parasite in its " vegetative " state was found in the Malpighian tubules and the intestine. Though the form varied, it may be said to be generally conical, the apex of the cone projecting freely into the lumen of the tube, while the base is furnished with fixative processes attached to the so-called immovable cilia of the epithelial cells. There is a distinct if thin cuticle, no differentiation of ectoplasm and endoplasm, an areolar cytoplasm filled with granulations, and a nucleus of spherical shape placed near the base of the cell. Amœboid movements were not observed. As the parasite increases in size the nucleus divides, and later the polynucleated individual divides up to form uninucleated young. Towards autumn this vegetative reproduction reaches its limit, and conjugation occurs, two individuals uniting to form a cyst. It is to be noted, however, that the " cyst "-wall is merely the cuticle of the conjugates, no special envelope being secreted. The single sporocyst formed by the union of the gametes gives rise to eight thread-like sporozoites.

Reproduction of Ophryocystis.† — Louis Léger finds in several species of this Gregarine that there is typical isogamic conjugation and also the possibility of the parthenogenetic origin of a microsporocyst from a single gamete. The sporogony is quite comparable to that of Gregarines, a single sporocyst resulting from the conjugation of two sporoblasts whose nuclei have previously undergone reduction. One may regard *Ophryocystis* as a simple schizogonic ancestor of, on the one hand, *Schizocystis* and the Eugregarinida, and, on the other hand, of the Coccidia.

* Arch. Zool. Expér., viii. (1900) pp. 40–5 (2 figs.).
† Comptes Rendus, cxxxi. (1900) pp. 761–3.

BOTANY.

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

a. Anatomy.

(1) Cell-Structure and Protoplasm.

Development and Function of the Cell-plate.*—After a historical review of the subject, H. G. Timberlake gives an account of his own observations on the development and function of the cell-plate in the higher plants, his examples being taken from the growing root-tips of various flowering plants, from pollen mother-cells, and dividing pollen-grains. Among the more important results obtained are the following.

The division of the cell-body is due to the activity of the kinoplasm of the cell; the splitting of the cell-plate, or at least its differentiation into separate layers, is the essential act in the division of the cell-body. According to the author, the whole of the substance of the fibres becomes transformed into a portion of the cell-plate; in other words, the cell-plate is a result of a change of form of the substance composing the fibres. The nucleus appears to be the centre of the metabolic processes concerned in the production of the kinoplasm. The real centre for the formation of the fibres is the chromatin. This is shown by the formation of new radiating fibres round the daughter-nuclei in the root-tip of the onion during the diaster stage, and by the formation of a spindle round a single chromosome in the pollen mother-cells of *Hemerocallis*. In the cells of the higher plants the kinoplasm appears to be formed round the nucleus as a centre. In this form the kinoplasm takes part in the process of nuclear division, and later divides the cell by a part of the fibres being transformed into a membrane which becomes, in splitting, the plasma-membranes of the daughter-cells.

The carbohydrate material for the formation of the cell-wall appears to be held in a reserve form in the protoplasm before it is actually needed for the process of wall-formation.

Development of the Karyokinetic Spindle in Vegetative Cells.†—From a study of nuclear division in the root-tips of *Allium cepa*, *Vicia Faba*, and *Erythronium americanum*, Amanda M'Comb maintains that the process of spindle formation in vegetative cells of the higher plants does not essentially differ from that of the reproductive cells. In both cases the spindle-fibres, or at least the vast majority of them, are of cytoplasmic origin. They may appear at first either in the form of a weft about the nucleus, or may radiate from it. In the vegetative cells the spindle primordium may be monaxial and strictly bipolar from the first; but it is often multipolar. No such organs as centrosomes or centrospheres exist in the root-tips of *Allium*.

Cones of the Multipolar Spindle.‡—A. A. Lawson gives the following as a summary of the phenomena connected with the origin of the cones

* Bot. Gazette, xxx. (1900) pp. 73–99, 154–70 (2 pls.).
† Bull. Torrey Bot. Club, xxvii. (1900) pp. 451–9 (2 pls.).
‡ Bot. Gazette, xxx. (1900) pp. 145–53 (1 pl.).

of the multipolar spindle in *Gladiolus*, which furnishes a good material for study of nuclear phenomena, from the large size of the anthers, pollen mother-cells, and nuclei.

As nuclear division approaches, a granular zone accumulates about the nucleus. This zone resembles in every respect the perikaryoplasm characteristic of the pollen mother-cells of *Cobæa*.* A close network or felted zone of kinoplasm fibres is formed immediately outside and completely surrounding the nuclear wall; this is probably developed from the perikaryoplasm. This network grows out into several projections which become the poles of the multipolar figure. The nuclear membrane persists until the cones are nearly fully developed. The spindle-fibres are formed by the elongation of the meshes of the network composing the cones. Neither the nuclear wall, the nucleole, nor the linin, takes any essential part in the formation of the achromatic figure. The cones of the multipolar figure fuse, and arrange themselves in two groups, forming a bipolar spindle.

Formation of Vacuoles.† — In order to determine the question whether vacuoles have a well-defined tonoplast or not, Dr. B. Němec incited in the cytoplasm the artificial formation of soluble bodies, round which vacuoles developed. Nucleole-like bodies may arise in this way in the meristematic cells by the operation of various injurious agencies. When the meristem of a root-apex is plasmolysed, in about 25 mins. "nucleoles" are seen in the cytoplasm after the material has been fixed and sectioned; after about 30 mins. the vacuoles begin to make their appearance round them; and after 40–45 mins. nothing is to be seen except the vacuoles without any contents.

Membrane of Hydroleucites.‡ —V. Boulet supports de Vries's and Went's contention that the vacuole or hydroleucite in living cells is an organised structure enclosed in a distinct membrane, the tonoplast. When plasmolysed by the action of potassium nitrate, the protoplasm contracts in a regular manner round the hydroleucite into a spherical or ellipsoidal mass, and the chloroleucites are massed together generally at one of the poles. At a more advanced stage of disorganisation, the hydroleucite appears to fill up the whole of the cell-cavity, pressing against its walls the debris of the protoplasm and the chloroleucites which are profoundly changed. The crystals are always localised in the hydroleucite, and appear to be unable to escape into the protoplasm, from which they are separated by an invisible membrane not belonging to the protoplasm.

Permeability of the Cell-wall for Air.§ —C. Steinbrinck discusses the question whether the permeability of the cell-wall for air is a hindrance to its shrinking, and, as the result of a series of experiments on different plants and various tissues, concludes that there is no connection between the two phenomena.

* Cf. this Journal, 1900, p. 685.
† S.B. k. Böhm. Ges. Wiss. (Math.-naturw. Cl.), 1900, No. 5. See Bot. Centralbl., lxxxiv. (1900) p. 163.
‡ Rev. Gén. de Bot. (Bonnier), xii. (1900) pp. 319–22 (3 figs.).
§ Ber. Deutsch. Bot. Ges., xviii. (1900) pp. 275–85.

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

Blue Chlorophyll.*—M. Tsvett divides the constituents of ordinary chlorophyll into two classes, *xanthophyllins* and *chlorophyllins*; the former (carotin, erythrophyll, chrysophyll, &c.) including those which absorb only short-period rays and are not fluorescent; the latter being characterised by their fluorescence, and by an absorption in the red. He describes the method of obtaining blue chlorophyllin in the crystalline form; it has nothing in common with the phyllocyanin of Frémy.

Alleged Violet Chromatophores.†—K. Kroemer contests the accuracy of Tschirch's statement‡ of the occurrence of violet chromatophores in the "berry" of the coffee. He maintains, on the other hand, that the appearance observed by Tschirch is due to masses of violet crystals in the central vacuole in the hypodermal and epidermal cells of the pericarp. The micro-chemical reactions are given on which the author bases his opinion.

Myrosin in Plants.§—Th. Bokorny records the presence of myrosin (chiefly in the seeds) in a number of plants belonging to the natural orders Cruciferæ, Leguminosæ, and Umbelliferæ. Several species belonging to the Compositæ, and a number of others, gave negative results.

Proteolytic Enzyme of Germinating Seeds.‖—In the case of germinating lentils, V. Harlay finds the proteolytic ferment to be, in the substances to which it gives rise by digestion, analogous to animal trypsin, and probably identical with that which occurs in germinating barley. The same results were obtained with germinating seeds of *Ceratonia siliqua*; and the author regards it as probably a general law that a ferment analogous to trypsin, and producing tyrosin as one of the products of its digestion, is present in all germinating seeds. This is the case also with rapidly growing plants like fungi; while in adult phanerogams where there is no rapid growth, the ferment present is one analogous to animal pepsin, giving rise on digestion to a chromogen which becomes green.

New Enzyme.¶—O. Loew disputes the accuracy of the statement that all enzymes have the property of decomposing hydrogen peroxide; he does, however, find in fresh tobacco leaves a ferment which possesses this power. This enzyme, which he believes to be of very general distribution in both plants and animals, he terms *catalase*. It occurs either in a soluble form, β-catalase, as an albumose; or as α-catalase, in an insoluble form as a compound of this albumose with a nucleoproteid. That catalase belongs to the oxidising ferments is shown by its capacity of oxidising hydrochinon into chinon.

New Glucoside from Erysimum.**—Schlagdenhauffen and — Reeb have detected, in the seeds of several species of *Erysimum*, especially *E. aureum*, in addition to the poisonous alkaloid, a new glucoside, to which they give the name *erysimin*. It is present in the form of a pale

* Comptes Rendus, cxxxi. (1900) pp. 842–4.
† Bot. Centralbl., lxxxiv. (1900) pp. 33–5. ‡ Cf. this Journal, 1900, p. 342.
§ Chem. Zeit., xxiv. (1900) pp. 771–2. See Journ. Chem. Soc., 1900, Abstr. ii. p. 746.
‖ Comptes Rendus, cxxxi. (1900) pp. 623–5. Cf. this Journal, 1900, p. 599.
¶ U.S. Deptmt. Agriculture, Bull. No. 3, 1900. See Bot. Centralbl., lxxxiv. (1900) p. 126. ** Comptes Rendus, cxxxi. (1900) pp. 753–5.

yellow amorphous mass, soluble in all proportions in water and alcohol, insoluble in ether, chloroform, benzin, and carbon sulphide, slightly hygroscopic, and melting at 190°. Injected into frogs and pigeons, it acts as a heart-poison. Erysimin belongs to the class of digitalins, and is analogous to the glucoside of *Cheiranthus*.

Exosmose of Diastases.* —As the result of experiments on various seedlings, J. Laurent states that during germination a portion of the amylase formed in the seeds may pass out by exosmose; but this process ceases on germination; the young roots do not possess this property. In the case of the sugar-cane small quantities of sucrase are also thrown out. The object appears to be to facilitate the digestion of starch in the cells which envelope the meristem.

Seminase in Seeds.† —Pursuing their investigation of seeds with horny endosperm, E. Bourquelot and H. Hérissey find that (in *Medicago sativa* and *Indigofera tinctoria*), when in a dormant condition, there is always a small proportion of the soluble ferment seminase, which is capable of hydrolysing the endosperm and transforming it into sugars capable of assimilation, viz. galactose and mannose.

Presence of an Inverting Sugar in Grapes.‡ — V. Martinaud has established the presence, in the juice of all kinds of grape, of a sucrase (inverting sugar, invertin) in sufficient quantity to invert the whole of the saccharose present, without the assistance of the organic acids. It is not present in vines attacked by bacterial diseases, and disappears entirely in wines which have been strongly oxidised.

Simultaneous occurrence of Two Sugars. § — E. Bourquelot and H. Hérissey record the simultaneous presence, in the root of the yellow gentian, of two carbohydrates of the nature of sugars, viz. saccharose and gentianose.

(3) Structure of Tissues.

Order of Formation of the Elements of the Central Cylinder in the Root and Stem.‖ — From a study of the central cylinder in flowering plants, Prof. G. Bonnier concludes that it presents the same general plan of structure in the stem and in the root; the constitution and the order of development of the tissues are the same in both cases. The only difference is in the position of the xylem-poles, which, in the root, are turned backwards towards the periphery of the central cylinder. It follows that the first vessel formed near a xylem-pole of the root originates not far from the primary cortex, i.e. in the neighbourhood of the tissue which regulates the current of water which passes from the root-hairs to the xylem-vessels. The author regards this difference as depending on a correlation between the arrangement of the vascular tissue and the absorption of water.

Anatomy of Monopodial Orchids.¶ — L. Hering describes in great detail the structure, especially of the fertile stem, in a large number of

* Comptes Rendus, cxxxi. (1900) pp. 848–51.
† Tom. cit., pp. 903–5. Cf. this Journal, 1900, p. 479.
‡ Tom. cit., pp. 808–10. § Tom. cit., pp. 750–52.
‖ Tom. cit., pp. 781–9 (6 figs.).
¶ Bot. Centralbl., lxxxiv. (1900) pp. 1–11, 35–45, 73–81, 113–22, 145–52, 177–84 (3 pls.).

genera and species of monopodial orchids. Among the more general results arrived at, the following are the most important. The cells of the epiderm vary greatly in form, and the development of the cuticle is also very various. Only one species is described as having a sharply defined endoderm. The cortical tissue is commonly distinguished by its altered appearance and by the lignified character of at least a portion of it. The ground-tissue of the vascular cylinder is usually composed of parenchymatous elements. The phloem-portion of the vascular bundle is always protected by a bundle-sheath. The arrangement of the vascular bundles is classified under three different types. There are rarely any vascular bundles in the pith.

Gall of the Monterey Pine.*—W. A. Cannon describes the injuries inflicted on the leaves and leaf-bases of the Monterey pine (*Pinus radiata* Don, *P. insignis* Loud.), by the larvæ of a gall-fly belonging to the Cecidomyiidæ. The gall consists mainly of hypertrophied epidermal tissue; and the immediate and principal cause of the hypertrophy appears to be the response on the part of certain plant-tissues to the parasite's demand for food. This is indicated by the gradual enlargement of the cells surrounding the parasite in a manner which corresponds to its growth, and also by the unusual amount of food-material which these cells contain.

(4) Structure of Organs.

Underground Flowers.†—E. Ule describes a shrub growing in the neighbourhood of Rio de Janeiro, *Anona rhizantha*, which produces its flowers and ripens its fruits entirely underground. Besides the open flowers, it produces more or less completely closed cleistogamous flowers. The former appear to be contrived for pollination by special insects.

Nectaries of the Cruciferæ. ‡—According to Dr. A. Villani, the variations in the number and arrangement of the nectaries in the flower of Cruciferæ may be arranged in three principal groups, those in which there are respectively four or two nectaries, or only one. In the latter case the flowers are always very small, and the nectary central; where the number is four or two, the nectaries are arranged in a great variety of ways in respect to the four longer or the two shorter stamens. In the very wide-spread *Alliaria officinalis*, the nectaries go through two stages. In the first stage, while the flower is expanded, they perform the ordinary nuptial function of attracting insects which are useful for pollination, and keeping off injurious insects, such as ants. But after the perianth has dropped, the nectaries increase in size, and still continue to secrete nectar; in this stage they attract ants in great numbers, and become extra-nuptial. The same is the case with a species of *Cardamine*, *C. Chelidonia*.

Nectaries of the Cucurbitaceæ.§—Prof. G. Arcangeli states that in *Cucurbita maxima* the male flowers remain open longer in wet weather and later in the year, than in fine weather and earlier, to avail them-

* Amer. Nat., xxxiv. (1900) pp. 801–10 (6 figs.).
† Die Natur, xlix. (1900) pp. 270–3 (5 figs.). See Bot. Centralbl., lxxxiv. (1900) p. 89.
‡ Malpighia, xiv. (1900) pp. 167–71.
§ Bull. Soc. Bot. Ital., 1899, pp. 198–204.

selves more of the visits of bees. In *Luffa cylindrica* the male flowers are provided with a bract, which bears from two to six glands on its underside, forming an extra-nuptial nectary. The stamens also form, as in *Cucurbita*, a nectar-receptacle at their base. The female flowers have honey-glands on the outer side of the calyx, and five globular structures in the place of stamens, between which and the style is an annular honey-pit.

Colour of Juniper-"Berries."* — M. Lendner does not confirm Nestler's statement that the black colour of the so-called "berries" of the juniper is due to a parasitic fungus, though fungus-hyphæ are occasionally found in them, but only exceptionally. It is rather due to the accumulation of a substance allied to the tannoids in the epidermal and hypodermal cells, which substance becomes subsequently transformed into another of the same very dark colour. The active factor in the change is probably the oxygen of the atmosphere.

Anatomy of Pedicels.†—A. Pitard discusses in detail the anatomy of the pedicel of flowers and fruits. The peculiarities of structure are described which are correlated with the increasing weight of the fruit, and with the need for the transport of food-materials. In the case of flowers which have become double under cultivation, the sclerenchymatous tissue is strengthened and often becomes lignified at an earlier period. In erect axillary flowers the medullary parenchyme of the pedicel is strongly developed, with a few scattered centrifugal vessels; when the flower is lateral, the pith is less strongly developed and the vessels are more numerous with a centripetal arrangement.

Mechanism of the Awns of Stipa.‡ — L. Murbach describes the mechanism of the seed-burying awns of *Stipa avenacea*. He confirms the view taken by other observers that the cause of the twisting of the awn is located in the individual cells; not only a layer of cells, but the whole of the mechanical cells, are active in bringing about this result. The twisted portion of the awn is composed principally of sclerenchymatous cells with a fibro-vascular bundle in the centre and a band of chlorophyllous tissue on each side; the mechanical cells are distinguished by their remarkably small and eccentric cell-cavities.

Colour of Box-leaves.§—According to Prof. R. Chodat, the bright orange-red colour frequently assumed by leaves of the box growing in rocky or sandy places, is due to a modification of the chromatophores. The white band which runs along the mid-rib on the under-side of the leaf is caused by the fact that the hypodermal cells of this region contain crystals of calcium oxalate, between which are retained bubbles of air which are exceedingly difficult to displace.

Chlorosis caused by the Nature of the Soil.‖ — J. A. Cl. Roux has grown a number of silicicolous (arenaceous) plants in calcareous soils, and finds that, although the seeds germinate readily, the seedling

* Ann. Sci. Phys. et Nat., ix. (1900) pp. 494–5. Cf. this Journal, 1900, p. 365.

† 'Rech. s. l'anat. comparée d. pédicelles floraux et fructifères,' Bordeaux, 1899, 369 pp. and 5 pls. See Bot. Centralbl., lxxxiv. (1900) p. 18.

‡ Bot. Gazette, xxx. (1900) pp. 113–7 (5 figs.).

§ Arch. Sci. Phys. et Nat., ix. (1900) pp. 488–9.

‖ Ann. Soc. Linn. Lyon, xlvi. (1900) pp. 87–98.

plants develope tardily and imperfectly, the leaves becoming in many cases more or less chlorotised. The production of flowers and fruit is also unfavourably affected. The author claims to have discovered, generally distributed in the green tissues of plants, quantities of very minute and extremely mobile micro-organisms—micrococci, bacteria, ovoid bodies—which he believes to be of great importance to the life of the plant, having frequently an injurious effect, and being probably one of the causes of chlorosis.

Viridescence and Fasciation caused by a Parasite.*—M. Molliard records an example of viridescence in the flowers of *Trifolium repens*, and one of fasciation in the stem of *Raphanus Raphanistrum*; the former caused apparently by the attacks of a parasitic fungus belonging to the Dematieæ, *Polythrincium Trifolii*, the latter to those of a coleopterous larva.

Stomates on the Upper Side of Leaves.†—E. Kühne finds the occurrence of stomates on the upper side of the leaves to be more common in woody plants than has generally been supposed. They were observed in 222 out of 1359 species examined. An attempt is made to connect their occurrence with climatic conditions.

Stomates of the Box.‡—Prof. R. Chodat and M. Bernard describe the peculiar structure of the stomates on the leaves of *Buxus sempervirens*, which somewhat resembles that in *Iris*. There are usually six modified epidermal cells belonging to each stomate. The power of movement by which the fissure is opened and closed does not reside in the guard-cells, but in three hypostomatic cells which put out papillæ that push themselves up to the fissure.

Lenticels.§—H. Devaux has made an exhaustive study of the structure and functions of lenticels, which he finds in all the great groups of vascular plants, and on all their organs where there is secondary growth. The total amount of surface covered by the lenticels is, within certain limits, nearly uniform, their size being nearly in inverse proportion to their number.

Three layers may be distinguished in a lenticel, analogous to those of the periderm:—a phelloderm, a suberised layer (or more than one), and an intermediate formative region. Two types are specified, viz.:—(1) those in which the closing layers are thin, and are composed of cells intimately united, with no or only very small intercellular spaces; and (2) those in which the closing layers are often thick, and are composed of rounded cells with abundant intercellular spaces.

Lenticels are either primary or secondary; the former are found at an early period at a point determined by an organ—stomate, root, or bud; the latter are formed later at points not determined by an organ. Wherever there are stomates, there is a tendency to produce lenticels below them in the cortex, sometimes in the pericycle; they occur normally at the base of young rootlets. The growth of lenticels takes place by a continual proliferation of new rounded elements and the suberification of the cells.

* Rev. Gén. de Bot. (Bonnier), xii. (1900) pp. 323–7 (3 figs.).
† Mittli. Deutsch. dendiol. Ges., 1899, pp. 47–67. See Bot. Centralbl., lxxxiv. (1900) p. 130.
‡ Arch. Sci. Phys. et Nat., ix. (1900) pp. 495–6.
§ Ann. Sci. Nat. (Bot.), xii. (1900) pp. 1–240 (6 pls. and 7 figs.).

With regard to their function, the author does not admit that lenticels exist primarily for the general interchange of gases; for they are often absent or inadequate; the plant often has other porous regions which serve for aeration; and the opening and closing of the lenticels is not due to the needs of aeration. They are to be regarded rather as organs of transpiration for the regulation of the internal moisture of the plant.

Relation between Lenticels and Adventitious Roots in Solanum Dulcamara.*—J. A. Terras states that the adventitious roots do not, in this species, arise below or grow out through lenticels, as is apparently the case in the majority of plants. As the first formation of the root precedes the appearance of phellogenetic divisions, it is entirely independent of the formation of lenticels. The protuberances on the surface of the stem are not lenticels, but result from the formation of a mass of secondary tissue which originates in the reaction of the phellogen to the pressure set up by the elongating root below it. The lenticels appear only after the protuberances are fully formed.

Development of Hairs.†—W. Hirsch accepts Weiss's classification of hairs, according to their mode of growth, as basipetal, acropetal, and intercalary; but points out that even in hairs of the third type, the hair does not undergo continual division from the base to the apex; on the contrary, the intercalary divisions are always confined to definite zones, and the intercalary is almost always accompanied by either a basipetal or an acropetal mode of growth. The mode of growth of hairs is not dependent on the systematic position of a species, though within each species it is constant.

Structure of Hyacinth Roots.‡—Ida A. Keller finds that secondary roots developed from hyacinth bulbs after the bulb had partially decayed and had then been restored to a growing condition by cleaning, differed in no essential respect from the original adventitious roots, but usually displayed a greater development of vascular tissue.

Formation of Tubercles in Plants.§—N. Bernard agrees with Stahl in his conclusion that an endophytic mycorhiza is probably necessary to the germination of the seeds of certain plants which constitute a biological group displaying a symbiosis altogether analogous to that of lichens. Infection by spores of the symbiotic fungus has a tendency to produce tubercles; and in plants which belong to this symbiotic group there is tendency to the production of tubercles at a very early period, as in the prothallia of the Ophioglossaceæ and of species of *Lycopodium*. The presence of an endophytic fungus appears to be a very wide-spread cause of tuberculisation in plants.

Influence of the Removal of the Flowers on the Root-tubercles of the Leguminosæ.‖ — Prof. O. Mattirolo has experimented on the effect produced on the root-tubercles of Leguminosæ (chiefly *Vicia*

* Trans. Bot. Soc. Edinburgh, xxi. (1900) pp. 341–53 (2 pls.).
† Beitr. z. wissensch. Bot. (Fünfstück), iv. (1900) p. 1. See Bot. Centralbl., lxxxiv. (1900) p. 166.
‡ Proc. Acad. Nat. Sci. Philadelphia, 1900, pp. 438–40 (1 pl.).
§ Comptes Rendus, cxxxi. (1900) pp. 626–9. Cf. this Journal, 1900, p. 707
‖ Malpighia, xiii. (1900) pp. 382–421 (1 pl.).

Faba) by the extirpation of the flowers. He finds the result of the castration to be invariably a much more luxuriant development of the whole of the vegetative system, especially of the root-tubercles. The castrated plant continues to develope after the period when normally it would have ripened its seeds and then perished. The production of fruits and of tubercles appears to be always in inverse proportion the one to the other. The conclusion seems inevitable that the purpose of the tubercles is to provide a source of food-supply for the leaves, and that the ploughing into the soil of the crop before the flowers are developed must tend greatly to increase its productiveness.

β. Physiology.

(1) Reproduction and Embryology.

Sexual Reproduction.* — Prof. P. A. Dangeard proposes a new classification of sexual phenomena, in accordance with the most recent discoveries in this department of physiology.

Wherever there are gametes, there is sexual reproduction, and gametes are zoospores deprived of energy; there are facultative gametes which develope indifferently with or without previous conjugation; and a transition is thus established between sexual and non-sexual reproduction. The energy which incites the development of gametes is not necessarily sexual; when it is furnished by a physical or chemical cause we have parthenogenesis, when by the action of one gamete on another, we have *sexual autophagy*. This autophagy is of three kinds, viz.:—(1) primitive autophagy or *protogamy*, in which the gametes combine without fusion of the nuclei; (2) ordinary autophagy or *hologamy*, where the nuclei fuse together as well as the cytoplasms; (3) reduced autophagy or *merogamy*, which does not require the participation of the whole of a second gamete, but only either of its cytoplasm or of its nucleus. Among isogamous species, two cases are possible:— the gametes may be impregnated by the cytoplasm of the second gamete or by its nucleus. The second case is unknown; the first appears to occur in Infusorians. In heterogamous species, merogamy includes four distinct cases:—(1) The male gamete is impregnated by the cytoplasm of the female gamete, *cytoplasmic androgamy*; (2) The male is impregnated by the nucleus of the female gamete, *nuclear androgamy*; (3) The female gamete is impregnated by the cytoplasm of the male gamete, *cytoplasmic gynogamy*; (4) The female is impregnated by the nucleus of the male gamete, *nuclear gynogamy*. Hertwig's, Boveri's, and Delage's experiments are concerned with cytoplasmic androgamy; the partial impregnation of Boveri is a case of cytoplasmic gynogamy. The author adopts Giard's term *adelphophagy* for a union of gametes of the same sex.

In the view of the author, all the eight nuclei of the embryo-sac of Angiosperms are gametes; the megaspore has germinated directly into a gametange; the two median cells which have the polar nuclei for their nuclear elements may be termed *mesodes*. He distinguishes between the uses of the terms albumen and endosperm;—the former is an abnormal sporophyte; the latter a gametophyte. Supernumerary

* Le Botaniste (Dangeard), vii. (1900) pp. 263–8.

embryos may result from the impregnation of a gamete by a simple fragment of the cytoplasm of a second gamete.

Double Impregnation in Angiosperms.* — Prof. E. Strasburger carefully reviews all the recent investigations on this process, and comes to a conclusion adverse to Nawaschin's view † that the formation of endosperm is the result of the fusion of the two polar nuclei, and that where this fusion does not take place, no endosperm is formed. Strasburger points out that as long ago as 1877 he had established the existence of this fusion in some of our native Orchideæ. The absence of endosperm in the Orchideæ is not due to any failure in the fusion of the embryo-sac nuclei, but to the fact that it is not needed for the nutriment of the embryo. The author proposes for the two processes the terms *generative impregnation* and *vegetative impregnation*. The object of the former process is the transmission of hereditary properties to the descendants. This is not the function of any process of vegetative impregnation such as the fusion of the polar nuclei with one another, or of one of the generative nuclei with them. An active motion of the generative nucleus within the embryo-sac does not rest on sufficient evidence. Where the pollen-tube nuclei have unquestionably a power of independent motion, they are furnished with cilia, as in the Cycadeæ.

Double Impregnation in Caltha.‡—Miss Ethel N. Thomas has continued her observations on the double impregnation in *Caltha palustris*. The polar nuclei have generally completely fused before the entrance of the pollen-tube into the embryo-sac. The antipodals are large pear-shaped cells, and, at this period very often contain two nuclei apiece. When the generative nuclei escape from the pollen-tube they are very minute, and may be oblong or dumbbell-shaped, or may have the form of a somewhat straight S. By the time that the vermiform generative nucleus has reached the middle of the sac, it has enlarged to a very considerable size; while the nucleus which impregnates the oosphere increases but very little in size. The polar impregnation appears always to take place at a period more or less in advance of that of the oosphere.

Archegones and Pollen-tubes of Sequoia. § — W. Arnoldi has followed out his investigation of the endosperm of *Sequoia sempervirens* by some observations on the corpuscles (archegones) and pollen-tubes.

The archegones are formed laterally in the endosperm, and are either single or associated in groups. Each archegone arises from a single peripheral endosperm-cell. Their structure resembles that of the Cupressineæ, but they have a bicellular neck, and, like the Cupressineæ, are destitute of a ventral canal-cell. A complete covering layer is never formed round the archegones, whether they are single or collected into groups; single endosperm-cells assume the character of covering cells. The position of the pollen-tubes corresponds to that of the archegones; they force their way in between the nucellus and the endosperm. Their structure corresponds to that in the Cupressineæ.

* Bot. Ztg., lviii. (1900) 2te Abt., pp. 293-316. Cf. this Journal, 1900, p. 689.
† Cf. this Journal, 1900, p. 602.
‡ Ann. of Bot., xiv. (1900) pp. 527-35 (1 pl.). Cf. this Journal, 1900, p. 605.
§ Bull. Soc. Imp. Nat. Moscou, 1899 (1900) pp. 405-22 (2 pls. and 4 figs.). (German). Cf. this Journal, 1900, p. 482.

Cross-Pollination and Self-Pollination. — According to Marchese Burgagli,* the insect visitor chiefly efficient in the pollination of the parasite *Cytinus hypocystis* is *Bombus agrorum* var. *pascuorum*.

Mr. G. W. Ord † records a series of observations with regard to the visits of Lepidoptera to flowers. He is of opinion that colour is a matter of but little importance in the attraction of moths. On the other hand, he has known insects to be attracted only by one flower which does not yield nectar, viz. the elder. The stinging-nettle, although specially adapted for anemophily, attracts insects of more orders than one. In the ragwort and field-thistle it appears certain that the visiting insects effect pollination between separate flowers of the same head. The nectar-sipping habit of moths reaches its greatest development in the genus *Plusia*.

Ornithophilous Flowers. — E. Werth ‡ gives an account of the arrangements exhibited by flowers in Tropical Africa for pollination by the agency of birds, chiefly Nectarinieæ (honey-birds), the representatives in Africa of the American humming-birds. He classifies these under 8 types, viz. :—(1) Myrtaceæ type. The attractive part of the flower is usually the long white stamens (e.g. *Jambosa vulgaris*, *Barringtonia racemosa*); (2) Bruguiera type; pendent, bell-shaped flowers, the access to the honey between the style and the stamens (*Bruguiera gymnorhiza*, &c.); (3) Ceiba type, corresponding to Delpino's Fuchsia type (*Ceiba pentandra*); (4) Hibiscus type; tubular or bell-shaped, horizontal or pendent flowers; the organs of reproduction completely enclosed or projecting (*Hibiscus rosa sinensis*); (5) Aloe type; flowers with long narrow tube, equalling in length the beak of most Nectarinieæ (*Aloë Volkensii*, &c.); (6) Lip-flowers; flowers zygomorphic, lipped (*Kigelia æthiopica*, &c.); (7) Erythrina type; horizontal zygomorphic flowers, with strongly projecting reproductive organs (*Erythrina indica*, &c.); (8) Explosive pollen type (*Loranthus Dregei*, &c.).

The ornithophilous species of Tropical Eastern Africa are mostly characterised by conspicuous scarlet or purple flowers, or of some shade of brown or orange corresponding to the colours of the plumage of the male as contrasted with the female Nectarinieæ.

Schenkling-Prévôt § holds that the number of truly ornithophilous flowers is much smaller than is usually stated. Among those which are actually pollinated by birds he names *Feijoa*, *Myrrhinum*; among Musaceæ *Musa*, *Ravena*, and *Strelitzia*; *Erythrina*; some Ericaceæ and Proteaceæ; *Loranthus Kraussianus* and *Dregei*. Beautiful examples of true ornithophily are afforded by the terrestrial bromeliads *Puya chilensis* and *cœrulea*, pollinated by a starling, *Curæus aterrimus*.

Cleistogamous Flowers. ‖ — M. Leclerc du Sablon has studied the cleistogamous flowers of *Viola odorata*. The hypodermal layer of cells

* Bull. Soc. Bot. Ital., 1900, p. 203.

† Trans. Nat. Hist. Soc. Glasgow, v. (1900) pp. 355–66.

‡ Verhandl. Bot. Ver. Brandenburg, xlii. (1900) pp. 222–56 (12 figs.). See Bot. Centralbl., lxxxiv. (1900) p. 188.

§ Naturw. Wochenschr., xiv. (1899) pp. 465–8. See Bot. Centralbl., lxxxiv. (1900) p. 325.

‖ Rev. Gén. de Bot. (Bonnier), xii. (1900) pp. 308–18 (12 figs.); Comptes Rendus, cxxxi. (1900) pp. 691–2.

in the anther-wall are mostly large, thin-walled, and contain but little protoplasm; but, at the upper part of the anther, both the epidermal and the hypodermal layer of cells are very small and contain abundant protoplasm with a large nucleus. The pollen-grains germinate while still within the anther, and the pollen-tubes creep along the inside of the anther-wall until they reach the small cells at the upper part of the anther. These act in a manner comparable to the conducting tissue of the style and stigma; their abundant food-material attracts the pollen-tubes, which penetrate the wall of the anther at this point, and thus reach the stigma which is exactly on a level with this portion of the anther.

Similar phenomena are presented by *Viola canina* and other species of the genus. In *Oxalis Acetosella* the conducting tissue of the anther extends along the whole length of the pollen-sacs on the side facing the stigma. In *Linaria spuria* the cleistogamous flowers are not so sharply differentiated, passing by insensible gradations into those of normal structure. The pollen-grains do not germinate while still within the pollen-sacs. The self-pollinated flowers of *Leersia oryzoides* are not properly cleistogamous.

Hybridisation of Hepatica.*—Prof. F. Hildebrand has tried a number of experiments on the hybridisation of three common species of *Hepatica*,—*H. triloba* with blue and white flowers, *H. angulosa* blue, and *H. acutiloba* white, and finds different results in different cases. All the species are proterogynous. The crossing of *H. triloba* ♀ by *H. angulosa* ♂ produced flowers which surpassed either of the parents in beauty. Crossing these two species in the other direction resulted in almost entire failure with white *H. triloba*, while with the ordinary blue variety of this species much better results were obtained. Hybrids between *H. acutiloba* ♂ and *H. triloba* ♀ gave the singular result that the leaves presented a close resemblance to those of one parent, while the flowers were altogether those of the other parent.

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

Electrical Effect of Light upon Green Leaves.†—Dr. A. D. Waller has made a series of observations on this subject, using chiefly the leaves of *Iris*. He concludes that the leaves of certain plants, under favourable conditions of life, exhibit electromotive effects and after-effects amounting to 0·02 volt, positive or negative, in response to illumination. As in the case of animal tissue, it is possible that the negative (inactive) effect may be significative of dissimilation, and the opposite effect or after-effect significative of assimilation. The absence of direct result in petals indicates that chloroplasts are essential to the reaction.

Influence of the Water of the Soil on the Development of Plants.‡—In the two instances investigated (oat and summer wheat) — v. Seelhorst finds that the number of internodes in the haulm is mainly determined by the turgor during the first period of vegetation,

* Bot. Centralbl., lxxxiv. (1900) pp. 65–73.
† Proc. Roy. Soc., lxvi. (1900) pp. 129–37 (5 figs.).
‡ Journ. f. Landwirthsch., xlviii. Heft 2, p. 163. See Bot. Centralbl., lxxxiv. (1900) p. 54.

while the vigour and length of the haulm depend mainly on the amount of water in the soil at the time of germinating. In wheat the length of the ear is also chiefly determined by the amount of water in the soil during the first period of growth.

Parasitism of Pedicularis.*—According to A. Volkaert, the various species of *Pedicularis* are parasitic almost exclusively on species of Gramineæ and Cyperaceæ, doing considerable damage in this way to pastures; *P. palustris* is in this respect the most injurious species. The haustoria appear, in some species at least, to persist through the winter. Some species choose especially particular grasses for their host-plant; thus *P. recutita* is partial to *Deschampia cæspitosa*, *P. verticillata* to *Sesleria cœrulea*. The various species differ greatly in the obligatory character of their parasitism; thus *P. palustris* displays the strongest parasitism; while *P. comosa* is almost independent of any host-plant.

Parasitism of Ximenia americana.† — Further experiments by E. Heckel on the germination of the seeds of this plant show that it is a true root-parasite. It produces suckers altogether resembling those of *Thesium*, which do not fix themselves indifferently to the root of any plant with which they may come into contact, and, in the absence of a suitable host-plant, may become autoparasitic, attaching themselves to another stem or root of the same species. In addition to the suckers, the root of *Ximenia* normally produces nodosities or tubercles resembling those of the Leguminosæ, which appear to be connected with the nutrition of the plant.

Germination of some Perennial Herbs.‡—A. Rimpach has studied the germination and development of some perennial herbs of North America, which he classifies under three heads, viz.:—(1) those which possess a rhizome which grows more or less vertically upwards, and becomes drawn down by contractile adventitious roots (*Lilium Martagon*, *Allium ursinum*, *Plantago major*, species of *Arisæma*, *Hypoxis*, *Trillium*, &c.); (2) the roots have a nutritive function only; they are of no great importance in fixing the plant to the soil, and produce no contractile rootlets (*Paris quadrifolia*, *Colchicum autumnale*, *Orchis mascula*, species of *Erythronium*, *Lilium*, &c.); (3) those which are furnished with a long tap-root, are confined to the place they occupy when germinating, and are reproduced only by seeds (a very common form on the prairies).

Germination of the Winter-buds of Hydrocharis Morsus-Ranæ.§ — According to J. A. Terras, the winter-buds of the frog's-bit separate from the runners as soon as they are ripe, sink to the bottom of the water, where they rest till the following spring, when they rise to the surface and develope at once into new plants. By covering up, they may be kept in their resting condition for at least two years. Heat and light by themselves are insufficient to induce germination; a co-operation of the two is necessary, as also is the presence of oxygen.

* 'Unters. üb. d. Parasitismus d. Pedicularis-Arten,' Zürich, 1899, 52 pp. See Beih. z. Bot. Centralbl., ix. (1900) p. 521.
† Comptes Rendus, cxxxi. (1900) pp. 764–5. Cf. this Journal, 1900, p. 354.
‡ Bot. Gazette, xxx. (1900) pp. 171–88.
§ Trans. Bot. Soc. Edinburgh, xxi. (1900) pp. 318–29.

Respiration is carried on by the buds during winter to a slight extent, both in darkness and in light.

Absorption of Nitrogen by Plants.*—Th. Schloesing fils finds, as the result of experiments, that the nitrification of ammonium salts is not, for all plants, a necessary preliminary to the absorption of nitrogen into the plant. While for some plants (e.g. buckwheat) the preferable form of the nitrogenous food-material is that of nitrates; others (e.g. *Tropæolum*) thrive better when the nitrogen is presented to them in the ammoniacal form.

(3) Irritability.

Perception of Geotropic Irritation.—In support of his view as to the nature of the conduction of geotropic irritation in plants, Dr. B. Němec † points out the importance of the existence, in certain cells of the organs in question, of minute bodies having either a higher or a lower specific gravity than protoplasm, and which are therefore constantly shifting their location in the cell with changes in its position. Among such particles which are of a higher specific gravity than protoplasm are leucoplasts, chloroplasts, and starch-grains; the nucleus behaves sometimes in one way, sometimes in the other. In the root these cells occur in the root-cap, and especially in the so-called columel, and may be regarded as forming, by their association, a special organ. In the leaves and stem, these shifting particles are found chiefly in the starch-sheath, occasionally in the fundamental parenchyme. The author finds such cells universally in those organs which are capable of a geotropic irritation; and their appearance corresponds to the period when the organ becomes sensitive to geotropism. The conclusion seems inevitable that these particles, heavier or lighter than protoplasm, are closely connected with geotropic sensitiveness.

G. Haberlandt ‡ arrives at the same conclusion, that the starch-sheath, with its large and motile starch-grains, is the perceptive organ for geotropic irritation. Such a typical starch-sheath occurs in the nodes of Gramineæ, Rubiaceæ, Caryophylleæ, Polygonaceæ, &c., which are all capable of geotropic curvatures. The writer gives an account of experiments which seem to show that the pith retains its power of geotropic curvature when the epiderm, the collenchyme, and the greater part of the cortical parenchyme have been removed; but loses it if deprived of the remainder of the parenchyme and of the starch-sheath.

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

Influence of Temperature on the Decomposition of Albumen.§—Pursuing his investigations on the formation and decomposition of albuminoids in plants, D. Prianischnikow has determined that the decomposition of albumen and the formation of asparagin go on more energetically at a temperature of 35° C., than at one of 28°.

* Comptes Rendus, cxxxi. (1900) pp. 716–9.
† Ber. Deutsch. Bot. Ges., xviii. (1900) pp. 241–9. Cf. this Journal, 1900, p. 487.
‡ Tom. cit., pp. 261–72 (1 fig.).
§ Tom. cit., pp. 285–91. Cf. this Journal, 1899, p. 509.

Lactic Acid Fermentation.*—S. Epstein points out the importance of a knowledge of the bacteriology of the process of cheese-ripening, the exact nature of which depends largely on the lactic acid organisms present; these affect both the odour and the intensity of the ripening by the production of enzymes.

Preparation of Saké.†—Y. Kozai gives a detailed account of the chemical and biological questions in the preparation of saké or rice-wine. The enzyme of the fermenting fungus, *Aspergillus Oryzæ*, forms dextrose from starch, dextrin, melitriose, sucrose, and maltose, but does not attack lactose or inulin.

γ. General.

Scott's Fossil Botany.‡—This excellent handbook is limited to the Pteridophytes and the Gymnosperms, excluding Fossil Algæ on the one hand and Angiosperms on the other hand. The organisms discussed are grouped as follows:—Equisetales (including Calamites), Sphenophyllales, Lycopodiales (including Lepidostrobus, Sigillaria, and Stigmaria), Ferns, Cycadofilices (including Medulloseæ), Cordaiteæ, and the Mesozoic Gymnosperms (including Gingkoaceæ). In his concluding chapter on General Results, the author points out the general concurrence of the conclusions drawn from morphological and from palæontological investigations. The origin of the Pteridophyta—the remains of vascular Cryptogams going back to the Silurian—lies too far back for the existing fossil evidence to touch the question. Angiosperms, on the other hand, appear with great suddenness in the Mesozoic period. Palæontology affords no support whatever to the theory of a bryophytic origin of the Pteridophyta. It is probable that a large part, if not the whole, of the Gymnospermous Phanerogams are derived from Ferns, but if so, the heterosporous stage of the Filices has been entirely lost. The author regards the great majority, or possibly even all the known families of Gymnosperms as having had a common origin from the Filicales.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Structure of Isoetes.§—Dr. D. H. Scott and T. G. Hill have studied the structure of *Isoetes Hystrix*, a terrestrial species of the genus, and find that it does not differ very essentially from *I. lacustris.* Among the more important results are the following.

There is some evidence that the apex may grow by means of a single apical cell. The stele is not composed of the united leaf-traces, but is probably a cauline structure. The differentiation of the primary xylem is nearly simultaneous over its whole area. The cell-division of the primary meristem passes over without any interruption into that of the cambium. Secondary xylem is always formed; its elements are typical

* Arch. f. Hygiene, xxxvii. (1900) pp. 329–59. See Bot. Centralbl., lxxxiv. (1900) p. 201.

† Centralbl. Bakt., 2te Abt., vi. (1900) pp. 385–405. Cf. this Journal, 1898, p. 113.

‡ 'Studies in Fossil Botany.' By Dukinfield H. Scott. London, 1900, xiii. and 533 pp., 1 pl. and 150 figs.

§ Ann. of Bot., xiv. (1900) pp. 413–34 (2 pls. and 2 figs.).

tracheids, without cell-contents. The vascular bundle of the leaf, which is collateral throughout, has an exarch structure in the lamina, the protoxylem lying next the phloem. The phloem contains true sieve-tubes with transverse sieve-plates, on both sides of which callus is formed. The stele of the root has in all parts a monarch structure, the differentiation of the xylem beginning with the development of a single tracheid, which lies exactly opposite the protophloem.

The observations of the authors tend to confirm the view of the affinity of *Isoetes* with *Lycopodium* rather than with the Filices.

Anatomy of the Hymenophyllaceæ.*—A study of the structure of several species of *Hymenophyllum* and *Trichomanes* leads L. A. Boodle to the following conclusions.

The stem is in all species monostelic, and one leaf-trace passes off to each leaf; the stele contains no pith. In the stem of *Hymenophyllum* the phloem forms a ring round the xylem. In *Trichomanes* the stele exhibits several different types of structure, viz.:—(1) a ring of xylem surrounding the parenchyme which contains the protoxylem (*T. reniforme*); (2) a solid mass of xylem with internal protoxylems accompanied by only scanty parenchyme (*T. radicans*, &c.); (3) the subcollateral type (*T. trichoideum*); (4) the collateral type (*T. muscoides*); (5) only one tracheid, or none at all, and no phloem (*T. labiatum*): (6) a solid mass of xylem with scattered indefinite protoxylem (*T. spicatum*); (7) a solid mass of xylem with distinct peripheral protoxylem (*T. scandens*).

The leaves of all Hymenophyllaceæ are destitute of stomates, as well as of intercellular spaces, even though they are several cells in thickness, as in *T. reniforme*.

Stem of Angiopteris.†—Miss R. F. Shove has made a study of the anatomical structure of the stem of *Angiopteris evecta*. The vascular strands are arranged in a series of inverted funnel-shaped zones; the leaf-trace bundles arise from superficial vascular tissue alone; the steles of the second zone do not share in the formation of the foliar strands. The centrifugal growth of the phloem is contrary to that described for most other Ferns. In the apical region of the stem the presence of several initial cells was satisfactorily demonstrated. The stem is apparently destitute of aerial roots.

Algæ.

Cell-division in Fresh-water Algæ.‡—Prof. R. Chodat states that in some filamentous fresh-water algæ (*Raphidium, Kirchneriella, Scenedesmus*), transverse septation frequently takes place; the second cell-division is often at right angles to the first; two of the daughter-cells being then at the poles of the mother-cell, the other two lateral. A similar mode of septation takes place in *Volvox*.

New Genera of Florideæ.§—Among algæ from our southern coasts, E. A. L. Batters finds types of no less than three new genera of Florideæ, viz.:—

* Ann. of Bot., xiv. (1900) pp. 455–96 (3 pls.).
† Tom. cit., pp. 497–525 (2 pls.).
‡ Arch. Sci. Phys. et Nat., ix. (1900) pp. 491–2.
§ Journ. Bot., xxxviii. (1900) pp. 369–79 (1 pl.).

Neevea (Bangiaceæ). Thallus microscopic, endozoic, filamentous, procumbent, creeping in the substance of *Flustra foliacea*, composed of violet or rosy-purple cells arranged in a single or two or more parallel rows within a gelatinous sheath; filaments irregularly branched, in the older parts of the thallus united into a compact pseudo-parenchymatous layer one or more cells in thickness; cells at first oval, becoming angular and very irregular in shape by mutual pressure. Reproduction effected by the escape of the cells from the gelatinous sheath, and their subsequent development into new individuals.

Rhodophysema. Fronds gregarious, minute, dark red, hemispherical, globose or pear-shaped, sometimes more or less plicate-rugose, composed of a medullary stratum of large roundish-angular colourless cells, becoming smaller towards the periphery, and a cortical portion formed of a few layers of small coloured closely packed cells, each containing several small disk-shaped chromatophores; tetraspores cruciate, borne in external convex sori, accompanied by slender rigid few-celled paraphyses; cystocarps and antherids unknown. *R. Georgii*, on *Zostera*.

Erythrodermis. Fronds membranaceous, horizontally expanded, orbicular or indefinite in outline, adhering closely to the substratum, monostromatic or composed of very few layers of polygonal cells arranged in dichotomous rows radiating flabellately from several points; chromatophores small, disk-shaped, several in each cell; tetraspores cruciate. arranged in moniliform simple or forked filaments, which are packed together in external convex nematheces; cystocarps and antherids unknown. *E. Alleni*, dredged from 4–6 fathoms.

Classification of Corallinaceæ.* — F. Heydrich now reckons 18 genera of Corallinaceæ, which he classifies under two primary heads:— (1) those in which the thallus has no basal disk, the rhizoids forcing their way into the tissue of the host-plant without the assistance of any special layer; and (2) those in which the thallus has a basal disk and is calcified; the rhizoids are in a single layer, and do not penetrate the tissue of the host-plant. The 1st section includes only the genera *Schmitziella*, *Choronema*, and *Chætolithon*. In the 2nd are included 5 new genera, viz.:—

Sphæranthera g. n. Vegetative development not differentiated; tetrasporanges in conceptacle-like sori; thallus composed of several layers of cells, with or without cuticle; auxiliary cell intercalary; carpogones terminal, not on the same filaments, auxiliary cell developing into a 1-spored gonimoblast; antherids spherical; diœcious.

Paraspora g. n. Similar; but auxiliary cell and carpogone side by side on one terminal filament; auxiliary cell developing into a chain-like gonimoblast.

Stichospora g. n. Tetrasporanges in conceptacles; thallus not flexible, composed everywhere of several layers of cells, with or without cuticle; auxiliary cell and carpogone terminal, one above the other on the same filament; auxiliary cell developing into a 1-spored gonimoblast; diœcious (?)

Hyperantherella g. n. Similar; but auxiliary cell intercalary, carpogone terminal, on different filaments; auxiliary cell developing into a gonimoblast; antherids above the procarps.

* Ber. Deutsch. Bot. Ges, xviii. (1900) pp. 310–17. Cf. this Journal, 1897, p. 225.

Perispermon g. n. Similar; but auxiliary cell and carpogone terminal on one filament, one above the other; auxiliary cell developing into a 1-spored gonimoblast; male elements surrounding the female in one conceptacle.

Œdogoniaceæ.*—Karl E. Hirn has brought out a magnificent and splendidly illustrated monograph of this family of Algæ. After a minute and exhaustive general description of the various parts, the three genera. *Œdogonium*, *Bulbochæte*, and *Œdocladium*, are taken in succession. Of *Œdogonium*, 199 species in all are described, but of these 43 are but imperfectly known, or their organs of reproduction have not yet been accurately observed; 38 are now described for the first time. Of *Bulbochæte* 44 species are described, six of them new; *Œdocladium* is monotypic. The monograph is one of the most complete published of any family of Algæ.

Fertilisation of Sphæroplea.†—M. Golenkin has afresh investigated the mode of fertilisation in *Sphæroplea annulina*, a form allied to Klebahn's var. latisepta, having both uninucleated and multinucleated oospheres. It presents some differences from the mode observed in any other algæ, indeed in any other plants, but resembles that in the Chlamydomonadineæ.

Nuclear division was followed both in the antherid and in the vegetative cells. The nucleole breaks up into a number of fragments, which arrange themselves in a nuclear disk, and then appear to split up and move to the two poles, where they fuse into daughter-nucleoles. All the chromosomes of the dividing nucleus appear to originate from the nucleole. This fusion of the nucleoles in *Spirogyra* and in the Chlamydomonadineæ (as Dangeard has shown) indicates that they are not true nuclei, but carriers of chromatin substance. Nucleoles of this kind occur also in a large number of green algæ, including all Volvocineæ, also in Musci. A similar process takes place in *Amœba hyalina*.

The septa of *Sphæroplea* exhibit at certain spots a kind of aerolation presenting an appearance of sieve-disks, but no continuity of protoplasm from one cell to another could be detected.

Division of the Oosphere in Cystosira.‡—H. Winkler has carried out a series of experiments for the purpose of determining the influence of external factors on the direction of the first division-wall in the impregnated oosphere of *Cystosira barbata*. He established that the direction was quite independent of a difference in the supply of oxygen to the different sides of a germinating oosperm, to gravitation, or to contact. On the other hand, light was found to have a distinct influence on the first division; the first septa in all the germinating plants were nearly parallel to and vertical to the direction of the incident light. When this polarity has once been established, it cannot be reversed.

Structure of the Diatom Girdle.§—As the result of observations, T. C. Palmer and F. J. Keeley have come to the conclusion that the

* Act. Soc. Scient. Fennicæ, xxvii. (1900) iv. and 394 pp., 64 pls. and 27 figs. (German).

† Bull. Soc. Imp. Nat. Moscou, 1899 (1900) pp. 343–61 (1 pl.) (German). Cf. this Journal, 1899, p. 514

‡ Ber. Deutsch. Bot. Ges., xviii. (1900) pp. 297–305 (1 fig.).

§ Proc. Acad. Nat. Sci. Philadelphia, 1900, pp. 465–79 (2 pls.).

generally held opinion that the girdle-band of diatoms is a "closed hoop" is erroneous in a large number of instances, with certain important exceptions however. The authors, in fact, state that "the closed hoop structure is unusual." "The girdle is a two-ended band of silica with the ends variously and characteristically rounded or otherwise modified and approximated or overlapping without being joined," at least in certain examples amongst the larger forms of, e. g. *Surirella*, *Nitzschia*, *Navicula*, &c., and inferentially in the minuter species of the same genera; and also in certain species of *Coscinodiscus*, *Aulacodiscus*, *Biddulphia*, &c. Forms with closed girdles are *Synedra superba*, *Arachnoidiscus Ehrenbergii*, *Triceratium favus* and probably all Triceratiinæ, *Isthmia nervosa*. The pertinence of these observations to the phenomena of reproduction and development is obvious, and they will serve to clear up some at least of the difficulties involved in the assumption of a closed fixed hoop. The important exceptions, however, seem to leave the problem much as before, although the paper is confessedly only a preliminary one. The structure called by the authors a "cleat" on the secondary girdles which make their appearance before reduplication, and which is particularly well marked in *Surirella elegans* Ehr., is very interesting and, so far as we know, new. The paper is accompanied by two plates of diagrams and photographs.

Actinocyclus Ralfsii.*—E. M. Nelson points out that diatoms in general appear white, when examined by a low power and ordinary transmitted light upon a light ground; but if the light ground be made dark, by placing a central stop beneath the condenser, those diatoms which have comparatively coarse structure will appear red, those with finer structure green, those still finer blue, and so on. He notices that these colours are due to diffraction, and that if the objective be changed for one of greater aperture, those diatoms which were red will be resolved and become colourless, those that were green will become red, those which were blue green, and the whole series lowered one step in the gamut of the spectrum.

He then calls attention to the very beautiful *Actinocycli*, which act in a manner precisely contrary to the above; for upon a dark ground they appear colourless, while upon a light ground they become brilliantly coloured. Mr. Nelson argues that the colours in this species can be caused neither by diffraction nor by pigments, and he asks for some explanation of the phenomena.

In conclusion, he describes an extremely delicate perforated cap or sieve covering the single process situated near the margin of this diatom, and says that it is similar to the caps of the processes of the Aulisci, to which he drew attention on a former occasion.

Schmidt's Atlas der Diatomaceen-Kunde.—Heft 56 of this magnificent work comprises, as usual, 4 plates, Nos. 221–224, with accompanying brief descriptions. The diatoms figured are species of *Rhabdonema* and *Cyclotella*.

Stigeoclonium.†—L. Iwanoff finds, in the neighbourhood of Moscow, a new terrestrial species of *Stigeoclonium*, which he names *S. terrestre*, and

* Journ. Quek. Micr. Club, vii. (1900) pp. 377–80.

† Bull. Soc. Imp. Nat. Moscou, 1899 (1900) pp. 423–32 (1 pl.) (German).

from its characters and those of others described by Klebs, proposes some modification of the characters of the genus. Each cell possesses a nucleus, a disk-shaped chromatophore, and one or more pyrenoids. The megazoospores have in some species 2, in others 4 cilia, and germinate readily. The microzoospores have also either 2 or 4 cilia, corresponding to the number in the megaspores of the same species. The microspores do not germinate directly, but pass into a resting-stage, or conjugate in pairs, producing stellate zygotes. The resting palmella-cells may either germinate directly or produce microzoospores.

Plankton Algæ. — In addition to a number of new species, E. Lemmermann * adds the following new genera to the list of plankton algæ.

Centratractus g. n. Cells free-swimming, furnished with a long hollow spine distinctly thickened at the base, with several chlorophores which are often broken up into a network; no pyrenoid; propagation by transverse division. Founded on *Schrœderia belonophora* Schmidle.

Marssoniella g. n. Cells mostly associated in a tufted radiating colony, pear-shaped, connected by the blunt ends, with homogeneous blue-green contents, and a more strongly coloured central body; propagation by division.

Eudorinella g. n. Cells associated in spherical colonies of 8, biciliate, enclosed in a common broad gelatinous envelope; the peripheral cells lying in two different planes, forming regular cubes; chlorophore parietal, with a pyrenoid (?); an eye-spot (?); propagation unknown. Founded on *Eudorina Wallichii* Turn.

Crucigeniella g. n. Cells associated in definite colonies; with a parietal chlorophore, but no pyrenoid; propagation by longitudinal division.

A synopsis is given of the 5 species of *Lagerheimia*.

Prof. G. B. De Toni and Sig. A. Forti † furnish a list, with descriptions of 45 genera and 85 species of plankton-algæ (including Peridinieæ) found in Lake Vetter, Sweden.

Among Plankton diatoms H. H. Gran ‡ proposes a new genus *Bacterosira*, founded on *Lauderia fragilis*, and another new genus *Coscinosira*, founded on *Coscinodiscus polychordus*.

Development of Pandorina morum.§—According to P. A. Dangeard, each zoospore is, in this alga, identical in structure with a *Chlamydomonas* with bell-shaped chromatophore. It possesses a nuclear membrane, a nucleole, and nucleoplasm. Each zoospore is invested with a membrane of its own, and secretes in addition a gelatinous substance, which goes to the formation of the common envelope of the colony. The division of the nucleus is karyokinetic, and exactly follows the same course as in the Chlamydomonadineæ. In the formation of a new colony, which generally consists of 16 individuals (though there may be 8 or 32), there is not simply an invagination of the cells, each one must undergo a

* Ber. Deutsch. Bot. Ges., xviii. (1900) pp. 272–5, 306–10. Cf. this Journal, 1900, p. 612.

† Atti r. Ist. Veneto di Sci., lix. (1900) pp. 537–61, 780–829.

‡ Nyt Mag. Naturvidensk., xxxiii. (1900) pp. 103–28 (1 pl.). See Hedwigia, xxxix. (1900) Beibl., p. 203.

§ Le Botaniste (Dangeard), vii. (1900) pp. 192–208 (1 pl.). Cf. this Journal, 1900, p. 229.

rotation of 180°. The bipartitions take place longitudinally, and each zoospore has in consequence the length of its mother-cell.

Chromulina Rosanoffii.* — N. Gaidukov states that *Chromulina* (*Chromophyton*) *Rosanoffii* is an entirely independent organism, with holophytic nutrition. He has determined the presence in it of chlorophyll. The characteristic pigment, called by Klebs *chrysochrome*, he has decomposed into three components, *chrysochlorophyll* and *chrysoxanthophyll*, both soluble in alcohol, and *phycochrysin*, a pigment soluble in water, which probably gives the peculiar colour to *Chromulina* and to other Chrysomonads.

In another paper † the author gives a more detailed account of the spectroscopic reactions ot this pigment.

Chlorocystis Cohnii (Reinhardt).‡—This unicellular epiphytic alga (*Chlorochytrium Cohnii* Wright) has been found by G. T. Moore encrusting fronds of *Enteromorpha*; it also grows on other marine algæ,—*Urospora*, *Polysiphonia*, *Ascophyllum*, *Navicula*, &c., and on hydrozoans and infusorians. It consists of a single nearly spherical cell, measuring from 16 to 26 μ. These cells, though they have been stated to be sometimes completely endophytic within the tissue of the host-plant, are usually merely epiphytic; and this must necessarily be the case with *Enteromorpha*, which is monostromatic. The cell contains a single large chromatophore, which may be central or lateral. Near the centre of the cell is a well-defined nucleus from which the protoplasm radiates in fine strands. Zoospores of two different sizes are produced; but no evidence of conjugation could be obtained.

Fungi.

Sexual Reproduction in Fungi.§—Prof. P. A. Dangeard reviews the present state of our knowledge respecting a sexual mode of reproduction among the higher Fungi. He asserts that there occurs a fusion of gametes which has all the essential characters of a sexual process in animals or plants, and which involves the necessity of a chromatic reduction. The nuclei of the gametes have a different origin, and their union ensures karyogamic rejuvenescence. A rejuvenescence of the cytoplasm does not, in the higher Cryptogams, accompany the formation of the ovum; it takes place before or after by means of anastomoses between the different hyphæ of a thallus or between different individuals. The double nucleus of the ovum is a nucleus of segmentation, which is always the sole source of the nuclei of new generations. The second fusion in the phenomenon which has been called "deuterogamy" ‖ is not a distinct process.

Chinese Yeast and Amylomyces.¶—According to C. Wehmer, the fermenting agent in Chinese yeast, a preparation used in Eastern Asia

* Hedwigia, xxxix. (1900) Beibl., pp. 139–41.
† Ber. Deutsch. Bot. Ges., xviii. (1900) pp. 331–5 (1 pl.).
‡ Bot. Gazette, xxx. (1900) pp. 100–12 (1 pl.).
§ Le Botaniste (Dangeard), vii. (1900) pp. 89–130.
‖ Cf. this Journal, 1900, p. 73.
¶ Centralbl. Bakt., 2te Abt., vi. (1900) pp. 353–65 (2 pls.).

for the fermenting of rice, and made by Calmette the type of an independent genus *Amylomyces*, is a true *Mucor*, and is named by him *M. Rouxii*. It ferments levulose, dextrose, galactose, sucrose, lactose, maltose, and inulin, with production of alcohol. The structure, life-history, and physiological properties are described in detail.

In another paper * the same author describes a hitherto unknown species which also takes part in the fermentation of Chinese or Javanese yeast, "ragi," and which he names *Mucor javanicus*.

Parasitism of the Ustilagineæ.† — O. Brefeld contests the ordinary view that the parasitism of the Ustilagineæ is obligatory. He has succeeded in growing several species of *Ustilago* quite independently of the host-plant; they thrive especially in the fæces of domestic animals, a point of very great importance in the spread of smut and the other diseases to which they give rise in cereal crops. The author succeeded also in developing these fungi in artificial nutrient solutions.

In the case of most cereals there is only one period in which they are liable to the attacks of these parasites, viz. the earliest stages of germination of the seedling, when the tissues are very soft; after that they are exempt; but, having once entered, the fungus reaches the growing point and destroys the inflorescence. The maize-smut, *Ustilago maydis*, exhibits somewhat different properties from those of other species, since it attacks not only young, but also mature plants.

The author further determined by experiment that the spread of smut is due to the power not only of the conids but also of the ustilago-spores (smut-spores) of germinating and multiplying rapidly outside the host-plant.

Mycosyrinx.‡—Prof. O. Penzig has had the opportunity of studying *Mycosyrinx Cissi*, a parasitic fungus belonging to the Ustilagineæ, which attacks exclusively the flower-stalks of several species of *Cissus* in various tropical countries. It there forms fungus-galls or mycocecidia imbedded in the tissue of the peduncle, where it produces its spores; the sporigenous stroma being formed in a perfectly closed cavity. Another species, *M. arabica*, is also parasitic on the pedicels and petioles of species of *Cissus* in Arabia, likewise forming imbedded mycocecidia.

Sexual Reproduction in Pyronema and the Morphology of the Ascocarp. § —After a review of the researches and theories of other authorities on the development and homology of the ascocarp in the Ascomycetes, Prof. R. A. Harper describes in great detail his own observation on *Pyronema confluens*; the sexual reproductive apparatus in this genus being the largest and most conspicuous yet discovered in the Ascomycetes. No trace of non-sexual reproduction by conids or otherwise was detected.

The sexual nuclei of both antherid and oogone are relatively large, and are very clearly defined in their structure; they contain a very small spherical nucleole. In order for impregnation to be effected, two processes are necessary. In addition to the fusion between the tip of

* Tom. cit., pp. 610–9 (1 pl.).
† J.B. Schles. Ges. Vaterl. Cultur, 1900, Zool.-Bot. Sect., pp. 17–32.
‡ Malpighia, xiii. (1900) pp. 522–32 (2 pls.).
§ Ann. of Bot., xiv. (1900) pp. 321–400 (3 pls.).

the antherid and the conjugating tube, the breaking down of a second wall at the base of the conjugating tube between it and the oogone is necessary. To effect this, a circular disk of the walls is entirely dissolved, leaving a roundish pore through which the protoplasm of the two cells becomes perfectly continuous. The nuclei of the connecting-tube become completely disorganised before those of the antherid migrate through this pore. The only true act of impregnation is the fusion of these nuclei with those of the oogone. The cytoplasm of the antherid takes no part in the process. There may be as many as 200 nuclei in each of the sexual cells, and they are quite indistinguishable from one another. They conjugate in pairs, no further fusion taking place. The development of the fertilised oogone or ascogone is described in detail. The phenomena of nuclear division and spore-formation in *Pyronema* do not differ in their general features from that which is known in other ascomycetous fungi.

We have, therefore, in *Pyronema* a true process of sexual impregnation homologous to that which occurs in *Cystopus*, *Œdogonium*, *Nemalion*, and *Batrachospermum*; and a very striking analogy is presented with the corresponding process in the Florideæ, and with that in lichens.

New Genera of Fungi.—In an account of the Ascomycetes of the first Regnell Expedition to Brazil, K. Starbäck * describes the following new genera :—

Nostocotheca (Plectascineæ). Perithecia nulla; glomeruli hyphis fasciculatis ramosis ascos obtegentibus compositi; asci depressione discreti velut in disco gelatinoso involuti videntur (an capsula gelatinosa primo inclusi); sporidia hyalophragmia, sepimento uno alterove etiam longitudinaliter divisa.

Ophiomeliola (Plectascineæ). Sporidiis filiformibus a *Meliola* et aliis proximis dignoscendum.

Ijuhya (Hypocreales). Perithecia textura vitreo-membranacea, hyphis vix visibilibus composita, discoidea-cylindracea, centro ore minutissimo, periphysibus cincto, pertuso, pilis rigidis hyalinis, membrana crassissima, centrum versus erectis, simplicibus, brevibus, marginem versus planiter currentibus, fasciculatim conglutinatis, longissimis radiantibus obsessa; sporidia uniseptata, hyalina.

Malmeomyces (Hypocreales). Perithecia corneo-membranacea, plane astoma, mox collabescendo-cupulata, setis parcis rigidis vestita, ochracea; sporidia 4-guttulata, denique septata.

Actiniopsis (Sphæriales). Perithecia superficialia, discoidea v. turbinato-discoidea, circa ostiolum centrale discum nudum præstantia, ad marginem pilis fasciculatis coronata; sporidia fusoidea v. fere filiformia, hyalina, multiseptata; textura carneo-coriacea.

In a collection of Fungi (Discomycetes) made by Ule in Brazil, H. Rehm † finds the following new genera :—

Physmatomyces (Bulgariaceæ). Apothecia in stromatibus lentiformibus crasse contextis gelatinosis innata, globosa, creberrima, dein emergentia et discoidea; asci clavati, octospori; sporidia fusoidea, unicellularia, hyalina; paraphyses filiformes.

* Bih. k. Svensk. Vet.-Akad. Handl., xxv. Afd. 3, No. 1, 68 pp., 2 pls.

† Hedwigia, xxxix. (1900) pp. 209–20 (3 figs.).

Psorotheciopsis (Mollisieæ). Apothecia patellaria, in mycelio tenuissimo hyalino sessilia, excipulo subhyalino gonidiis destituto prædita, ceracea; asci oblongo-ovoidei, unispori; sporidia magna, 1–2-septata, hyalina; paraphyses subramosæ.

M. Raciborski * describes four new genera of parasitic fungi from Java, viz.:—*Elsinoe* g. n. belonging to the Ascomycetes, near to *Magnusiella*; *Telimena* g. n. placed in the Pyrenomycetes; *Aldona* g. n., Discomycetes (*A. stella nigra* forms beautiful large black radiating spots on leaves of *Pterocarpus*); *Hemileiopsis* g. n., belonging to Uredineæ, on leaves of *Strophanthus*.

F. Tassi † describes a new genus of Sphæropsideæ, *Bartalinia* g. n., nearly related to *Robillarda*, and belonging to the section Trichosporæ. with the following diagnosis:—Perithecia globosa-depressa, poro centrali pertusa, primo epidermide velata, dein erumpentia, membranacea; sporulæ oblongæ, 4-septatæ, chlorino-hyalinæ, apice setulas ternas hyalinas gerentes, basidiis filiformibus brevibus suffultæ.

In an account of the Hypogæi of Sicily and Sardinia, Prof. O. Mattirolo ‡ describes a new genus *Martellia*, belonging to the Hymenogastreæ. The following is the diagnosis of the genus, or of the single species *M. mistiformis* sp. n.:—Fungus hypogæus v. pæne hypogæus, globosus, plerumque irregularis, avellanæ circiter magnitudine; peridium læve, facile secedens; integumentum ex hyphis filamentosis; moles interior carnosa, eximie cellulosa; septa loculos limitantia sine ordine proprio disposita; hymenium basidiis stipitatis brevibus vestitum; quæ ex inferioribus stratis pseudoparenchymatibus subhymenialibus oriuntur; sporæ ex sterigmatibus tenuissimis longiusculis orientes, sphæricæ v. subsphæricæ, leviter ellipticæ, colore umbrino, leviter echinatæ.

From Borneo, Dr. L. Petri § describes two new species of Gasteromycetes, viz.:—

Clathrogaster. Fungus hypogæus, irregularis v. rotundatus, radicatus, basi excavata instructus, peridio tenui, sericeo, toto v. partim reticulatim sulcato, volva plus minus crassa, gelatinosa, a parietibus nec gelatinosis transjecta, gleba cellulosa spongiosa, lacunis rotundatis v. gyrosis; uterus et mycelium præditum hyphis vascularibus, crassis, longissimis; basidia cellulis sterilibus emersa, subcylindrica; sporæ sphæricæ interrupte cristatæ, in basidii apice sterigmatibus brevibus suffultæ.

Caloderma. Fungus epigæus, rotundatus, substipitatus, peridio crasso, coriaceo, irregulariter dehiscente, cortice initio verrucoso-aculeato, demum subnudo, substantia interiori in loculos farctos permultosque divisa, septis albidis reticulatim dispositis interstructa, singulis loculis venis minoribus transjectis, basi sterili; puls fructifera e filamentis densissime implexis, apice basidia et cystidia constantibus; sporæ sphæricæ, umbrinæ, echinatæ v. ciliatæ, in basidiis latere sterigmatibus longissimis suffultæ.

* Parasitische Algen u. Pilze Java's, 1ter Th. (Batavia, 1900). See Bot. Centralbl., lxxxiv. (1900) p. 48.

† Bull. Lab. Bot. Siena, iii. (1900) pp. 1–3 (1 pl.). See Bot. Centralbl., lxxxiv. (1900) p. 51.

‡ Malpighia, xiv. (1900) pp. 78–82 (4 figs.).

§ Tom. cit., pp. 111–39 (3 pls.).

Erysiphaceæ.—E. S. Salmon points out * that in our present knowledge of the life-history of this group of Fungi two great gaps exist:—in the first place we do not know in what way every spring the ascospores give rise to the conidial or oidium-stage; and secondly, we do not know to what extent each form of mildew is limited in its choice of host-plants, and whether the same species, on different host-plants, may not exhibit slight morphological characters correlated with its occurrence on those plants.

In a monograph of the order,† the same author describes 49 species, in addition to a number of well-marked varieties, arranged in six genera,—*Podosphæra*, *Sphærotheca*, *Uncinula*, *Microsphæra*, *Erysiphe*, and *Phyllactinia*. He regards the ascus as the result of a true sexual process, and does not support Dangeard's view that the fusion of the nuclei in the young ascus is of sexual signification. Too much significance must not be attached to the presence of appendages to the peritheces. The memoir is accompanied by a very copious bibliography.

Isaria arbuscula.‡—J. Beauverie and C. Vaney give a description of this fungus, parasitic on the larva of a Mexican cricket. The fungus is characterised by its gigantic size as compared with the animal attacked, reaching a height of 6 cm. The fungus perforates the chitinous coat of the insect, and forms a mycelial stroma in the tissues of the host, finally completely destroying them and filling up the chitinous envelope.

Parasitic Fungi.—In a collection of Fungi from Japan, E. S. Salmon § finds a new species of *Uncinula* (Erysipheæ) parasitic on *Quercus glandulifera*, which he names *U. septata*.

Under the name *Oidium Citri Aurantii*, Dr. T. Ferraris ‖ describes a new parasitic fungus belonging to the Hyphomycetes, which is very destructive to the orange crop in Italy.

On the leaves of *Euonymus japonicus*, Prof. G. Arcangeli ¶ finds a new species of *Cicinnobolus*, to which he gives the name *C. Euonymi japonici*; it is parasitic on the hyphæ of another fungus, a form of *Oidium leucoconium*.

R. Aderhold ** has found the ascoform of *Cercospora cerasella*, a parasitic fungus which forms brown spots on the leaves of cherry trees, and determines it to belong to the genus *Mycosphærella*, naming the species *M. cerasella* sp. n.

Expressed Yeast-cell Plasma.—Dr. A. Macfadyen, Dr. G. H. Morris, and S. Rowland †† summarise the results obtained by them as follows. The top yeast of English breweries yields, by suitable treatment, a cell-juice which possesses the transient power of decomposing sugar into alcohol and carbonic acid. The amount of gas formed by an active juice is as great as or even greater than that found by E. Buchner.

* Journ. Quek. Micr. Club, vii. (1900) pp. 411–2.
† Mem. Torrey Bot. Club, ix. (1900) 292 pp. and 9 pls.
‡ Ann. Soc. Linn. Lyon, xlvi. (1900) pp. 79–86.
§ Journ. Bot., xxxviii. (1900) pp. 426–7 (6 figs.).
‖ Malpighia, xiii. (1900) pp. 368–81 (1 pl.).
¶ Atti Soc. Tosc. Sci. Nat. (Proc. Verb.), xii. (1900) pp. 108–10.
** Ber. Deutsch. Bot. Ges., xviii. (1900) pp. 246–9.
†† Proc. Roy. Soc., lxvii. (1900) pp. 250–66.

The cell-juice prepared by the authors undergoes a very considerable auto-fermentation, in some instances exceeding that given by a mixture of the same juice and cane-sugar. A dilution of 1–2 with water or physiological salt solution practically stops all fermentative activity. Only with a very active cell-juice does the ratio between the alcohol and carbon dioxide formed approximate to that found in ordinary alcoholic fermentation. When the cell-juice is allowed to act on sugar—either cane-sugar or dextrose—the quantity of sugar which disappears is considerably in excess of that which can be accounted for by the production of carbon dioxide and alcohol. These results appear to lead in the direction not of an enzyme explanation of the process, but rather of a theory which refers the phenomenon to the vital activity of the yeast-cell protoplasm.

In connection with the foregoing, Prof. J. R. Green * ventures to disagree with the conclusion that the yeast-juice exhibits the vital activity of the yeast-cell protoplasm; for he has found that an active preparation could be obtained by grinding the yeast with kieselguhr in such proportion that a perfectly dry impalpable powder resulted, and then extracting the latter with a solution of cane-sugar. It is hardly credible that protoplasm without the protection of cell-walls can resist desiccation. The action of the extract was considerable in the presence of antiseptics which, in the proportions used, were inevitably and rapidly fatal to the life of protoplasm.

Rabenhorst's Cryptogamic Flora of Germany, &c. (Fungi Imperfecti).† — Volume I. of this important work by A. Allescher is now complete with the publication of two more parts, 73 and 74. The large genus *Rhabdospora* comprises altogether 142 species. It is followed by the comparatively small genera *Collonema* (4 sp.), *Trichoseptoria* (1 sp.), *Phleospora* (10 sp.), *Phlyctæna* (15 sp.), *Sphærographium* (4 sp.), *Cornularia* (4 sp.), *Eriospora* (1 sp.), *Dilophospora* (1 sp.), *Septoriella* (1 sp.), *Cytosporina* (24 sp.), *Micula* (2 sp.), and *Micropera* (11 sp.). The next section, the Hyalophragmiæ, is characterised by its elongated or fusiform spores with two or more septa, hyaline or nearly so, and is made up of three genera, *Stagonospora* with 78, *Mastomyces* with 2, and *Kellermania* with 1 species.

Dictyophora Ravenelii.‡—C. S. Scofield gives an account of the structure and development of this fungus belonging to the Phalloideæ, and a somewhat aberrant member of the genus. The points which he regards as of special interest are these. The mycele of the plant is of considerable structural importance. There are borne upon it certain organs which seem to function as storage places for reserve material. There is, in the young mycelial threads, very good evidence of the occurrence of cell-fusion previous to, or in intimate connection with, the formation of the sporophore. The indusium cannot be considered as homologous with the indusium of normal members of the genus *Dictyophora*, but is rather the persistent remnant of tissue which is completely broken down in most other plants of the order.

* Nature, lxiii. (1900) p. 106.
† Leipzig, 1901, 1016 and viii. pp. and numerous figs. Cf. this Journal, 1900, p. 620.
‡ Minnesota Bot. Studies, 2nd ser., 1900, pp. 523–36 (3 pls.).

Mycetozoa.

Mycetozoic Infection of the Cornea.* — Dr. C. Gorini inoculated the cornea of rabbits with *Plasmodiophora Brassicæ.* This infection was followed by tumour formation and ulceration. Very similar appearances result from vaccinia infection of the cornea, but in the latter case the corneal epithelium is chiefly involved, while in the former it is the proliferation of the connective-tissue elements which causes the swelling. The infection may be transferred from rabbit to rabbit, and infected cabbage, preserved in glycerin, will retain its activity for six weeks.

Protophyta.

β. Schizomycetes.

Colourable Granules in the Bacterial Cell.†—Under the imposing title of morphological researches on the biology of bacteria, H. Marx and F. Woithe record at considerable length their impressions of the colourable granules in the bacterial cell. They find that these "Babes-Ernst" granules are associated with the life-history of the species, and are to be regarded as evidence of the highest importance of the vital development of the species. The paper is illustrated by some coloured drawings showing the effect of single and double staining. The preparations were stained with methylen-blue (Loeffler, alcoholic, and acetic acid) and afterwards with aqueous solution of Bismarck-brown.

Occurrence of Acid-resisting Bacilli in the Lower Animals. ‡ — Dr. D. M. Cowie has found acid-resisting bacilli in many of the lower animals, more especially the horse, cow, dog, guinea-pig, and white rat. No such organisms were detected in the rabbit and in the cat. Many of these acid-resisting bacilli resemble the tubercle bacillus of the smegma bacillus of man. These bacteria are undoubtedly of different species, and there seems reason to believe that the term smegma bacillus denotes not a definite species but rather a group of bacilli having common staining properties.

New Pathogenic Streptothrix.§—Prof. Aoyama and Prof. Miyamoto isolated from a case of pneumonitis characterised by lobar consolidation and excavation a streptothrix, which was easily stainable by ordinary dyes, by Gram's method, and by the tubercle bacillus stain. Cover-glass preparations showed typical branched filaments, and these were also present in micro-sections of the lungs. The organism was cultivated on the ordinary media and also in sterilised water. Positive results were obtained by injecting guinea-pigs with pure cultures.

Two new Pyogenic Microbes.‖— Dr. E. Klein found in the sero-fibrinous exudate of the inflamed udder of a cow a bacterium designated *Streptococcus radiatus.* Colonies on gelatin resemble small grey disks with radiating processes ; on agar and blood-serum the growths are fairly round with somewhat irregular border. Milk remains fluid and un-

* Atti Reale Accad. Lincei, ix. (1900) pp. 319–20.

† Centralbl. Bakt., 1te Abt., xxviii. (1900) pp. 1–11, 33–9, 65–9, 97–111 (18 figs.).

‡ Journ. Experim. Med., v. (1900) pp. 205–14.

§ Mittheil. Med. Facult. Kaiserl.-Japan. Univ. Tokio, iv. (1900) pp. 231–76 (3 pls. and 18 figs.).

‖ Centralbl. Bakt., 1te Abt., xxviii. (1900) pp. 417–9.

changed, though good growth takes place at the bottom. Litmus milk is reddened in 24 to 48 hours. In all media the microbe forms long chains, which in fluid cultures are wound up into skeins and balls. The diameter of the coccus varies from 0·6 to 0·8 μ. It stains well by Gram's method. It quickly dies, so that it must be resown within the week. It lasts longest in gelatin.

Bacterium diphtherioides. This microbe was isolated from the purulent secretion from a cow's udder. It has the following cultural characters. It grows badly or not at all on gelatin, agar, and bouillon; grows well in milk at 37°, which is coagulated and acidified. It grows best on blood-serum, which is slowly liquefied. At 37° the colonies are small, white, and roundish by the second or third day, and by transmitted light are yellowish-brown and granular. Taken from serum cultures, the majority of the microbes are oval or spherical and show a central deeply staining granule. The minority are club-shaped or transitional. *B. diphtherioides* stains well with the ordinary anilin dyes, and especially so by Gram's method. Intraperitoneal and subcutaneous injections into guinea-pigs were followed by suppuration. Cultures require to be re-sown within a week, the serum cultures retaining their vitality longest.

Bacterial Flora of American Cheddar Cheese.* — Mr. J. Weinzirl, who in conjunction with Prof. H. L. Russell had found previously that the lactic acid bacteria predominated in American cheese, and that the casein digesting forms were relatively few or absent, now records experiments relative to the constancy and distribution of the bacterial flora in American cheese. These experiments show that the lactic acid producing group of bacteria is constantly present, though their exact function cannot at present be positively stated. It seems probable that they exert considerable influence on the flavour of cheese.

It is specially noted that when in small numbers *B. acidi lactici* produces no untoward effects, but when it predominates it causes the swelling or "huffing" of the cheese, which is highly detrimental to the product.

Bacillus microbutyricus.†—Dr. F. E. Hellström isolated from butter a bacillus which he has named *B. microbutyricus.* The microbe is 1·2–1·3 μ long and 0·2–0·3 μ thick. It is a straight rodlet with rounded ends, and is quite motionless. On gelatin the growth is slow and of a yellowish hue. The colonies are small and discrete, and the medium is not liquefied. On agar the growth is quicker and the appearances are very similar. In bouillon a bottom growth occurs, the sediment being slimy and greyish-yellow. Glucose bouillon is slowly acidified without gas formation. Milk is not coagulated, but the casein is after a time gradually peptonised. On potato the growth is fairly rapid and of a yellow colour. The bacillus is not pathogenic to mice, guinea-pigs, or rabbits. It is stainable only with alcoholic solutions and not by Gram's method. It grows better with than without oxygen. Spore-formation was not observed.

Koumiss Bacillus.‡—Dr. D. Schipin isolated the Koumiss bacillus in gelatin under anaerobic conditions. The colonies are whitish, and

* Centralbl. Bakt., 2te Abt., vi. (1900) pp. 785–91. Cf. this Journal, 1897, p. 571. † Tom. cit., pp. 683–4 (1 fig.). ‡ Tom. cit., pp. 775–7.

resemble a central body with radiating processes. The bacillus thrives best on acid-sugar gelatin, though it grows pretty well on ordinary alkaline gelatin. The gelatin is not liquefied. It does not do well on agar or blood-serum. At room temperature cow's milk is not coagulated, but clots at 37° to a thick soupy consistence, and in both cases with free access of air. The optimum temperature is between 20° and 30° C. It is killed in 10 minutes at 60°. It developes gas (CO_2) in mare's milk. Spore-formation was not observed. It is easily stained, and is not decolorised by Gram's method. From cultivations in mare's milk, the author concluded that the Koumiss bacillus decomposes milk-sugar, producing lactic acid and alcohol, and that it is able to peptonise albumen.

Microbe of Stringy Bread.* —Dr. J. Thomann isolated from two kinds of flour—mixtures of wheat and rye meal—a mesentericus-like bacillus, pure cultures of which made normal bread stringy. The bacillus is a long, thin rodlet, often forming filaments; it is motile, and forms oval spores; it is easily stainable, and also by Gram's method; it liquefies gelatin, and is cultivable also on agar and potato, in grape-sugar, and in pepton bouillon; it grows better at incubation than at room temperature. It is probably identical with the organism described by Vogel under the name of *B. mesentericus panis viscosi ii.*

Tubercle Bacilli in Frogs.†—Prof. O. Lubarsch discusses the statements relative to the effect of tubercle bacilli on frogs made by Sion,‡ and expresses his own views as follows:—When tubercle bacilli are introduced into a lymph-space of a frog, they are regularly transported to the internal organs, and are there demonstrable even after weeks and months. At the inoculation site it is not uncommon to find granulations formed around the small collection of fungi so as to resemble the histological picture of a tubercle, while in the internal organs there is little or no tissue proliferation. The tubercle bacilli, after a stay of a week or so in the internal organs, are no longer able to excite tuberculosis in a guinea-pig, and this loss of virulence is proportionate to the original virulence of the inoculated fungus.

Ætiology of Tropical Dysentery.§—Prof. S. Flexner, who had the opportunity of studying tropical disease occurring in the Philippine Islands, states that there are two distinct types of bacteria in dysentery. Type i. is abundant in acute cases. It is about the same size as *B. coli communis*; it grows well on all media at room temperature, but better in the thermostat; it is motile, and does not stain by Gram's method; gelatin is not liquefied; it does not produce gas; indol is not always formed; it is pathogenic to ordinary laboratory animals. Type ii. is present in all instances, though in acute cases it may be less numerous than type i. It has the characters of the *B. coli* group, and differs from the preceding type by the formation of acid and of gas, and the amount of indol produced. Observations were also made as to the presence of amœbæ. These were commonly present, though in variable numbers, in the chronic cases. The author concludes that tropical dysentery con-

* Centralbl. Bakt., 2te Abt., vi. (1900) pp. 740–2.
† Op. cit., 1te Abt., xxviii. (1900) pp. 421–30.
‡ Cf. this Journal, 1900, p. 623.
§ Centralbl. Bakt., 1te Abt., xxviii. (1900) pp. 625–31.

sists of a bacillary and probably an amœbic form; that the bacillary form occurs as an acute and a chronic disorder, and that the cause of the bacillary disease agrees in its morphological cultural characters and pathogenic properties with the bacillus isolated by Shiga in Japan.*

Changes in Anthrax in Decomposing Blood.† — E. Berndt kept blood of cattle dead of anthrax in a dark cool place, and examined samples thereof daily by both Klett's and Olt's staining methods. Up to the thirteenth day the preparations showed well-marked anthrax bacilli. The decay of these bacteria appears to start in the central parts, the blue staining segments becoming insensitive to pigments and granular, while the external portion or sheath retains its staining properties longer.

Immunisation of Anthrax against Rat Serum.‡ —J. Danysz, who has conducted experiments with anthrax and rat serum, finds that this serum does not contain a bacteriolytic diastase, but merely a substance analogous to an antiseptic which fixes on the bacterium, and while, on the one hand, it paralyses the functions of assimilation and growth, on the other it favours the secretion and digestive action of a diastase secreted by the microbe itself. Against the action of the noxious substance in rat serum the microbe defends itself by the formation of a mucilaginous sheath which fixes this substance outside the body of the microbe. The immunisation of the bacterium against this substance does not render it individually more resistant to auto-digestion, but simply allows it to nourish itself and give new cultures before it is digested. Rat serum freed from its antiseptic forms a good culture medium, and this explains why, under certain conditions, a mixture rich in serum will give a culture more abundant than a mixture containing a less proportion of serum. The author then passes on to discuss the immunisation of anthrax to arsenic, and shows that there is a great analogy between the mechanism of the action of arsenious acid and that of rat serum, and that the mechanism of immunisation is identical in the two cases.

Feeding Animals on Food Contaminated with Anthrax Spores.§ — Dr. Nikolsky fed animals (rabbits, rats, guinea-pigs, mice) on food contaminated with anthrax spores, and found that the disease developed just as easily as from other methods of infection. The spores developed in the intestines, notwithstanding the competition and antagonism of the intestinal microbes. They penetrated the mucosa and passed into the lymphatic and blood-vessels.

Loss of Liquefactive Power of Anthrax.‖ — Dr. T. Matzuschita, after referring to the variability of certain functions in bacteria, and more especially the loss of their power to liquefy gelatin, states that *Bacillus anthracis* may be affected in this way. By cultivating for about 18 months in 10 p.c. gelatin at room temperature, and with occasional transferences, he has obtained cultures which only begin to liquefy gelatin after about 50 days, though their other properties (morphological

* Cf. this Journal, 1899, p. 72.
† Centralbl. Bakt., 1te Abt., xxviii. (1900) pp. 648–51 (1 pl.).
‡ Ann. Inst. Pasteur, xiv. (1900) pp. 641–55. § Tom. cit., pp. 791–801.
‖ Centralbl. Bakt., 1te Abt., xxviii. (1900) pp. 303–4.

and pathogenic) were retained in full. Passage through an animal did not restore the liquefying power, though it could be regained by cultivating on agar at 37°.

Structural Division of the Endoplasm in Plague Bacilli.*—A. A. Merlin draws attention to certain exceedingly minute internal structural details within the stained forms of the plague and other bacilli which point to the existence of a regular subdivision or partition of their cell contents. In the round forms the division of the contents is quadripartite, so that the interior appears to show beams arranged more or less crosswise, while in the elongated forms there is a longitudinal partition with numerous transverse septa. In many micrococci a protuberant boss or knob is a common feature, and when present appears to be invariably situated on the line of one of the internal divisional partitions; the flagellum, when observable, having its point of attachment so placed.

Relations of the Coli Bacillus to Plague and Yellow Fever.†—Dr. P. Caldas has arrived at the conclusion that the plague is a coli-bacillosis of the rat excited by the ingestion of rice containing a mould fungus (*Aspergillus niger*), and that the coli bacillus, by transference from rat to rat, finally assumes properties which are pathogenic to man.

The same author had previously expressed the conviction that *B. icteroides* is a variety of the coli bacillus which acquires its virulence from contact with a pyogenic microbe and in presence of a mould.

Chemical Nature of Tetanus Toxin.‡—Dr. H. Hayashi, who has made researches as to the chemical nature of tetanus toxin, expresses the opinion that this poison is an albumose. This conclusion is arrived at in consequence of the behaviour of the toxin with salts of zinc.

Bactericidal and Agglutinative Properties of Pyocyaneus Serum.§—The results of Dr. P. Müller's researches may be summed up as follows. The bactericidal power of normal guinea-pig serum is no greater in the absence than in the presence of oxygen. While non-virulent bacilli are affected to no inconsiderable extent by normal serum, virulent bacilli may, after a transitory impairment of growth, thrive therein. Pyocyaneus serum has, under aerobic conditions, no greater bactericidal power over virulent pyocyaneus bacilli than normal serum. But in the absence of oxygen the serum discloses energetic germicidal properties. One hour's heating to 55° destroys this anaerobic germicidal power, but it may be restored by the addition of normal serum. No agglutinating substances exist in pyocyaneus bouillon cultures. The agglutinins of the immunising serum are therefore formed in the body.

Bacterium pneumoniæ caviarum.‖—Dr. F. Strada and Dr. R. Traina describe a new form of infectious lung disease in guinea-pigs. From the inflamed tissues was isolated an oval microbe, easily stained, but quickly decolorised by alcohol. In hanging drops lively movements were observed; it is cultivable on the usual media, the optimum

* Journ. Quek. Micr. Club, vii. (1900) pp. 387–90 (11 figs.).
† C.R. Soc. de Biol., lii. (1900) pp. 953–5.
‡ Mitth. Med. Facult. Kaiserl.-Japan. Univ. Tokio, iv. (1900) pp. 341–62.
§ Centralbl. Bakt., 1te Abt., xxviii. (1900) pp. 577–87.
‖ Tom. cit., pp. 635–48.

temperature being 34°–37° C. It is an essential aerobe, and does not liquefy gelatin. The growth on most media is yellowish; old cultures exhale a disagreeable odour; gas and indol are not produced; experiments on guinea-pigs with pure cultures reproduced the disease. The post-mortem appearances varied with the duration of the disease and with the method of infection. Positive results were obtained by spraying the trachea, by injecting the bacteria into the thorax and into the circulation. Subcutaneous injections were however followed by abscess and recovery. Injections of filtrates of bouillon cultures gave negative results. In general terms it may be said that *B. pneumoniæ caviarum* excites a pneumonitis with a focal or lobular distribution.

Diphtheria in Horses.*—Dr. L. Cobbett expresses the opinion that horses are probably peculiarly liable to diphtheria, and hence may have no inconsiderable share in the dissemination of this disorder. This idea receives confirmation from the well-known sensitiveness of some of these animals to the action of the diphtherial poison. The author's view was derived from finding the diphtheria bacillus in the nasal discharge of a pony. An exhaustive examination of the characters and toxins of the bacillus conclusively proved its diphtherial nature, and led to the examination of other horses, in order to test if antitoxin were present in their blood. Out of 13 animals, in 9 the antitoxin was found to be present. From this the author infers that such animals had acquired the disease naturally.

Streptococcus decolorised by Gram's Method. † — J. Cottet and H. Tissier isolated from cases of purulent cystitis and diarrhœa a streptococcus which is decolorised by Gram's method. With the ordinary anilin dyes it stains easily. The diameter of the coccus does not exceed $0 \cdot 5\,\mu$. It grows under aerobic and anaerobic conditions, and was cultivated on agar, gelatin, in bouillon and milk. No growth was observed on potato. Only a few streptococci which are decolorised by Gram's method have been described, and the authors allude to four only, from which theirs is distinctly different.

Action of Anthrax on Carbohydrates.‡—Mdlle. Napias has found that anthrax easily attacks amylaceous and saccharine substances; at the expense of each it forms a fixed acid (lactic) and a volatile acid (acetic). When the carbohydrate nutriment becomes scanty (sugar) or difficult to attack (starch), the bacterium attacks the lactic acid which has been formed, and consumes it in two stages: it leaves as residue some acetic acid which is destroyed later, so that all the carbon of the original carbohydrate substance is converted into carbonic acid. The bacterium and the vaccines derived from it behave inversely, in regard to their proteolytic and amylolytic properties; the proteolytic properties predominate in the virulent species, and the amylolytic in the attenuated.

Effect of Acid-resisting Bacteria of the Tubercle Group on Animals. § —Dr. G. Mayer's experiments with acid-resisting bacteria of ercle group were made by infecting cultures rubbed up with

* Centralbl. Bakt., 1te Abt., xxviii. (1900) pp. 631–4.
† C.R. Soc. de Biol., lii. (1900) pp. 627–8.
‡ Ann. Inst. Pasteur, xiv. (1900) pp. 232–47.
§ Centralbl. Bakt., 1te Abt., xxvi. (1899) pp. 321–36 (5 figs.).

butter into the peritoneal sac of guinea-pigs and rabbits. A plastic peritonitis resulted which would ultimately fibrify or degenerate. The bacteria which were included in the exudation might continue to grow, and then their increase appeared to give rise to a proliferative tissue reaction, whereby nodules were produced. These nodules either fibrosed or caseated. The virus did not become generalised, and was confined to the peritoneal sac.

Ætiology of Dysentery.*—Prof. Escherich confirms the occurrence of the serum reaction in cases of dysentery noted by Shiga,† and is inclined to think that *Bacillus coli communis* is the probable cause of the disease.

* Centralbl. Bakt., 1te Abt., xxvi. (1899) pp. 385-9.
† Cf. this Journal, 1899, p. 72.

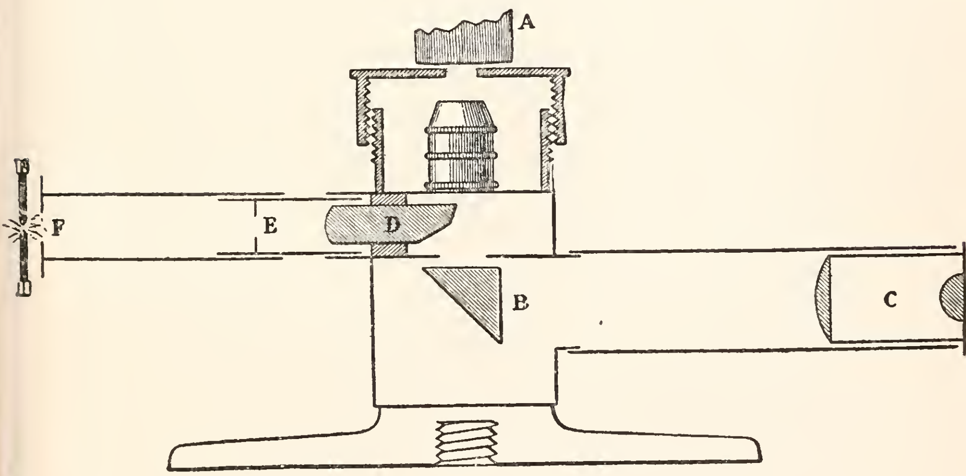
MICROSCOPY.

A. Instruments, Accessories, &c.*

(1) Stands.

Le Chatelier's Microscope for Examination of Opaque Bodies.†—The inverted position of the stage in this Microscope facilitates the arrangement of fragments of metal, which may then, with the exception of the polished surface, be of any shape. The horizontal pencil of light received by the illuminating prism D (fig. 1) is refracted upward and taken up by that half of the objective which is covered by D. The two faces of the prism make an angle of 45°, one of them forming

Fig. 1.



an angle of 22·5° with a horizontal line, the other a similar angle with a vertical line, which causes the axis of the reflected pencil to be vertical. The extreme edge of the prism intersects the axis of the objective and also its principal focus, or, at least, comes as near doing so as possible. The diaphragm E, placed at the conjugate focus of the object examined, and the screen F with its rectangular opening, provide a means for cutting off all the useless rays, whose diffusion by the lenses of the objective would otherwise illuminate the field of the Microscope and diminish the visibility of the images. To reach this result, the diaphragm E must have an opening exactly equal to the diameter of the

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

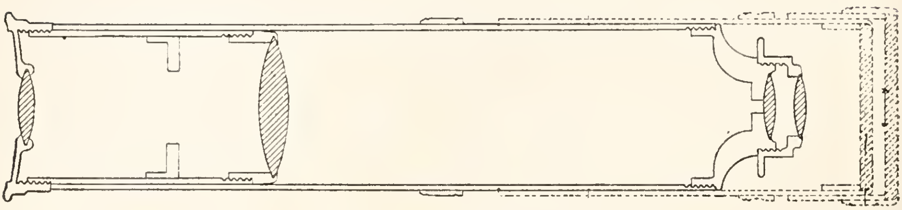
† Metallographist, Jan. 1898, pp. 83–4 (1 fig.).

image of the useful portion of the object under examination; and the opening of the screen F a height equal to half the dimensions of the image of the upper lens of the objective.

A is the object examined; C the eye-piece.

Gilbertson's Microscope. — This old non-achromatic Microscope, kindly lent for exhibition by Mr. H. E. Freeman, and since presented to the Society, was made by H. Gilbertson, of London; the date of its manufacture, however, has not been determined. The instrument was evidently designed for use in the field, for on reference to fig. 2, drawn by Mr. Parsons, it will be seen that it is essentially a hand Microscope, without either stand or stage, but in place of the latter there is a compressorium, or live-box, fitted to the end of a tube which slides over the body-tube of the Microscope; this sliding tube constituting its sole focussing adjustment.

Fig. 2.



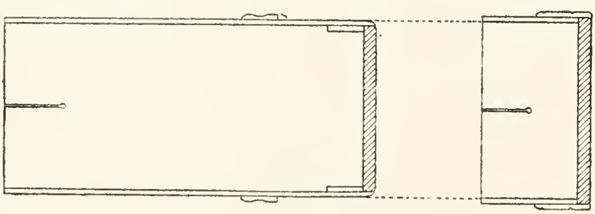


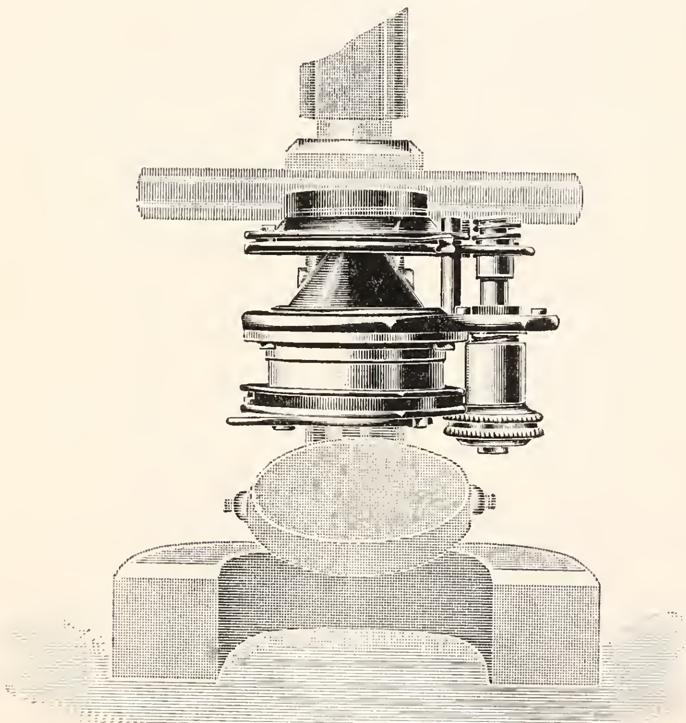
Fig. 3.

A lower power is obtained by removing the front lens of the objective; the body has marks upon it indicating the position of the sliding tube when either the high or low power is employed. There is one drawback in the design of this instrument, and that rather a serious one, viz. the only motion that can be given to the object is in the direction of the line of sight for focussing; all other movements, such as lateral motion in the field, are impossible. If the object, therefore, is not placed with tolerable accuracy in the centre of the compressorium, it will not be visible in the field of the Microscope. Diameter of field with high power, $\frac{1}{10}$ in. Diameter of field with low power, $\frac{1}{5}$ in. Working distances, $\frac{7}{16}$ and $1\frac{1}{16}$ in. respectively. Length with live-box closed, $4\frac{1}{2}$ in. Greatest diameter, 1 in.

Fig. 2 represents the arrangement with the tube drawn over the instrument, indicated by the dotted lines; fig. 3 the compressorium detached from the Microscope and the cap removed.

Bausch and Lomb's Duplex Substage.* — To meet the need for a substage attachment which shall be simpler than the complete Abbe substage, and yet embrace its principal advantages, Mr. E. Bausch has constructed a modification designated as above. As shown in fig. 4, two arms are movable up and down upon a metal post rigidly fixed to the stage. The upper arm carries an iris diaphragm which may be used in the plane of the stage or below it; the lower heavier arm carries the Abbe condenser with an iris diaphragm attached below. In addition to

Fig. 4.



the firmness afforded by the rigidly fixed supporting post, a metal guide passes through the arm of each ring, the result of which is to render the substage accessories, when in position, absolutely free from any appreciable lateral movements, and to keep them throughout all vertical movements in the optical axis of the Microscope.

The upper arm has a vertical movement sufficient to obtain the best optical results from the iris diaphragm when this is used alone. The lower arm, however, has a vertical movement the upper limit of which brings the condenser into immersion contact with the object-slide; from

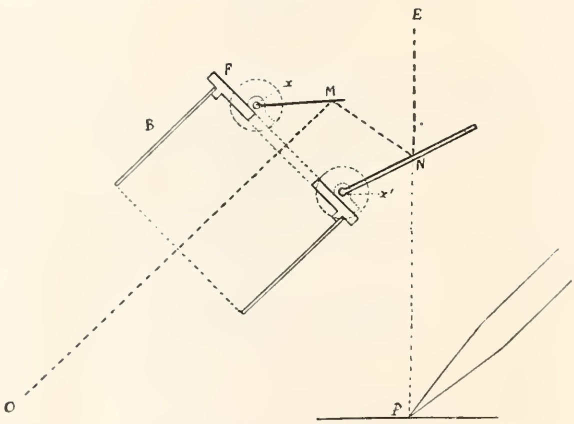
* Journ. App. Micr., July 1900, pp. 933–4 (1 fig.).

which point it may be rapidly lowered free of the guide-post where it may be swung to the left, completely out of the path of light from the mirror. When in this position it may be again raised, the guide-post passing through a second hole in the arm and preventing its accidental displacement.

(3) Illuminating and other Apparatus.

Ashe's Camera Lucida.*—D. J. Scourfield describes this accessory, which has been lately slightly modified and thereby improved by its inventor. As will be seen from fig. 5, Ashe's camera lucida is, in essence, an improved form of Beale's neutral tint reflector, the most important difference being that the light from the eye-piece, instead of

Fig. 5.



being received directly upon the neutral tint glass, is first of all received upon a small mirror, which reflects the light down upon the neutral tint and so up to the eye. By this means the light undergoes two reflections before reaching the eye, and the most important defect of Beale's neutral tint reflector, viz. the reversal of the top and bottom of the image without a corresponding reversal of the sides, is corrected.

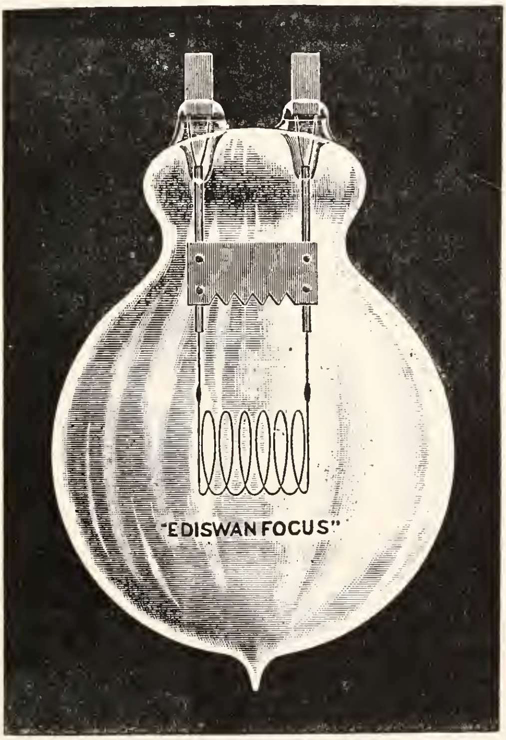
But by making the mirror and the neutral tint glass to rotate upon two parallel pins, the inventor has succeeded in producing a camera which can be used in any position of the Microscope. When the latter is inclined at any angle between about 45° and the horizontal, the image can be projected (only apparently, of course) vertically downwards on to the table by a suitable adjustment of the relative positions of the mirror and neutral tint glass. When the Microscope is vertical (and also when inclined) the image can be projected to the side by rotating the camera 90° from its former position. The drawing paper must now be placed on a board inclined at the proper angle, i.e. at right angles to the line of sight. The correct placing of the board is easily determined by observing the outline of the image of the field. If this be a circle, the

* Journ. Quek. Micr. Club, 1900, pp. 413-6 (1 fig.).

board is correct. A sheet of paper with a series of concentric circles drawn upon it will enable the question of the circular outline of the field to be readily settled. Such a sheet of paper is also useful for determining whether the line of sight is vertically downwards when the camera is used to project the image upon the table.

If the camera is used not only with low-power, but also with moderately high-power eye-pieces, the mirror must be so arranged that its free end, when the mirror is inclined at about 45°, is as close as possible to the eye-lens. This can only be done by making the mirror

Fig. 6.



rather small and pivoting it to the front plate just above the central opening in the latter. After several trials it was found that a small cover-glass, say, about half-an-inch in diameter, silvered on one side and cemented to a thin metal plate, gives excellent results, and seems altogether the simplest and most suitable form of mirror for this camera.

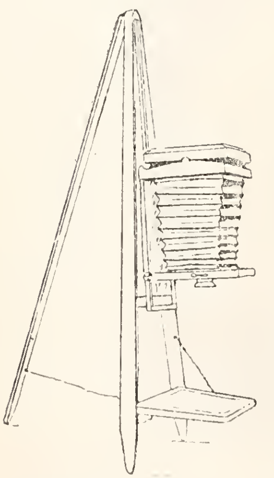
As regards the neutral tint glass, it is necessary to make it rather large, because, owing to the adjustments which have to be made for various inclinations of the Microscope, the light is not always reflected from the same spot. Moreover, it is evidently essential that the whole image of the field, as seen on the drawing-paper, should be visible through the neutral tint glass.

Lastly, the tube-fitting of the camera should be made as long as possible, thus allowing of the camera being moved closer to or farther from the eye-piece, and enabling the best position to be obtained for use with eye-pieces of different powers and focal lengths.

Electric Focus Lamp for the Microscope.—Fig. 6, on the foregoing page, illustrates Edison and Swan Company's focus lamp recommended by Mr. C. F. Rousselet for use with the Microscope, and described by him in the number of this Journal for December 1900, p. 741. The lamp should be of 8 candle-power, and mounted with the usual brass collar terminal for use with the ordinary bayonet-joint holder, like the ordinary electric lamp. Mr. Rousselet recommends that the standard to carry the lamp should have an arm to move up and down, similar to the ordinary Microscope lamp, and the arm a knuckle-joint in order to be able to adjust the lamp in an upright or horizontal position, or at any intermediate angle, as may be desired. A second similar arm may be provided to carry a bull's-eye condenser.

Resolution of Striæ.*—Dr. R. H. Ward, of Troy, N.Y., recommends for the resolution of striæ, &c., the old method of obtaining oblique light by the decentralisation of the substage condenser.

Fig. 7.



(4) Photomicrography.

Photography in Botany and in Horticulture.†—Messrs. Waugh and Macfarland consider the importance of the camera as second only to the Microscope for the botanist; while for the horticulturist they would give it the first place.

The essentials are a vertical camera and a horizontal shelf. Figs. 7 and 8 show two modes of attaining the result. The former is in use at the Vermont Experiment Station, and is more of an out-of-door form; the latter is used at the Mount Pleasant Printery, and is more intended for the studio.

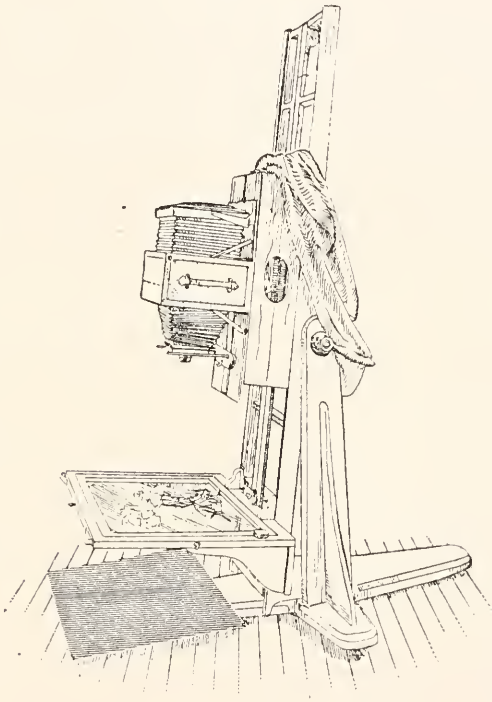
The advantages are: (1) Nearly all trouble in arranging the object is avoided, as the specimen has merely to be placed on the shelf; in the case of a fruit which sometimes does not readily assume stable equilibrium, a rubber hose-washer forms a useful holder, and a supply of them should be always at hand. (2) A sheet of paper of any tint can be placed under the object so as to form any background desired. (3) Shadows are avoided. (4) The making of photographs exactly to the size is facilitated.

A photograph the same size as the object is most desirable; to obtain

* Trans. Amer. Micr. Soc., 1900, p. 111.
† Bot. Gazette, xxx. (1900) pp. 264–6 (2 figs.).

this a camera with considerable bellows extension is necessary, and the lens must be midway between the object and the camera glass. The best work will be possible with a wide-angle lens of rather short focal length.

FIG. 8.



Extreme care and cleanliness are urged; dust is a great enemy in full-size photography. It will generally be found necessary to arrange a wire frame with velvet hood to cover the camera top so as to exclude all reflections.

PENNY, R. GREENWOOD—**Photomicrographic Apparatus.**
Amer. Mon. Micr. Journ., Nov. 1890, pp. 310–4; and *English Mechanic and World of Science* (reference not given)

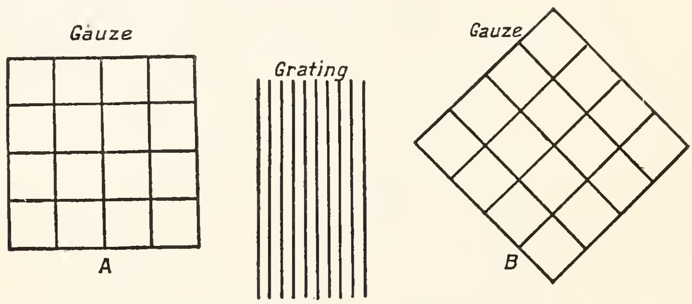
(5) Microscopical Optics and Manipulation.

Imitation of Polarised Light Effects by Diffraction.* — Mr. J. Rheinberg, by inserting a straight-lined diffraction grating of 100 lines per millimetre (about 2500 per inch) just above the objective, and focussing down on a small piece of wire gauze (wires 0·5 mm. apart), produces a series of brilliantly coloured results, which are strongly suggestive of polarised light effects; although, in reality, they are diffraction fringes.

* Journ. Quek. Micr. Club, 1900, pp. 407-10 (2 figs.).

As is well known, such a grating forms an uncoloured central image of a bright line, flanked on each side by a number of spectra, violet side inwards, red outwards. In the wire gauze each space between the wires takes the place of the bright line, and forms its own white central image in the proper place, with several broadened-out spectra on each side. The spectra produced by a number of the spaces overlap and produce composite colours. When these colours fall upon the bright white image of the interspaces, they produce no observable effect, being, in fact, flooded out. Where, however, the bright colours fall upon the dark image of the opaque wires, they readily manifest themselves. When the wires are parallel to the lines of the diffraction grating (fig. 9, A), then, if they are spaced regularly, the colours developed upon them must be the same in each case; but so soon as the wires are rotated, then, instead of having equally wide spaces lying transverse to the grating, the width of the spaces varies in a regular manner (Fig. 9, B), and the

Fig. 9.



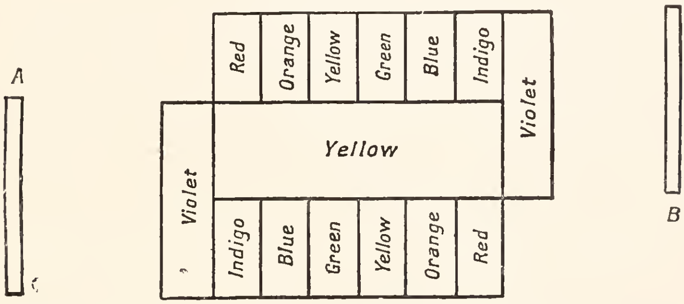
spectra formed vary accordingly, so that we get the different colours showing themselves on the same wire.

There are one or two useful purposes to which the above principle may be applied. Thus, in experimenting with wire and other gratings it is tedious to measure whether the wires and interstices are evenly spaced; but in this diffraction method any irregularity in the spacing or ruling of the object grating reveals itself immediately to the eye by reason of the different coloration of the particular wire or set of wires (or rulings) to the others.

Again, the arrangement may be used in investigations on colour sensation, as it is easy to obtain an admixture of two or more pure spectral colours in the *natural proportions* present in white light. If a screen be taken with two adjustable slots, any part of the spectrum of the one may be made to overlap the spectrum of the other, and, by having the slots A and B arranged the one a little above the other (fig. 10), the top or bottom of the field of view shows the two colours separately, and in the central part of the field we have the admixture.

This arrangement of slots, one above the other, seems to have been employed many years ago by Helmholtz (see his *Handbuch der Physiologischen Optik*, p. 353). It is also referred to by Ogden N. Rood in his *Modern Chromatics*. But apparently the employment of gratings is a novelty, as both the above writers used prisms. The distinctive feature of the gratings is that the spectra with the order of their colours reversed can be superposed, whilst with a prism the superposed spectra would both have their colours in the same order, i.e. red ends both on

Fig. 10.



the same side. The former arrangement has an obvious interest of its own, because of the comparison it affords of colour sensation produced by a series of pairs of colours, each pair of which has the same wave-length.

(6) Miscellaneous.

Forgan, W.—**Simple Method of obtaining a Large Field of View with the Compound Microscope.**

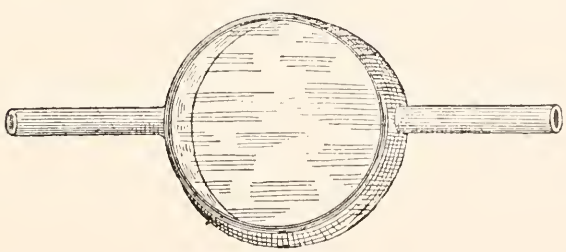
[The enlarged field of view caused by closing the draw-tube is simply a result of the reduction in power.] *Proc. Scottish Micr. Soc.*, iii. pp. 32–4 (1 fig.).

B. Technique.*

(1) Collecting Objects, including Culture Processes.

Simple Method for Cultivating Anaerobic Bacteria in Capsules.†—Dr. St. Epstein describes a very simple procedure for cultivating

Fig. 11.



anaerobic bacteria. A Petri's double capsule is fixed round with a broad rubber band having a couple of rubber tubes at opposite sides. 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.

† Centralbl. Bakt., 1te Abt., xxviii. (1900) p. 443 (1 fig.).

chink between the capsule and the band is smeared up with paraffin and wax, and then hydrogen gas passed through for three minutes. The exit opening is then closed, and directly after the entrance opening. The bacillus of malignant œdema, *Bac. botulinus*, and *Bac. tetani* have been cultivated by this method. The contrivance is represented in fig. 11.

New Method of Cultivating the Tetanus Bacillus.*—Dr. L. Debrand describes a new method for cultivating the tetanus bacillus. A mixed culture of *B. tetani* and *B. subtilis* is grown under ordinary aerobic conditions in bouillon composed of Liebig's extract 5 grm.; peptone (Chapoteaut's) 10 grm.; salt 5 grm.; water 1000 grm. *B. subtilis* developes first and forms a thick surface scum, and after some 24 hours the drumstick microbe begins to grow. The toxin of the cultures is in no way modified by the symbiosis, and is in fact identical with that formed by *B. tetani* when cultivated under anaerobic conditions. It was found advisable to start the cultures at about 34°; but when the toxin production had attained its maximum (5 or 6 days), the tubes were withdrawn from the incubator, as the toxicity was from that time no longer increased.

(2) Preparing Objects.

Method of Preserving Crustacea.†—O. A. Sayce describes a method of preserving small animals which, while obviating the necessity of keeping them in a fluid, retains their suppleness and natural appearance. The method is specially adapted for crustacea and such animals as have a firm outer skeleton. The specimens (fresh or preserved in 70 per cent. alcohol) are placed in the following mixture:—glycerin $1\frac{1}{2}$ parts, water 1 part, methylated spirit 1 part (each by volume); corrosive sublimate 1 in 2000. The time of immersion will depend on the size of the object, but there is no detriment from an indefinite period. Ten days will suffice for *Astacopsis bicarinatus*.

When the specimens have soaked sufficiently long to allow of all the tissues being penetrated by the solution, they may be taken out, and having been set aside for a few days to drain and allow the spirit to evaporate, they may be stored in suitable boxes or wrapped in waterproof paper. To prevent too much drying, or the deposit of moisture owing to the hygroscopic property of the glycerin, the specimens may be coated with gelatin and then immersed in 10 per cent. formalin for a few minutes. This renders the gelatin insoluble to water. In practice the author uses a quart glass jar in which are placed 8 oz. of methylated spirit, 7 grains of corrosive sublimate, 8 oz. of water, and 12 oz. of glycerin.

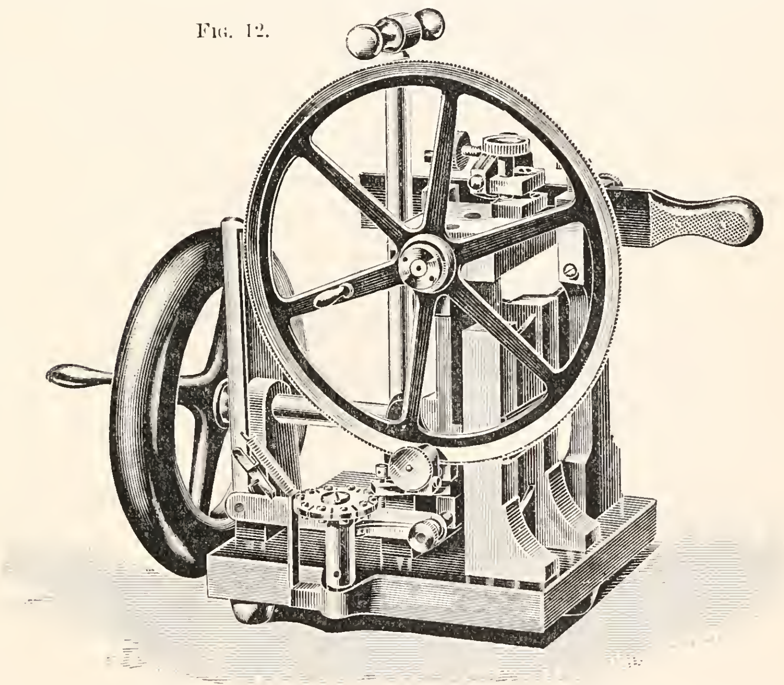
Silvering Nerve-tissue.‡—Sig. Mosso impregnates nervous tissue with 1–2 p.c. solution of argentamin, and reduces with 10 p.c. pyrogallol solution. The impregnation takes 10 minutes and the reduction five. The method was successful for the medullary sheath and for nerve-cells.

* Ann. Inst. Pasteur, xiv. (1900) pp. 757–68.
† Victorian Naturalist, xvii. (1900) pp. 75–8.
‡ Zeitschr. f. angew. Mikr., vi. (1900) pp. 161–2.

(3) Cutting, including Imbedding and Microtomes.

Minot-Blake Microtome.* —F. Blake has devised a microtome which remedies the mechanical defects of its prototype the Minot Wheel-Microtome. The substantial difference between the two instruments is in the methods used for supporting and guiding those structural parts by means of which the specimen to be cut is moved in a vertical and a horizontal direction. The moving parts have only three bearing points, and are held in contact with the guiding surfaces by the action of a flat steel spring. The points which form the base of the triangle are V-shaped, and are held in contact with a V-shaped groove, while the third

Fig. 12.



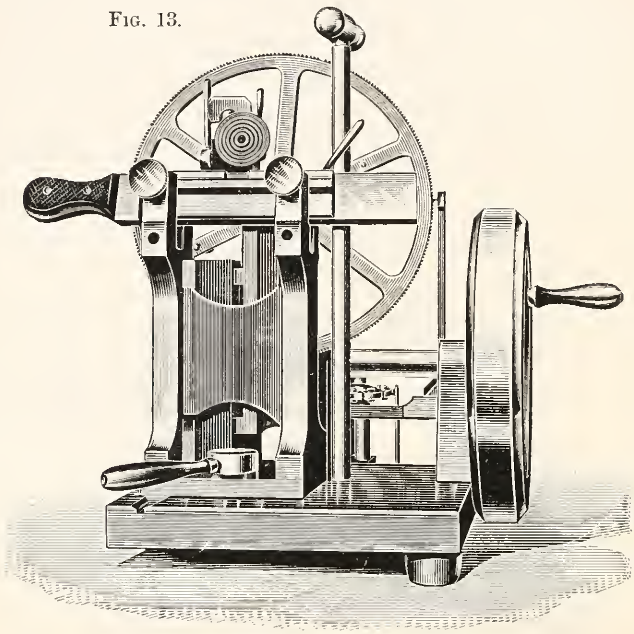
point is a flat block held in contact with a plane surface. The tripod bearing insures absolute stability under contact; and the stiff but yielding bar-spring gives absolute contact and compensation for wear.

From the description given by the Buff and Buff Manufacturing Company the following further details are gathered. The microtome is made up of a heavy base and fly-wheel of iron. The shaft and sliding block are of hardened steel operating on hard composition metal, and the vertical carriage moves on bell-metal uprights. The knife has a blade of $1\frac{1}{8}$ in. The feed-wheel is 7 in. in diameter, and is accurately cut to 500 teeth. The micrometer feed-screw for the cross-feed has 50·8 threads to the inch (half millimetre pitch) so that a single tooth of

* Journ. Boston Soc. Med. Sciences, iii. (1899) pp. 75–8 (3 pls.).

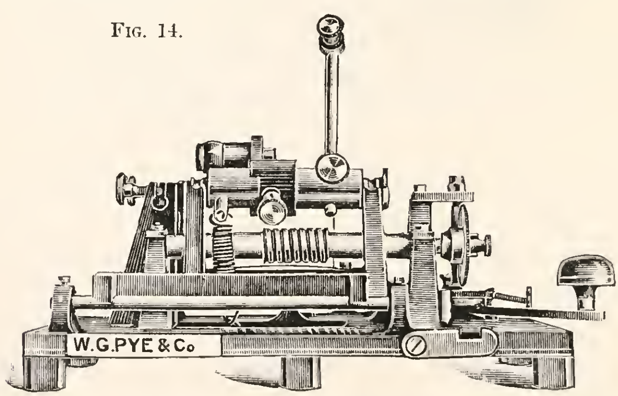
the feed-wheel advances the specimen one micron or $\frac{1}{25400}$ in. toward the knife. By a circular adjustment the feed may be varied from one to ten microns per stroke. The vertical movement is 1 in.

Fig. 13.



This instrument (see figs. 12, 13) will cut single micron sections in series without missing.

Fig. 14.



Leake's Microtome.—The accompanying cut (fig. 14) illustrates the microtome shown by Mr. Hugh M. Leake at the meeting of the Society on January 16th (see p. 106), designed for cutting perfectly flat sections.

(4) Staining and Injecting.

Mordants in Staining Technique. * —After alluding to the great advances made in dyeing by means of mordants, decolorising and other reagents, G. Marpmann suggests that similar combinations might be employed in microscopical technique. For this purpose the chloramin colours are recommended, such as chloramin yellow C.G., which is fast to alkalis, acids, heat, and chlorine, and chloramin violet R, which is fast to acids and alkalis.

The relations of pigments to organic cell-substances are deserving of special analysis. The following reactions are those best known:— Substances containing pectin, vegetable mucus, or gums stain red with ruthenium oxychloride in ammoniacal solution $Ru_2(OH)_2Cl_4+7NH_3$. The aqueous solution $\frac{1}{5000}$ is kept in dark bottles. With this stain plus acetic acid bacteria stain blue.

Vegetable fibres. The specimen is boiled with naphthol solution in alcohol $\frac{1}{5}$. One drop of the solution with 10 drops of water are mixed on the slide. After boiling, sulphuric acid is added. This gives a violet hue if vegetable fibres be present, and a brownish-red with animal fibres.

Cell-nuclei. A mixture of 0·5 carmin, 20 alcohol, and 2 hydrochloric acid, is heated, and then 25 chloral hydrate added. In this fluid nuclei stain a deep red in 10 minutes.

Mucin is stained a dark-brown in 1 p.c. Bismarck brown.

Muscle-fibres stain yellow in saturated aqueous solution of orange G.

Cell-substance stains reddish with orange G.

Nerve-fibres become deep red in saturated aqueous solution of acid fuchsin (fuchsin S).

Chromatin. Preparations stained with safranin are treated with one per thousand hydrochloric acid alcohol. Thionin stains the chromatin bodies of the nucleus in a similar way.

Diabetes blood is decolorised by methylen-blue solution. The solution consists of 1 part methylen-blue, 6000 parts of water, and 2 parts of 6 p.c. caustic potash. One part blood is mixed with 2 parts of water and 50 parts of the solution, and the preparation heated for 3 minutes in a water-bath. Normal blood remains blue, while diabetes blood turns yellow.

Wood (lignin). Sections are stained with phloroglucin and hydrochloric acid a rose colour; with orcein, reddish-violet; with carbazol, violet; with resorcin, bluish-violet; with naphthalin, yellow; with pyrogallic acid, bronze yellow; with indol, dark-red.

Differential Stain for Cell Structures. † —J. H. Schaffner uses the following stain for differentiating cell-structures. Stain first for two or three hours with anilin-safranin (equal parts of anilin oil, water, and saturated alcoholic solution of safranin). Then stain with picro-nigrosin solution (distilled water, 100 ccm.; picric acid, 1 gr.; nigrosin, 1 gr.; first dissolve the picric acid and then add the nigrosin). Dehydrate, and mount in balsam. The cell-wall stains black; the cytoplasm bluish; spindle-threads green; chromatin network brick-red; granules of the cell-plate black.

* Zeitschr. f. angew. Mikr., vi. (1900) pp. 169–73.
† Journ. Applied Microscopy, iii. (1900) p. 960.

Staining Elastic Fibres.*—Prof. C. Weigert has devised the following solution for staining elastic fibres a blue-black colour:—200 ccm. of a mixture of 1 p.c. aqueous solution of basic fuchsin and 2 p.c. aqueous solution of resorcin are heated to boiling in a porcelain vessel; 25 ccm. of liq. ferri perchlor. are added, and the mixture kept stirred for 2–5 minutes. After cooling it is filtered, and the precipitate on the filter is boiled in 200 ccm. of 94 p.c. alcohol. When cold the solution is filtered and brought up to 200 ccm. with alcohol, 4 ccm. of HCl are then added. The solution is now ready for use. The sections are immersed for 20–60 minutes, and then washed in alcohol and cleared up in pure xylol.

Differential Stain for Connective-Tissue.†—Dr. F. B. Mallory has found that the following method for staining connective-tissue fibrillæ and reticulum is very good, and though not absolutely perfect, gives better results than any yet proposed for the purpose. (1) Fix in corrosive sublimate or in Zenker's fluid; (2) imbed in celloidin or in paraffin; (3) stain the sections in $\frac{1}{20}$ to $\frac{1}{10}$ of a 1 p.c. aqueous solution of acid fuchsin for 1–3 minutes; (4) wash in water; (5) place in a 1 p.c. aqueous solution of phosphomolybdic acid for 1 minute or longer, using platinum or glass needles; (6) wash in two changes of water; (7) stain in the following solution for 2–30 minutes or longer:—anilin blue soluble in water 0·5, orange G 2, oxalic acid 2, water 100; (8) wash in water; (9) dehydrate in 95 p.c. alcohol; (10) blot on the slide, and clear up in xylol or in oleum origani cretici; (11) xylol balsam.

Staining Neuroglia Fibres with Phosphotungstic Acid Hæmatoxylin.‡—Dr. F. B. Mallory recommends the following method:—(1) Place the sections in 0·5 p.c. aqueous solution of permanganate of potash for 15–30 minutes; (2) wash in water; (3) 1 p.c. aqueous solution of oxalic acid 15–30 minutes; (4) wash in two or three changes of water; (5) stain in the following solution for 12–24 hours or longer:—hæmatoxylin 0·1, water 80, 10 p.c. aqueous solution of phosphotungstic acid 20, peroxide of hydrogen 0·2. Dissolve the hæmatoxylin in a little water by the aid of heat, and add it after cooling to the rest of the water and the acid, then add the peroxide of hydrogen; (6) wash quickly in water; (7) dehydrate in 95 p.c. alcohol; (8) oleum origani cretici; (9) xylol balsam. The nuclei, neuroglia fibres, and fibrin stain blue; axis cylinders and ganglion cells pale pink; connective-tissue deep pink.

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

Mounting in Glycerin.§—J. H. Schaffner recommends the following procedure. The objects are taken from water to glycerin by adding the latter gradually until pure glycerin is arrived at. They are then placed in a small drop of glycerin jelly on the slide, and a ring of Canada balsam is run round the drop, after which the cover-glass is put on.

Media for Mounting Diatoms.‖—Dr. J. F. W. Tatham refers to his experiences with different media of exceptionally high refractive indices

* Centralbl. f. allgem. Pathol. u. pathol. Anat., ix. (1898) pp. 289–92.
† Journ. Experim. Med., v. (1900) pp. 15–6. ‡ Tom. cit., pp. 19–20.
§ Journ. Applied Microscopy, iii. (1900) p. 960 (1 fig.).
‖ Journ. Quek. Micr. Club, vii. (1900) pp. 299–308.

for mounting diatoms. One of these is a solution of biniodide of mercury in excess of iodide of potassium. The solution is not only readily obtained, but is easily retained within a ring of Rousselet's gold-size-dammar (saturated solution of dammar in benzol 2 parts, gold-size 1 part). The solution, which is colourless, brings out the structure with clearness and beauty. Another colourless medium is phosphorus, which has a refractive index of 2·2. The pictures are clear and brilliant, but are only obtained by tedious and difficult manipulation. Quinidine is colourless and is easily manipulated; it is only necessary to place a portion along with the diatoms between the cover-slip and the slide, and fuse the quinidine with a spirit-lamp. Its chief fault is that the mounts soon become opaque from crystallisation of the medium. Realgar, which has a refractive index of 2·5, has several drawbacks. Great heat is required to fuse it, the high temperature often twists or distorts the valves, and the colour of the finished mount is yellow. Another medium is a mixture of piperine and bromide of antimony (3 to 2 by weight). A quantity sufficient only to fill two-thirds of the area of the cover-glass is placed on the slide; the mixture is then gently heated over a spirit-lamp; when the medium has set, the unoccupied margin is filled up with paraffin, and the cover-glass encircled with Hollis' liquid glue. This medium answers well for the finely lined species, but not for *Coscinodiscus* or for any of the other coarse circular forms.

(6) Miscellaneous.

New Thermo-Regulator.* — Dr. St. Epstein has devised a thermo-regulator which is not only easily filled, but can be rapidly set for different temperatures. The temperature oscillations do not amount to more than 0·1° C., and are quite independent of external conditions (gas and air pressure).

Demonstrating Form and Size of Bacteria. † — Dr. A. Macfadyen and M. J. E. Barnard give a short account, with photographic illustrations, of the main types of bacteria. The organisms described and depicted are *Streptococcus pyogenes*, *Staphylococcus pyogenes aureus*, *Diplococcus pneumoniæ*, *Bacillus pestis*, *Spirillum choleræ*, *Bacillus typhosus*, and *Bacillus tetani*. The magnification used (× 1750) was the same in all cases, so that by a glance at the plate the relative size and characteristic appearance of the various organisms can at once be grasped. The objectives used were a Zeiss 3 mm. apochromatic, and a Winkel 1·8 mm. fluorite system, low-power projection-oculars being used in each case, and magnification obtained by suitable camera extension. The organisms were all stained, and the screen used was a saturated solution of acridine yellow, about 15 mm. thick.

Apparatus for Testing Milk and for Cultivating Bacteria. ‡ — Dr. St. Epstein describes a new fermentation apparatus for testing the value of milk for cheese making and also for the aerobic cultivation of bacteria. The apparatus (fig. 15) consists of two parts: the vessel A for holding the milk or the nutrient medium, and B for collecting the gases. B

* Centralbl. Bakt., 1te Abt., xxviii. (1900) pp. 503–4 (1 fig.).
† Nature, lxiii. (1900) pp. 9–10 (1 pl., 8 figs.).
‡ Centralbl. Bakt., 2te Abt., vi. (1900) pp. 658–9 (2 figs.).

consists of a eudiometer *f*, which reaches almost to the bottom of the glass globe *d*. In the lower end *h* of the eudiometer is inserted a tube with a valve *v*. Before use A is sterilised or, as is customary in dairies, is washed with acid and then with milk, and is then filled with milk up to the mark 100. The eudiometer *f* is filled by pouring water in at the opening *o* up to the level of *n* at the lower part of the eudiometer. The stopper *s* at the top of the burette is then removed, *o* closed with the finger, and the eudiometer filled with water. The stopper is again inserted, and the finger removed. When the part B has been filled, its lower end *c* is flamed and carefully adjusted on A. Any gases that develope open the valve *v* and ascend into the eudiometer. If a chemical analysis of the gases be desired, the stopper *s* is replaced by a perforated caoutchouc stopper closed by a clamp (fig. 16). Should it be desired to transfer the collected gases to another vessel, the opening *o* of the glass bulb is connected with a tube. Then, by pouring water from a greater height than that of the endiometer into the bulb *d*, the gas is expelled through the opening K. It is advisable to warm the flask A up to the temperature at which the experiment is to be carried on, and this is best done by placing it, when filled and inoculated, for some minutes in the incubator or in warm water.

Fig. 15.

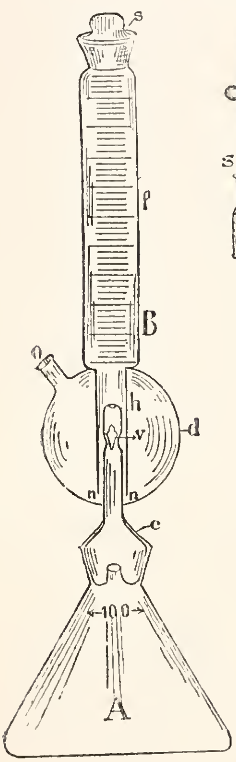


Fig. 16.

Demonstrating the Bacterial Capsule.*—Dr. I. Boni states that the capsules of bacteria, even from solid cultures, may be demonstrated by the following method. The white of one egg, 50 grm. of glycerin, and two drops of formalin, are mixed together, well shaken, and filtered. With a loopful of this fluid a trace of an agar culture of pneumococcus is carefully mixed and spread on a slide. The slide is then heated till white vapour ceases to be given off. The film is then covered with Ziehl's solution, which is allowed to act for half a minute. The preparation is washed, dried, and mounted in balsam.

Method of Examining Fæces and Morbid Secretions for Bacteria.†—Dr. J. Strasburger takes a piece of fæcal matter, the size of half a pea, stirs it up with a glass rod, and then centrifuges. The supernatant fluid is then treated with 96 per cent. alcohol in the proportion of 1 to 2 parts, in order to diminish the specific gravity, and so allow the bacteria

* Münchener Med. Wochenschr., xlvii. (1900) pp. 1262–3.
† Zeitschr. f. angew. Mikr., vi. (1900) pp. 169–1.

to sediment. Pus, urine, and other secretions may be treated in the same way.

Method for Examining quickly moving Micro-organisms.*—Herr H. Plenge gives the following procedure for obtaining an extremely thin layer of fluid in which the motility of micro-organisms is impeded. A very thin cover-glass which has been kept for some days in absolute alcohol is carefully dried. A trace of pure glycerin is then rubbed on with the finger tip, and afterwards rubbed off with a clean cloth. In this way an extremely thin and regular layer can be obtained from a culture fluid after the superfluous fluid is poured off.

Method of Measuring the Bactericidal Power of the Blood.†—Prof. A. E. Wright has devised a method of determining in a quantitative manner the bactericidal power of the blood. Measured volumes of serum and of graduated dilutions of serum are introduced into a series of capillary cultivation tubes along with a series of equal volumes of a gelatin culture containing an appropriate number of bacteria. Mixture of the contents of the serum and culture is then effected in the capillary tube. It will be noticed that by this arrangement the serum comes in contact with the bacteria only after they have been suspended in a fluid which is sufficiently viscid to make it impossible for them to come together into groups. After the gelatin has solidified, the tubes are incubated for a period of two or more days. The number of colonies is then counted under the Microscope, and the results compared with those from a series of control tubes filled with an equal volume of the gelatin diluted with an indifferent diluting fluid. For the details of the procedure, which are given with much minuteness, the original should be consulted.

Microscopy of Starches.‡—Dr. H. Galt has collected together in a booklet the results of his observations on some of the more commonly occurring starches, and has illustrated his work with 22 original photomicrographs. The author prefers to use the term microphotograph on the ground of euphony, but does not suggest that this atavistic spelling is easier to write or print. Another example of an old and not to be admired custom is the different magnifications under which the starches have been photographed. For the purpose of comparison and for the use of students it is wiser to adopt a single standard, as was done by W. Griffiths in *The principal Starches used as Food* (1892). Indeed, Griffiths' work is superior in every way, not only in the photomicrographs but also in the letter-press, which contains a large amount of useful information.

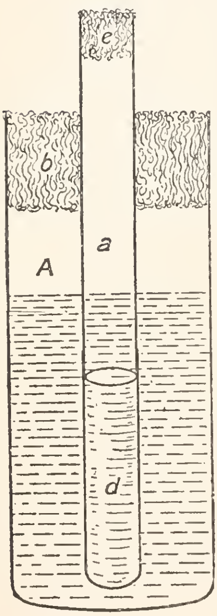
Simple Method for Estimating the Damage to Living Cells.§—Dr. M. Neisser states that the reducing power of living cells such as leucocytes may be used as an estimate of their vitality. Thus the normal leucocyte speedily decolorises methylen-blue; but if in any way damaged, the cell is unable to exert this power, and the solution retains its hue in proportion to the vital activity of the cell. If 0·5 ccm. of aleuron-

* Verhandl. Naturhist.-med. Vereins zu Heidelberg, vii. p. 218. See Zeitschr. f. angew. Mikr., vi. (1900) p. 188.
† Lancet, 1900, ii. pp. 1556–61 (4 figs.).
‡ Baillière, Tindal, and Cox, London, 1900, 108 pp., 22 pls.
§ Münchener med. Wochenschr., xlvii. (1900) pp. 1261–2.

exudate and 1·5 ccm. of physiological salt solution be mixed in a narrow test-tube (6–7 mm. diam.) and a drop of weak methylen-blue solution added, the colour is discharged in a short while. The tube is closed and placed in a thermostat. If, however, the leucocytes be damaged at all by leucocides, heat, chinin, &c., the fluid will remain more or less blue, and the amount of damage may be roughly estimated from the colour.

New Method for Making Collodion Bags.*—Dr. M. A. Ruffer and Dr. M. Crendiropoulo describe a new procedure for obtaining the diffusible poisons of micro-organisms in an ordinary culture tube. The apparatus (fig. 17) consists of an ordinary test-tube A filled to any required level with bouillon or some other fluid cultivating medium, and plugged with cotton wool at *b*. Through this plug *b* is introduced another smaller glass tube *a*, to the lower extremity of which is attached a collodion sac *d*. This inner tube is filled to any required level with some cultivating fluid, and is plugged at the upper extremity *e* with cotton wool. The collodion bag is made as follows: a small test-tube is rapidly dipped bottom downwards into a vessel filled with collodion until 2 or 3 in. are covered with collodion. The layer is allowed to dry, and then the process is repeated twice or thrice. In order to free the collodion from the tube, the whole is dipped alternately in strong spirit and then into water. After a few minutes the bag is loosened and can be slipped off the tube. A small glass tube is then inserted into the bag and the whole incubated at 37° C. The bag is by this means shrunk firmly on to the tube. In order to sterilise the collodion bag tube, it is fixed in an empty test-tube in the manner shown in the illustration, and the whole is sterilised at 150° C. by dry heat on one or several occasions. When this has been done, the inner tube *a*, together with the plug *b*, is transferred aseptically to a tube of sterilised bouillon or gelatin of equal size, the plug *b* now serving to close the tube of bouillon into which the inner tube is dipped. The bouillon in tube *a* is now inoculated with the micro-organisms to be studied, and the whole placed in the incubator. After a time the inner tube *a* is withdrawn; the outer tube contains the diffused products. This method may, of course, be used for other purposes—for example, for testing the action of microbes on fluids, or the antagonism of two different microbes.

Fig. 17.



The Plague.†—It may be useful to mention that the *British Medical Journal* for October 27, 1900, contains a series of original articles dealing with the plague from its clinical, pathological, bacteriological,

* Brit. Med. Journ., 1900, ii. pp. 1305–6 (1 fig.).
† Tom. cit., pp. 1229–58 (16 figs.).

and historical aspects. Among these may be mentioned 'Bacteriology of Plague,' by Mr. D. C. Rees, and 'Methods of making Antitoxic and Preventive Fluids,' by Dr. C. B. Stewart.

Progress in Metallography.*—T. K. Rose treats this subject with special reference to Le Chatelier's suggestions in the *Bulletin de la Société d'Encouragement* for September last. These relate mainly to the best methods of obtaining graduated polishing powders, of illumination, and of making alloys. In examining the alloys of two metals, much time is consumed in making and suitably preparing a series of typical specimens. Le Chatelier proposes to shorten the search by melting together two superimposed layers, each consisting of a pure metal, the lighter one being on the top. If no alloys are formed of greater density than the heavier metal, and the crucible is allowed to cool undisturbed, a culot can be obtained which, on being sawn through vertically, shows a complete graduation from one pure metal to the other, passing through the whole series of alloys, which can then be studied in one specimen. Figures are given of the aluminium-copper series obtained in this way.

Crystalline Structure of Iron and Steel.†—J. E. Stead describes an elaborate investigation of this subject. He arrives at ten conclusions, of which the following is a condensed summary:—

(1) That granules and crystals should not be confused; for although a granule is built up of crystals, its external form is not that of any kind of crystal, as it takes its shape from its surroundings. It is better to replace the term granule by grain.

(2) That grains formed in the solidification of liquid metals are large or small, according to whether the freezing is rapid or slow.

(3) That in practically carbonless pure irons, and in steels of fine grain produced by either forging or certain heat treatment, the grains increase in size slowly at 500° C., and more rapidly at between 600° and 750° C.; and it is possible, by heating at about 700° for a few hours, to develope granular masses of exceeding coarseness. When pure iron made coarsely granular by long heating at a dull red heat is heated between 750° and 870°, as a rule the structure is not materially altered; but at 900° the granules again become small, and heating to 1200° C. does not apparently produce any difference in their dimensions.

(4) That when steels containing 0·20 to 1·20 p.c. of carbon are subject to prolonged heating at 700° C., the grains do not increase in size; but they do increase if the temperature is raised above 750°. When, however, this coarse steel is reheated to between 700° and 750°, the coarse structure vanishes and the grains become very fine.

(5) That in steels with 0·10 to 0·15 p.c. containing the pearlite in widely separated areas, on heating and quenching from 750°, the large ferrite grains are not broken up, and the carbon apparently does not expand or diffuse beyond the original areas, as previously demonstrated both by Osmond and Arnold; yet, when the heating is raised to near 850° and the steel allowed to cool down naturally, the carbon areas are found far beyond their original positions, and exist in a number of smaller segregations.

* Nature, Jan. 3, 1901, pp. 232-3 (3 figs.).
† Metallographist, Oct. 1898, pp. 289-341 (26 figs. and 3 diagrams).

(6) That good open-hearth steel with 0·23 p.c. carbon may be heated to close upon its burning-point without becoming brittle, and that it only becomes truly burnt when intergranular separation is effected.

(7) That when solid steel is partially decarburised by oxidising agents at between 700° and 800°, an envelope of pure iron forms at the surface, and the grains in this layer assume a columnar structure radiating from the outside to a point below where there is carbon.

(8) That by strongly etching pure iron, or iron containing much phosphorus, aluminium, or silicon, the cubical crystals of pure iron are readily developed.

(9) That by mechanically testing micro-sections of pure iron by the method of fracture, it seems to follow that the smaller and finer the grain the safer the structure.

(10) That soft steel plates treated under certain conditions develope a most peculiar crystalline structure, whose cleavage lines are invariably at an angle of 45° to the direction in which the plates are rolled. This extraordinary development is sometimes destroyed by close annealing for 36 to 48 hours; but it is invariably destroyed by heating to 900° C., and the steel then becomes exceedingly tough.

Constitution of Steel considered as an Alloy of Iron and Carbon.* —Albert Sauveur argues that the formation of a cryohydrate and of an eutectic alloy are analogous phenomena; the only difference being that the former takes place at ordinary temperatures, and the other at high temperatures. The result in each case is a mechanical compound in which the constituents are juxtaposed in minute crystals and in definite proportions. He illustrates his reasonings by the solubility curve of sodium chloride in water, and by the cooling curve of the alloy of iron and carbon (i.e. steel). A plate of 16 figures reproduces the microstructure of the alloy. He quotes Ponsot's opinion † that the name "cryohydrate" should be abandoned, as being inapplicable to a mechanical mixture, and should be replaced by "cryosel."

Allotropic Iron and Carbon.‡—E. H. Saniter's researches are intended as an unbiassed contribution towards the controversy encircling the cause of the glass-hardness of quenched carbon steel. His results were obtained by hot-etching on specimens of metal selected for their freedom from mechanical treatment—in other words, specimens in which the normal structure would be as perfect as possible. His investigations were arranged in three sections:—

i. The structure of pure carbonless iron at a bright red heat. (The cubical crystals of cold iron became replaced by rhombohedral crystals in the hot specimen, showing that iron is dimorphous.)

ii. The structure of pure carbon-iron compounds at a bright red heat. (There was a marked reduction in the size of the amorphous carbon grains, as compared with their cold state.)

iii. The effect of moderate quantities of sulphur, phosphorus, and manganese on the structure of carbonless iron at a bright red heat.

The dimorphism of section i. and the reduced amorphism of section ii.

* Metallographist, 1898, pp. 210–29 (1 pl. and 3 figs.).

† 'Recherches sur la congélation des solutions aqueuses étendues,' Paris, 1896.

‡ Metallographist, 1898, pp. 251–8 (7 figs.).

seem to point to allotropy, which is found to be modified by the impurities in section iii.

Notes on the Microscope in the Drug Store.*—Dr. H. M. Whelpley describes the value of even a low power cheap Microscope to a pharmacist. Among articles which are readily discriminated by such an instrument are: the different grades of hydrargyrum cum creta, leaves of senna and long buchu, short buchu and uva ursi; adulterations of lupulin; powdered rhubarb; distinction between fruits of hemlock and anise, &c.

Rice, F. S.—**Microstructural Characteristics of Steel.**
Trans. Amer. Micr. Soc., Aug. 1897.

Molderke, R.—**The Microscope in the Study of Iron.**
Iron Trade Review, Oct. 28, 1897, p. 19.

Renard, A. F., & F. Stöber—**Notions de Minéralogie.**
[A noticeable feature of the short section on chemical crystallography is the inclusion of a number of micro-chemical tests, with figures of the crystalline products.] Ad. Hoste, Gand, 1900, x. and 374 pp., 732 figs.

The Metallographist. A quarterly publication devoted to the study of Metals, with special reference to their Physics and Microstructure, their Industrial Treatment and Applications. Boston, U.S.A.

In addition to the articles abstracted in our Journal, the following possess microscopical interest:—

Jan. 1898. Microstructure of Steel and the Current Theories of Hardening, pp. 27–51, numerous tables and figs. Albert Sauveur.

Jan. 1898. Microscope Accessories for Metallographers, pp. 82–3 (2 figs.). J. E. Stead.

[The author applies a method of fracturing to determine the locality of impurities in a metal.]

April 1898. Bibliography of the Metallography of Iron and Steel, pp. 168–78.

[Arranged alphabetically under authors' names; too long to quote; apparently a very complete list; nearly all the citations seem to bear on microscopy; some sixty authorities (English, French, German, American), covering the last twenty years, are given.]

* Amer. Mon. Micr. Journ., 1900, pp. 305–8; quoted from Bull. of Pharmacy.

PROCEEDINGS OF THE SOCIETY.

MEETING

Held on the 19th of December, 1900, at 20 Hanover Square, W.
The President (W. Carruthers, Esq., F.R.S.) in the Chair.

The Minutes of the Meeting of 21st of November last were read and confirmed, and were signed by the President.

Notice was given on behalf of the Council that at the next Meeting of the Society the name of Dr. C. T. Hudson, F.R.S., would be submitted for election as an Honorary Fellow of the Society.

The President said that Dr. Hudson had, on account of his age and his removal from London, expressed a desire to retire from the Fellowship of the Society. The Council thought it would be very undesirable that the name of one who had been so long associated with them, and who was so distinguished for his work as a microscopist, should be omitted from their roll of Fellowship, and they therefore proposed to elect him as an Honorary Fellow, and in this way still to retain his name upon their list.

The List of Donations to the Society received since the last Meeting (exclusive of exchanges and reprints) was read, and the thanks of the Society were voted to the Donors.

	From
P. Chalmers Mitchell, Thomas Henry Huxley. A Sketch of his Life and Work. (8vo, New York and London, 1900)	*The Publishers.*
Dukinfield Hy. Scott, Studies in Fossil Botany. (8vo, London, 1900)	*The Publishers.*
A Powell and Lealand Microscope, No. 1 Stand, with Apparatus	*Miss A. Whittell, of Adelaide, S. Australia.*

The Microscope received from Miss Whittell was a very valuable instrument by Powell and Lealand, with a complete set of objectives and accessories, the property of her late father, Dr. Horatio T. Whittell, of Adelaide, Australia, one of the Fellows of the Society, who had expressed a wish that his memory might be perpetuated by the Society's possession of his Microscope and whatever pertained to it. The instrument, together with the case of apparatus, &c., was placed upon the table for the inspection of the Fellows present, and their special thanks were voted to Miss Whittell for forwarding this valuable donation.

Mr. E. M. Nelson exhibited a small pocket Microscope which had been lent for the purpose by Mr. Freeman. It was a brass tube carrying the eye-piece at one end and the objective at the other, the focussing being by means of a sliding tube. At the objective end a cap with a glass top was fitted, another similar cap fitting over this. The object to be viewed was placed between these two caps, which, when brought together, formed a sort of compressorium, and retained the object in the centre of the field, where alone it could be clearly seen. He thought this was a very valuable little contrivance for taking into the field, as it could be used for examining objects if in water when a drop was placed between the glasses of the two caps. There was one drawback to its usefulness, which was rather a serious one, viz. that unless the object was in the centre of the cap it could not be properly seen, because there was no means by which the object could be moved laterally in the field. A diagram was exhibited showing the construction of the instrument, enlarged four times linear (see p. 82).

The thanks of the Meeting were, on the motion of the President, voted to Mr. Freeman for sending this Microscope for exhibition, and to Mr. Nelson for explaining its use and construction.

Dr. Hebb reminded the Fellows that their next Meeting would be the Annual Meeting, and that in accordance with the bye-laws he now presented the list of those who had been nominated by the Council for election at the next Meeting as Officers and Council for the ensuing year, as follows:—

President—Mr. W. Carruthers.

Vice-Presidents—Messrs. Braithwaite, Michael, Nelson, and Sir Ford North.

Treasurer—Mr. J. J. Vezey.

Secretaries—Dr. Dallinger and Dr. Hebb.

Council—Messrs. Allen, Beck, Bennett, Browne, Carr, Dadswell, Disney, Karop, Plimmer, Powell, Dr. Pritchard, and Mr. Rousselet.

Curator—Mr. Rousselet.

Auditor on behalf of the Council—Mr. J. M. Allen.

It being necessary to elect Auditors that evening, the Fellows were asked to appoint some one to act in that capacity on their behalf with Mr. Allen. Mr. G. E. Mainland was thereupon proposed by Mr. C. L. Curties, seconded by Mr. Freshwater, and unanimously elected.

The President then called upon Mr. Barton, who, he said, did not want to give a lecture on lantern demonstration, but rather to exhibit and explain some new apparatus for the purpose made by Messrs. Ross.

Mr. Barton expressed his regret if any misconception or disappointment had been caused through the form of announcement as to what he proposed to do, which was merely to show some new forms of lanterns which could be used for ordinary projection purposes either with or without the Microscope. The first of these was an ordinary projection lantern made with a small body, but so constructed as to exclude all light from the room except what passed through the lenses. The manner of using this in connection with a Microscope was also shown. The other lantern was a larger and more complete article, which could be used for all purposes, including enlargements. The fine definition given by this lantern was then demonstrated by the exhibition on the screen of some photomicrographs of mounted preparations of insects, and by a further series of whole insects mounted in balsam, all of which were defined with remarkable sharpness and brilliancy.

In addition to the foregoing, Mr. Barton also exhibited and described several new forms of Microscope, with detachable circular stage, &c.; a new form of electric arc lamp for lantern use, with vulcanite milled head for ensuring perfect insulation to the operator; also an arc lamp of ordinary construction. A new form of lime-light was also exhibited, which attracted much attention, from its extreme brilliancy and the perfect steadiness and silence with which it burned, with a consumption of from 5 to $7\frac{1}{2}$ ft. of gas per hour.

Mr. E. M. Nelson thought Mr. Barton was to be highly congratulated upon the successful demonstration which he had given them. He was very much struck with the perfection to which the lamp had been brought, and inquired how so intense a light had been obtained, and if the gas had been enriched in any way by ether or by the admixture of some hydrocarbon, and how it was produced with such complete absence of noise.

Mr. Barton said that nothing whatever was used but the two gases themselves, the effect being produced by the particular way in which the gases were caused to impinge upon one another previous to their entrance to the mixing chamber, and by the construction of the chamber itself through which they were passed.

In reply to other questions, Mr. Barton said that this form of lamp required the gases to be used under pressure, although this could, at the expense of light, be reduced to a consumption of $2\frac{1}{2}$ ft. per hour. The heat was intercepted by a water-trough in the usual way, and the projection with the Microscope could be successfully carried out with objectives as high as $\frac{1}{4}$ in. or even $\frac{1}{12}$ in., but for all-round purposes a $\frac{4}{10}$ was about the best, provided that the lenses were properly corrected for the purpose; everything depended upon the quality of the lens and the nature of the object to be shown.

The President was sure that the Fellows of the Society present would feel grateful to Messrs. Ross, and to their representative, Mr. Barton, for the Microscopes and lanterns which had been submitted to their inspection, and especially for the extremely interesting exhibition on the screen, which was a remarkable illustration of perfect definition. The photographs did not appeal to him so strongly as the natural objects. He had great pleasure in proposing that the hearty thanks of the Society be given to Mr. Barton for what he had shown them, and to Messrs. Ross for the instruments and apparatus exhibited.

The vote of thanks, having been put to the Meeting, was carried by acclamation.

The President announced that the Annual Meeting of the Society would be held on January 16th, 1901, and that the Library would be closed from December 22nd to January 2nd inclusive.

The following Instruments, Objects, &c., were exhibited:—

Mr. E. M. Nelson:—A Pocket Aquatic Microscope by Henry Gilbertson.

Mr. J. H. Barton:—The following instruments, &c., by Messrs. Ross:—No. 1 Petrological Microscope. No. 1 Standard Microscope. New Combination Lantern. "No. 1 Model" Projection Lantern, fi ed with lime-light. The "Radiant" Jet. The Ross Arc Lamp "A." The Ross Arc Lamp "B."

New Fellows.—The following gentlemen were elected *Ordinary* Fellows of the Society:—Dr. Arthur M. Edwards, Messrs. Geo. Hy. Godwin, John Atmore Knights, Henry Taverner, and Benj. Wm. Williams.

ANNUAL MEETING

Held on the 16th of January, 1901, at 20 Hanover Square, W.
The President (W. Carruthers, Esq., F.R.S.) in the Chair.

Minutes of the Meeting of 12th December, 1900, were read and confirmed, and were signed by the President.

On the motion of the President, Mr. C. L. Curties and Mr. Radley were appointed Scrutineers of the Ballot for the election of Officers and Council of the Society for the ensuing year.

The following Donation was announced, and the thanks of the Society were given to the donor:—

	From
An old Pocket Field Microscope, by H. Gilbertson	*Mr. H. E. Freeman*

The President called attention to the small Microscope presented to the Society by Mr. Freeman, as being the same which was exhibited at the last Meeting, and then described by Mr. Nelson.

Mr. Hugh M. Leake, of Cambridge, exhibited a new form of microtome which he said was the result of many attempts to produce a machine which would cut perfectly flat instead of curved sections, as cut by the ordinary Cambridge rocking microtome. The rocking movement was caused to take place at right angles to the feed, and was capable of cutting $1\frac{3}{4}$ in. of material into a continuous series. It was also supplied with an additional clamp for holding hard objects, and with a spray apparatus for freezing (see p. 92).

The President said Mr. Leake had taken great pains to bring this instrument to perfection, and it appeared to be very efficient and likely to be of great service to those whose studies required the use of anything of the kind.

The thanks of the Society were unanimously voted to Mr. Leake for bringing this microtome before the notice of the Society.

REPORT OF THE COUNCIL FOR 1900.

Dr. Hebb then read the Report of the Council for the year 1900, as follows:—

FELLOWS.

Ordinary.—During the year 1900, 26 new Fellows were elected, whilst 9 have died, 16 have resigned, and 15 have been removed from the list for non-payment of subscriptions and other causes.

Honorary.—The number of Honorary Fellows remained the same as for last year.

The list of Fellows now contains the names of 456 Ordinary, 1 Corresponding, 46 Honorary, and 83 Ex-Officio Fellows, being a total of 586.

FINANCES.

Subscriptions.—Though the amount received for Subscriptions is rather less than that in last year's account, this is due to the fact that there were less arrears to collect. The sum received for the current year's subscriptions is rather larger than that for the previous year.

During the year the sum of 60*l.* 12*s.* 6*d.* was placed on deposit at the Bank, bringing up the total to 373*l.* 12*s.* 6*d.* This amount has now been invested in India 3 per cents. The present investments of the Society, therefore, more nearly approach the figures at which they stood a few years ago, than they have for some time past. The Council hope that by economy and proper management this improvement may continue.

The Council desires to remind Fellows that prompt payment of their Subscriptions, which are due at the commencement of the year, is a great assistance in arranging the financial affairs of the Society.

The sale of Journals for the year shows a small improvement on that for 1899; and as some new features are being introduced which will add to its value, the Council look for a steady increase in its sale.

JOURNAL.

The Journal has been conducted through the past year on the same lines as heretofore. In addition to the subjects already included, it is intended to commence with the new year furnishing the Fellows with brief abstracts of papers on the microscopic structure of metals and minerals, which it is hoped may be useful to those engaged in metallurgy and in mining operations.

CABINET.

The Society's collection has been enriched by the donation of the cabinet and microscopical specimens, some 1014 in number, belonging to the late Treasurer, Mr. W. T. Suffolk.

INSTRUMENTS AND APPARATUS.

During the past year the Catalogue of Instruments and Apparatus in the Society's collection has been completed, and every item has been furnished with a label and reference number. The Catalogue contains all the information as to number of apparatus belonging to each Microscope, date of manufacture, date of donation, name of donor, &c., which it has been possible to discover.

The standard plug and ring gauges ordered last year have been delivered, and may now be inspected on payment of a small fee.

Standard screw-chasers for cutting the threads of objectives and nose-pieces are now ready for sale at the price of 2*s.* 6*d.* per pair.

The Society is greatly indebted to Mr. Conrad Beck for much valuable assistance and gratuitous work rendered in connection with these apparatus and instruments.

The following additions have been made to the collection during the past year:—

February 21.—A Jones Most Improved combined Microscope and apparatus. Presented by Mr. E. M. Nelson.

February 21.—A Powell and Lealand No. 1 Microscope-stand, with a quantity of apparatus, belonging to the late Dr. Whittell, of Adelaide, South Australia. Presented by Miss Whittell.

March 21.—An old Microscope by Benjamin Martin, dating about 1765. Presented by Mr. F. R. Dixon-Nuttall.

LIBRARY.

During the past year the Library has been thoroughly overhauled; a large number of useless journals and obsolete periodicals have been disposed of, and the proceeds are being devoted to binding and repairing; in this way over 250 volumes have already been dealt with.

A card catalogue, kindly undertaken by Mr. P. E. Radley, one of the Fellows, has been commenced, and is in a fair way towards completion.

A Library Committee has been formed, and from their supervision and care it is hoped that the Library may be further developed and rendered still more valuable to workers in Microscopy.

Mr. J. J. Vezey, Treasurer, then read the Annual Statement of Accounts and the Balance Sheet for 1900, duly audited by **Messrs. J. M. Allen** and **G. E. Mainland**.

Mr. Vezey said he did not think that the figures he had read called for much explanation, but he might point out that the smaller amount received as subscriptions was chiefly due to the fact that during the previous year there had been fewer arrears to collect, and it would be his care in the future to see that subscriptions were promply paid, and he hoped Fellows would assist him to this end. One other matter he wished to mention, viz. the Journal. A reference to the Balance Sheet would show Fellows how large a sum was expended on it, more even than the amount received for subscriptions. For many years the Journal had held a foremost place among those issued by the various scientific societies, and in view of the additional features announced in the Annual Report, Fellows would see that it was clearly the intention of the Council to maintain its high position. He trusted Fellows would show their appreciation of this liberality on the part of the Council by increasing the number of Fellows and the circulation of the Journal.

The Rev. A. G. Warner said he had great pleasure in moving that the Report of the Council and the Treasurer's Balance Sheet be received and adopted, and that they be printed in the usual way. He thought both these were very satisfactory, and would speak for themselves. The Report was a model of terseness, and although the Treasurer said there was nothing particular in his Balance Sheet to call for attention, he thought the fact that they had been able to add 60*l*. to the amount of their investments was one very well worth noting.

The motion, having been seconded by Mr. Freshwater, was put to the Meeting by the President and unanimously carried.

THE TREASURER'S ACCOUNT FOR 1900.

Dr.

1900.	£	s.	d.	£	s.	d.
To Balance from 1899				195	11	3
,, Admission Fees				49	2	0
,, Annual Subscriptions—						
1897	4	4	0			
1898	28	17	6			
1899	46	5	9			
1900	626	3	5			
1901	24	3	0			
1902	1	1	0			
				730	14	8
,, Interest on Investments				38	10	9
,, ,, on Deposit Account				1	16	11
,, Sales of Journal				326	4	7
,, Receipts for Advertisements				60	0	0
,, ,, ,, Sale of Surplus Books				68	0	6
,, ,, ,, Catalogues sold				0	4	0
,, ,, ,, Lists of Fellows sold				0	3	1
,, ,, ,, Reprints sold				5	4	2
,, ,, ,, Screw Tools sold				2	15	0
,, Withdrawn from deposit				373	12	6
,, Sundries				0	11	3
				£1852	10	8

Cr.

1900.	£	s.	d.	£	s.	d.
By Rent, &c.				130	0	0
,, Salaries and Reporting				151	17	8
,, Books, &c., purchased				100	8	5
,, Bookbinding				49	10	6
,, Expenses of Journal—						
Printing	£451	3	2			
Illustrations	63	13	7			
Editing	181	8	9			
				696	5	6
,, Purchase of 356*l.* 12*s.* 8*d.* India Three per Cents.				373	12	6
,, Refreshments				13	10	0
,, Stationery, &c.				16	5	4
,, Fire Insurance				2	0	0
,, Postage and Petty Expenses				27	10	0
,, Deposited with Union Bank				60	12	6
,, Repairs				6	3	3
,, Cost of Screw Tools				8	14	6
,, Sundries				11	4	3
,, Balance in hand				204	16	3
				£1852	10	8

Investments.

400*l.* Nottingham Corporation Stock Three per Cents.
315*l.* 11*s.* 1*d.* New South Wales Three and Half per Cents.
400*l.* North British Railway Three per Cents.
356*l.* 12*s.* 8*d.* India Three per Cents.

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 11th, 1901.

J. MASON ALLEN
G. E. MAINLAND } *Auditors.*

The Scrutineers having handed in their report of the result of the ballot, the President declared the whole of the Fellows nominated to be duly elected as under.

President—William Carruthers, Esq., F.R.S., F.L.S., F.G.S.

Vice-Presidents—Robert Braithwaite, Esq., M.D., M.R.C.S., F.L.S.; A. D. Michael, Esq., F.L.S.; E. M. Nelson, Esq.; The Right Hon. Sir Ford North, P.C., F.R.S.

Treasurer—J. J. Vezey, Esq.

Secretaries—Rev. W. H. Dallinger, LL.D., F.R.S.; R. G. Hebb, Esq., M.A., M.D., F.R.C.P.

Twelve other Members of Council—James Mason Allen, Esq.; Conrad Beck, Esq.; Alfred W. Bennett, Esq., M.A., B.Sc., F.L.S.; E. T. Browne, Esq.; Rev. Edmund Carr, M.A., F.R.Met.S.; Edward Dadswell, Esq.; A. N. Disney, Esq., M.A., B.Sc.; George C. Karop, Esq., M.R.C.S.; Henry George Plimmer, Esq., M.R.C.S., F.L.S.; Thomas H. Powell, Esq.; Prof. Urban Pritchard, M.D., F.R.C.S.; Charles F. Rousselet, Esq.

Curator—Charles F. Rousselet, Esq.

The President expressed his thanks to the Fellows of the Society for again placing him in the position which he had occupied during the past year, and congratulated them upon the Report which had been presented, and upon the improved conditions which this indicated. As regards the Library, everything had been carefully gone through, and much that was useless eliminated, and their thanks were heartily due to Mr. Radley for the great pains he had taken in the preparation of the catalogue.

Their collection of instruments had been also put in excellent order, and would in this respect compare well with those in any shop in Regent Street; everything was properly marked, and arranged in such a way as to make it difficult for anything to go astray. He also congratulated the Fellows upon the state of their funds; although the income of the Society was not large, it was most economically expended with very advantageous results; but it would be a means of great good to the Society and to science if the income could be increased during the next few years by the addition of many more to the number of their Fellows.

The President then read his Annual Address, which consisted chiefly of an interesting epitome of the life and work of John Ellis, known at the time as "Coralline" Ellis.

Mr. A. D. Michael said he rose to ask the Fellows of the Society to give their hearty thanks to the President for the charming address which they had just heard, in which he had unearthed one of those attractive bye-paths of science which, when brought to light, so often proved to contain lessons which all might learn with advantage. It was certainly very interesting to see how history repeated itself, men like Ellis being originally attracted only by the picturesque side of the subject, but getting gradually drawn on towards the scientific side, and then endeavouring to turn that scientific knowledge to the practical benefit of the human race. There was no field of research more enticing than that border land which lies between the animal and vegetable kingdoms, and the steps by which the existing knowledge in this subject had been acquired were always of the greatest interest. It was still most imperfect; but when they considered what kind of instruments men like Ellis, who won that knowledge, possessed, it was clear that he set an example which biologists of to-day would do well to imitate; it seemed that with the improved means at their command they ought to be able to do so much, and that they really did so little. Perhaps, however, one reason for the contrast was the fact that these early naturalists had an unworked field before them for discovery. From the growth of knowledge the gap between the lowly Hydrozoa and the highly organised Polyzoa seemed a wide one, but the keen insight into nature shown by the man or men who first appreciated the difference between these very similar looking groups of creatures deserved the greatest admiration, and went far to show how great an observer Ellis really was. He had great pleasure in moving that the best thanks of the Society be given to the President for his most instructive address, and in begging that he would allow it to be printed in the Journal.

The motion having been seconded by Dr. Braithwaite,

Mr. Michael said that as the President could not put this to the Meeting himself, he would ask them to pass it.

The vote of thanks was accordingly carried by acclamation.

The President said he was much obliged to the Fellows for this vote of thanks and for the manner in which it had been proposed and carried. He was very glad to find they had been interested in this narrative, which certainly had interested him very much in the course of its preparation.

Mr. G. C. Karop moved a very cordial vote of thanks to the Honorary Officers, Secretaries, Treasurer, and Curator. Their efficient services to the Society were known and very highly appreciated. All would regret the continued absence of Dr. Dallinger, caused by ill-health, and hope for his speedy recovery.

The motion having been seconded by Mr. Dineen, was put to the Meeting by the President, and carried unanimously.

Mr. Vezey, in responding for the Officers, said that he was entitled to a very small portion of the vote of thanks, but Dr. Hebb had asked him to reply for the Officers. This gave him an opportunity of telling Fellows how much of the work of the rearrangement of the Library had fallen on Dr. Hebb's shoulders. He had entirely undertaken the clearing out of useless literature which had accumulated for years on the shelves of the Society. This work may have covered him with glory, but it had certainly covered him with dust. Mr. Vezey added that Fellows were heartily welcome to the small services he had been able to render as Treasurer.

A vote of thanks to the Auditors and Scrutineers, moved by Mr. Disney and seconded by Mr. Ersser, was also put, and carried unanimously.

The following Instrument was exhibited :—

Mr. Hugh M. Leake :—A new Flat-cutting Rocking Microtome.

New Fellows.—The following gentlemen were elected :—

Honorary Fellow :—Mr. Charles Thomas Hudson, F.R.S.

Ordinary Fellows :—Messrs. Wm. Geo. Albert Edwards, Jno. Hy. Holland, Clarence J. H. Sidwell.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

APRIL 1901.

TRANSACTIONS OF THE SOCIETY.

II.—*The President's Address.*

By William Carruthers, F.R.S., F.L.S., F.G.S.

(*Delivered January* 16*th*, 1901.)

Some months ago I had occasion to consult the works of John Ellis in connection with an inquiry regarding some of our British sea-weeds. I was so much impressed with the story of his investigations, the care with which he prosecuted them, the instruments which he used, and the simple and clear style of his writing, that at the time it seemed to me that some account of him and his work might be an entertaining and instructive subject for the Annual Address expected from the chair at the January meeting. I have since made further investigations regarding John Ellis—"Coralline Ellis" as he was familiarly called in reference to his most important work; and I venture to hope that his story may secure your attention while I attempt to tell it.

Ellis was a native of Ireland, probably of Dublin, where his sister continued to live after he was settled in London. The day and year of his birth are unknown, but he was considered to be sixty-six years of age when he died in 1776. He was probably born in 1710. At what time he came to London is likewise unknown. He was, when he began in 1756 to correspond with Linnæus, sufficiently known that he asked him to address his reply to "Mr. John Ellis, merchant, in London." There is no reason for supposing that he was not a prosperous merchant. He nevertheless found time to prosecute his studies in Natural History. In 1751 he received a collection of sea-weeds and zoophytes from Anglesey, and another from his sister in Dublin. He spread them out in fresh water and mounted them on thin boards covered with white paper so as to form a kind of land-scape, using the larger fronds of *Ulva marina* to represent hills, dales, and rocks, and arranging the smaller sea-weeds and zoophytes as little trees.

His friend, the Rev. Dr. Stephen Hales, who had some years before published his essay on *Vegetable Staticks*, called on him and was charmed with the landscapes. He asked Ellis to prepare some similar ones for the Princess of Wales, with the view of helping to lead the young princesses to study natural objects. Ellis proceeded, with his characteristic energy, to make collections with the view of complying with Dr. Hales' request. He obtained the help of a friend who was secretary to the Postmaster-General, and of his sister in Ireland. In due time he was able to present several landscapes to the Princess.

The large number of specimens that came into his hands in this way raised in him a desire to determine the species and arrange them systematically. Up to this time the Zoophytes, both Hydrozoa and Polyzoa, were treated as plants, and these, with the calcareous Algæ and Molluscan egg-cases, were called Corallines. The early herbaria, like those of Sloane, Petiver, &c., in the Botanical Department of the British Museum, contain the oldest preserved specimens of these zoophytes. They are included as plants in John Ray's great and learned *Historia Plantarum*. Ellis arranged his collection according to the then standard British Flora, Ray's *Synopsis Stirpium Britannicarum*, the third edition of which, edited and brought up to date by Dr. Dillenius, was published in 1724. The result of his more careful study of the Corallines was communicated to the Royal Society in June 1752. He grouped these objects into three classes:—(1) those that were evidently the cells of animals; (2) the branched Corallines; and (3) the articulated Corallines. The first group he considered to be animals, but the other two to be plants. In the discussion that followed the reading of his paper, opinions were expressed as to the probable animal nature of the whole of the organisms which were called Corallines. Ellis had separated one group which had hitherto been considered to be plants, and he resolved to study with care the other groups in the view of the suggestions made by the Fellows of the Society. Accordingly, in August of the same year he went to Sheppey, taking with him to make proper drawings, "Mr. Brooking, a celebrated painter of sea-pieces." Here he made observations on the living Corallines under a Microscope made by Mr. Cuff, of Fleet Street, under his directions. The first Coralline he investigated was the Hydrozoan which we now call *Laomedea geniculata*, a small generally branchless erect stem, giving off at each joint a short stalk supporting a single bell-shaped cell in which the animal lives. Under the Microscope he saw the animal. This observation led him to withdraw his paper from the Society.

In June 1754 he persuaded Mr. Ehret, the famous botanical artist, to accompany him to Brighton to continue his investigations. Ehret's drawings are beautiful works of art, and singularly accurate representations of the plants. A large collection of his drawings is preserved in the Botanical Department of the British Museum, and among them the original draft of Linnæus's families of plants, drawn by Ehret, and lettered by Linnæus. This was executed when Linnæus was living in the house of his patron Clifford, at Hartekamp, where Ehret went to make his acquaintance, and remained to make drawings for the *Hortus Cliffortianus.*

At Brighton they found a Coralline with all its minute capillary branches expanded, what we now call *Antennularia ramosa*. further specimens of the *Laomedea*, and the Polyzoan, *Flustra foliacea*. These he examined in salt water in a watch-glass under his Microscope, and, in addition to the animals, he noticed little vesicles or bladders (egg-vesicles of to-day) which were till then supposed to be the seed-vessels of the plant, but which he concluded were the habitations of young polyps.

In August of the same year he took a journey to the northern shore of Kent, and had as his companion Prof. Oeder, of Copenhagen, the original author of the *Icones Floræ Danicæ*, the first volume of which was published in 1751, and part after part has been issued since, and yet the work is still unfinished. At Whitstable he got some of the fishermen to collect the animals they found in their fishing nets, and to place them at once in water. He found here for the first time *Alcyonium ramoso-digitatum*, &c., of Ray's *Synopsis*, the large fleshy compound zoophyte which we still call *Alcyonium digitatum*. The specimens, brought in buckets of sea-water, gradually expanded, and when the polyps were fully out, he took them quickly from the water and plunged them into brandy, and thus secured many of the expanded animals for further examination.

The study of the materials obtained in these excursions led to the publication of Ellis's famous memoir, entitled 'An Essay towards a Natural History of the Corallines, and other Marine Productions of the like kind, commonly found on the Coasts of Great Britain and Ireland.' London, 1755. In the copy presented to the Royal Society by the author he inscribes in his own handwriting the more definite date, "March 6, 1755." The work has as its frontispiece an engraving of one of his "Landscapes." It consists of 103 pages of letterpress and 38 plates, to which is added an engraving of "Mr. Cuff's Aquatic Microscope, used in the Discoveries made in this Essay." The only aquatic element in the instrument is the stage, which supported a watch-glass in which the objects could be examined in water. Besides giving accurate figures of many species of marine animals, Ellis settled the animal nature of many objects which had been up to his time referred to the vegetable kingdom, and he separated the Hydrozoa from the Polyzoa. He arranged the animals described in the following classes :—1. Vesiculated Corallines ; 2. Tubular Corallines ; 3. Celliferous Corallines ; 4. Articulated Corallines ; 5. Keratophyta ; 6. Eschara ; 7. English Corals ; 8. Sponges ; 9. Alcyonia ; and 10. Other marine substances. The Vesiculated

Corallines, Tubular Corallines, Keratophyta (Gorgonia), and Alcyonia are Hydrozoa; the Celliferous Corallines and Eschara are Polyzoa; while the Articulated Corallines and the English Corals are Vegetables. Ellis detected the pores of the conceptacles in the Articulated Corallines, the modern genera *Corallina* and *Jania*, and interpreted them as the cells in which the animal lived. It is unfortunate that, in separating the different groups, the name *Corallina*, which suggests animal affinities, has been retained for the group that belong to the vegetable kingdom. The English Corals are Nullipores. On this essay rests the fame of Ellis. He had in contemplation a greater work on Corallines, and had prepared a series of plates for illustration, but he died before the work was ready for the press. Dr. Solander prepared descriptions of the species, but before his work was completed he suddenly died in 1782, and the volume was not published until 1786.

The value of Ellis's work on the Corallines was recognised by the Royal Society, and for it he received from them the Copley medal in 1768.

But Ellis did not confine himself to these marine animals. He communicated twenty-four papers to the Royal Society, which were published in the *Philosophical Transactions*, and one to the Academy of Sciences at Upsala.

His position as King's agent for the American colonies gave him excellent opportunities for obtaining specimens, and urged him to secure the introduction into them of useful plants, and the transmission of their products into Britain. He was appointed agent for West Florida in 1764, and for Dominica in 1770. He gave much attention to the transmission of seeds in conditions that would preserve their vitality. He began by coating them with gums, varnishes, and paints, but as the result of many experiments he found that a coating of beeswax and then completely investing them in molten wax produced the best results.

He was very anxious to introduce the tea-plant into Britain. It was thought it might grow freely here, and he was convinced that it would be a great gain if it could be carried alive to Florida and the other southern States. He sought out plants that would yield useful textile fibres.

Ellis had an extensive correspondence with Dr. Alexander Garden, and from him received many new plants and animals, and transmitted many to Linnæus.

Among his many friends may be included Dr. Stephen Hales, Peter Collinson, John Fothergill, Daniel C. Solander, Richard Warner, and George D. Ehret. But he had relations with men who through jealousy were far from friendly to him. Microscopes have greatly improved in these hundred and fifty years, but men's tempers appear to have been little altered. Philip Miller, the well-known Superintendent of the garden at Chelsea of the Apothecaries' Company, and author of the *Gardeners' Dictionary*, was not friendly with him. He attacked his paper on the animal nature of Corallines by submitting a reply to the Royal Society, and Ellis answered it at the next meeting. Ellis had a final word about Miller when he told Linnæus of his leaving the Chelsea Gardens. He wrote, "Poor Miller, through his obstinacy and impertinence to the Society of Apothecaries, is turned out of the Botanical Garden of Chelsea. I am sorry for it, as he is now seventy-nine years of age; they will allow him his stipend, but have chosen another gardener. His vanity was so raised by his voluminous publications that he considered no man to know anything but himself; though Gordon, Aiton, and Lee have been long infinitely superior to him in the nicer and more delicate parts of Gardening." Gordon was held by Ellis in high esteem, and he showed his appreciation by dedicating to him the genus *Gordonia.* Ellis was always desirous of connecting a new genus with the name of a friend who had done creditable work in his favourite science. And in choosing new plants he was singularly happy in finding undescribed types, so that his genera are acknowledged to the present day. *Halesia*, after Dr. Hales; *Gardenia*, after Dr. Garden; and *Gordonia*, after Gordon, whose nursery was at Mile End, were new forms, and they were so clearly described that they have been easily recognised.

But to return to those who were not his friends; it was to be expected that he could not be cordial with Dr. John Hill, whose folio volumes are as worthless as they are huge. His botany was of the same quality as his physic, of which Garrick, in reference to a farce written by Hill, said,—

> "For physic and farces his equal there scarce is;
> His farces are physic, his physic a farce is."

Prof. Buttner, of Göttingen, was guilty of the most barefaced plagiarism, supported by falsehoods. Having heard Ellis's account of the nature of Corallines at the Royal Society, he palmed it off as his own, and then asserted that Ellis got his knowledge from him. It is no wonder that Ellis thanks Linnæus "for supporting my character against that insolent plagiary Buttner."

I should not overlook his introduction of the Venus's Fly Trap to science and to cultivation. His figure and description "of that most rare and singular plant, than which certainly nothing more interesting was ever seen" (Linnæus), are admirable. He gave it the name of *Dionæa muscipula*, which it still retains.

Linnæus held Ellis in high esteem. He says of him, "You are still the main support of Natural History in England, for your attention is ever given to all that serves to increase or promote this study Without your aid the rest of the world would know little of the acquisitions made by your intelligent countrymen in all parts of the world. For my own part, I acknowledge myself to have derived more information through your various assistance than from any other person."

Of the extensive correspondence carried on between Linnæus and Ellis a portion only is preserved by Sir J. E. Smith in his *Selection of the Correspondence of Linnæus and other Naturalists*; sufficient, however, to manifest the mutual benefits derived, and the general gain to science. I cannot detain you any longer than to give an illustration, I fear somewhat lengthy, of this correspondence. I select passages from several letters referring to phenomena observed in the germination of the spores of Fungi.

The first mention of this subject is in a letter to Linnæus, dated December 5, 1766. Ellis writes, "Peter Collinson spent the evening with me, and showed me a letter you wrote to him about funguses being alive in the seeds and swimming about like fish. You mention something of it to me in your last letter." This letter is missing, unfortunately. He continues, "If you have examined the seeds of them yourself, and found them to be little animals, I should believe it. Pray what time of the year, and what kinds? I suppose they must be taken while growing and in a vigorous state. I intend to try. I think my glass will discover them, if they have animal life in them. The seeds of the *Equisetum palustre* appear to be alive by their twisting motion, when viewed through the Microscope; but that is not animal life."

Linnæus replied in the following month, January 1, 1767:—"With regard to *Fungi*, you may pick up, in most barns or stacks of corn, spikes of wheat or barley, full of black powder, which we call *ustilago*, or smut. Shake out some of this powder and put it into tepid water, about the warmth of a pond in summer, for three or four days. This water, though pellucid, when examined in a concave glass under your own Microscope, will be found to contain thousands of little worms. These ought first to be observed to prevent ocular deception. In mould, *Mucor*, you will find the same, but not so easily as in the larger *Fungi*. If, in the course of from eight to fourteen days, the water has been kept up to the same temperature, you may observe how these minute worm-like bodies become fixed, one after the other, and acquire roots. I have just printed a dissertation on the Invisible World,* which shall be sent you by the first opportunity.

* This dissertation was published in 1767, and is contained in the seventh volume of the *Amœnitates Academicæ*. It is chiefly devoted to the discoveries of Baron Munchausen, who held that the dust (spores) of the Fungi were the ova of animalcules. Linnæus at first adopted this opinion, as appears from the above correspondence with Ellis. He states it somewhat hesitatingly in the *Systema Naturæ* (p. 1326). The experiments of Ellis induced him to suppress this view in his subsequent publications, though he does not appear to have repudiated it. Linnæus closes the dissertation with a discussion of the nature of the animalcules which appear in small-pox, anthrax, and similar diseases. There is an interesting practical fact recorded in the treatise as to Baron Munchausen's treatment of his seed wheat. He washed it with a lye made of lime and salt water, and for twenty years his crops were free from smut, while it was destructively prevalent in his neighbours' crops.

These chaotic worms are nearly akin to the last species of animals which I have placed in my *Systema* under the genus *Chaos*. . . . I have long been well acquainted with the elastic or jumping seeds of *Equisetum* described by Staehelin in the Paris Memoirs, and still longer with the elastic seeds (or rather capsules) of ferns in general, known for above a century. These having no real vital motion, are totally different from the vermicular bodies of *Fungi*, which are truly alive."

The subject seems to have been laid aside for a while; for in August of the same year Ellis writes :—"I have not had time to try yours and Baron Munchausen's experiments on the animalcules in the origin of mushrooms and smut in corn; but have recommended it to the public to try the experiments. As soon as I do I shall communicate my thoughts to you on the subject." Then in his letter dated September 8, he says, "I have lately been trying experiments on the seeds of the Fungus called by you *Agaricus campestris*, and also on those called the *Agaricus fimetarius*. The minuteness of these bodies obliged me to make use of the first magnifying glasses in the double Microscope. This plainly showed to me that these seeds, though put into water according to your directions, have no animal life of their own, and are only moved about by the *animalcula infusoria*, which give them such a variety of directions, both circular as well as backward and forward, that they appear as if alive."

"The animalcula are so numerous, and at the same time so pellucid, that without good glasses the most accurate observer may be mistaken. I wait for an opportunity to try the seeds of the *Lycoperda* and the dust of the *Ustilago* in corn."

Linnæus still holds to his opinion that fungus spores "are alive in the seed," and in his answer to Ellis, dated October 1767, he says :—

"I received yours, in which you speak of the living seeds of *Fungi*, asserting that you have only seen the *animalcula infusoria* moving the powder of these vegetables.

"I am not able rightly to understand whether you have actually seen the *animalcula* or not. If really so, they ought, at the end of fourteen days, to begin to attach themselves to the bottom of the glass, first a solitary one, then several more adjoining to it, till almost all of them are thus become fixed, after which they grow up into *Fungi*.

"With respect to the *animalcula infusoria* themselves, unless I am totally mistaken, I think I have seen these to be the living seeds of mould, *Mucor*. But before I venture to put forth such an opinion, I beg of you to lend me your lynx-like eyes; and you will see in the vessel or glass, where there is so little water that it may soon evaporate, whether these bodies do not change to plants of *Mucor*. This point is of the greatest importance, and if my ideas be correct, we shall no longer be surprised at the quantity of such animalcula in common water, any more than at the mould itself on decaying food, &c.

"I beg and intreat of you not to slight my request. You will find it worth your while to look closely into the nature of these minute beings, as they are related, though remotely, to your own marine *animalcula*. Everybody wonders at the *animalcula infusoria* being produced by an infusion of pepper, and such substances; whereas the difficulty vanishes if they belong to *Mucor*; for pepper, if long kept moist, is as liable to grow mouldy as anything else.

"Having once discovered the little worms in the *Ustilago*, by the help of the Microscope, I can now see them with my naked eyes, though less distinctly; and I showed them a fortnight ago to some of my pupils."

Ellis replied at the end of the month to Linnæus:—

"I have received your obliging letter about the seeds of *Fungi* being animated. By your letter you seem to think that the seeds of the *Fungi* are animated, or have animal life, and move about; my experiments convince me of the contrary. I must first let you know that I am convinced that in almost all standing or even river water there are the eggs, and often the perfect animals, of those you call *animalcula infusoria*. As soon as these meet with their proper *pabulum*, they grow and increase in numbers equal to the *Musca vomitoria*. I often have examined river water and pond water, and scarce ever found it without some species of these *animalcula*, especially in summer and autumn; besides, the same *animalcula* that attack, eat, and move about the *farina*, or seeds of the *Fungi*, do the same with other vegetables, as I have lately been convinced of by a fair experiment. I have tried, at your request, my experiments over again, and showed them to D. C. Solander. I will keep these infusions, according to your desire, fourteen days, and examine the particulars you desire of the *animalcula* fixing themselves, first one, then many more, to the bottom of the glass, and will endeavour to find out what you mean by their growing up into *Fungi*. If you mean that *animalia infusoria*, when they are dead, are a proper pabulum for *Mucor*, I agree with you; for I have many animal substances that are covered with *Mucor*, even between the Muscovy talcs used on purpose for microscopic animals in the Microscope. But what appears to me most difficult to comprehend is, for instance—I have now a *Lycoperdon Bovista*, which I received from our good friend P. Collinson four days ago. I put part of it into river water, and in two days I perceived the seeds or *farina* of it moving about distinctly. The fourth day I perceived the figure of the *animalcula* that moved them. Are these seeds or these *animalcula* (for they are evidently distinct bodies) to turn into *Fungi*, *Mucores*, or *Lycoperda*? This is what I do not comprehend in this new discovery. If the *animalcula* that moved the seeds of the *Lycoperdon* [turned into *Fungi*] it would be amazing; and again, it would be as surprising that the seeds of one genus should produce another; for instance, that the seeds of *Lycoperda* should produce *Mucores*. However, I have determined to go through these experiments with precision, and to call in witnesses of the several appearances.

"I have not yet got any of the *Ustilago*. If you will be so good as to send me a spike of corn infected with it, proper for trial, you may depend on me in carefully going through the experiments properly."

Linnæus soon replied to this letter, though, as we see, under a misapprehension:—

"I am beyond measure delighted with your observations upon the *Lycoperdon* in river water; that its powder moved about, and was transformed into that species of *Mucor* which I have named *Mucedo*. I have long suspected this *Mucedo* to belong to *Lycoperdon*; but my suspicion has never before been confirmed."

Ellis wrote again very soon, January 1768:—

"In your letter of the 8th December, you seem to misapprehend the meaning of the letter which I wrote to you the 30th October. I find, on looking over the copy which I have of it, it runs thus, or much to this purpose"—and he repeats the statements he had already made. He then continues, "Thus far I thought it necessary to quote from my former letter of 30th October, as my real opinion. I have kept a regular journal of my observations in making experiments on the seeds of the *Fungi*, which I have shown often to Dr. Solander, to prevent any mistake; and do assure you I have convinced him that they do not move of themselves when kept in water; but it appeared evidently to him, and many more gentlemen who saw my experiments, that the motion which they had proceeded from *animalia infusoria*, whose shape we plainly saw, and observed distinctly the particular motion, with some attention, which these little creatures had while they were eating the seeds of the *Fungi*, and which they communicated to the seeds of the *Fungi*, so as to make them appear alive."

He records the results of further experiments on animalcules in a letter written in the following March:—

"I have now discovered why putrid vegetable substances yield volatile alkaline salts, the same as animal substances. I put a rotten potato into water about ten days ago, in a glass, and covered the top with a card, having a weight on it to keep it close, and placed it on a shelf in a room over the fire-place. In four days the water was full of small animalcules, so that, I believe, for every particle of the potato there were ten minute animals, as in the experiments with the *Fungi*. In order to know for certain whether these animals came from the potato or the water, I boiled a small potato till it was ready to fall to pieces. I likewise boiled some water for half an hour, and then put the mashed potato and the boiled water together in a glass, and they were placed in the same warm situation with a card over it. I examined a drop of the liquor four days after, and could perceive millions of animalcules, of a tadpole shape, turning about the crystalline round particles of the potato in all directions, just as I had observed them turning the seeds of the *Fungi* last autumn. I must inform you I used the largest magnifiers I had, which were the first and second of Wilson's Microscope. I wish you would try the same experiments: you will find many new scenes in nature will be discovered by this hint. I have shown the experiment to Solander and a very few friends, but have not yet made it public. I wish Baron Munchausen would try the same."

One cannot fail to be impressed with the thoroughness and care with which Ellis carried out his experiments, or to accept the conclusions at which he arrived. On the other hand, Linnæus was touching the fringe of a great question in the life-history of *Fungi* which a better Microscope would have probably led him to discover, but which our more perfect instruments are only now fully developing.

III.—*On Tube Length.*

By Edward M. Nelson.

(*Read 20th February*, 1901.)

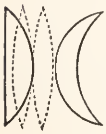
The subject of tube length has been but imperfectly treated in microscopical literature, and nearly twenty years have elapsed since anything has appeared about it in our Journal, although promises were at the time made that it would be dealt with more fully. The object then of this paper is to lay before the Society a brief account of the subject in such a way that it may be understood by any microscopist, whether he has any previous knowledge of mathematical optics or not.

At the outset we may point out, that which nearly every microscopist knows, that there are two tube lengths, viz. a mechanical and an optical. The Mechanical Tube is measured from the end of the nose-piece to the end of the draw-tube. The standard length for the English tube is 8¾ in. (222 mm.), and for the Continental 160 mm. (6·3 in.). The mechanical tube does not in any way represent the distance by which the lenses of the eye-piece are separated from those of the objective, as that obviously will depend upon the manner in which those lenses are mounted, as well as upon the length of the mechanical tube. In brief, the mechanical tube is the length of the Microscope-body when in use.

We now come to the Optical Tube. This in the nature of things should be nearly as easy to describe as the mechanical tube, but, owing to the fact that there are two optical tube lengths, a detailed explanation of some length will be necessary. Most microscopists are aware that every lens and every combination of lenses have what is called an equivalent lens. This equivalent lens is a mathematical abstraction, for it can neither be made nor always drawn; its position on the axis need not necessarily be coincident with that of the lens to which it is equivalent, so that it may be found sometimes inside and sometimes outside the actual lens. Now the bearing this has upon the matter before us is very important, as will be realised when it is understood that two lenses are in optical contact when their equivalent lenses are in contact, and not necessarily when there is physical contact between the actual lenses themselves. For the benefit of those unacquainted with this subject, fig. 18 shows a plano-convex in optical contact with a converging meniscus, and it will be noticed that the actual lenses are not touching one another. The actual lenses are represented by continuous, and the equivalent lenses by dotted lines. When two lenses are separated from one another, the optical distance of their separation is not the distance between the actual lenses which could be measured by a foot rule, but it is the distance between the equivalent lenses, and it is this distance which may appropriately be termed the natural optical tube length.

When two lenses are in optical contact (fig. 18), the focus of the combination is determined by dividing the product of their focal lengths by their sum; thus, $F = \frac{ff'}{f+f'}$, where F is the focus of the combination and f, f' the foci of the plano-convex and the meniscus. For example, in fig. 18, if f, the focal length of one lens, is 2, and f' that of the other, 3, then $F = \frac{2 \times 3}{2+3} = \frac{6}{5} = 1\frac{1}{5}$. When, however, the equivalent lenses are separated by a distance d, which we have called the natural optical tube length, it is necessary to subtract this quantity from the sum of the foci in the denominator. For example, let the same two lenses be separated by a distance 1, then $F = \frac{ff'}{f+f'-d} = \frac{2 \times 3}{2+3-1} = 1\frac{1}{2}$.* It must be pointed out that, in this case, F is positive and the image is erect; but if the distance d, the natural optical tube length, be increased so that it is greater than the sum of the foci, F will become negative, which indicates that the image will be inverted. Example:—let $d = 8$, then $F = \frac{2 \times 3}{2+3-8} = -2$. This is the condition which prevails in the compound Microscope.

Fig. 18.

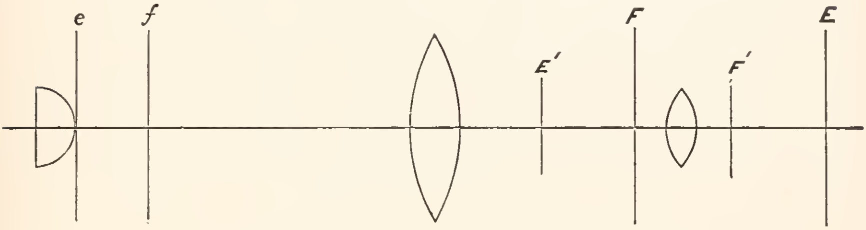


One more little piece of elementary arithmetic, viz. that p, the combined magnifying power, is determined from the focus by dividing the conventional quantity 10 by the focus; thus, in the last example, $p = \frac{10}{-2} = -5$, the negative sign indicating the inverted image as before; conversely, if the magnifying power is known, the focus F can be found; thus $F = \frac{10}{p} = \frac{10}{-5} = -2$. So far for the natural optical tube length for the present; but we have another optical tube length, viz. one which was introduced by Prof. Abbe, and which may be called the conventional optical tube length Δ, to distinguish it from the one we have just been considering. Prof. Abbe's tube length is the distance measured between the foci. Fig. 19 illustrates the two kinds of optical tube length, where the natural optical tube length d is measured from e to E, and the conventional Δ from f to F; the plano-convex lens in the figure represents the lens that is equivalent to the objective, but the eye-piece has both lenses drawn. It will be noticed at once that Δ is equal to d less the sum of the foci ($e f +$ E F); in other words, Δ is the denominator in our fraction above, viz. $F = \frac{ff'}{f+f'-d} = \frac{ff'}{-\Delta}$.

* This formula is given by Coddington (1830), part ii. p. 34.

Some of you will perhaps be wondering why the subject should be complicated by the introduction of a new optical tube length. The reason for it is that p, the magnifying power, is directly proportional to the optical tube length Δ, but it is not proportional to that of d. Thus, with the same objective and eye-piece, if we double Δ

FIG. 19.



we double the magnifying power; but this obviously will not be true with regard to d.

Now, in order to ascertain practically the optical tube length called d, we must find the position of the last surface of the lens which is equivalent to the objective, and the first surface of that equivalent to the eye-piece. (The terms first and last being referred to a movement from the object towards the eye.)

Very often in Microscope lenses, both in objectives and eye-pieces, we find the surfaces of the equivalent lenses crossed over, i.e. the front surface lying behind the posterior surface; and for this reason it was previously stated that the equivalent lenses could be neither made nor drawn. In the Huyghenian eye-piece, for example, this inversion of the surfaces takes place, and the front surface E of the equivalent lens of this eye-piece lies as far beyond the eye-lens as the diaphragm is in front of the eye-lens; and this is the point from which the tube length d should be measured.

As to the objective, the position of the back surface of its equivalent lens varies, so that it cannot be assigned once for all to any definite place with regard to objectives generally; sometimes it will be found in front of the front lens, and sometimes behind it. So too in the case of tube length Δ, the position of the back focus of the equivalent lens of the objective cannot be defined generally; but in the Huyghenian eye-piece the front focus is situated half-way between the diaphragm and the eye-lens. With Ramsden and positive eye-pieces, the position of the front focus is at the diaphragm, or if there should be no diaphragm, it can be easily found by turning the eye-lens towards a window and by focussing the image of the window bars upon a piece of paper.

We have now found a point in the eye-piece from which the optical tube may be laid off, when its length is known; and the length of the optical tube may be determined in the following manner.

Place the Microscope in a horizontal position, and by means of the objective to be measured, but without any eye-piece, project the image of a stage micrometer on to a ground-glass screen,* making the distance of the screen from the micrometer exactly 100 in. Divide the size of the image on the screen by the size of the ruling on the micrometer, the quotient giving of course m, the magnifying power. Add 2 to m and move the decimal point one place towards the left hand, and the result will be the initial magnifying power of the objective.

Look out this initial power in a table of reciprocals, and move the decimal point one place to the right, the result will be the precise focal length of the objective. We see, therefore, that when once the magnifying power for a projection distance of 100 in., measured from the *object* to its image, is known, the focal length of the objective may be accurately determined, and that practically without calculation.

The next step is to select an eye-piece, of about 1-in. focus, or 10 power, and treat it exactly as if it were an objective, project the image of the stage micrometer upon the screen at the distance of 100 in. (the eye-lens being used as the front lens of an objective), and determine its precise focal length as above. One more measurement is required, viz. the magnifying power of the objective when combined with the eye-piece upon a fixed mechanical tube length; this also is better measured by projection than in any other manner. The distance from the screen to the point beyond the eye-lens, where the window bars would be brought to a focus, if the field-lens of the eye-piece were pointed to them, should be exactly 10 in.†; this combined power we will call p. Returning now to the formulæ, viz. $F = \frac{ff'}{f+f'-d}$ and $F = \frac{10}{p}$, previously mentioned, if these two are combined and simplified (p being negative changes the sign in front of the fraction in which it occurs); the equation becomes $d = \frac{pff'}{10} + f + f'$. Now, as p the combined magnifying power, f the equivalent focus of the objective, and f' that of the eye-piece, have all been determined, d the natural optical tube length is found. By omitting to add the two last terms of the expression, the value of Δ is obtained.

The following Table, which comprises a heterogeneous selection of objectives, illustrates not only the variations in the lengths of the two different optical tubes d and Δ, but also the effect these variations have upon the power.

* It is convenient for this kind of work to have a scale engraved upon a glass slip; this, when held in the hand in contact with the ground-glass, may be moved about until the lines of the projected image cut those upon the ruled scale.

† The precise spot from which the measurement should be made is the posterior focal point of the *entire Microscope*, but this is very close to the posterior focal point of the *eye-piece*.

Objective	A m	B $\frac{m+2}{10}$	C $f = \frac{100}{m+2}$	D p = power with eye-piece	E $d = \frac{pff'}{10} + f + f'$	F $\Delta = \frac{pff'}{10}$	G $p' = \frac{10\Delta}{ff'}$	H Error per cent.	K $p'' = \frac{10\Delta}{\phi f'}$	L Error per cent.
Powell 4 in. (1876) ..	38·3	4·03	2·481	30	9·69	6·36	47	− 36	29	+ 3·3
Zeiss a* closed	42·5	4·45	2·247	15·5	6·08	2·97	52	− 70	—	—
Ross 3 in.	45	4·70	2·128	47	11·61	8·63	55	−14·5	39	+20·5
Powell 2 in. (1840) ..	54	5·60	1·786	56	11·19	8·55	66	− 15	58	− 3·4
Powell 1½ apo.	60	6.20	1·613	75	12·80	10·33	73	+ 2·7	78	− 3·8
Powell 2 in. (1876) ..	63	6·50	1·538	65	10·93	8·54	76	−14·5	58	+ 12
Powell 1½ (1876) ..	77·5	7·95	1·258	82	10·97	8·86	93	− 12	78	+ 5·1
Zeiss $a\,a$ 26 mm. ..	96·7	9·87	1·013	105	10·95	9·08	115	− 8·7	114	− 7·9
Zeiss 24 mm. apo. ..	108	11·0	·909	130	11·85	10·09	129	+ 0·8	106	+ 23
Powell 1 in. (1840) ..	110	11·2	·893	110	10·15	8·40	131	− 16	117	− 6
Powell 1 in. (1857) ..	117	11·9	·840	128	10·87	9·18	139	− 8·0	117	+ 9·4
Ross 1 in. (1836) ..	118	12·0	·833	120	10·23	8·54	140	− 14	117	+ 2·6
Ross 1 in. (1840) ..	127	12·9	·775	138	10·76	9·13	151	− 8·6	117	+ 18
Zeiss A A 18 mm. ..	145	14·7	·680	160	10·82	9·29	172	− 7	165	− 3
Beck ⅔ (1850)	145	14·7	·680	163	10·99	9·46	172	− 5·2	175	− 7·4
Powell ⅔ (1876) ..	160	16·2	·617	179	10·90	9·43	190	− 5·8	176	+ 1·7
Powell ½ (1840) ..	200	20·2	·495	220	10·66	9·31	236	− 6·8	234	− 6
Zeiss 12 mm. apo. ..	205	20·7	·483	238	11·16	9·82	242	− 1·6	212	+ 12
Powell ½ (1876) ..	210	21·2	·472	244	11·16	9·83	248	− 1·6	234	+ 4·3
Ross ½ (1840)	215	21·7	·461	250	11·16	9·84	254	− 1·6	234	+ 6·8
Reichert 8 mm... ..	225	22·7	·441	267	11·36	10·06	265	+ 0·8	317	− 16
Powell $\frac{4}{10}$ (1876) ..	310	31·2	·321	367	11·24	10·06	364	+ 0·8	292	+ 26
Powell ¼ (1840) ..	370	37·2	·269	433	10·78	9·96	435	− 0·5	468	− 7·5
Leitz P. 7 mm. ..	390	39·2	·255	463	11·19	10·08	459	+ 0·9	425	+ 9
Powell ¼ apo.	395	39·7	·252	483	11·51	10·40	464	+ 4·1	468	+ 3·2
Ross ¼ (1840)	395	39·7	·252	463	11·08	9·97	464	− 0·2	468	− 1·1
Powell ¼ (1876) ..	460	46·2	·216	550	11·22	10·15	542	+ 1·5	468	+17·5

Let the initial magnifying power of an objective whose focus is f be N, then $N = \frac{10}{f}$; and let n represent the initial magnifying power of the objective calculated according to its designated focus ϕ, then $n = \frac{10}{\phi}$; and let n' be the initial magnifying power of the eye-piece whose focus is f', then $n' = \frac{10}{f'}$.

Column A contains the power m of the objective alone, measured by projection upon a screen placed 100 in. from the object upon the stage, no eye-piece being used.

B. The initial magnifying power N of the objective. This is obtained by adding 2 to the figures in column A and dividing the sum by 10.

C. The true focal length. This is found by looking up the figures in column B in a reciprocal table, and moving the decimal point one place to the right.

D. The combined power of the objective and eye-piece (the mechanical tube being kept at $8\frac{3}{4}$ in.) measured by projection at a distance of 10 in.* from the posterior focal point of the eye-piece. The focal length of the eye-piece used was $0 \cdot 8547$, and n' its power $11 \cdot 7$.

E. The length of the optical tube d. This is found by multiplying the product of the figures in columns C and D by $0 \cdot 8547$, the focal length of the eye-piece, dividing by 10, and adding the focal lengths of the objective and eye-piece to the quotient.

F. The length of Prof. Abbe's optical tube Δ. This is the same as E, omitting the adding of the focal lengths of the objective and eye-piece.

G. In this column, p' is the calculated combined power of the objective and eye-piece, assuming that $\Delta = 10$ in. The focal length of the objective f is that given in column C, and that of the eye-piece f' is $0 \cdot 8547$ as before. $p' = N\,n'$, or figures in column B $\times$ $11 \cdot 7$.

H. The percentage of error in the actual measured power in column D, compared with the calculated power in column G. In brief, it is the percentage of error due to the deficiency or excess of the tube length above or below 10 in.

K. The calculated combined power p'' of objective and eye-piece, assuming that $\Delta = 10$ in., and that ϕ the focal length of the objective is true to its designation, i.e. that the 4 in. is a 4 in. and not a $2\frac{1}{2}$; that the $\frac{1}{4}$ is a $\frac{1}{4}$ and not a $\frac{1}{5}$, &c. $p'' = n\,n'$.

L. The percentage of error in column D compared with that in K.

The figures in column K show what the magnification ought to be, and what we ought to expect it to be. In the first lens, the lowest

* As a matter of fact the distance was 20 in., and the magnifying power was halved. This plan ensures greater accuracy.

power in the list, it will be noticed that the percentage of error is not large, Powell having got over the difficulty of the loss in magnifying power owing to the shortening of the optical tube (see column F), by increasing the power of the objective; the lens is nominally a 4 in., but in reality it is a $2\frac{1}{2}$ in. In the second lens the nominal focus is not given, so the values in K and L could not be filled in.

Ross 3 in. is rather overdone. It has 2 in. more optical tube than Powell's 4 in., and so the reduction in its focal length has been too great.

Powell's 2 in. (1876) is likewise overdone.

Zeiss 24 mm. apo. is also overdone. Δ in this instance is very nearly 10 in.

Ross 1 in. (1840) is another example of a lens with too short a focal length; his earlier objective, however, is about right.

The Zeiss 12 mm. apo. is also overdone, the tube length being slightly less than 10 in.; and so to a greater extent are Powell's $\frac{4}{10}$ and $\frac{1}{4}$, the former being a $\frac{1}{3}$ and the latter nearly a $\frac{1}{5}$. Reichert's 8 mm. is an example in the other direction, the lens with a correct tube length being considerably underdone. The Ross $\frac{1}{4}$ (1840) is almost exactly right, both as regards focus and tube length.

If the figures in column F and H are compared, it will be seen in F that in those cases where the tube length Δ is less than 10 in. there is a $-$ sign in H, and *vice versâ*; but if a comparison is made between the figures in E and H, a very different result will be noticed; e.g., with a tube length d of $11 \cdot 61$ in E there is an error of $-14 \cdot 5$ in H; but with one of $12 \cdot 8$ there is an error of $+2 \cdot 7$; another of $11 \cdot 85$ yields an error of $+0 \cdot 8$, and one of $11 \cdot 51$ gives $+4 \cdot 1$ in error. These results bear out the statement above that the combined magnifying power is not proportional to the tube length d.

With regard to the formula for the initial power and the focus in columns C and D, some explanation of their derivation is necessary. Let a' be the distance of the object from the lens, and a the distance of the screen from the lens upon the other side. The relations of these quantities to one another and to f the focus is fixed by the well-known formula, which is given in every elementary text-book, viz. $\frac{1}{f} = \frac{1}{a'} + \frac{1}{a}$. a' and a are both positive as they are measured from the object to the lens, and from the lens to the image respectively. There is one other common formula, viz. that the size of the object bears the same proportion to the size of the image as the distance of the object from the lens does to the distance of the image from the lens. Thus, if o is the object and i its image, $\frac{i}{o} = \frac{a}{a'}$; but $\frac{i}{o}$ is the magnifying power m, therefore $m = \frac{a}{a'}$, and $a' = \frac{a}{m}$.

Putting this value of a' in the equation above, we have $\frac{1}{f} = \frac{m}{a} + \frac{1}{a} = \frac{m+1}{a}$, and $a = f(m + 1)$. This last expression is all we should require if we could measure a, the distance of the ground-glass screen from the equivalent lens, but this is just what we are unable to do, because we do not know the position of the equivalent lens; we can, however, measure the distance of the object from its image, and this distance, viz. $a + a'$, we have made 100 in. Now, when the image of an object is projected to a distance which is considerable in comparison to the focal length of the lens projecting it, the object will be situated very close to the principal focus of the lens, and therefore we may write f for a', without introducing any great error.

We have then $a + f = 100$, and $a = f(m + 1)$;

therefore $$f(m + 1) + f = 100$$

and $$f = \frac{100}{m + 2}.$$

The error of which we have just been speaking increases as the focal length of the objective increases, but is practically of no moment provided that the distance of the object from the image remains 100 in.; as we have in the Table no objective with as much as 3 in. of focus, it might be as well to examine what the error will amount to if a 3 in. objective is calculated by the above formula. Let $m = 31 \cdot \dot{3}$, then $f = \frac{100}{33 \cdot \dot{3}} = 3 \cdot 0$. If the focal length is calculated by a longer though strictly accurate formula, $f = 2 \cdot 99713$; the error therefore is only $+ 0 \cdot 00287$. If a higher power is taken, the error will be less. Let $m = 48$, then $f = \frac{100}{48 + 2} = 2 \cdot 0$; the longer formula makes $f = 1 \cdot 99917$; the error is $+ 0 \cdot 00083$, and quite insensible.

The formula in column B is derived from this one; for as the initial power is equal to $\frac{10}{f}$, it is therefore equal to $\frac{m + 2}{10}$. We may therefore infer that in using these simple and convenient formulæ no error worthy of our consideration has been introduced into the Table.

In fig. 19, the objective and the curves of the lenses of the eye-piece are diagrammatic, but the position of the lenses of the eye-piece, as well as the surfaces E E′ and the foci F F′ of its equivalent lens, are correctly placed. It will be seen that the front surface E of the equivalent lens is behind the back surface E′, but the front focus F is in front of the back focus F′. The front surface and focus are represented by long lines, while the back surface and focus are indicated by shorter lines. The tube Δ should be measured from F, a point situated between the eye-lens and the field-lens, at a distance from the eye-lens equal to one-fourth of the distance between the eye-lens and field-lens. The tube length d is measured from E, a point lying a little further beyond the eye-lens than the diaphragm does in front of it.

The point F′, the back focus of the eye-lens, is important, because close to it lies the back focal point of the entire Microscope. This point can be readily found by using the eye-piece as a simple lens and focussing the window bars on a piece of paper, the field-lens being, of course, turned towards the window. It is important that the point F should be kept in a certain fixed position with regard to the mechanical tube, and manufacturers should be more careful in this respect. The great bulk of Microscopes have Huyghenian eye-pieces, and the common practice of makers, both here and on the Continent, is to let the eye-lens rest on the top of the tube; the two exceptions to this rule are Powell's, which have been ringed since 1839, and Zeiss' new compensating Huyghenians.

Every microscopist wishes to be able to determine the magnifying power of his Microscope, by merely multiplying the initial power of the objective by that of the eye-piece.

Let c be the conventional distance of accommodation, p the power of the entire Microscope, while N and n' are the initial powers of the objective and eye-piece respectively; then, as we have seen above, $F = \frac{c}{p}$, $f = \frac{c}{N}$, and $f' = \frac{c}{n'}$; inserting these values in the first equation $F = \frac{ff'}{\Delta}$, we have $p = \frac{N\,n'\,\Delta}{c}$; so that, when Δ is made equal to c, $p = N\,n'$, the condition desired by every Microscopist.

Now if we turn to old works on the Microscope, we shall find various values assigned for c. Baker in 1743 makes $c = 8$ in.; both Brewster and Pritchard in 1837 make it equal to 5 in.; but Pritchard in 1838 and Ross in 1839 increase it to 10 in. So, too, if we examine old Microscopes, we shall find corresponding differences in the length of the mechanical tubes. Old non-achromatic Microscopes had short objective mounts, but the eye-piece was screwed to the top of the body, so that the value of Δ for all except very low powers was just about 8 in., and therefore the formula $p = N\,n'$ gave a fairly accurate idea of the magnification. An early achromatic Microscope by Hugh Powell (a compound and single Microscope, dating about 1839) had a mechanical tube of $7\frac{1}{2}$ in.; this reduction of $\frac{1}{2}$ in. allowed for the increased length of the mount of the achromatic objective. A little later we find that c is increased to 10 in.; and then we meet with an increase of $1\frac{1}{4}$ in. in the mechanical tube; the objective mount is also lengthened to about the size it is at the present time; and the eye-piece has a collar or ring fitted to it which raises its front focus to about the level of the top of the tube.

In column F the result of such a mechanical tube length upon the value of Δ is clearly seen. Column H shows the percentage of loss or gain in power, owing to the difference between the actual optical tube length Δ and a theoretical one of 10 in. It will be seen that there is an error of 8 per cent. with a 1 in. objective; but with powers higher than that it quickly vanishes. The error with very old objectives is necessarily greater, because they have shorter mounts.

In a Microscope with a short tube $\Delta = 6$ in., consequently if we want p to equal $m\,m'$ we must adopt an optical fiction, and assume for the same objective a different initial power when it is used upon a short tube than when upon a long tube. Thus the initial power of a $\frac{1}{2}$ in. is $\frac{10}{\frac{1}{2}} = 20$; but if we wish to use this lens upon a short tube we must consider it as $\frac{6}{\frac{1}{2}}$ or 12; moreover, we must treat the eye-piece differently, and leave it the same value as it had before; then, when we have assigned these values to m and m', the power p of the short tube Microscope will be represented by their product.

The firm of Messrs. Zeiss treat the subject differently, and catalogue the power of their objectives as calculated for the long tube, and give a fictitious value to the magnification of their eye-pieces; thus, for example, the same eye-piece is catalogued as an 8-power for the short and as a 12-power for the long tube.

In 1860 the Wenham binocular was invented, and the effect of its introduction was to lengthen the tubes in order to avoid too steep an angle of convergence for the eyes; to this may be traced the origin of those Microscopes one occasionally sees, with enormously long bodies. Powell's tube length was hardly affected by the Wenham binocular, because a separate monocular body was provided.

If, in conclusion, these few remarks should induce any maker to lengthen the mount of his low-power objectives and shorten those of high power, and at the same time make his Huyghenian eye-pieces so fit the body tube that the front foci will all lie at the top of the tube, they will not have been written in vain.

NOTE.—If any one wishes to obtain hypercritically approximate results, when dealing with very low-power objectives by the formula in column C, he may apply a correction by subtracting $\frac{100}{(m+1)^3}$ from the values given there. But this correction should be applied only to very low-power objectives, where m is less than 50. This correction, like the principal formula, may be found without calculation in Barlow's Tables (Spon), a book indispensable to all microscopists interested in optical science. The Microscope lens of lowest power is nominally a 6 in. (actually a 4 in.); but when the correction is applied, the formula is applicable to photographic lenses up to 15 in. of focus, a distance of 100 in. between the object and image being maintained.

SUMMARY OF CURRENT RESEARCHES

RELATING TO

ZOOLOGY AND BOTANY

(PRINCIPALLY INVERTEBRATA AND CRYPTOGAMIA),

MICROSCOPY, ETC.*

ZOOLOGY.

VERTEBRATA.

a. Embryology.†

Can Extract of Sperm act as a Fertilising Agent?‡—Dr. Hans Winkler put the sperm-material of *Sphærechinus granularis* or of *Arbacia pustulosa* into distilled water, left it with repeated shakings for half an hour, filtered five or six times through three folds of filter-paper, adjusted the salinity to that of normal sea-water, and added unfertilised eggs of the same species. In some cases a small number of the ova showed signs of segmentation (apparently with mitoses), regularly for one or two cleavages, and then irregularly. In another experiment he placed the sperm-material in water with about 20 p.c. of salt (to kill them), and with this method he had similar results. What the nature of the stuff is that passes through the filter remains quite obscure, nor does the author regard his work as more than tentative. He reviews some analogous experiments by others.

Does Nutrition influence the Determination of Sex?§—Dr. J. F. Gemmill has extended and confirmed some previous observations ‖ bearing on this problem. If it be granted that high-level limpets and mussels are relatively starved when compared with low-level forms, it might be expected that this would be seen in some disproportion between the sexes. But the author's results show that there is not a greater relative proportion of males in the upper zones or of females in the lower zones.

Reaction of Developing Sea-Urchins to Environment.¶—Dr. H. M. Vernon kept the impregnated ova of *Strongylocentrotus lividus* for

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

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

‡ Nachricht. Ges. Göttingen, 1900, Heft 2, pp. 187–93.

§ Communications Millport Station, i. (1900) pp. 32–6.

‖ Cf. this Journal, 1897, p. 27.

¶ Proc. Roy. Soc., lxvii. (1900) pp. 85–101.

various periods during development at an abnormal temperature, and compared the size of the larvæ with that of others allowed to grow normally. He was thus able to prove that the permanent effect of temperature on the growth diminished rapidly and regularly from the time of impregnation onwards. Exposure to about 8° C. for an hour at the time of impregnation produced an average diminution of 4·1 p.c. in the size of the larvæ measured after eight days' growth; by exposure during the 4th hour after impregnation a diminution of about 1·2 p.c. was brought about; during the 15th hour about 0·2 p.c. Exposure to about 22° produced an increase in size, about 1·1 p.c. for each hour's exposure in the 4th hour; to 0·4 in the 14th; to 0·13 in the 46th; and to 0·01 in the 120th hour.

Exposure to a temperature of 26° during the first few hours of development produced a diminution of from 20·8 to 7·4 p.c., but in the later hours an increase of 4·3 to 11·0 p.c. The reaction of the organism to a constant environmental condition was thus a variable one. This is probably explicable by the fact that the temperatures necessary to kill the organisms, and presumably also those which cause an unfavourable effect on growth, rise steadily during development. Thus the death temperature is about 28·5° for unsegmented ova, 34° for blastulæ, and 40° for plutei. The impregnated ova were also found to be much more sensitive to changes in the salinity of the water during the early stages of development than during the later ones.

Accelerating Effect of Heat upon Growth.*— Prof. T. W. Galloway has experimented with developing ova of *Rana sylvestris*, *Amblystoma punctatum*, and *Bufo americana*, which were subjected to three different temperature conditions, but without other food than that contained in the egg and the surrounding albumen. He sought to discover whether the increased growth due to raised temperature is brought about by accelerated imbibition of water or by increased anabolic metabolism. So far as the results go, they point to the conclusion that it is chiefly the imbibitory process which is accelerated by heat.

Production of Double Embryos from Newt's Eggs.†—Dr. W. Tonkoff has done for the ova of *Triton tæniatus* what O. Schultze and G. Wetzel have done for frogs' eggs. The artificially fertilised ovum is placed in a drop of water on a glass plate, with glass bars of suitable thickness on each side; the animal pole comes as usual to the top; a covering plate, fixing the egg, is laid on; and the whole is turned through 180°, bringing the animal pole to the under side. In a variable number of cases this results in *duplicitas ventralis* or *lateralis*, as the author describes in detail.

Experimental Embryology.‡—Dr. G. Cutore finds that by varnishing the eggs of the common fowl, in whole or in part, it is possible to produce anomalies of development, especially as regards the central nervous system. He describes in detail the various malformations produced, compares them with similar appearances noted by various authors in incubated eggs, and assigns as a common cause the insufficient aeration of the eggs.

* Amer. Nat., xxxiv. (1900) pp. 949–57 (6 figs., 4 tables).
† SB. Preuss. Akad. Wiss., 1900, pp. 794–7 (1 fig.).
‡ Anat. Anzeig., xviii. (1900) pp. 391–414 (12 figs.).

Maturation and Fertilisation.*—Dr. P. Poljakoff, in the course of his studies on the biology of the cell, has directed his attention to the sexual elements of the much-investigated *Ascaris megalocephala*, and, as the result of his work on this and other forms, puts forward some new conclusions. He finds that the head of the spermatozoon consists chiefly of nucleolar substance, the middle piece contains the lininogen corpuscles, and both are surrounded by an envelope of linin substance, which also forms the tail when this is present. The germinal spot of the egg-nucleus is regarded by the author as a nucleolus (= nuclear corpuscle). He opposes the usual view that the chromatin is of supreme importance in fertilisation or cell-division, and regards the nucleolus (nuclear corpuscle) as the important central organ of the cell. To the linin substance he assigns the power of taking up nutritive substances from the surrounding medium, and believes that the phenomena of fertilisation, as well as of cell-division, can all be satisfactorily explained in terms of the cell-physiology, as the result of the nutritive processes within the cell. He re-describes these phenomena from this point of view, some parts of the descriptions, e.g. the emphasis laid on the differences as regards food-material between egg and sperm, following lines already made familiar by others.

Germinal Vesicle of Amphibian Eggs.†—The late Prof. J. B. Carnoy and H. Lebrun made a series of observations on the nuclei of the eggs of various Anura (species of *Bufo*, *Rana*, &c.), which are published by the latter author as the second part of a joint memoir on the general subject. In default of a general summary of results by the authors, details may be given for *Bufo vulgaris*. In it the nuclear coil of the oogonium disappears rapidly to form a number of primary nucleoli, which fuse to form a large nucleolus. This large nucleolus then breaks up (undergoes "resolution") with the production of "bottle-brush" and plumose figures in the caryoplasm, as well as of scattered secondary nucleoli. These nucleoli become vacuolated, and are resolved with the formation of rods and threads, which give the nucleus temporarily its original reticulated appearance. The resolution of the nucleoli is followed by the vacuolation of the nucleus, which gradually disappears. Of its nucleoli some eight or nine only are left; these become converted into the chromosomes at the time of the formation of the spindle. The chief points of contrast with the eggs of Urodela, no less than the minor differences occurring among the Anura, are in regard to the exact method in which the process of "resolution" is accomplished.

Pluriovular Follicles in the Rabbit.‡—Ch. Honoré has found in the same ovary a number of follicles containing more than one ovum. Cases where two, three, four, or even nine ova were present were seen. The general aspect of these follicles seems to the author to cast doubt upon Stoeckel's explanation that the phenomenon is due to division of an originally single ovum. The occurrence of so large a number as nine is in itself against the hypothesis, and further, the ova contained within one follicle were in such various stages of development as to

* Arch. Mikr. Anat., lvii. (1900) pp. 9–54 (3 pls.).
† La Cellule, xvii. (1900) pp. 201–65.
‡ Arch. Biol., xvii. (1900) pp. 489–97 (1 pl.)

make a common origin very doubtful. On the other hand, the author believes that the appearances are readily explained on the hypothesis that in Pflüger's tubes in the embryo the primordial ova, instead of being isolated with their follicular cells by the ingrowth of the connective-tissue, were left in groups round which the sheath of connective-tissue formed.

Peripheral Nervous System of Salmo salar.* — Dr. R. G. Harrison finds that in the development of the nerves of the salmon, the nerves clearly originate from single cells, there is no indication of the occurrence of chains of cells. The spinal ganglia arise from wandering cells which separate themselves from the medullary cord, and, migrating ventrally, arrange themselves in little clusters which form the ganglia. These are therefore not primitively metameric. For a long period the cell-clusters remain undifferentiated, the cells then become bipolar, and send one of their prolongations upward to the medullary cord. The medullary cord consists chiefly of epithelial cells with a central zone of "germ-cells" (His), and a peripheral zone of neuroblasts. The medullary canal arises by the fusion of intracellular vacuoles which arise within the central cells. Most of the neuroblasts become pear-shaped, and send out a long process which forms a nerve-fibre. The "posterior cells" (giant-cells of Rohon) arise in the dorsal part of the cord, give rise to one or two prolongations, and migrate towards the centre of the cord, the prolongations remaining in the original position. Of these prolongations or fibrils certain become metameric peripheral nerves, the majority are confined to the cord. The posterior cells degenerate as the yolk-sac disappears, and are to be regarded as the homologues of the spinal ganglion-cells, which in the later stages of development take over their functions. They are to be compared with the "transient ganglion-cells" of Beard in *Raia*.

Development of Peripheral Nerves.†—Prof. F. Raffaele has studied the structure of the nerves in embryos of *Lophius* and in larval Amphibians. He finds that the evidence clearly points to their origin from a chain of cells united by their extremities, or perhaps rather from continuous protoplasm in which the cells are represented by their nuclei. He figures the developing nerves showing the nuclei imbedded in the protoplasm. Elongation of the nerves is produced by the mitotic division of the nuclei, followed by an increase in length of the cells. A striking figure shows the bifurcation of a developing nerve; in it the products of nuclear division lie side by side instead of end to end, and the protoplasm has split into two threads.

Development of Sympathetic System.‡—Dr. C. K. Hoffmann has investigated the development of this system in *Acanthias vulgaris*, as a type of Selachians. Like Balfour and Van Wyhe, he finds that the sympathetic ganglia originate as little swellings on the rami ventrales of the spinal nerves. These swellings become differentiated into two parts, of which the one consists of large nerve-cells and forms the sympathetic ganglion proper; while the other and larger part, which

* Arch. Mikr. Anat., lvii. (1901) pp. 354–444 (3 pls. and 7 figs.).
† Anat. Anzeig., xviii. (1900) pp. 337–44 (11 figs.).
‡ Verh. K. Akad. Wet. Amsterdam, vii. (1900) pp. 1–80 (3 pls.).

consists of "chromaffine" cells, forms with its fellows the supra-renal body. Of the ganglia as first formed, the first five (I-V) disappear during the early stages of development; the next ten or eleven (VI-XV or XVI) fuse to form one large ganglion, with simultaneous degeneration of the first five of them (VI-X). From the fifteenth or sixteenth ganglion onwards, the ganglia persist as definite structures. In regard to the question of the existence of a sympathetic nervous system in the head, the author points out that a difficulty in the comparison of cranial and spinal nerves seems to lie in the non-applicability of Bell's law to the former. He suggests that an explanation of this apparent anomaly may be found in the supposition that the cranial nerves, no less than the spinal, have arisen by the union of sensory and motor elements; but while in the latter case the union takes place *outside* the central nervous system, in the former it takes place within. In consequence, the large peripheral ganglia of the dorsal cranial nerves must be supposed to contain sympathetic elements, and the nerves must contain sensory, motor, and sympathetic elements. Where, as in the higher Vertebrates, special "sympathetic" ganglia exist in the head, the ganglia must contain cerebro-spinal in addition to sympathetic elements. In Selachians the interrenal organ arises in connection with the tubules of the mesonephros, and is thus contrasted with the suprarenal; but the author is not perfectly convinced that it can be regarded as completely homologous with the cortical part of the adrenal of Birds and Reptiles. In Selachians the interrenal arises entirely behind the developing genital organ; in Birds and Reptiles the cortical part of the adrenal has a close relation to the genital organ; a distinction to which considerable importance is attached.

Post-Larval Changes in Vertebral Articulations in Salamanders.*—J. Percy Moore notes that in *Spelerpes ruber*, for instance, the vertebræ are both osteologically and physiologically amphicœlous during late larval life and for a time after the metamorphosis; that during the prime of life they are still amphicœlous as far as the strictly bony portions of the centra are concerned; but if, as seems more logical, the cartilaginous structures also are considered, they cannot be characterised otherwise than as opisthocœlous; and that in old age they are opisthocœlous. There is thus a progress throughout life from a primitive to a more specialised type. Similar changes occur in *Desmognathus fusca* and other forms.

Development of Teleostean Vertebral Column †—S. Ussow contrasts the Teleostean vertebral column with that of Selachians and Holostei. In Selachians the vertebra arises entirely at the expense of the cartilaginous elements of the bases of the arches, the fibrous sheath of the notochord serving as the locus of development. In Holostei it developes similarly from the cartilaginous elements of the arches, and also at the expense of the intercalaria and an independent ossification of the perichordal connective-tissue, which unites the arch-bases with the intercalaria, and covers with a bony layer the peripheral portions of the fibrous notochordal-sheath in the parts free from the cartilage of the arch-bases. Thus the vertebra rises not in, but over and

* Proc. Acad. Nat. Sci. Philadelphia, 1900, pp. 613–22.
† Bull. Soc. Imp. Nat. Moscou, 1900, pp. 175–240 (4 pls.).

around, the fibrous notochordal-sheath, and the notochord atrophies early, playing little part in the formation of a vertebra. In Teleostei (*Gasterosteus*, *Leptocephalus*, *Cyclopterus*, &c.), the vertebra developes outside the notochordal-sheaths, exclusively at the expense of the cells of the perichordal connective-tissue. The cartilaginous arch-bases are in the majority of cases passive, whilst the notochord and its sheaths are more important, especially in the inter-vertebral spaces. In short, the vertebra of Teleostei is a specialised form of the vertebra of Holostei. But this is only a suggestion of the author's main results.

Ear-Bones of Opossum.*—R. Weil finds in a study of *Didelphys murina* confirmation of the conclusion that the malleus is a derivative of the mandibular arch, and that the incus is likewise. The continuity of incus and malleus is clear, and it is plain that the incus has absolutely no relation with the hyoid arch.

Two Hearts in a Pigeon.†—C. I. Constantinescu gives a description of a rare abnormality—two complete and normally formed four-chambered hearts in a pigeon. The larger was ventral, the smaller dorsal; there was no communication between them; there were abnormalities in the arterial trunks and veins, but the heart had been cut out before the author got it. There must have been a complete duplicity in the development of the primitive cardiac tubes. A few—somewhat vaguely recorded—analogous cases are referred to.

Origin of Lymphoid Elements of the Thymus in Teleosts.‡—Prof. J. Nusbaum and Th. Prymak find that in *Salmo fario* and *Carassius vulgaris* large numbers of lymphoid elements ("lymphoid nuclei"), which are to be observed in the earliest stages of the thymus, originate from the (endodermic) epithelium of the pharyngeal mucous membrane in the branchial region—a conclusion of importance. It seems to the authors that this is the real source of the lymphoid elements of the thymus. In later stages they also observed a marked migration of leucocytes from the thymus into the surrounding tissue—a fact of importance in connection with the functional rôle of the thymus in fishes, and in accordance with Dr. Beard's results as to Selachians.

Pseudobranch of Amia calva.§—Mr. E. P. Allis has made a detailed study of the pseudobranchial circulation in embryos of this Ganoid. He finds that the nature of the blood-supply shows that the pseudobranch is the homologue of the spiracular demibranch of Selachians. There is some uncertainty as to whether it belongs to the mandibular or the hyoidean arch, though the comparison with Selachians suggests the former arch as the region of origin.

b. Histology.

Histological Study of Crystals.‖—Prof. O. Bütschli has already extended his detection of alveolar structure from cytoplasm to sub-

* Ann. New York Acad. Sci., xii. (1899-1900) pp. 103-7 (2 pls.).
† Bull. Soc. Sci. Bucarest, ix. (1900) pp. 403-5.
‡ Anat. Anzeig., xix. (1901) pp. 6-19 (4 figs.).
§ Zool. Jahrb., xiv. (1900) pp. 107-34 (1 pl.).
‖ 'Untersuchungen über Mikrostrukturen des erstarrten Schwefels, etc.,' Leipzig, 1900, 4to, 96 pp., 4 pls., 6 figs. See Amer. Nat., xxxiv. (1900) p. 976.

stances like starch, cellulose, and chitin; and he finds hints of it in crystals of sulphur and of certain salts. In the forming crystal he also finds radial lines proceeding from a centre, structurally like the radiations of asters, both being due to a central pull exerted on an alveolar structure. The work is of biological interest, not only in regard to the point here noted, but for the discussion of the growth and polymorphism of crystals, and the determination of the polymorphic form by external conditions.

Intestinal Mucous Membrane of Lota vulgaris.*—Profs. E. Yung and O. Fuhrmann note several important features in the intestine of *Lota*. Comparing the distribution and structure of the elements of the mucous membrane with those in *Scyllium*, they observe:—(1) The buccal cavity contains distinctly fewer goblet-cells, while on the other hand there are many "sacciform glands" which have no homologue in the dog-fish. (2) The œsophagus has the same structure as the mouth. It is completely devoid of ciliated epithelium, which is abundant in *Scyllium*. This region is therefore not homologous in these two types of fish. (3) The peptic glands of the stomach, uniformly tubular and covered with pepsin-cells in the two types, are in *Lota* grouped into sets of tubes opening into a common neck, while in *Scyllium* they are simple and uniformly distributed in the mucous membrane. (4) The intestine is characterised by the presence of solid glands (*glandes pleines*) over its whole extent. These glands are wanting in *Scyllium*. (5) The stratified pavement epithelium resembles that of the buccal cavity. In *Scyllium* it covers the whole of the cloacal region, while in *Lota* it is limited to the edge of the anus. The last portion is thus not a cloaca, and although separated from the middle part of the intestine by a valve, yet undoubtedly belongs to it.

Alimentary Canal of Birds.†—Dr. K. E. Schreiner has investigated the minute characters of the œsophagus and stomach in a number of families of birds. He finds that while in *Larus* the œsophageal glands are of great simplicity, those of the duck are of a complicated character. But he has been able to draw up a list of transitional forms, and finds further that the difference between the glands of a reptile such as *Testudo* and those of *Larus*, is hardly greater than that between *Larus* and the duck. In regard to the stomach, the point of most interest is the relation of the so-called "blind-sacs" of the proventriculus to the compound glands of that region, and to the glands of the gizzard. As in some birds (e.g. *Uria*, *Tringa*) the blind-sacs possess cells similar to the secretory cells of the compound glands, the author concludes that sacs and glands have a common origin in the simple tubular glands of reptiles, and have both arisen as the result of a concentration of glandular surface, rendered necessary by the division of the stomach into two parts. This conclusion is supported by the comparative morphology of the blind-sacs in the different families of birds. It is probable that the glands of the gizzard are the homologues of these proventricular blind-sacs, but this is not quite certain. This paper includes a descrip-

* Arch. Zool. Expér., viii. (1900) pp. 333–51 (2 pls.).
† Zeitschr. wiss. Zool., lxviii. (1900) pp. 481–581 (6 pls. and 11 figs.).

tion of the musculature and connective-tissues of the gut in the families of birds studied.

Micro-Chemistry of Nerve-cells.* — Mr. F. H. Scott supports the view that all iron-holding nuclein compounds are derived from pre-existing ones, and that in mitosis all the iron-holding substance of the cell is in the nuclear chromatin. The Nissl granules are morphological elements of the nerve-cell, of a nucleo-proteid nature, containing "masked" iron and organic phosphorus, and are derived from the nuclear chromatin of the germinating cells. The nucleolus of the nerve-cell has an oxyphile centre with a basophile covering. The latter seems to correspond to the original kinetic chromatin of the germinal cells, and, like the oxyphile nuclear substance, contains iron and phosphorus. All the three nuclein compounds of the adult nerve-cell are derived from the mitotic chromatin of the primitive nerve-cell. It follows that the Nissl granules are constituted of chromatin that has diffused from the nucleus into the cytoplasm.

Relation of Nerves to Muscle.†—Dr. Chr. Sihler has studied this question in the frog, and finds that the terminal fibrils of the motor nerves lie upon the sarcolemma, and are invested by Schwann's sheath and by nuclei up to their ends. Whether or not these membranes actually separate the nerve and muscle substance at the points of contact, is still undetermined, but the author considers that more stress should be laid on these points of contact than on the nerve-endings. In the frog, and in certain muscle-fibrils in the snake, Henle's sheath is open and fuses with nothing, whereas in the typical end-plate it covers the terminal fibrils like a cap. In the frog there is no "sole," so that this structure can form no necessary part of the stimulating apparatus of the muscle. The "sole" substance when present must be regarded as the protoplasm of the endothelial cells forming the terminal swelling of Henle's sheath ; the nuclei of the end-plate belong partly to these cells, partly to the terminal part of Schwann's sheath. In unstriped muscles there are no end-plates, but merely a terminal network of nerve-fibrils. In connection with the capillaries in the frog there is an even richer supply of nerve-fibrils than in the muscular tissue, the fibrils ending as in unstriped muscle. Their function is complex, for they are connected both with the sensory nerves and with the nerves which surround the arteries and veins, and so influence the capillaries as to produce an increased transudation of lymph, and not a mere widening of the lumen. This active change in the walls of the capillaries the author compares to the contraction of muscle.

Histology of the Blood.‡ — Profs. P. Ehrlich and A. Lazarus have made a very important contribution to hæmatology in this treatise on the cellular elements of the blood in health and disease. That lymphocytes and leucocytes are quite distinct types of white blood-corpuscles; that the cell-granules are of great importance ; that chemiotaxis plays an important part in the emigration of cellular elements from marrow to

* Trans. Canadian Inst., vi. (1899) pp. 405–38 (1 pl.).

† Zeitschr. wiss. Zool., lxviii. (1900) pp. 323–78 (2 pls.).

‡ 'Histology of the Blood : Normal and Pathological.' Edited and translated by W. Myers. Cambridge. 1900, 8vo, xii. and 216 pp.

blood and from blood to tissue, are three characteristic theses of what some experts have already called an epoch-making book.

Blood of Rabbit.*—Dr. N. Tschistowitsch and Dr. W. Piwowarow have studied the morphology of the blood in embryos and new-born young of the rabbit. They find that the following kinds of leucocytes occur:—(1) Polynuclear leucocytes, with nuclei which appear to be intermediate between those of neutrophilous and eosinophilous leucocytes in man; (2) large polynucleated leucocytes with non-granular protoplasm, which form a transition to (3) large, mononuclear leucocytes with large oval nuclei; (4) lymphocytes, small leucocytes with rounded nuclei. The total number of leucocytes was always small. In both embryos and new-born young, many nucleated erythrocytes occurred. The paucity of leucocytes in fœtal blood the authors explain as due to the peculiar method of life, the maternal leucocytes acting as a means of protection against the risk of attack by micro-organisms. After birth the leucocytes rapidly increase in number.

Nomenclature of Connective-Tissue Elements.†—Prof. W. Waldeyer considers that all the following—connective-tissue proper, elastic tissue, mucoid tissue, cartilage, bone, dentine, pigmented connective-tissue, adipose tissue, and lymphoid tissue—should be classed as "ground-substance tissues." All possess (1) "ground-substance cells"; (2) "inter-cellular substance," which usually consists of basophilous amorphous ground-substance, and scattered ground-fibrillæ, which do not form bundles and are often invisible in fresh preparations; (3) "intercellular fibrillæ," differing from the above in that they are visible in fresh preparations, and are of various kinds, such as elastic fibrillæ, white fibrillæ, and so on.

Fat Absorption.‡—Prof. Julius Arnold finds that when fatty substances are introduced into the dorsal lymph-sac of the frog, or beneath the skin of the back in the guinea-pig, the wandering cell may take up the particles of fat by a phagocytic process. The cells then display droplets of fat lying between the structural elements of the cell. It is otherwise with the fatty granular cells which also make their appearance. In them the fat is contained in granules which originate from the modified plasmosomes of the cell. That these fatty granules are modified plasmosomes is shown clearly by their position in the cell and their relation to the cell-constituents, no less than by their staining reactions. It is not impossible that fat absorbed by a phagocytic process may be capable of conversion into granular fat.

Glands of the Eye.§—Dr. A. Alt has endeavoured to remove some of the vagueness which he finds in previous descriptions of the glandular structures appertaining to the human eye and its appendages. He describes the orbital, palpebral, and conjunctival lachrymal glands, those situated in the tarsal tissue of the eyelids, those in the tissue of the lid margin, those in the caruncula lachrymalis, and the lachrymal drainage apparatus. The paper is profusely illustrated by photographs.

* Arch. Mikr. Anat., lvii. (1901) pp. 335–45. † Tom. cit., pp. 1–8.
‡ Anat. Anzeig., xviii. (1900) pp. 385–91.
§ Trans. Acad. Sci. St. Louis, x. (1900) pp. 185–207 (36 pls.).

Artificially induced Mitosis.*—Mr. A. P. Matthews has succeeded in setting up cell-division in unfertilised sea-urchin (*Arbacia*) eggs, by depriving the eggs of oxygen, by the action of heat, and by subjecting them to the influence of ether, alcohol, and chloroform.

His theory is the following. All the methods thus far found for inducing cells to divide are the methods in common use for causing protoplasm to liquefy. As Bütschli said long ago, the karyokinetic figure itself is but the expression of the movement of liquid in the cell. In short, localised liquefaction induces karyokinesis.

"The question naturally arises here whether these several agencies set up liquefaction by direct action themselves, or whether they interfere in some way with the respiration of the cell, leading thereby to the production of a liquefying enzyme, the centrosome. The general phenomena of division strongly suggest a digestion of certain cellular structures, the nuclear wall, nucleolus, yolk, and certain chromatin constituents."

c. General.

Index of Vitality.†—Dr. A. D. Waller explains in a very interesting communication that it is possible to find what we may call an electrical index of vitality—the "blaze" reaction. His best results are with the eggs of the hen. Whenever "life" is—let us say, whenever metabolism is—in operation, there is this "blaze" reaction, which is absent in conditions of latency or mere potentiality.

Growth of Biology in the Nineteenth Century.‡—Prof. O. Hertwig discusses the biological progress of the past century in his usual clear and interesting way. The doctrine of the cell, the study of micro-organisms, the theory of evolution, the experimental method in physiology and embryology, the position of biology among the sciences, and the outlook on unsolved problems, are the chief topics of the lecture.

Fauna of Black Sea.§—Sir John Murray, in an interesting paper on the deposits of the Black Sea, has some notes on the Fauna. In the denser water there are forms derived from the Mediterranean, through the Sea of Marmora and the Bosphorus, but the lower salinity, the more rigorous temperature, and the presence at a moderate depth of a cold layer, have proved obstacles to abundant migration. Some relics of the glacial epoch, now rare or absent in the Mediterranean, flourish in the Black Sea, e.g. *Modiola phaseolina*. Among the shells on the *Modiola*-mud (35–100 fathoms) there may be found simple Ascidians, two little Ophiuroids, a small *Synapta*, a few Annelids, *Cerianthus vestitus*, &c. Below this zone is the domain of hydrosulphuric bacteria. At the mouths of the rivers or "limans" the Mediterranean elements are less numerous, giving place to forms identical or closely allied to those of the Caspian Sea, relics of a pliocene brackish-water fauna.

Alleged Effect of Lecithin on Growth.‖—Dr. Eugène Wildiers has experimented on tadpoles, chickens, and dogs, and finds that there is no

* Journ. Boston Soc. Med. Sci., v. (1900) pp. 13–7.
† Comptes Rendus, cxxxi. (1900) pp. 1173–6.
‡ 'Die Entwicklung d. Biologie im 19. Jahrhundert,' Jena, 1900, 31 pp.
§ Scot. Geogr. Journ., xvi. (1900) pp. 673–702.
‖ La Cellule, xvii. (1900) pp. 383–407 (1 pl.).

foundation for the statement made by Danilewsky that lecithin has a marked effect in accelerating growth. When the experiments are performed with sufficient care, it is seen that lecithin has no appreciable effect whatever on growing animals.

Occipital Condyles and the Origin of Mammals.* — Prof. H. F. Osborn favours the view that Mammalia may have arisen from some unknown member of the Anomodont or Theriodont reptile stock. His present contribution relates to the condyles, four types of which are recognised:—(1) typical monocondylic, in which the exoccipitals have no share; (2) tripartite monocondylic, in which the exoccipitals share; (3) transitional dicondylic, chiefly exoccipital but partly basioccipital; and (4) typical dicondylic, in which the basioccipital element is cartilaginous or reduced in the median line. His conclusions are:—(*a*) unlike reptiles, no mammals have the basioccipital projecting backwards as far as the exoccipitals; (*b*) nevertheless the participation of the basioccipital in the condylar articulation is a common feature, and the Monotremes present some grounds for considering this a primitive mammalian feature; (*c*) the weight of evidence is in favour of derivation from a tripartite type with a depressed basioccipital. The reptilian tripartite origin is more probable than the amphibian dicondylic origin.

Papillary Lines on the Foot.†—Dr. Ch. Féré has made a study of these in imbecile, epileptic, insane, and paralytic subjects, confirming his conclusion ‡ (in regard to the hand) that the figures are originally related to movements of the skin rather than to pressure, and that they are congenital characteristics practically invariable in the life of the individual, but differing in each particular case.

Claws on Birds' Hands.§—E. Regalia gives lists showing the occurrence of claws:—59 forms have a claw on digit I., 10 have a claw on digit II., and 72 have claws on both I. and II.

Change of Colour and Moult in Birds.‖ — Jonathan Dwight, jun., has made an elaborate investigation of the Passerine birds of New York, in order to solve the problem whether, as many believe, change of colour can take place without moult. He finds that "every feather developes with a definite colour and pattern, which it retains, modified only by wear, until the next moult." This has hitherto been doubted only because the subject of moult has not been adequately studied. When a sufficient series of birds of known age and sex is studied, it becomes obvious that every species has a definite series of plumages and moults, that the moults—the seasons of periodical feather-growth—may be complete or incomplete, and that they are modified by age, sex, and even by individual variation. All cases of apparent colour change not explained in this way are due to wear, i.e. to passive destructive changes.

Flightless Birds.¶—Dr. J. Wigglesworth took this as the subject of his inaugural address to the Liverpool Biological Society, and divides

* Amer. Nat., xxxiv. (1900) pp. 943-7 (3 figs.).
† Journ. de l'Anat. Physiol., xxxvi. (1900) pp. 602–18 (18 figs.).
‡ Tom. cit., pp. 376–92 (14 figs.).
§ Atti Soc. Tosc. Sci. Nat., xii. (1900) pp. 111–27.
‖ Ann. New York Acad. Sci., xiii. (1900) pp. 73–160 (7 pls.).
¶ Trans. Liverpool Biol. Soc., xiv. (1900) pp. 1–33.

such birds into three sets:—(1) the Ratitæ, where the posterior limbs have become greatly developed, (*a*) for aquatic progression (*Hesperornis*), or (*b*) for terrestrial progression (ostrich, &c.); (2) birds in which the fore-limbs, though useless for flight, are important agents in aquatic progression (penguins); (3) birds like *Didus* and *Stringops*, which appear to possess no compensatory advantage for the loss of functional fore-limbs, and are apparently degenerate. Examples of each of these three sets are described by the author, who also discusses their probable origin and relations.

INVERTEBRATA.

Limnoplankton of Russia.*—R. Minkiewicz describes various new Protozoa and Rotatoria found by him in Lake Bologoië and Lake Glubokoië. In regard to the specimens of *Difflugia* in the lakes—previously described by him as *D. planctonica* sp. n.—he now finds that there is considerable individual variation. This fact leads him to the conclusion that all the plankton "species" are to be regarded as varieties of *D. lobostoma*, the varieties being the result of the varying environmental conditions in the different lakes.

Potamoplankton of the Volga.†—W. Zykoff gives a brief list of Microphyta, Protozoa, Rotatoria, and Crustacea found by him in the Volga at Saratow. As indicated by the list, the Volga plankton has a generally West European character.

The author further notes ‡ that during his investigations he found *Plagiostoma lemani* var. *quadrioculata* in mud at the bottom of the river. This Turbellarian has not hitherto been described in Russia, and further, is rather a lake than a river form.

"Sapropelic" Fauna.§—Dr. R. Lauterborn uses the term "*sapropelische*" to denote the organisms found in the muddy debris covering the bottom of stagnant fresh-water pools. The stuff consists largely of vegetable remains, abounds in species of *Oscillatoria* and bacteria, and in its black under layers smells strongly of sulphuretted hydrogen. Rhizopods are represented by *Pelomyxa palustris*, *Pamphagus armatus* sp. n., &c.; Flagellates include *Mastigamœba trichophorum* sp. n.; the Volvocine *Spondylomorum quaternarium* is also characteristic. It may be said that the Infusorian fauna is well defined. Rotifers are scarce, but Gastrotricha abound. The author describes *Pelamphora bütschlii* g. et sp. n., *Dactylochlamys pisciformis* g. et sp. n., and a number of new species.

Northumberland Marine Investigations.‖—Alexander Meek, who edits this report, describes the results of some trawling excursions, gives statistics of the numbers and sizes of fishes caught at different times, discusses the food and the time of maturity of various flat-fishes, states the results of experiments on "waste ova," and so on. Prof. G. S. Brady discusses the marine microfauna as a source of food supply. Mr. Meek has also faunistic notes on the Mysidæ of Cullercoats and the Cumacea of Northumberland, and Mr. G. P. Bulman adds to his list of marine molluscs of Northumberland.

* Zool. Anzeig., xxiii. (1900) pp. 618–23 (18 figs.). † Tom. cit., pp. 625–7.
‡ Tom. cit., pp. 634–5. § Op. cit., xxiv. (1901) pp. 50–5.
‖ Northumberland Sea Fisheries Committee, Rep. Scient. Investigations for 1900, 82 pp.

Tunicata.

Molgula ampulloides.*—Marc de Selys-Longchamps and D. Damas have studied the anatomy and post-embryonic development of the branchial sac in this Tunicate, and have also noted the relations of some organs, e.g. the genitalia, in larva and adult. The youngest specimens obtainable were already fixed, and had two pairs of protostigmata; from this stage onwards the development of the branchial sac takes place in regular order from before backwards. The next stage possessed three pairs of protostigmata, which then, by the formation of horse-shoe-shaped partitions, give rise to six pairs of secondary protostigmata. The early or primary protostigmata, the authors believe to be formed by independent perforations of the wall, and not to arise from one another. As each of the six secondary protostigmata gives rise by division to new stigmata, the innumerable stigmata of the adult may be conveniently arranged in six series, each series having arisen from one of the secondary protostigmata. The origin of these series is then described in detail.

In their examination of the adult, the authors have made out a spherical corpuscle in the sub-neural gland, which appears to be the persistent remains of a larval organ, apparently homologous with the cerebral vesicle of other larval Tunicates. In regard to the development of the genital organs, the most salient features are, the absence of a duct morphologically equivalent to the vas deferens of other Tunicates, and the absence of bilateral symmetry in the germinal epithelium.

Development of Ciona intestinalis.†—Marc de Selys-Longchamps has studied the development of the heart, the pericardium, and the epicardia in this form, in order to settle the points at dispute between Willey and Julin. He finds with Willey that the first rudiment of the cardio-pericardial organ appears at a time when the mesoderm has invaded the space between ectoderm and endoderm, but he is not able to definitely decide the question as to its layer of origin. The rudiment consists of two vesicles and is paired from the first. The vesicles unite so as to present the appearance of a vesicle divided by a double-walled septum. Towards the end of metamorphosis, the two layers separate, the resulting cavity forming the heart. The cavities of the two original vesicles form the pericardium, and the epicardia have thus nothing to do with the origin of the heart. The latter do not arise until the fixed Ascidian has undergone a considerable part of its development, while the cardio-pericardial organ originates in the tailed larva. The author thus strongly dissents from Julin's statements as to the common origin of pericardium and epicardium.

Structure of Ascidia.‡—Prof. W. A. Herdman publishes an exceedingly clear description of a simple Ascidian, with a brief account of the development, and a summary classification. Though professedly based on previous researches by the author and others, and therefore not

* Arch. Biol., xvii. (1900) pp. 385–488 (3 pls. and 2 figs.).
† Tom. cit., pp. 499–542 (1 pl.).
‡ Trans. Liverpool Biol. Soc., xiv. (1900) pp. 34–88 (3 pls.). Also published separately as Memoir I. of Liverpool Marine Biology Committee.

containing novel results, it is worthy of special notice as a simple and comprehensive account of Tunicate anatomy.

New Tunicates from the Clyde.*—Dr. James Rankin makes a preliminary report on the Tunicata of Millport and neighbourhood. His list includes *Fritillaria gracilis* sp. n., *Glossophorum variabile* sp. n., and *Psammaplidium molle* sp. n.

Mollusca.

α. Cephalopoda.

Experiments on Eggs of Squid.† — Wl. Schimkewitsch, in an appendix to his recent paper on the eggs of *Loligo*, amplifies his previous statements as to *intra vitam* coloration with methylen-blue. He finds that the staining of the cells is not due to the staining of chromatin granules, but to the presence in the cells of what appear to be coloured particles of yolk, which have apparently undergone a process of metamorphosis under the influence of the nucleus. Ordinary yolk stains only feebly, but these particles become intensely blue. They are present in the cells of the embryo until almost the last stages of development, persisting longest in certain special regions, e.g. in the ventral epithelium. They are most abundant in cells which are about to give rise to the rudiment of an organ, and therefore afford a means of tracing the first origin of the different organs. Their presence in such cells is to be correlated with the increased metabolism of the cells.

γ. Gastropoda.

Phylacites of Hyalina.‡—Émile André under this name describes certain structures, apparently of defensive nature, which occur in the skin of the species of this genus, and present certain analogies to nematocysts. When still inclosed in the parent-cell (phylacoblast), a phylacite is a rounded transparent body inclosing a vesicle within which lie 3–20 refracting spherules. After expulsion it appears somewhat mushroom-shaped, and is inverted so that the vesicle bearing the spherules at its tip is protruded at the surface. The phylacoblasts are at first similar to ordinary connective-tissue cells; but when the phylacite is completely developed, they have lost both nucleus and protoplasm. From the staining reactions it is clear that the phylacites are not composed of mucus, but their chemical composition, no less than their exact function, remains obscure.

δ. Lamellibranchiata.

Structure of Cardium edule.§ — J. Johnstone publishes a comprehensive and fully illustrated account of the structure and habits of the edible cockle, with special reference to its occurrence in Lancashire.

Eyes of Mollusca.‖—Dr. Richard Hesse has made a series of observations on the eyes of certain Lamellibranchs (*Arca*, *Lima*, *Pecten*), on

* Communications Millport Station, i. (1900) pp. 42–53.

† Zeitschr. wiss. Zool., lxviii. (1900) pp. 478–9. Cf. this Journal, 1900, p. 36.

‡ Rev. Suisse Zool., viii. (1900) pp. 425–33 (1 pl.).

§ Trans. Liverpool Biol. Soc., xiv. (1900) pp. 178–261 (6 pls.). Also published as Memoir II. of Liverpool Marine Biology Committee.

‖ Zeitschr. wiss. Zool., lxviii. (1900) pp. 379–477 (8 pls. and 1 fig.).

those of certain Heteropoda, and on the retina in Cephalopoda. The compound eyes of *Arca* the author considers to be without parallel among other Mollusca, though he is of opinion that the remarkable receptive cells—the retinophoræ of Patten—may occur among such Mollusca as are known to be sensitive to light, although "eyes" have not been described. The eyes have a striking resemblance to those of the worm *Branchiomma*. In certain species of *Lima* there occur pigmented epithelial pits, which resemble the eyes of *Patella*, and are to be regarded as "eyes"—that is, as organs for the reception of light. In the much-investigated eyes of *Pecten* the author figures some remarkable structures in the cells of the lens. These cells contain a very distinct central corpuscle, with a system of radii, extending to the periphery of the cell. Their function the author believes to be to increase the contractility of the lens. In addition there is an arrangement of fibrils which appear to alter the shape of the lens, and so accommodate the eye to different distances. Many new details are also given as to the structure of the different parts of the eye. In regard to the Heteropoda, it is found that there is considerable uniformity in the structure of the eyes. The most notable variation is in regard to the presence or absence of one or more gaps in the pigmentation of the choroid. These pigment-free "windows" are always associated with the development of accessory receptive-cells, which receive the light entering through the gaps. The structure of the receptive-cells suggests to the author the idea that the rhabdom of the Arthropod eye may have arisen from the fusion of the striated margins of receptive-cells such as occur in many Mollusca.

Cruciform Muscle of Tellinacea.* — H. von Ihering finds that all members of the Tellinacea have at the base of the siphons in the connected ventral parts of the margins of the mantle a singular muscle, formed by two crossing muscles which are inserted in the valves in the region of the angle formed by the mantle-impression and the sinus, or between it and the borders of the shell. One of the two branches perforates the other, both being united into a cross-shaped muscle, which functionally may serve as a secondary adductor. Evidently this cruciform muscle is a special development of fibres of the mantle-edge which have been isolated only secondarily from these margins, and this, according to the author, was the origin of the adductor-muscles as well.

Arthropoda.

α. Insecta.

Morphology of Insect's Head.† — M. Charles Janet has made a most careful study of this difficult subject, with especial reference to *Myrmica rubra* and *Vespa crabro*. The criteria as to number of somites are to be found in the development, in the suture-lines, in the articulating membranes of the chitinous pieces, in the nervous system, and especially, perhaps, in the musculature. It is not difficult to distinguish six divisions—the acron, the antennary segment, the post-antennary (in-

* Proc. Acad. Nat. Sci. Philadelphia, 1900, pp. 480–1 (2 figs.).

† 'Essai sur la constitution morphologique de la tête de l'Insecte,' Paris, 1899, 74 pp., 7 pls. See Zool. Centralbl., vii. (1900) pp. 800–4.

tercalary) segment, and the mandibular, maxillary, and labial segments; but Janet raises the total to nine by analysing the acron into four somites.

Mouth-parts of Insects.*—J. W. Folsom has studied the development of the mouth-appendages of *Anurida maritima*, a member of the Collembola, with a view especially of determining the homologies of these structures in the different Arthropods. He finds that the antennæ of Hexapoda are equivalent to the antennules of Crustacea and to the embryonic præantennæ of Chilopoda. In the embryo of *Anurida* and the adults of certain Apterygota, rudimentary premandibular appendages occur, which represent the second antennæ of Decapod Crustacea, and probably the antennæ of Diplopoda and Chilopoda. They belong to an intercalary segment which, from its distinct ganglion, must be regarded as one of the primary head-segments. The hypopharynx in Apterygota consists of two superlinguæ and a lingua which originates independently. The superlinguæ correspond to a distinct segment, and are the homologues of the first maxillæ of Malacostraca and Chilopoda, while the maxillæ in Insects are the homologues of the second maxillæ in these groups. In *Anurida* the labium developes essentially as in Pterygota, and is homologous with the first maxillipeds of Crustacea. In consequence, including the ocular, intercalary, and superlingual segments, the author finds that the head in *Anurida* consists of seven segments, as it probably does in all Insects.

Œnocytes of Insects.†—Sig. Enrico Verson points out that Koschevnikow, in his recent (1900) paper on these cells in the hive-bee, has overlooked Verson's earlier work on the similar cells in *Bombyx mori*. The "hypostigmatic gland-cells" of Verson are identical with the "larval œnocytes" of Koschevnikow, his "epigastric gland-cells" with the "imaginal œnocytes" of the latter. As common characters the two kinds of cells have (1) their origin from the hypodermis, and (2) the fact that both produce a visible secretion. They differ from one another, apart from the primary difference in size and position :—(1) in the time of appearance, the hypostigmatic glands appearing in the egg and the epigastric at the time of pupation; (2) in that while the former do not increase in extra-ovular life, the latter multiply by amitotic division during pupation; (3) in the shape of the nuclei, those of hypostigmatic cells being branched and those of the epigastric rounded. These conclusions are compared with Koschevnikow's statements as to the origin and relations of the two kinds of cell.

Structure of Ocelli.‡—W. Redikorzew has studied the ocelli in the larvæ and imagines of a number of insects, and finds that, according to their position on the vertex or on sides of the head, they may be divided into two sets. The difference in position corresponds to a difference in structure; for while the lateral eyes contain few cells and are of relatively simple structure, those on the vertex are much more complex. A complexity of considerable importance is that in the latter ocelli the retina cells are united in groups of two, three, or more, each group forming a retinula which is furnished with a typical rhabdom. This

* Bull. Mus. Comp. Zool. Harvard, xxxvi. (1900) pp. 87–157 (8 pls.).

† Zool. Anzeig., xxiii. (1900) pp. 657–61.

‡ Zeitschr. wiss. Zool., lxviii. (1900) pp. 581–624 (2 pls. and 7 figs.).

is important, because it is often stated that the presence of retinulæ sharply differentiates ocelli from compound eyes; but, though absent from lateral ocelli, they are unquestionably present in the median type. To the statement that lateral ocelli are of simple structure, those of the larvæ of the Tenthredinidæ forming a striking exception. In them the lateral ocelli of the larvæ are of complex structure, with retinulæ composed of four cells and a typical four-partite rhabdom. The development of ocelli was studied by the author in *Apis mellifica*. The first indication of the developing ocellus is a thickening of the epidermis, followed by a separation of the cells in the thickened area into two layers. Of these the distal layer forms the crystalline-cone layer, the proximal the retinal layer. As the cells proliferate the epidermis shows an insinking over the developing ocellus. Next there occurs a remarkable separation of the ocellus from the epidermis, which appears to be due to traction exerted by the optic nerve, and results in the withdrawal of the ocellus into the interior of the head. Later, the ocellus again unites with the epidermis, the cells of the latter fusing with the crystalline-cone layer, and forming the so-called iris, as well as probably a part of the lens.

Simple Eyes of Insects.*—Dr. Richard Hesse, in a preliminary note, states that these can be divided into two groups. First, those without crystalline-cone, without axone or with polyaxonic arrangement of the nerve end-organs; to this group belong the ocelli of all imagines and of a few larvæ. Second, those with crystalline-cone, without axone or with monaxonic arrangement of the nerve end-organs; such are the ocelli of the larva of *Myrmeleo*, of caterpillars, and of some other larval forms. In the first group the receptive organs show some variation in structure; they are simplest in *Helophilus*; in *Vespa*, *Apis*, and some others rhabdoms are present just as in the compound eyes, each rhabdom consisting of two rhabdomeres in bee and wasp, of four in *Anabolia*. Of the second group, the simplest type exists in *Myrmeleo*, where the individual cells bear at their distal ends a tuft formed of the thickened ends of the neuro-fibrillæ, and constituting a peripheral brush (*Stiftensaum*). In the larvæ of *Sialis* each receptive-cell bears a rhabdom. The rhabdomeres are to be regarded as derived from the peripheral brush. In consequence of the above, the compound eyes of insects can no longer be regarded as having originated from ocelli such as those which occur in imagines, but rather from monaxonic eyes with crystalline-cone of the larval type.

Insect with Many Eyes.†—Dr. O. E. Imhof describes a two-winged insect which, in the female, has two pairs of large ocelli and a pair of small ocelli, six in all; and, in the male, a pair of small eyes, two pairs of large ocelli, and three pairs of small ocelli, twelve in all. It may require a special family; for the genus the name *Polyocellaria* is suggested. He also says that it may have to do with *Ortheria cataphracta*.

Male Genitalia in Coleoptera.‡—Dr. L. Bordas finds that, although there appears to be enormous diversity as regards the genital organs of

* Zool. Anzeig., xxiv. (1901) pp. 30–1.
† Biol. Centralbl., xx. (1900) p. 527.
‡ Ann. Sci. Nat. (Zool.), xi. (1900) pp. 283–448 (11 pls.).

male beetles, yet all the variations can be grouped around two main types. It does not appear that the variations can be utilised in classification, for there are marked differences among the members of a single family. In the first type, represented in the Carabidæ, the Cicindelidæ, the Dytiscidæ, &c., the testes are simple and tubular. In this case the spermatozoa are chiefly formed in the proximal end of the tubes, and these proximal ends are wound into a ball. The distal ends of the two tubes are dilated and form seminal vesicles, which join the simple tubular accessory glands at a point more or less remote from the ejaculatory duct. In the second type the testes are compound, and two subgroups are formed according as they are (A) arranged in fasciculi, or (B) in grape-like masses. (A) This type is represented in Aphodiinæ, Chrysomelidæ, Curculionidæ, &c.; in it the testes form two clusters of ampullæ, each ampulla having a short efferent canaliculus. The canaliculi of each side open into the vas deferens of that side, and this is dilated during part of its course to form the seminal vesicle. The accessory glands meet the vasa deferentia at the top of the ejaculatory duct, and the latter bears a vesicle at some part of its course. In the sub-group (B), represented in Tenebrionidæ, Silphidæ, Elateridæ, &c., the ampullæ of the testis at either side are placed in series along a median tube which is continuous with the vas deferens. A seminal vesicle is present, as in the other cases, but the accessory glands are numerous, and varied in shape. As to histology, the author finds that the chitinous intima is not a product of cellular secretion, but is due to an actual differentiation of the cytoplasm of the underlying cells.

Stridulating Organs in Beetles.* — C. J. Gahan comments upon Schrodte's discovery of well-developed stridulating organs in the larvæ of several genera of beetles, and on the fact that the structures are generally alike in both sexes of adults, though with some notable exceptions. He describes the stridulating organs on the head, on the prothorax and front legs, on the mesothorax and middle legs, and on the hind legs, elytra, and abdomen.

Stridulating Organ of Rhynchota.† — A. Handlirsch describes the thoracic stridulating apparatus found equally on both sexes of all true Reduviidæ and Phymatidæ, but absent in Hemiocephalidæ and Nabidæ. Another kind of apparatus—on the ventral surface of the abdomen—occurs in Tetyrariæ, and is described in detail. In a third group, that of the Corisidæ, a third kind of organ is found.

Prothoracic Stigmata in Diptera.‡ — Dr. J. C. H. de Meijere has collected the pupæ of a number of Diptera, for the purpose of investigating the peculiar breathing organs which are often present, and have been described as homologues of wings. He publishes a brief preliminary note in regard to his results. He finds that these peculiar breathing organs have essentially the same structure as the abdominal stigmata of the pupæ, and can therefore not be homologised with wings. Further, he finds that the anterior stigma of the imago is to be regarded as prothoracic in position, and as originating from that of the larva.

* Trans. Entom. Soc. London, 1900, pp. 433–52 (1 pl.).
† Ann. Hofmuseum Wien, xv. (1900) pp. 127–41 (1 pl., 15 figs.). See Verh. Zool.-bot. Ges. Wien, l. (1900) pp. 520–2.
‡ Zool. Anzeig., xxiii. (1900) pp. 676–8.

Nycteribiidæ.* — P. Speiser publishes a paper on this family of pupiparous Diptera, the members of which are parasites of bats. He gives a historical account of the family, an anatomical description based chiefly on *Nycteribia blasii*, some account of development, and finally descriptions and diagnoses of certain of the known species and of a number of new ones, with an account of the geographical distribution.

Larva of Lonchoptera.†—Dr. J. C. H. de Meijere has made a study of this dipterous larva, and shows that it is intermediate between "Orthorrhapha" and "Cyclorrhapha," though nearer the latter. As the frontal sac still opens on the surface of the head, and there is, therefore, no head-atrium, the Lonchopteridæ may be distinguished as "Cyclorrhapha anatria" from the "Cyclorrhapha atriata."

Male Genitalia of Microlepidoptera.‡—H. Stitz sums up the results of his observations on a series of species as follows. In the forms investigated the abdomen consists essentially of eight distinct segments, of which the first is aborted ventrally, while the ninth, or genital segment, and the tenth have become greatly modified. In regard to this tenth some doubt exists. It is the anal segment, and bears a ventral sub-anal and a dorsal supra-anal plate, but the relation of these to the sternite and tergite of the typical segment is obscure. The testis usually lies in the fourth segment, and is typically unpaired, though the presence of a septum shows that this condition is secondary. From the single testis two vasa deferentia arise. These are short, and open into canals known as the intercalary segments of the vasa, which again open into the seminal vesicles. The seminal vesicles open into the middle of the coiled tubular glands, which are paired. Each gland is connected with an accessory gland, and the two open together into an unpaired gland which can be divided histologically into three regions. This opens into the ejaculatory duct, which passes into the penis, an organ of complicated structure. It is possible that not only the penis and ejaculatory duct, but also the whole glandular system, are of ectodermal origin.

Amitosis in Ovary of Hemiptera.§ — J. Gross confirms the facts reported by De Bruyne, and the theory of amitosis advocated by H. E. Ziegler and vom Rath. In the ovary of Hemiptera (nine forms) amitosis is restricted to the nutritive cells and the follicular epithelium. It has no regenerative import. A nucleus which has once divided by amitosis is no longer in a position to divide by karyokinesis. The occurrence of amitosis implies a speedy or immediate cessation of all nuclear division. As regards the nutritive cells, it may be regarded as the outcome of the degeneration of tissue which has spent itself, whose import is past; as regards the follicular epithelium, it follows in consequence of specialisation in unusually intense secretion.

Parasites on Cockroaches' Eggs.‖—Dr. N. F. Surveyor notes the occurrence of two species of Hymenoptera in the egg-cases of the

* Arch. Naturgesch., lxvii. (1901) pp. 11–78 (1 pl. and 1 fig.).
† Zool. Jahrb., xiv. (1900) pp. 87–132 (3 pls.).
‡ Tom. cit., pp. 135–76 (5 pls.).
§ Zeitschr. wiss. Zool., lxix. (1901) pp. 139–201 (3 pls. and 4 figs.).
‖ Journn. Bombay Med. Phys. Soc., iv. (1900) pp. 1–6 (2 pls.).

"common cockroach." One species was recognised as *Evania lævigata* Olivier, and was found to lay only one egg in each cocoon. The other, an unnamed form, is smaller, and lays on an average 50–60 eggs in each cocoon; the mature insects hatch out after an interval of 30–40 days.

Cardiac Body in the Larva of Phalacrocera replicata.*—Simon Bengstsson states that he observed this remarkable structure in 1893–94. He now supplements and corrects the description given by L. C. Miall and R. Shelford † in 1897. The organ in question is a glandular body (in the heart-cavity) with a secretory portion and an efferent duct; it has probably a compensatory respiratory function of much importance in the (apneustic) larval life. Its structure is fully discussed, and its possible analogy with annelid cardiac bodies is dismissed as too remote.

German Collembola.‡ — C. Börner, in the course of his studies on this subject, has found that the species of the genus *Sminthurus* have never been classified in a scientific manner, and that further Willem's discovery of *Megalothorax minimus* necessitates a revision of the diagnosis of the family Sminthuridæ. He makes the new form the type of a new sub-family, gives revised diagnoses of the family and of the two sub-families, and finally describes and classifies all the German species of the genus *Sminthurus*.

Guests of Dorylinæ.§—E. Wasmann makes his 114th contribution to our knowledge of myrmecophily and termitophily—even the number expresses an achievement—and discusses new *Eciton*-guests from Brazil, new guests of the African driver-ant *Anomma*, a new guest of *Dorylus helvolus*, and a new guest of *Ænictus*. He also gives a list of the known guests of Dorylinæ in general, and makes a comparison of those from Neotropical and Ethiopian regions.

β. Myriopoda.

Male Dimorphism in Diplopoda.‖—H. W. Brölemann opposes Verhoeff's view that of the two male forms which occur in the Julidæ, the *forma typica* is the more primitive and the *forma elongata* the derived form. Brölemann believes, on the contrary, that it is the *forma elongata* which is primitive, basing his opinion on the following grounds. As indicated by the structure of the copulatory appendages, the Spirobolidæ are to be regarded as the most primitive of the Julidæ (in the wide sense). In the genus *Spirostreptus* we have intermediate forms which link *Spirobolus* to the specialised types included in *Julus* and *Schizophyllum*. Now in the families Spirobolidæ and Spirostreptidæ, the author has found that in the males the copulatory appendages do not pass suddenly into the mature condition, as in the *forma typica* of Julidæ, but exhibit at least one intermediate stage (*Schaltstadium*) as in the *forma elongata*. The suppression of such a stage in the *forma typica* he regards as a proof of specialisation, suggesting an approach to the complete metamorphosis of higher Arthropods.

* Bihang K. Svenska Vetensk. Akad., xxv. (1900) 23 pp. (2 pls.).
† Cf. this Journal, 1898, p. 299.
‡ Zool. Anzeig., xxiii. (1900) pp. 609–18.
§ Zool. Jahrb., xiv. (1900) pp. 215–89 (2 pls.).
‖ Zool. Anzeig., xxiii. (1900) pp. 630–4. Cf. this Journal, 1900, p. 198.

Palæarctic Myriopoda.*—Prof. Karl W. Verhoeff, in the course of a further contribution to this subject, discusses the Diplopoda of the Mediterranean area.

Tracheæ of Centipede.†—Mr. A. A. Merlin pointed out some years ago that the chitinous fibre in the tracheæ of *Dytiscus* larvæ consists of a number of short and varying lengths, sometimes sufficing to form a couple of loops, sometimes falling short of one coil. In *Scolopendra morsitans* he now finds that the fibres occur in short lengths, often not forming one complete turn; that extremely short narrower threads occasionally appear between the larger fibres; that the fibres are not uniform in breadth, and exhibit an uneven wavy aspect; and that all the fibres towards their extremities taper off into very finely pointed and long undulating filaments. In one instance a fibre was seen split into two terminal filaments.

γ. Protracheata.

Peripatopsis blainvillei.‡—Prof. E. L. Bouvier finds that this Chilian species has affinities with species from South Africa and with others from Australia, but is much nearer the former than the latter. The American continent seems to have been the headquarters of the Onychophoron stock, and it is there that we may look for transitional forms between the different types. This species of *Peripatopsis* is one of these.

δ. Arachnida.

Copulation of Ixodes reduvius.§—R. T. Lewis makes a contribution to the life-history of this tick which is held responsible for conveying the infection of Louping Ill to the sheep. His observations relate to the copulation, and his results make it probable, though not certain, that impregnation is effected, as Mr. E. G. Wheler suggested, by the rostrum of the male being inserted in the female genital aperture. He shows in figures the male and female in copula, and the dilatation of the "genital process" of the male's hypostome (the lower part of the rostrum) at this period.

British Species of Arrenurus.‖—Chas. D. Soar notes that this large genus is now known to be represented in Britain by 21 species, while Piersig has reported 42 for Germany. A list of the British forms is given. *A. tricuspidator*, *A. maximus*, *A. cordatus*, are added in this communication, and George has recently reported another, *A. integrator*.

Scottish Hydrachnida.¶—Chas. D. Soar describes a collection of fresh-water mites made near Oban, his list being the first published for Scotland. Among the points of interest are, the absence of the very common English form, *Arrenurus globator* Müller, and the presence of *Acercus ligulifer*, *Oxus longisetus*, and *Torrenticolor anomala*, three forms not hitherto described within the British area. The collection contains about forty species, belonging to some twenty genera.

* Arch. Naturgesch., lxvii. (1901) pp. 79–102 (2 pls.).
† Journ. Quek. Micr. Club, 1900, pp. 405–6.
‡ Zool. Anzeig., xxiv. (1901) pp. 59–61.
§ Journ. Quek. Micr. Club, 1900, pp. 381–6 (1 pl.).
‖ Illus. Annual Microsc. for 1900, pp. 22–4 (1 pl.).
¶ Journ. Quek. Micr. Club, 1900, pp. 391–4.

Patagonian Mite.*—Ivar Trägårdh records the very interesting discovery of an Acarid—*Nothrus maximus* sp. n.—both as a fossil in the so-called *Glossotherium*-caves of Patagonia, and living in "damp places" in the same region. The material was furnished by the Nordenskiöld expedition, and the two fossil specimens occurred in coprolites assigned to *Glossotherium*, and consisting of vegetable debris. Their position makes it hardly possible to doubt their age, and they present the appearance of having been swallowed with food, and rejected in an undigested condition. Their identity with the living specimens appears also incontestable, a fact of great interest in view of the great changes which have occurred in Patagonia since the *Glossotherium* period.

ε. Crustacea.

Tropical Plankton.†—I. C. Thompson publishes a report on two collections, chiefly of Copepoda, made on board steamers by means of tow-nets fixed to water-taps, during voyages in the Pacific, Mediterranean, Red Sea, &c. The collections are of interest as showing in many cases an extension of range of known species of Copepoda.

Palæarctic Isopods.‡—Prof. Karl W. Verhoeff finds that the form which he previously described as *Armadillidium fruxgalii* sp. n. has the epimera of the first and second segments of the body split, and he therefore erects for it a new genus, *Echinarmadillidium*. He also takes the opportunity to further split up the genus *Armadillidium*, on the basis of the condition of the epimera in segments one and two.

Swimming Movements of Entomostraca.§—D. J. Scourfield points out that, of the four genera into which the old genus *Daphnia* has been divided, the members of two (*Daphnia* and *Ceriodaphnia*) always swim either vertically or obliquely back uppermost, while in the genera *Simocephalus* and *Scapholeberis* the animals swim obliquely back downwards. This constitutes a useful method of distinction between the two pairs of genera, and is further interesting in view of the great similarity of the genera to one another. By an ingenious method of experimentation, the author has succeeded in showing that in the case of *Daphnia* and *Simocephalus* the difference in position is primarily due to differences in the position of the centre of gravity. Further, he finds that in *Daphnia* the shell-spines are of much importance in regard to the movements of the animal.

Ostracoda of Switzerland.‖—Dr. A. Kaufmann, as the second instalment of his work on this subject, discusses the Cypridæ and Darwinulidæ. The systematic part of the paper is prefaced by a discussion of the anatomy and habits of the Cypridæ, which are represented in the Swiss fauna by 43 species. The Darwinulidæ are represented by *Darwinula stevensoni*. The paper is very fully illustrated.

Daphnia hyalina.¶—D. J. Scourfield describes this species and figures it beautifully. It appears to be very plastic, for not only does

* Zool. Anzeig., xxiv. (1901) pp. 25–30.
† Trans. Liverpool Biol. Soc., xiv. (1900) pp. 262–94 (1 pl.).
‡ Zool. Anzeig., xxiv. (1901) pp. 33–41.
§ Journ. Quek. Micr. Club, 1900, pp. 395–404 (7 figs.).
‖ Rev. Suisse Zool., viii. (1900) pp. 209–423 (17 pls.).
¶ Illus. Annual Microsc. for 1900, pp. 9–12 (1 pl.).

it differ in outline in different localities, but in the same locality at different seasons. From probably being polycyclic, it has become monocyclic in Lake Constance, and practically acyclic in Lake Mendota and the Lakes of Holstein. In Britain it is most likely monocyclic, but has not been sufficiently studied.

Marine Crustacea in a German Lake.* — Dr. M. Samter and Dr. W. Weltner record *Mysis relicta*, *Pallasiella quadrispinosa*, and *Pontoporeia affinis* in the Madü Lake on the Baltic coast of Pomerania The occurrence of these three species in inland lakes in Sweden, Norway, Finland, &c., has been generally accepted as indicating that such lakes were formerly connected with the sea, and are relics of a great ocean. Their presence in the Madü Lake makes the hypothesis difficult of acceptance in this case, as *Mysis relicta* appears to be derived from *M. oculata*, and this species does not occur in the Baltic. After a very elaborate discussion of the matter from the geological standpoint, the authors conclude that the Madü is a remnant of a great fresh-water basin which communicated with the North Sea at a time when this, owing to melting ice, was largely brackish. In this North Sea there must have lived a fauna whose members could tolerate considerable variations in the density of the water. From this fauna has arisen the "marine" element in the fauna of the Madü by a gradual process of adaptation, as the volume of fresh water poured into the North Sea diminished in amount.

Position of the Scinidæ.†—Prof. J. Vosseler discusses the position of this family of Amphipods, which has hitherto contained only one genus. He rapidly surveys the structure of the Amphipoda in general, with a view to ascertaining the classificatory value of the various organs. His survey leads him to the conclusion that the Scinidæ cannot be separated from the Hyperiidæ as Chun and Garbowski suggest, but must be regarded as true Hyperiidæ, probably closely related to the Xiphocephalidæ. He further describes as *Acanthoscina serrata* g. et sp. n., a new type of the family in which the first two thoracic segments are fused, a character hitherto known only in some Hyperiidæ.

Subterranean Amphipoda of Britain.‡—Dr. Charles Chilton gives full details of the four known British species, with a revision of the nomenclature and notes on distribution. He notes that as yet no subterranean Amphipod has been found in Scotland.

Annulata.

Origin of Segmented Worms.§—Dr. H. M. Bernard suggests that the origin of segmented worms may be looked for in free-swimming Cœlentera "trailing behind them longer or shorter strings of buds diminishing in size progressively backwards." The posterior buds would tend to be poorly nourished; apertures can occur almost anywhere in the Cœlenterate wall; a posterior opening might early be developed in order to free the terminal buds from their useless and deleterious

* Zool. Anzeig., xxiii. (1900) pp. 638–54.
† Tom. cit., pp. 662–76 (4 figs.).
‡ Journ. Linn. Soc. (Zool.), xxviii. (1900) pp. 140–60 (3 pls.).
§ Ann. Nat. Hist., vi. (1900) pp. 509–20.

burden; this anus might become more specialised until there appeared a regular "anal segment," the budding zone being always between it and the last-formed bud. If we suppose an increased development of the wall-muscles for locomotion, we can understand how the endoderm and the ectoderm would be gradually divorced from each other by an increasing development of intervening tissue, with spaces for streams of nutritive fluid. Thus mesodermal chambers may be accounted for. "With the perfection of the powerful neuro-muscular sheath and the necessary mesodermal apparatus for its nutrition and excretion, we have brought our strings of Cœlenterate buds near enough to the typical Annelid to show that, whether this was the true origin of the Annelids or not, it could easily have been so." "The parapodia, whatever specialisation and differentiation they may since have undergone, were originally nothing more than gill-folds, and they arose concomitantly with the rise and concentration of the powerful longitudinal muscles, as these latter required more and more oxygen for their work."

Ciliated Organs of Hæmenteria officinalis.*— Prof. H. Bolsius gives some details as to position and structure of these organs (= the nephridial funnels of other authors) in this leech. The organs do not occupy the same relative position in the different parts of the body:—(1) in the posterior region of the body they are placed ventrally as in the Glossiphonidæ; (2) on the other hand, those of the anterior region are placed as in the Herpobdellidæ, and open into the dorso-lateral lacunæ; (3) between the two sets there are one or two which occupy an intermediate position. In structure the organs on the whole are of the Glossiphonid type, and base (*pied*), stalk, and lobes can be distinguished. The base is without a nucleus, and is slender, but of considerable lateral extent; the stalk is short, not very mobile, and has a small nucleus; the lobes are freely movable, have each a nucleus, are rounded, and bear a superficial ciliated groove.

Notes on Clyde Polychætes.†—Dr. M. I. Newbigin has notes on a variety of *Jasminiera elegans* St. Jos. (a form of which there seems no previous British record), on the close resemblance between *Phyllodoce lamelligera* and *P. laminosa*, on *Glycera gigantea*, and on *Trophonia glauca*.

Fresh-water Polychæte.‡—Prof. J. Nusbaum describes a worm found by Prof. Dybowski (1875) in Lake Baikal—the first instance of a Polychæte in fresh water. He calls it *Dybowscella baicalensis* g. et sp. n. In an appendix it is noted that another species, *D. godlewski*, was found in 1900 in the same lake by Goriajeff, and that Prof. Korotneff reports a similar discovery.

The worm is 7–8 mm. in length, with twelve segments (two to the head), with thirty to forty gill-like cephalic outgrowths, with a well-developed "collar" on the head-segment in the female, with a pair of short tentacles above the mouth-opening, with somewhat dorsal, rather weakly developed parapodia bearing bristles and hooks, with two coiled kidneys or tubiparous glands in the head, without segmental nephridia

* La Cellule, xvii. (1900) pp. 267–81 (1 pl.).
† Communications Millport Station, i. (1900) pp. 1–8.
‡ Biol. Centralbl., xxi. (1901) pp. 6–18 (4 figs.).

or septa, with separate sexes. The worm lives in a very delicate transparent chitinoid tube, to which sand-grains are fixed.

Swiss Oligochætes.*—Dr. K. Bretscher has studied the little-known Oligochætes of Southern Switzerland, with a view to determining the relation to those found north of the Alps. As yet he has made collections only at Ascona, on the western border of the Maggia delta, but he has found there a number of new species, and an Oligochæte fauna in many ways sharply contrasted with that of Northern Switzerland. The contrast is most marked among the Enchytræidæ; of nine species, seven are new, two only are identical with northern forms. Among the Lumbriculidæ, *Bichæta sanguinea* g. et sp. n., is described. The genus is defined by the characters of the male genital ducts.

Platyhelminthes.

Influence of Temperature on Reproduction of Polycelis cornuta.†—Prof. W. Voigt has made an admirably careful study of this problem. In contrast to some easy-going inductions, it is noteworthy that he dealt with over 4000 specimens. The Turbellarian in question is a survival of the glacial fauna, found in many of the mountain streams in Germany. Sexual reproduction may occur at any time of year, perhaps with an interruption in midsummer, but it is inhibited locally by a rise in temperature, and seems often all but suppressed. Asexual reproduction abounds except in winter. The point is that the worm would have been long since extinct, had it not compensated for the inhibition of sexual reproduction by increased asexual multiplication.

Nervous System of Distomum hepaticum.‡—Dr. J. Havet has used Golgi's method in studying the nervous system of the liver-fluke, and has made out some new points. He finds that bipolar and multipolar nerve-cells occur in large numbers throughout the thickness of the peripheral muscular layer. Their prolongations form extensive intramuscular and sub-muscular plexuses, which are connected with the adjacent longitudinal nerve-cords. The nerve-cords are made up by the continuations of these prolongations, and by others arising from nerve-cells present in the cords themselves. Similar nerve-cells constitute the cerebral ganglia. The "large cells" found in the parenchyma and in the walls of certain of the organs are for the most part muscle-cells, some are nerve-cells, a few probably gland-cells. All the muscular organs of the body, e.g. genital ducts, the anterior region of the food-canal, the suckers, contain nerve-plexuses, the fibrils ending in the muscles in terminal ramifications with thickened tips.

Names of Genera of Distomidæ.§—Prof. A. Looss finds that of the genera into which he recently (1899) divided the genus *Distomum*, no less than nine are preoccupied as genera of insects. He replaces these nine by others, and discusses various debatable cases, in several of which he replaces his genera by others on account of the great similarity between his names and those of existing genera. He also discusses the

* Rev. Suisse Zool., viii. (1900) pp. 435–58 (1 pl.).
† SB. Niederrhein. Ges. Bonn, 1900, I. Hälfte, pp. 19–21.
‡ La Cellule, xvii. (1900) pp. 352–81 (4 pls.).
§ Zool. Anzeig., xxiii. (1900) pp. 601–8. Cf. this Journal, 1900, pp. 207, 329.

question of priority as between himself and Lühe, whose publication on the same subject appeared at the same time.

Forms of Cercocystis.* — Dr. E. von Daday discusses the forms of Cercocystis found in fresh-water Entomostraca. What is a Cercocystis? The term was invented by R. Blanchard for bladder-worms in which the scolex partially or wholly fills a proscolex cyst, with a posterior or caudal process. In a Cysticercus the scolex occupies only a small part; in a Cysticercoid it almost fills the cyst; in a Cercocystis there is a tail. The first known Cercocystis larva was described in 1872 by O. von Linstow, but many are now known; there are about 27 different kinds in 21 Entomostracan hosts. Dr. von Daday describes the general structure of these cysts, with the six layers in their wall, and so on, and no less than eleven new forms from fresh-water Entomostraca.

Drepanidotænia lanceolata Bloch.†—Dr. K. Wolffhügel describes the anatomy of this tape-worm, in which the proglottides are extraordinarily broad and short, the width being about ten times the length. In regard to the male organs, the sacculus accessorius, present in *D. gracilis*, is here absent. The cirrus-sheath resembles in its structure that of *D. fasciata*, and is regarded by the author as of considerable importance in classification.

Development of Tænia serrata.‡—G. Saint-Remy has obtained some results which do not wholly agree with previous descriptions by Moniez and by E. van Beneden. The shell is formed somewhat late; no polar bodies were seen. An early stage of segmentation shows two cells—one small and formative, the other large and vitellophagous. The latter divides, and one of its products re-divides, but the three take no part in forming the embryo. The formative-cell divides into two, and one of the daughter-cells becomes large and granular, seeming to accumulate nutritive residues without taking active part in development. The other daughter-cell proceeds to embryonic development, but here again three elements are set apart to form the chitinous shell.

New Nemertean.§—Caroline B. Thompson describes as *Carinoma tremaphoros* sp. n. a Nemertean found at Woods Holl, Mass. No member of the genus has hitherto been described in North America. The chief point of interest in the new species is the presence of twelve dermal sense-organs on the head. Each is a circular pit containing cells which bear long cilia.

Incertæ Sedis.

Development of Phoronis sabatieri.‖—Louis Roule now publishes the full text of his paper on this subject with plates and bibliography. His general results were noted on the appearance of his paper in abstract; to the account there given a few sentences from the section on the affinities of *Phoronis* may be added. The Actinotrocha is a

* Zool. Jahrb., xiv. (1900) pp. 161–214 (3 pls.).
† Centralbl. Bakt., xxviii. (1900) pp. 49–56 (6 figs.).
‡ Comptes Rendus, cxxxii. (1901) pp. 43–5.
§ Zool. Anzeig., xxiii. (1900) pp. 627–30 (1 fig.).
‖ Ann. Sci. Nat. (Zool.), xi. (1900) pp. 51–249 (15 pls.). Cf. this Journal, 1900, p. 677.

trochophore furnished with a preoral hood, with a prebuccal vestibule, and with a rudiment of a notochord. It closely recalls the embryo of a Vertebrate at the time when the latter begins to form neural axis and notochord, but after this point the two embryos diverge rapidly. While the Actinotrocha is a trochophore modified as above, the Vertebrate embryo may be regarded as a reversed trochophore, the anterior region having become the posterior, and *vice versa*.

New Enteropneuston.*—W. E. Ritter describes a new Enteropneuston from Alaska, *Harrimania maculosa* g. et sp. n., which he regards as the most primitive of living species of that group. It is a littoral non-burrowing form, possessing in the adult, besides a nuchal notochord, an œsophageal one. This consists of a median dorsal ridge and a pair of lateral pockets, and extends along the whole of the collar into the branchial region. Histologically the pockets resemble the nuchal notochord, while the ridge has more the character of the general œsophageal wall. The proboscis-pores are persistent; the gonads are retained in the body-cavity, and are not raised up into genital pleuræ.

Variation in Statoblasts of Pectinatella magnifica.†—Prof. C. B. Davenport has studied the hooks on this Bryozoon from Lake Michigan. The hooks on 827 statoblasts were counted; the numbers ranged from 11 to 21; the mode is 13; average, $13 \cdot 782 \pm \cdot 031$; index of variability, $1 \cdot 318 \pm \cdot 022$. The skewness was $+ 0 \cdot 077$; that is, the variation tends in the direction of the larger numbers, and this is correlated with the fact that species or races of *Pectinatella* with much larger numbers of hooks occur. There is a slight hereditary tendency in the statoblasts from one colony, about $0 \cdot 1$ when 1 is the maximum inheritance. There is an inverse correlation (of $- \cdot 092 \pm \cdot 006$) between the number of hooks and the perimeter, and a larger one between number and size of hooks. The number of hooks is thus not determined by room, nor does it seem to be predetermined from an early stage of development of the statoblast. The hooks show abnormalities, some of which resemble the normal condition of hooks in *Cristatella*.

Classification of Cheilostomatous Bryozoa.‡—Dr. S. F. Harmer gives reasons for his conviction that a complete rearrangement of the Cheilostomata is required. The division Cellularina in particular is an unnatural one, for it is made up of Cheilostomes which belong to several distinct groups, though agreeing in their dendritic habit. Paying especial attention to the characters of the front-wall (= opercular-wall), the author indicates what the natural grouping may be, but a summary could hardly be shorter than the original, which is a pattern of terseness.

Rotifera.

Variation Cycle of Anuræa cochlearis.§—Dr. Robert Lauterborn has studied the yearly cycle of variation of this very common rotifer as it occurs in the backwaters of the Rhine by Neuhofen and adjacent

* Proc. Washington Acad. Sci., ii. (1900) pp. 111–32 (1 pl.).
† Amer. Nat., xxxiv. (1900) pp. 960–8 (6 figs.).
‡ Proc. Cambridge Phil. Soc., xi. (1901) pp. 11–17.
§ Verh. Naturhist. Med. Ver. Heidelberg, Bd. vi. 5 (1900) pp. 412–48 (1 pl.).

lakes and ponds. The first part of his elaborate and instructive paper now published deals with the morphology. Taking as type Gosse's published figure of *A. cochlearis*, the author shows how the form varies in three or four definite directions, which he calls respectively:—(1) *Macracantha-typica-tecta* series, (2) *hispida* series, (3) *irregularis* series, and (4) *robusta* group, after the names the several varieties have received by different authors. With an elaborate table of measurements he shows how the animal as a whole, and particularly the posterior spine, increase and decrease in size; a table of 100 measured individuals of the first series is given, varying in total size from 271 μ to 96 μ, and the posterior spine from 100 μ to 0, the last being identical with Gosse's *A. tecta*. A plate with 27 figures illustrates the cycle of variation. A discussion of the probable causes of these variations is promised in the second part of this paper, to be published shortly.

Rotatoria of the United States.*—In connection with the work of the U.S. Commission of Fisheries, Mr. H. S. Jennings has published an interesting list, with critical notes, of all species of rotifers, 246 in number, hitherto found in the United States, with special reference to those found by him in the great lakes. Two species, *Notops pelagicus* and *Pleurotrocha parasitica*, are described as new. As a general result of his investigation the author formulates the conclusion that the Rotatoria are potentially cosmopolitan, any given species occurring wherever on the earth the conditions necessary to its existence occur. In stagnant swamps all over the world are likely to be found the characteristic rotifers of stagnant water, with little regard to the country in which the swamp is found; in clear lake water will be found everywhere the characteristic limnetic Rotifera; in Sphagnum swamps everywhere the Sphagnum or Moss Rotifera. Variation in the rotifer fauna of different countries is probably due to variation in the conditions of existence in the waters of those countries, not to any difficulty in passing from one region to another.

In the introduction the author gives a word of warning against the senseless abuse of naming species by those who, through want of experience or knowledge of what is known, fail to recognise the fact that they are not in a position to publish names of new species; such work he describes as a positive injury to science and a nuisance to all careful scientific students. It is to be hoped that everyone wishing to describe a new species of rotifer will learn by heart and inwardly digest this sentence.

Rotifers of New Zealand.†—Mr. F. W. Hilgendorf has published a "Contribution" on this subject, which comes under Mr. Jennings' recent designation of a positive "injury to science and nuisance to all careful scientific students." The author succeeded in finding sixteen species of rotifers, twelve of which he describes as new. Half of these new species can at once be recognised as old acquaintances, and the other half are of no value, and scarcely recognisable as rotifers. The figures of the four plates bear about the same relation to rotifers as the wooden blocks in a child's Noah's ark have to the animals they pretend

* U.S. Fish Commission Bulletin for 1899 (1900) pp. 67–104 (9 pls.).

† Trans. New Zealand Inst., xxxi. (1898) pp. 107–34 (4 pls.).

to be. The names with which science has been burdened are the following:—*Callidina quadridens*, *Hydatina monops*, *Mastigocerca flectocaudatus*, *Notommata pentophthalma*, *Planoventer varicolor*, *Mastigocerca rectocaudatus*, *Dinocharis inornata*, *Diaschiza taurocephalus*, *Postclausa minuta*, *Postclausa circularis*, *Colurus gracilis*, *Notholca regularis*.

Echinoderma.

Structure of Echinus esculentus.*—H. C. Chadwick gives a fully illustrated account of the main features in the structure and development of this sea-urchin. In the vicinity of Liverpool he finds that it is carnivorous in habit, the intestine frequently containing shells of barnacles and tubes of Serpulids.

Pigment of Echinus esculentus.†—A. B. Griffiths finds that this violet pigment is a lutein or lipochrome. It corresponds to the formula $C_{16}H_{12}N_2O$; is soluble in alcohol, ether, benzine, acetic acid, &c.; and changes into leucine and formic acid when boiled for a long time with strong mineral acids.

Regeneration in Ophiuroids.‡—C. Dawydoff has studied the regenerative phenomena in a species of *Amphiura*, with which he compares several other forms. After amputation there is a period of phagocytosis; the first sign of regeneration is a proliferation of the skin over the cut surface. The ambulacral canal grows out from the old canal; the mesoderm of the new bud arises in greater part (mesenchyme) from amœboid cells, and from the separation of connective-tissue from the internal layer of the skin of the bud. The cœlom is continued from the old cœlom; the epineural canal is derived from the schizocœl formed by a separation of the nerve-strand from the epithelium, and has thus no ontogenetic relation to the pseudohæmal canal which is derived from the enterocœl. The nerve-strand is formed afresh from the ectoderm. Tube-feet arise by evagination of the lateral parts of the ambulacral canal, and the nerve-strand shares in their development. In a general way, the regenerative processes are in harmony with those of ontogenetic development.

Development of Agaricocrinus.§—Mary Klem concludes that the first plates to be formed ventrally were the six orals. The basals appeared simultaneously. The next step was the formation of a series of smaller pieces around each oral; but in no two cases is the ring composed of the same number of pieces, or of pieces of the same size. "The variations in the size, shape, and number of these plates, in all probability, depended upon the quality and the quantity of food, the amount of light, and the nature of the surroundings." Intervening pieces, also very variable, were formed at a later period, as the necessary material could be produced. The number of species based on variations is absurdly large; it can be readily reduced from forty-two to ten.

* Trans. Liverpool Biol. Soc., xiv. (1900) pp. 298–325 (5 pls.). Also published as Memoir III. of Liverpool Marine Biology Committee.
† Comptes Rendus, cxxxi. (1900) pp. 421–2.
‡ Zeitschr. wiss. Zool., lxix. (1901) pp. 202–34 (2 pls. and 3 figs.).
§ Trans. Acad. Sci. St. Louis, x. (1900) pp. 167–84 (4 pls. and 1 fig.).

Cœlentera.

Variation and Regulation of Abnormalities in Hydra.* — H. H. Parke finds that the number of tentacles in *H. viridis* varies from 4–11; that the average number varies in specimens from different localities; that large specimens have more than the small specimens have, and old forms more than young ones.

The size of the just-separated bud is on an average directly proportional to the size and number of tentacles in the parent; the number of tentacles in the just-separated bud is less than that in the parent; it varies between four and six, and is in direct relation to the size of the bud and of the parent.

The number of tentacles in an individual is not constant; it may increase during life, or it may decrease in unpropitious conditions. There is less numerical variation in *H. fusca* than in *H. viridis*. Longitudinal division sometimes occurs in *Hydra*.

Porifera.

Minute Structure of Sponge Spicules.† — Prof. O. Bütschli finds that gentle heating reveals a fine vesicular or alveolar structure, which is probably represented, though too fine to be seen, in the normal state of the spicules. The axial thread of siliceous spicules gives albuminoid reactions, and there is some organic matter along with the siliceous substance. The thread may be stained when there is some breakage in the spicule, or when one end is still open. In *Tethya* the siliceous needle is entirely surrounded by girdle-like cellular bands (silicoblasts), and branched cell-like bodies are sometimes seen between the thread and the wall of the axial canal. In *Leucandra* there is no axial thread, and only the sparsest representation of organic substance. But we cannot give more that an indication of the chief results of this elaborate study.

Protozoa.

Cell-Division in Protozoa.‡—Dr. F. Doflein has studied *Noctiluca miliaris* with special reference to the nuclear changes accompanying cell-division. He gives the life-cycle as follows:—The adult multiplies by cell-division repeatedly and finally comes to rest, copulation of two individuals occurs, and is followed by rapid budding; the liberated buds are at first similar to Dinoflagellata, but ultimately become converted into adults. When division occurs a sphere appears near the nucleus, and a process presenting what the author regards as a superficial resemblance to the karyokinesis of Metazoa follows. The actual process of nuclear division seems to some degree independent of the division of the sphere, but the latter is intimately associated with the division of the plasma. This is explicable on the author's view that the sphere is merely a concentration of the plasma. The budding after copulation consists in rapid cell-division, during which the division products remain connected by a common stroma. Whether this stroma does or does not indicate the existence of a process of reduction remains uncertain. The

* Arch. Entwickmech., x. (1900) pp. 692–710 (9 figs.).
† Zeitschr. wiss. Zool., lxix. (1901) pp. 235–86 (3 pls. and 2 figs.).
‡ Zool. Jahrb., xiv. (1900) pp. 1–60 (4 pls. and 23 figs.).

paper includes a discussion on the structure of protoplasm, and the causation of protoplasmic movement.

Nuclear Division in Protozoa. * — Prof. P. A. Daugeard criticises the usual statement that the nuclear division of Protozoa is invariably direct. He figures and describes the ordinary process of division, exemplified, e.g. in *Amœba polypodia*; the division in *Amœba crystalligera*, where the dividing nucleus is drawn out into a thread at the division plane; the division in *Sappinia pedata*, where the nucleus divides twice without division of the cytoplasm; finally, he gives a full account of cell-division in *Amœba hyalina* sp. n., in which true karyokinesis occurs. In this form the nucleus contains a large nucleolus, which breaks up before division, and appears to give rise to the chromosomes. Some part of the nucleus also mingles with the nucleoplasm and imparts to it chromatic properties; this nucleoplasm forms a spindle, in which the very fine chromosomes arrange themselves in an equatorial plate. Later they separate and approach the poles of the spindle. As they do this the spindle becomes pulled out, a process which is continued as the chromosomes migrate to the poles of the elongating amœba, until the spindle is represented by elongated fibrils. This the author regards as proof that the chromosomes migrate by their own activity, here as elsewhere; for in the present case there are no spheres, and as the movement continues after the chromosomes have reached the poles of the spindle, the threads of the latter cannot be the active agents. As the new cells separate, the chromosomes round themselves off and constitute the nucleolus, and the remains of the spindle form nucleoplasm around them. The above is clearly a karyokinetic process, but its simplicity, in the author's opinion, shows that indirect division is merely a modification of the simpler direct division, special emphasis being laid on the conditions exemplified in *Amœba crystalligera*.

Physiology of Pelomyxa. † — Antonín Štolc has made a series of observations on the digestion and formation of carbohydrates in *Pelomyxa palustris* Greeff. In the first place, a prolonged series of experiments has convinced him that the "refracting-bodies" of the plasmodium consist of glycogen inclosed in an envelope of less soluble carbohydrate. Experiments on fasting specimens show that the bodies so far act as reserves that they greatly diminish in size when food is not obtainable; but they do not appear to be ever completely absorbed, however prolonged the fasting. Under such conditions they shrink owing to the absorption of their contents, and also become aggregated into groups. It is remarkable that a similar process of aggregation occurs simultaneously in regard to the nuclei, which likewise collect in groups. Feeding experiments showed that starch, whether raw or cooked, was digested by the *Pelomyxa*, and led to an increase in size of the refracting-bodies. The same result was obtained with cellulose and coniferin, both substances which not improbably form a part of the natural food. On the other hand, proteids (white of egg, fibrin, casein, &c.) and fats (milk, fish-fat) produced no change in the refracting-bodies. The part played by these refracting-bodies is summed up by the author as follows.

* Le Botaniste (Dangeard) vii. (1900) pp. 49–82 (1 pl. and 4 figs.).
† Zeitschr. wiss. Zool., lxviii. (1900) pp. 625–68 (2 pls.).

When the food contains carbohydrates, these are subjected to the action of an enzyme secreted by the protoplasm, and are converted into simple sugars. These are conveyed by osmosis through the protoplasm, and are no doubt in part used up in cell-metabolism. If in excess of immediate needs, they are stored up in the refracting-bodies as glycogen. The author is disposed to lay considerable emphasis on the investing membrane of these bodies, as an important agent in the process of conversion of the sugar into glycogen. If food becomes scarce, then the zymogen in the vicinity of the investment gives rise to an enzyme which permeates the membrane, converts the glycogen into sugar, and so permits the process of osmosis to recommence. The origin of the refracting-bodies is somewhat obscure, but it is probable that they originate during periods of abundant food, and that the investing membrane is the first part to appear. In a note, the author points out how admirably *Pelomyxa* is adapted for the experiments on the chemical physiology of simple organisms.

Experiments on Difflugia.*—Dr. Eugène Penard has succeeded in several cases in separating the intact nucleus from the cytoplasm of *Difflugia*, and in three cases in accomplishing this without other material injury to the organism. Separated nuclei preserve a healthy appearance for from 9–24 hours after being liberated, but they ultimately die, apparently of inanition. On the other hand, the non-nucleated specimens lived and moved about for several days after the removal of their nuclei, apparently unaffected by the operation, and in the three cases, when finally killed for purposes of examination, were seen to consist of apparently normal protoplasm. Food-taking was not observed in non-nucleated animals, but perfectly intact forms can remain without food for weeks without injury, and there seems no reason to doubt that the mutilated specimens could ingest food-particles.

Deep-Sea Rhizopods in Clyde Area.† — F. G. Pearcey remarks on the interest of finding deep-sea forms in the Clyde area, and records the following new species:—two Astrorhizidæ—*Storthosphæra depressa* and *Bathysiphon minuta*, and one of the Lituolidæ *Hippocrepina oblonga.*

Infusoria of Lake Geneva.‡ — Jean Roux gives some brief notes on the results of lake-dredging for Ciliata. He has obtained about eighty species, about four times as many as those previously recorded. The majority of the species are littoral, and occur most abundantly where the bottom is covered by plants. Pelagic forms are exceedingly rare, and almost all belong to the Peritricha. They occur attached usually to *Fragilaria* or *Botryococcus*, both abundant forms. Up to a depth of 25–30 metres the bottom has a fairly abundant fauna. At this depth there occur both fixed forms and free Hypotricha and Holotricha as well as others. No observations were made at depths greater than 30 metres.

Structure and Development of Colpodella pugnax.§ — Prof. P. A. Dangeard finds that this Infusorian occurs not unfrequently as a para-

* Rev. Suisse Zool., viii. (1900) pp. 477–90.
† Communications Millport Station, i. (1900) pp. 37–42 (2 pls.).
‡ Rev. Suisse Zool., viii. (1900) pp. 459–65.
§ Le Botaniste (Dangeard), vii. (1900) pp. 5–29 (1 pl.).

site on various species of *Chlamydomonas*. The zoospores at the time of their liberation are colourless, and possess a posterior flagellum as long as the body. The nucleus is large and the nucleolus appears to be absent. These zoospores attach themselves to specimens of *Chlamydomonas*, often larger than themselves, and rapidly absorb the cell-contents, becoming green in the process owing to the absorption of the chlorophyll of the host, and also greatly distended. A very remarkable circumstance is that *Colpodella*, after the ingestion of the cell-contents of the victim, may contain more starch than the latter did in life. The author suggests that the ingested chlorophyll preserves its active properties for some time after being absorbed. After a longer or shorter period the zoospores give rise to sporangia, within which new zoospores are formed. As to the position of *Colpodella*, the author is disposed to regard it as a highly differentiated member of the Flagellata.

Apparent Commensalism of Conochilus and Vorticellids.*—H. A. Doty describes swimming colonies of *Conochilus* in the jelly of which Vorticellids (*Vorticella* ?) were imbedded. The stalks were abortive, tapering to invisibility at a distance from the body equal to about twice its length. The half of the stalk next the body of the Vorticellid was contractile, but the inner half was very slender and lost itself in the jelly. No sheath was discernible. To the Vorticellids the advantage of protection and economy in locomotion seemed obvious, but it is not evident that *Conochilus* derives any benefit. If so, the Vorticellid is rather epizoic than commensal. There is an unfortunate vagueness in the communication.

New Species of Gonyostomum.†—Herr L. Iwanoff describes *G. latum* sp. n., a new representative of this rare genus, hitherto known only from *G. semen* (Ehrenberg's *Monas semen*).

Coccidium fuscum.‡—Dr. Valentin Voirin has studied the disease in pigs known as *Schrotausschlag*, which is characterised by the formation of shot-like granules in the skin. The disease, as was first shown by Olt, is due to the occurrence within the sweat-glands of *Coccidium fuscum*. In their earlier stages of development the coccidia live in the gland-epithelium, but later stages occur free in the lumen of the gland, as well as in the skin-cysts which are outgrowths of the infected glands. The intracellular parasites are naked and show amœboid movements, while those which occur free are encysted. Of these encysted forms two distinct varieties occur:—(1) oval cells with thick shells which give rise to coated resting spores; and (2) rounded cells with a thin investment which give rise either to eight macrogametes or to 30–40 microgametes. Though some stages of the development are obscure, the author believes that a comparison with the results of others justifies the following statement of the life-history. The young develope within the epithelial cells, become adult, and, leaving these cells, multiply endogenously to form sickle-shaped embryos (macrogametes), which can directly infect new epithelial cells of the same gland, or, emerging by the gland-pore, may even attack neighbour-

* Journ. Applied Microscopy, iii. pp. 989–90 (2 figs.).
† Bull. Soc. Imp. Nat. Moscou, 1899, No. 4 (published 1900), pp. 447–9 (1 pl.).
‡ Zool. Jahrb., xiv. (1900) pp. 61–106 (1 pl.).

ing glands. The macrogametes probably also copulate with the microgametes, and the thick-shelled cysts no doubt arise from their union. These cysts produce resting-spores by exogenous sporulation, the resting-spores being the agents by means of which the infection of new animals, or autoinfection of distant parts of the body, occurs. The parts affected are usually those parts of the body which the animals are in the habit of rubbing, and the disease probably results from the animals rubbing themselves against infected pens.

Psorospermic Tumours of Xiphias.*—Dr. L. Facciolà describes the so-called psorospermic tumours in the muscles of *Xiphias gladius*, which, he thinks, are due to a stage in the development of *Gregarina mulleriana*.

New Myxosporidian in Fishes.†—E. E. Tyzzer gives a short account of tumours and Sporozoa in fishes, and describes a new form, which occurs in minute cysts in the muscles of herring, alewife, scup, menhaden, hickory shad, and cunner, especially in the younger specimens. The spores are quadrilateral when seen face on, and oval in profile; they show a tendency to occur fitted together in clumps of four or eight. Each spore contains four capsules, very delicate pale green in colour, radiating from the anterior extremity toward the four corners, and extruding vibrating filaments which cause movement. After a time the filaments shorten and return into the capsules.

* Neptunia, xv. (1900) pp. 197–202.
† Journ. Boston Soc. Med. Sci., v. (1900) pp. 63–8 (1 pl.).

BOTANY.

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

a. Anatomy.

(1) Cell-Structure and Protoplasm.

Attractive Spheres in Angiosperms.*—Ch. Bernard confirms, in a general way, the observations of Guignard and others with regard to the occurrence of attractive spheres in the plants observed—chiefly *Lilium candidum* and *Helosis guayanensis* (Balanophoraceæ); but finds them much less sharply defined and less easy to detect than has been stated by others. Around the nucleus is an accumulation of very dense and very granular protoplasm, the kinoplasm of Strasburger. This is the seat of the attractive spheres. The centrosome may be wanting, or at least may not be visible. The size of the spheres is variable, and their outline badly defined. The number of centrosomes also varies. The author agrees with Guignard in tracing the spheres to a cytoplasmic origin.

In both the species named, a double embryo-sac was occasionally observed.

As a fixing material, the author used Flemming's mixture. The best staining results were obtained with a mixture of 1 part aqueous solution of 1 p.c. fuchsin, 2 parts aqueous solution of 1 p.c. iodine-green, and 40 parts water.

A good bibliography is appended to the paper, and it commences with a critical survey of existing literature.

Dimorphism of Protoplasmic Connecting Threads.†—F. G. Kohl points out that the protoplasmic connections between cell and cell of a tissue are of two kinds, between which there are scarcely any intermediate conditions:—either the connecting threads perforate only the membrane of the pits, when they may be termed aggregate threads, or they perforate solitarily any portion of the cell-wall. It is rare for both kinds of connection to concur in the same tissue and the same cell. The endosperm of *Chamærops excelsa* presents, however, an exception to this rule. In the peripheral cells the connecting threads are chiefly or exclusively solitary, while in the central cells they are both solitary and aggregate. The swollen knots which are seen on solitary connecting threads are for the most part artifacts. The swelling of the membrane which lies outside a pit must proceed very uniformly in the separate layers; for the solitary connecting threads which perforate them are usually without such swellings. The bendings of the threads which perforate the margin of the pit-membrane are not a result of the swelling of the membrane; the latter causes rather a flattening of these bendings.

In the endosperm-cells of many palms the protoplasmic threads take

* Journ. de Bot. (Morot), xiv. (1900) pp. 118–24, 177–88, 206–12 (2 pls.).

† Ber. Deutsch. Bot. Ges., xviii. (1900) pp. 364–72 (1 pl.).

a deep stain from methyl-violet, saffranin, or brilliant-blue, without any previous fixing, and remain perfectly homogeneous.

First Mitosis of Spore-mother-cells of Lilium.*—Dr. H. H. Dixon has made a study of this subject for the purpose of determining the sequence of processes in the mitotic division of the nucleus. The stages in the process in which all observers are agreed are recounted in detail. With regard to the early stages, the author states that a careful study of the process in the pollen-mother-cells and embryo-sac of *Lilium longiflorum* has led him—contrary to the opinion of most observers—to regard the strepsinema or second stage as probably arising from the looping on each other and approximation of two portions of the thread in its first or dolichematous stage. The reasons for adopting this view are given in detail. In the next stage the double thread is broken up into a number of chromosomes, each composed of two portions twisted and looped together. The author does not believe that the first mitosis of the spore-mother-cells is a differential or "reducing" division. The two daughter-nuclei receive half of each primary chromosome, which is itself a segment of the original dolichonematous thread.

Hardness of Vegetable Membranes. †—According to Emma Ott, vegetable membranes, tried by the test of scratching, exhibit, when freed from mineral substances, a smaller variation in their hardness than has generally been supposed. They range, as a rule, in the second grade, being somewhat harder than muscovite, but scarcely scratching rock-salt. When the apparent hardness of a vegetable membrane is much higher than this, it is always due to the presence of a larger or smaller quantity of a mineral deposit, most commonly silica. The pericarp of *Coix lachryma* has a hardness of seven. The ash of *Equisetum maximum* contains as much as 70·64 p.c. of silica.

Shrinking of the Cell-wall.‡—C. Steinbrink gives formulæ for the energy of transpiration, and further discusses the effect on transpiration of the permeability of the cell-wall, and the effect of increased transpiration as a hindrance to the shrinking of the cell-wall.

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

Composition of Aleurone-grains §—According to A. Tschirch and H. Kritzler, the aleurone-grains of seeds consist mainly of globulins similar to those of animal proteids. The crystalloids contain at least two globulins. Aleurone-grains contain also possibly small amounts of albumose. The globoids contain protein (globulin), calcium, magnesium, and phosphoric acid. The germinating power of seeds probably depends directly on the solubility of the crystalloids in dilute sodium chloride solution. The oil of seeds is not present in the form of drops, but is mixed with the cell-plasma in the form of oleoplasm; the aleurone-grains contain no oil.

* Proc. R. Irish Acad., vi. (1900) pp. 1–12 (2 pls.).
† Œsterr. Bot. Zeitschr., l. (1900) pp. 237–41.
‡ Ber. Deutsch. Bot. Ges., xviii. (1900) pp. 386–96.
§ Ber. Deutsch. Pharm. Ges., x. (1900) pp. 214–22. See Journ. Chem. Soc., 1901, Abstr. ii. p. 33; also Kritzler, Microchem. Unters. üb. d. Aleuronkörner, Bonn, 1900, 80 pp. and 2 pls. See Bot. Ztg., lix. (1901) 2te Abt. p. 74.

Compound Starch-grains.*—A. Peter describes the peculiar compound starch-grains found in the endosperm of wheat, barley, and rye. They readily break up into separate grains, and are not to be detected in the dry seed. The number of separate grains of which a compound grain is composed is usually from 20 to 25. They frequently exhibit two peculiarities which have been observed also in ordinary grains, a reticulate surface, and crater-like depressions due to the commencement of absorption.

Anthophæin, a Brown Pigment of Flowers.†— Prof. M. Moebius has isolated the colouring matter from the black spots on the corolla of *Vicia Faba*, and finds it to be a brown pigment dissolved in the cell-sap, to which he gives the name *anthophæin*. It presents a strong resemblance in its chemical and optical properties to the phycophæin of brown sea-weeds, but differs from that pigment in its mode of formation, being dissolved in the cell-sap instead of being present in the solid state in the chromatophores. Anthophæin occurs also in the petals of species of *Delphinium*, but does not appear to be a widely distributed substance, the brown colour in most flowers being produced by a mixture of chlorophyll and anthocyan.

Alkaloids of the Compositæ.‡— Out of 150 genera of Compositæ examined, M. Greshoff detects the presence of an alkaloid in 50, an increase of 30 over the number previously recorded as containing an alkaloid. In *Echinops Ritio* he finds four alkaloids: echinopsine, β-echinopsine, echinopseïn, and echinops-fluorescine.

Proteolytic Enzyme in Germinating Seeds.§—W. Butkewitsch produces further evidence of the presence of an enzyme in seeds of *Lupinus luteus* after germination, which has the power of producing leucin and tyrosin from (manufactured) conglutin. No production of asparagin could be detected. Similar results were obtained from the auto-digestion of the substance of the germinating plant.

Indican and its Enzyme.‖—The enzyme which causes the production of indigo in the leaves of *Indigofera* is called by J. J. Hazewinkel *indimulsin*. The substance which is decomposed by the enzyme must be a glucoside; dextrose is formed by the action on it of acids. The product of the technical fermentation is not indigo-white but indoxyl.

Presence of Methyl-alcohol in the Ferments of Certain Fruits.¶—J. Wolff finds traces of methyl-alcohol in various fruits after fermentation, and in the black currant before fermentation. The proportion in the fermented juice of the grape varies greatly, depending largely on the amount of stalk left in; while in other fruits (plums, quinces, apples, cherries, black currants), it is more uniform, averaging from 1 to 2 p.c. in 90 p.c. alcohol.

* Œsterr. Bot. Zeitschr., l. (1900) pp. 315–8 (3 figs.).
† Ber. Deutsch. Bot. Ges., xviii. (1900) pp. 341–7.
‡ Ber. Deutsch. Pharm. Ges , x. (1900) pp. 148–54. See Bot. Centralbl., lxxxiv. (1900) p. 351.
§ Ber. Deutsch. Bot. Ges., xviii. (1900) pp. 358–64. Cf. this Journal, 1900, p. 599.
‖ Chem. Ztg., 1900, p. 409. See Bot. Centralbl., lxxxiv. (1900) p. 320.
¶ Comptes Rendus, cxxxi. (1900) pp. 1323–4.

(3) Structure of Tissues.

Differentiation of the Vascular Tissues in the Leaf and the Stem.*—Pursuing his investigations on the continuity of the tissues in the axile and appendicular organs of vascular plants, Prof. G. Bonnier now brings forward evidence that the uniformity previously established in the formation of the elements of the central cylinder in the root and the stem occurs also in the leaves. The continuity is complete between the tissues of the leaves and the corresponding tissues of the stem; and it is possible to regard the stem as formed from the concrescence of the prolongations of the bases of the leaves. The leaves remain coherent to one another by their bases, the union of which constitutes the stem; the vascular bundles combine; and then, in the stem, the xylem is found towards the centre, the phloem towards the periphery. Finally, when the stem is transformed laterally or at its apex into organs destined for absorption—the leaves—the poles of the xylem turn inwards in order to place themselves in contact with the tissue which serves to draw up the water from the soil, and we get the structure of the root.

Common Origin of the Tissues of the Leaf and Stem in Phanerogams.†—L. Flot entirely supports the conclusions of Bonnier as to the continuity of the tissues between the leaf and the bud on one hand, and between the bud and the stem on the other hand, and extends these observations to the meristem of the vascular bundles and even to the pith. It may be said that the apex of the stem, above where the first leaves begin to show themselves, is composed simply by the juxtaposition of segments each of which potentially encloses a leaf and its axillary bud. The author disputes Baranetzky's assertion that the arrangement of the initial layers has no necessary influence on the nature or ultimate differentiation of the tissues.

Conducting Tissue in the Ovary of Orchideæ.‡—W. Busse has studied the nature of the tissue which supplies the pollen-tubes with food-material in the form of soluble carbohydrates in the Orchideæ, especially in species of *Vanilla*. It is formed either by a modification of the inner epiderm of the ovary alone, or of two or three layers of hypodermal cells as well; and consists usually of six distinct streaks, the cells of which are distinguished by their small size, thick walls, and abundant protoplasm. It is formed before the opening of the bud, commencing with the apex of the ovary, and advancing gradually towards its base. The cuticle becomes detached from the epiderm, and more or less disorganised before the arrival of the pollen-tubes in the cavity of the ovary. The outermost layer of cells is used up first of all for the nutrition of the pollen-tubes, and then the lower ones. The production of the soluble carbohydrates is effected by an enzyme. The conducting tissue is localised in those spots in the wall of the ovary where it will best facilitate the act of impregnation.

Succulent Plants.§—W. Brenner has studied the anatomical structure of several species of *Sedum*, *Sempervivum*, and *Mesembryanthemum*.

* Comptes Rendus, cxxxi. (1900) pp. 1276–86 (8 figs.). Cf. this Journal, *ante*, p. 51.
† Tom. cit., pp. 1319–22 (3 figs.).
‡ Bot. Centralbl., lxxxiv. (1900) pp. 209–22.
§ Flora, lxxxvii. (1900) pp. 387–439 (15 figs.).

In the palisade-tissue are a number of suberised "water-cells," distinguished from the neighbouring cells by their very large size. In moist air the diameter of the cells of the leaf—i.e. of the organ which assimilates and transpires most strongly—is lengthened in such a way as to increase the surface which is in direct communication with the air. In the cells of the stem this extension takes place chiefly in the axial direction. The effect on the number of stomates of transplanting into a moist air varies with the species. In some cases it is increased, in others decreased. The results on the vegetative organs of a removal into a moist situation are described in detail.

(4) Structure of Organs.

Heteromorphic Flowers of Helianthemum.*— J. H. Barnhart describes the heteromorphism which distinguishes most of the American species of *Helianthemum*. In addition to the conspicuous flowers, apetalous cleistogamic flowers are produced, in some years in the autumn, in others along with the conspicuous flowers in the spring or summer. The apetalous flowers have, as a rule, a larger calyx and shorter peduncle than the conspicuous flowers. In the incomplete flowers the stamens are always less numerous than in the complete ones, and the filaments are much shorter, so that the anthers are in contact with the stigma, ensuring self-fertilisation, and the ovules are always fewer. Intermediate conditions between the two kinds of flower occur.

Bud-blossoming of Deutzia gracilis.†—F. Ludwig records the observation that, under favourable conditions of weather, the flower-buds of this plant will more or less completely open in almost any stage of development. The phenomenon has no relation to cleistogamy; these early flowers have no functional reproductive organs, and soon wither.

Peculiarity of Alpine Compositæ.‡—Dr. A. von Hayek calls attention to the fact that in a large number of alpine Compositæ the involucre has a strikingly dark tint. This occurs either in species peculiar to high altitudes or in alpine varieties or races of species which do not present this peculiarity at low elevations. Seeing the phenomenon is seen chiefly in late-blossoming species, the author regards it as serving for the protection of the young fruits, which are enclosed in the involucre, and are thus protected against excessive changes in temperature between day and night, the heat-rays being absorbed by their black covering.

Inversion of the Ovule in Statice.§—Ph. van Tieghem calls attention to a not infrequent anomaly in the structure of some species of *Statice*, especially *S. puberula*. Normally the ovule is attached to a long funicle, at the extremity of which it is pendent. In the abnormal examples the funicle remains short, and the ovule is erect. This is accompanied by sterility, since the pollen-tube, when it reaches the chalazal region of the ovule, is unable to penetrate it and to reach the micropyle.

eeds of Leguminosæ.‖—L. H. Pammel has studied the structure of the seed in a very large number of genera and species of Legu-

* Bull. Torrey Bot. Club, xxvii. (1900) pp. 589–92.
† Mutterercle, ii. (1900) p. 417 (1 fig.). See Bot. Centralbl., lxxxiv. (1900) p. 294.
‡ Œsterr. Bot. Zeitschr., l. (1900) pp. 383–5.
§ Journ. de Bot. (Morot), xiv. (1900) pp. 97–9.
‖ Trans. Acad. Sci. St. Louis, ix. (1899) pp. 92–263 (29 pls.).

minosæ, and attempts to found a system of classification on characters described from this source. The paper is profusely illustrated with plates of the anatomical details, and a very copious bibliography is appended.

Branching of the Vegetative Organs.*—M. Raciborski treats this subject under the following heads:—(1) The radial or dorsiventral structure of the shoot; (2) the arrangement of the leaves, both in longitudinal direction and in their lateral distance from one another (including dimorphism or anisophylly; (3) periodicity in the formation of the twigs; (4) lateral distance of the twigs from one another; (5) the specific length of the axis; (6) the position of the branch which bears the twigs; (7) other influences. Of these, Nos. 3–5 are treated of in detail in this paper, with a large number of illustrations from tropical trees and shrubs.

Causes of the Vernation of Leaves.† — W. Arnoldi classifies the causes which determine the position of the leaves in the leaf-bud under two heads—internal and external. The former are dependent on the localisation of growth in the embryo; the latter on the conditions of space. The inner causes must be assumed; we are unable to explain why some few leaves display a long-continued apical growth, while in others this ceases at an early period; or why, in many leaves, there is always an unequal growth of the two halves; or why the under side of the leaf grows more rapidly than the upper side, causing a circinate vernation. By the removal of the stipules of *Magnolia* the leaves remain flat in the bud; the crumpled æstivation of the petals of *Papaver* may be prevented by the removal of the calyx; showing that the external causes which determine the vernation are readily modified.

Appendicular Organs of the Leaves of Myriophyllum.‡—E. Perrot calls attention to the presence in several species of *Myriophyllum* (*verticillatum*, *spicatum*, &c.) of peculiar minute lamellar appendages in the axils of the segments of the leaves, at their apex, and distributed irregularly over their surface. They are extremely caducous, leaving a smooth scar. They are not, as has been stated, of a stipular nature, but are entirely trichomic; no useful function can be readily assigned to them.

Glandular Hairs of Salvia glutinosa.§ — Prof. L. Macchiati states, as a fact beyond question, that the glutinous hairs which cover the stalk of the inflorescence of this plant secrete a peptonising ferment, through the agency of which the insects captured by the secretion are digested, as in the sundew or Venus's fly-trap.

Roots of Cactaceæ.‖—In several species of Cactaceæ natives of Arizona, C. E. Preston notes that there are two distinct root-systems, a horizontal and a vertical, of which the latter are developed first, while the former perform the chief part of the absorptive function. The horizontal roots are always very brittle, the vertical ones being more elastic. The woody cylinder in large absorptive roots is much smaller

* Ann. Jard. Bot. Buitenzorg, xvii. (1900) pp. 1–67 (31 figs.).
† Flora, lxxxvii. (1900) pp. 440–78 (46 figs.).
‡ Journ. de Bot. (Morot), xiv. (1900) pp. 198–202 (5 figs.).
§ Bull. Soc. Bot. Ital., 1900, pp. 327–8.
‖ Bot. Gazette, xxx. (1900) pp. 348–51.

than in the vertical roots. The xylem of the absorptive roots is composed mainly of ducts, that of the vertical roots consists almost entirely of wood-cells.

β. Physiology.

(1) Reproduction and Embryology.

Female Prothallium of the Stigmatæ.*—In his researches on the comparative anatomy of flowering plants, Prof. Ph. van Tieghem proposes the following new terms:—Vascular plants he now terms *Rhizophytes*, divided into *Exoprothalleæ* (Vascular Cryptogams) and *Endoprothalleæ* (Phanerogams), according as the prothallium (unisexual or hermaphrodite) is free in the surrounding medium, or (always unisexual) enclosed within the adult plants. The latter he has already † again classified under Astigmatæ or Nudiovulatæ (Gymnosperms) and Stigmatæ or Tectiovulatæ (Angiosperms).

In the latter group he proposes to apply the term *mesocyst* to the (definitive) central nucleus of the embryo-sac with which the second antherozoid fuses, and the result of this fusion is the *trophime*. The ovum (fertilised oosphere) and the trophime are, in the Stigmatæ, the sole survival of the female prothallium. For the result of the development of the trophime he restores the term *albumen*, the sole function of which is, at one time or another, to serve for the nutriment of the embryo. Nothing of this kind occurs in the Astigmatæ, where there is a true *endosperm*, not the result of a sexual fusion, but the remains of the female prothallium, serving the same purpose as the albumen of the Stigmatæ. There is in the Astigmatæ neither mesocyst, trophime, nor albumen.

While the oosphere perishes without further development if it does not receive an antherozoid, the mesocyst is able to develope even if it does not receive the antherozoid which converts it into a trophime. There are examples of adventitious embryos, not the result of a sexual fusion, as in *Cœlebogyne* and in certain Balanophoraceæ; and, on the other hand, there are plants in which the mesocyst does not develope into an albumen, as in the Orchideæ, Canneæ, Alismaceæ, and Vicieæ.

Double Fertilisation in Compositæ.‡—According to W. J. G. Land, the following is the process of impregnation in *Erigeron philadelphicus* and *Silphium laciniatum*.

In *Erigeron* the pollen-tube passes down a short distance into the embryo-sac, and discharges the male cells, which bore their way through the surrounding cytoplasm. One male cell fuses with the oosphere nucleus, the other with the endosperm nucleus. This latter, after fusion with the male cell, rapidly divides, and soon fills the sac with a mass of nuclei. The fertilised oosphere remains some time in the resting condition, doing little beyond developing a dense membrane and becoming slightly larger. The first wall is transverse.

In *Silphium* the polar nuclei fuse long before fertilisation. The pollen-tube passes down into the embryo-sac and discharges two male

* Journ. de Bot. (Morot), xiv. (1900) pp. 100–4.
† Cf. this Journal, 1897, p. 313.
‡ Bot. Gazette, xxx. (1900) pp. 252–60 (2 pls.). Cf. this Journal, 1900, p. 483.

cells. These cells in some instances leave a well-marked path through the cytoplasm. They retain their coiled form for some time after contact with the nuclei, with which they ultimately fuse, one with the oosphere-nucleus, the other with the endosperm-nucleus. Before fusion is completed they become nearly spherical, being slightly flattened on one side.

Embryogeny of Impatiens and Tropæolum.* — C. Brunotte has studied in detail the anatomical structure, and especially the development of the embryo, in these two genera. The polymorphism of the leaves, and the variations in the conformation of the embryo, offer a strong contrast to the uniformity in the structure of the flower. The lateral nectariferous appendages of the petiole are wanting only in *Impatiens noli-tangere.* This species differs also from the others of the genus in the abortion of its terminal root, its place being supplied by a second whorl of four lateral roots.

The rudiment of the radicle of *I. noli-tangere* is limited by a simple primitive epiderm, like that of the hypocotyl of which it is a prolongation; and this epiderm covers not merely a group of four initial cortical cells placed side by side, as in *I. Balsamina*, but four or five layers of nearly similar cells. In *Tropæolum* the mantle of 10–15 layers of cells which surrounds the epiderm is not, as has been supposed, an epidermal portion of the embryo; it represents, in fact, the enlarged basal portion of the suspensor, which is greatly elongated, and dilated at its lower end, into a parenchymatous projection.

Fertilisation of Stylidiaceæ.†—In a detailed account of the structure of this small order, G. P. Burns discusses the cause and the purpose of the remarkable motions of the gynostemium in the open flower. The sudden movement is caused by unequal growth and by the arrest of this rapid growth. It may take place spontaneously, but only by night and with a high temperature, and the result is then to bring the anther-lobes into contact with the stigma. But it is usually brought about by the irritation of visiting insects attracted by red spots on the labellum. Its effect is then to promote cross-pollination, the pollen being thrown, by the violent bursting of the anther-lobes, on to the back of the insect, and is then taken up, in the next flower visited, by the rough hairs on the stigma. After fertilisation there arise in the embryo-sac two large haustoria, each of which contains two nuclei resulting from the division of the embryo-sac nucleus. The embryo is at this time undifferentiated; the cotyledons are formed only during germination. The observations were made on several species of *Stylidium.* In two species a mycorhiza was observed.

Embryology and Fertilisation of Rhopalocnemis.‡—Dr. J. P. Lotsy describes the structure of the remarkable *Rhopalocnemis phalloides*, a parasite on the roots of different kinds of trees in British India and Java.

* 'Rech. embryogéniques et anatomiques sur quelques espèces d'Impatiens et de Tropæolum,' Nancy, 1900, 10 pls. See Bull. Soc. Bot. France, xlvii. (1900) p. 398. Cf. this Journal, 1900, p. 345.

† Flora, lxxxvii. (1900) pp. 340–54 (2 pls. and 8 figs.).

‡ Ann. Jard. Bot. Buitenzorg, xvii. (1900) pp. 73–101 (12 pls.) (English).

The female flower is reduced to a simple gynæcium consisting of 2–5 carpels, the usual number being two. The male flower consists of a single perianth and one very large stamen, in which the pollen-chambers are simple cavities in a homogeneous tissue. There is no indication of its having been formed by the concrescence of three stamens. The pollen developes normally up to the time of two nuclei being formed, but may later on form three nuclei, which appear to degenerate.

No pollen was observed attached to the stigmas, nor any emission of pollen-tubes. The production of seeds appears to be extremely rare, but does occur. The author believes that in this case the embryo is not produced parthenogenetically as in *Balanophora elongata* and *globosa*, but normally, by impregnation of the ovum-cell. It is possible that the extreme difficulty of pollination in *Rhopalocnemis* has led to apogamy in *Balanophora*. Unlike *Balanophora*, *Rhopalocnemis* is able to form a normal endosperm-nucleus without impregnation.

The systematic position of *Rhopalocnemis* appears to be in the Balanophoraceæ.

Embryo-sac of Helosis.*—Prof. R. Chodat and C. Bernard regard the embryo of *Helosis guayanensis*, belonging to the Balanophoraceæ, as probably an additional example of apogamy, resembling that of *Balanophora elongata*. A marginal cell of the archesporial tissue, always situated at the side of the styles, increases, to become directly the embryo-sac. The sister-cells of the archespore do not, however, perish, but remain distinct up to the period when the generating nucleus of the endosperm is about to divide. There is occasionally a second smaller embryo-sac, or perhaps more correctly, a second ovule. Each of the synergids is a utricular cell prolonged in its upper part into a saddle-like structure directed at right angles outwardly. No fusion appears to take place of the secondary polar nuclei of the embryo-sac; the sister-nucleus of the oosphere developes directly into the endosperm. At the moment when this nucleus, rich in chromatin, divides, the synergids are disintegrated, and the oosphere has become so poor in chromatin as to be scarcely stainable.

Multiplication of the Sporanges in Salisburia.†—Prof. L. J. Celakovsky elucidates several points in the structure of the flower of *Salisburia adiantifolia* (*Gingko biloba*). The male and female flowers present a much greater resemblance to one another than in the other Coniferæ, exhibiting an approach to the Cycadeæ. He regards the male and female flowers of the Coniferæ as homologous to one another, both being true flowers or floral shoots, and not leaf-like outgrowths of the bract, as has been assumed by Delpino and Penzig in the case of the female flowers.

An increase in the number of ovules beyond the normal two is not uncommon, and indicates the great antiquity of the genus as compared to the other Coniferæ, where the number two has become stereotyped. The ovules are normally sessile; occasionally they have a longer or shorter funicle, and, when there are more than two, they are all alike in this respect; i.e. they are either all sessile, or all stalked, the funicles

* Journ. de Bot. (Morot), xiv. (1900) pp. 72–9 (2 pls.). Cf. this Journal, 1900, p. 51.

† Œsterr. Bot. Zeitschr., l. (1900) pp. 229–36, 276–83, 337–41 (5 figs.).

being concrescent in their lower part. A similar multiplication of the pollen-sacs also occurs, though not so often. When the number of pollen-sacs is three or four, they form a true sorus, comparable to that of the Cycadeæ.

The author points out the importance of these facts as indicating that the Cycadeæ are not the most ancient Gymnosperms, from which the Coniferæ are descended, since the latter present a still more ancient form in *Salisburia*, from which the Cycadeæ are derived. The Gingkoaceæ, Taxaceæ, and Pinaceæ must be regarded as three distinct groups of Coniferæ.

Distribution of the Sexes in Diœcious Plants.*—Prof. S. Strasburger has made a long series of experiments on growing *Melandrium album* (*Lychnis vespertina*) under different conditions, with a view of determining the influence of external conditions in promoting the production of male or of female plants. The conclusion arrived at is that no material effect is produced by external conditions, the relative proportion of the sexes being, within certain limits, fixed by heredity. The only mode of varying the relation appears to be by artificial selection.

A number of observations are also recorded on the well-known phenomenon of the so-called castration of the male flowers of this plant by the attacks of the parasitic fungus *Ustilago violacea*. This parasite stimulates the development, in the female flowers, of the rudiments of stamens up to the point when the pollen-mother-cells are produced in a normal manner. But the contents of these cells are then consumed by the parasite, the anther-lobes becoming entirely filled up by its violet-coloured spores. The development of the pistil is also arrested before it arrives at a stage capable of impregnation, and other characters of the male form are assumed. The individuals which present these phenomena are, however, not male plants, as is often stated, but female plants.

Cleistogamous Flowers.†—W. Rössler has studied the cleistogamous flowers of *Juncus bufonius* and *Oxalis Acetosella*.

In *Juncus bufonius* all the grains of a pollen-tetrad may put out tubes. The pollen-tubes do not take the shortest way to escape from the anther, but display many windings. They always emerge from the lateral furrows between the pollen-sacs. After leaving the anther, the pollen-tubes do not always find their way to the stigma. Those that reach the ovary always enter the ovules through the micropyle.

In *Oxalis Acetosella* there is a difference in the period of maturity of the epipetalous and hypogynous stamens; the former put out their pollen-tubes somewhat earlier. The pollen-tubes do not always escape through the sutures of the anthers; they sometimes pass through the anther-wall. As in the previous case, the pollen-tubes do not all find their way to the stigma. Intermediate forms occur between the cleistogamous and the chasmogamous flowers.

Influence of the Number of Pollen-grains on Fertilisation.‡—C. Correns has made a series of observations—chiefly on *Mirabilis*

* Biol. Centralbl., xx. (1900) pp. 657–65, 689–98, 721–31, 753–86.

† Flora, lxxxvii. (1900) pp. 479–99 (2 pls. and 1 fig.). Cf. this Journal, *ante*, p. 58.

‡ Ber. Deutsch. Bot. Ges., xviii. (1900) pp. 422–35.

Jalapa and *M. longiflora*—for the purpose of determining the questions of the relationship between the number of ovules actually impregnated and the number of pollen-grains applied to the stigma, and between the character of the seeds and seedlings and the number of pollen-grains made use of. The results are in favour of the advantage given by the application to the stigma of a large quantity of pollen. It was found that in *M. Jalapa* there is only about one functional to four functionless pollen-grains; and that out of three ovules only two are functional. In *M. longiflora* there was one functional to about three functionless pollen-grains, and about an equal number of functional and functionless ovules. If the stigma is pollinated by a large quantity of pollen, the progeny is stronger (i.e. heavier), from the co-operation of functional pollen-grains with one another. The quicker the pollen-grain makes its way through the style, the stronger are the resulting seeds and seedlings.

Cross-Pollination and Self-Pollination. — In the hermaphrodite flowers of the horse-chestnut, Prof. L. Macchiati * points out that the change in the colour of the patches on the petals, from yellow to red, corresponds to the change in the sexual condition of the proterogynous flowers, and contributes to the efficiency of cross-pollination. The flowers are nectariferous, and are visited by numerous Hymenoptera of the class Apidæ, which visit them first for their honey only, then for both the honey and the pollen, and finally for the pollen only.

In *Hæmanthus tigrinus* (Amaryllideæ), (see p. 179), the flowers are, according to Prof. F. Hildebrand,† capable of both self-pollination and cross-pollination, the latter being apparently effected by honey-birds. Experiments in artificial pollination indicated a distinct advantage in favour of cross-pollination.

The cultivated species of *Chrysanthemum* belonging to the species *C. indicum* and *C. sinense*, are, according to R. Gérard,‡ proterandrous and cross-pollinated. Artificial pollination is likely to prove of great value in the production of new and superior varieties.

Unequal Results of Hybridisation. §— Hugo de Vries adopts Millardet's term pseudo-hybrid ‖ for those products of hybridisation which do not present a combination of the characters of the two parents, the crossing itself being termed *anisogonous*; while those products which exhibit a symmetrical splitting in the formation of their sexual organs are true hybrids, and the process of crossing is *isogonous*. The observations were chiefly made on different species of *Œnothera*, in which genus a much greater variety in the results of hybridisation was observed than in most others, The first generation is sometimes uniform; sometimes it presents two or more distinct forms. The hybrids of this generation usually produce, as the result of self-pollination, only one form of seed; but there are some in which the splitting of characters is displayed. These do not then split into equal, but into unequal portions.

* Bull. Soc. Bot. Ital., 1900, pp. 245-54.

† Ber. Deutsch. Bot. Ges., xviii. (1900) pp. 374–5.

‡ See Bull. Soc. Bot. France, xlvii. (1900) p. 371.

§ Ber. Deutsch. Bot. Ges., xviii. (1900) pp. 435–43. Cf. this Journal, 1900, pp. 484, 609.

‖ Cf. this Journal, 1895, p. 451.

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

Conditions for successful Grafting.* — L. Daniel enters at great length into the modus operandi and the rationale of successful grafting, and insists first of all on a clear definition of terms. The term grafting (*greffage*) must be limited to the operation itself, graft (*greffe*) to the symbiosis of two or more plants. There are two distinct kinds of graft, —grafts by approach or anatomical grafts, and grafts properly so called, which are both anatomical and physiological. The latter may again be divided into ordinary grafts and mixed grafts, the latter alone having both an absorbing and an assimilating apparatus furnished both by the subject (stock) and the graft. The graft by approach is said to be successful when the two plants unite in a durable manner, so that their separation destroys them; a graft properly so called is successful when the graft, developing upon the stock, produces fertile seeds.

The conditions of successful grafting may be classed under two heads,—extrinsic conditions, independent of the plants grafted; and intrinsic conditions belonging to the species grafted. In grafting by approach the absolutely necessary extrinsic conditions are:—(1) the maintenance of the adhesion of the plants; (2) a suitable temperature, neither too high nor too low; (3) the maintenance of the vitality of the symbionts. In the case of grafts properly so called, three other equally important conditions must be added:—(1) the maintenance of the life of the graft and of the stock up to a definite level; (2) the material possibility of the graft to re-establish the turgor which it has lost in cutting; (3) the necessity of never leaving, after the operation, the level of the graft under water. The intrinsic conditions are the mode of cicatrisation, analogy, and the parentage of the symbionts. By analogy is meant such conditions as that one of the symbionts does not produce a substance poisonous to the other; and that each of them must receive a sufficient supply of food.

The botanical parentage of the symbionts for successful grafting is not subject to definite laws. Two species belonging to the same genus or two closely allied genera of the same tribe, may be more difficult to graft on one another than two species belonging to different tribes, as occurs in the Solanaceæ and Compositæ. This is evidently the result of the fact that the dominating characters in classification are essentially the reproductive characters. But analogy in the reproductive apparatus does not necessarily go along with analogy in the vegetative apparatus; hence it may be easier to graft a species on one which differs more widely from it than on one which more closely resembles it in the characters which are ordinarily used for classification.

Development of Etiolated Plants when replaced in the Light.†— H. Ricôme finds that etiolated plants, when again exposed to light, will, in some cases, grow even more luxuriantly than under normal conditions. This is ascribed to the larger stores of reserve food-material contained in the longer stem and larger leaves of those individuals which have developed in the dark.

* Rev. Gén. de Bot. (Bonnier), xii. (1900) pp. 355–68, 405–15, 417–55, 511–29. Cf. this Journal, 1900, p. 693. † Comptes Rendus, cxxxi. (1900) pp. 1251–3.

Absorption of Phosphoric Acid by Plants.*—Experiments made by D. Prianischnikow as to the absorption of phosphoric acid by plants from salts which are only slightly soluble, showed that different plants exhibit different capacities in this respect. The tricalcium phosphate of bones is assimilated much more readily than when the phosphorus is presented in the form of apatite or phosphorite; but the form of phosphoric acid which is most readily taken up by the higher plants is that of freshly precipitated tricalcium phosphate which contains water of crystallisation.

Germination of Hæmanthus tigrinus.†—Prof. F. Hildebrand describes the remarkable phenomena exhibited by this plant and other species of the genus, belonging to the Amaryllideæ. When the fleshy berry bursts, the seeds do not fall to the ground, but remain attached to the open pericarp by very long and extremely elastic mucilaginous threads, which may attain a length of 20 cm., and which are the result of the disintegration of the septa of the ovary. When a bird attacks the fleshy berry, the seeds still remain attached to its beak by these elastic threads; and, in getting rid of them, it carries the seeds to a considerable distance. The germination of the seeds and the early growth of the plant present several interesting peculiarities. The seeds will not germinate unless they are freed from the seed-vessel. The bulbs continue to grow for some time after the commencement of germination, and may increase their size several fold before the appearance of the flower-stalk.

(3) Irritability.

Geotropic Sensitiveness of the Root-tip.‡—F. Czapek replies at length to Wachtel's § criticisms on his previous observations, and gives the results of fresh experiments which support the correctness of Darwin's ascription of a "brain-function" to the apex of the root. He states, however, that too sharp a distinction is often drawn between the root-apex and the zone of growth. Even the apical 2 mm, which are the seat of the geotropic sensitiveness, may, under all circumstances, exhibit a not inconsiderable growth, although a zone of 1 mm. lying behind the apical 2 mm. displays a very much greater power of growth, and may be termed the zone of maximum growth.

Irritability of the Stamens of Berberis.‖—A. Usteri gives a *resumé* of the published observations regarding the movements of the stamens of *Berberis* when touched by an insect or other exciting cause. His own observation leads him to the conclusion that the effect of the irritability is to throw the pollen on to that part of the insect which will come into contact with the stigma of the next flower it visits.

Nature of the Stimulus which causes the Change of Form in Polymorphic Green Algæ.¶—From experiments on a form of *Stigeoclonium* (probably *S. tenue*), B. E. Livingston draws the general con-

* Ber. Deutsch. Bot. Ges., xviii. (1900) pp. 411–6.
† Tom. cit., pp. 372–85 (1 pl.).
‡ Pringsheim's Jahrb. f. wiss. Bot., xxxv. (1900) pp. 313–65.
§ Cf. this Journal, 1899, p. 621.
‖ Helios, 1900, p. 49. See Bot. Centralbl., lxxxiv. (1900) p. 228.
¶ Bot. Gazette, xxx. (1900) pp. 289–317 (2 pls.).

clusion that the changes in form of the alga are due to alterations in the density of the nutrient fluid, i.e. in the osmotic pressure, rather than to changes in its chemical composition. A high osmotic pressure decreases the vegetative activity of the alga, inhibits the production of zoospores, and causes cylindrical cells to become spherical; while a low pressure increases the vegetative activity, accelerates the production of zoospores, and causes cells in process of formation to become cylindrical. The nutrient fluid used was Knop's solution.

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

Chemical Transformations during the Development of the Bud.*—G. André traces a close analogy between the chemical changes which take place during the germination of the seed and the development of the bud. In the case chiefly examined—the development of the bud of the horse-chestnut from the end of February till the first appearance of the flower-buds—a large increase is observable in the amount of soluble amide-nitrogen; and the insoluble albuminoids are probably formed at its expense. There is a remarkable diminution in the amount of carbohydrates, which have been consumed by respiration. Other changes correspond closely to those which take place in germinating seeds.

Photosynthesis.†—According to Dr. G. Pollacci, green organs of plants which grow in sunlight give the aldehyde reaction with Schiff's reagent; while fungi do not, nor do leaves after having been kept for some hours in darkness, or in an atmosphere containing no carbon dioxide. Formic aldehyd reactions may also be obtained from expressed sap. He concludes that formic aldehyd is produced by green organs under the normal conditions of photosynthesis.

Formation of Albuminoid Substances in the Dark.‡—As the result of a series of experiments on *Zea Mais* and *Vicia Faba*, Mlle. M. Maliniak comes to the following conclusions:—The higher plants can elaborate albuminoid substances in the dark. These substances are probably regenerated from amides in the presence of carbohydrates, of saccharose as well as glucose. The specific nature of these carbohydrates is not without influence on the amount of albuminoid substances regenerated.

Formation of the Cinchona Alkaloids.§—Dr. J. P. Lotsy has carried on a series of observations for the purpose of determining the seat of formation of the alkaloids in *Cinchona succirubra* and *Ledgeriana*. He states that the sieve-tubes and the food-storing tissue of the seeds contain no alkaloids, and that they appear in the cotyledons only after these become green. The meristematic tissue is also free so long as it is in an active condition. On the other hand, the alkaloids are always found, at least at certain times, in the parenchyme-cells of the cortex, wood, and leaves. On the death of these cells they may be absorbed

* Comptes Rendus, cxxxi. (1900) pp. 1222–5. Cf. this Journal, 1900, p. 488.
† Atti Ist. Bot. Pavia, vii. (1899) pp. 1–21. See Bot. Gazette, xxx. (1900) p. 358. Cf. this Journal, 1900, p. 343.
‡ Rev. Gén. de Bot. (Bonnier), xii. (1900) pp. 337–43.
§ Bull. Inst. Bot. Buitenzorg, 1900. See Bot. Centralbl., lxxxv. (1901) p. 248.

into the cell-membranes; but otherwise the alkaloids are always dissolved in the cell-sap of living cells; or, in older cells of the secondary cortex, occur as solid amorphous bodies. They often form a combination with tannin; the raphid-cells never contain alkaloids. They are present in the largest quantity in the cortex.

The author was led by his observations to the conclusion that the seat of formation of the cinchona alkaloids is the leaves, whence they travel to the stem, and are there stored up, either in their original form, or after transformation into some other alkaloid. They are not the result of the decomposition of proteids, but are formed by direct synthesis from the reaction of cinchonic acid on ammonia or some compound of ammonia.

Production of Transitory Starch.*—According to J. Grüss, sucrose is the first carbohydrate utilised in the germination of barley, the starch not being used until the embryo reaches a certain stage, and is able to furnish the enzymes necessary for rendering the starch available. The rootlet is enclosed in a gum which probably consists of galactans; this contains a liquefying enzyme.

Origin of Tannin in Galls.†—According to H. Kraemer, the crystalline substance found in the galls of *Quercus coccinea* (probably produced by *Cynips aciculata*) is not tannic, but gallic acid. It appears to be formed at the expense of the starch during the chrysalis stage of the insect. With the maturing of the winged insect this is transformed into tannic acid. The transformation of gallic into tannic acid appears to be a simple process of the combination of two molecules of the former with loss of one molecule of water, according to the equation $2C_7H_6O_5 = C_{14}H_{10}O_9 + H_2O$.

Influence of Carbonic Acid on Fermentation.‡—Dr. H. Ortloff draws the following general conclusions from his investigation as to the influence of carbonic acid on fermentation. On the inverting power of certain yeasts this influence is sometimes accelerating and sometimes retarding. The fermentation of dextrose is apparently rendered more difficult. When fermentation takes place in a current of CO_2, less alcohol is formed, not only the absolute quantity but the quantity relative to the amount of sugar consumed. On the production of acid the action of carbonic acid is not decisive either way. The energy of cell-increase is diminished, and with two exceptions the power of increase also. The fermentation energy is diminished, but the fermentative power is almost invariably notably increased. The individual cell exposed to a current of CO_2 forms more alcohol and more acid than in ordinary fermentation. As far as its total effect is concerned, carbonic acid apparently acts inhibitively on fermentation, though the fermentative power of the yeast-cells is increased by its influence.

Enzymes in Cheese.§—O. Jensen, who has made an elaborate and extensive investigation relative to the intrinsic enzymes in cheese, thus sums up the chief results of his work. The conversion of the casein in

* Woch. Brauerei, xvi. (1899) p. 519. See Journ. Chem. Soc., 1901, Abstr. ii. p. 33.
† Bot. Gazette, xxx. (1900) pp. 274–6.
‡ Centralbl. Bakt., 2te Abt., vi. (1900) pp. 676–82, 721–39, 753–63.
§ Tom. cit., pp. 734–9, 763–74, 791–5, 826–44.

the ripening of Backstein cheese depends chiefly on a pseudo-yeast or bacterial fermentation extending from the surface, which, at any rate at first, is supported by a pepsin digestion permeating the whole mass of cheese. The conversion of the casein in Emmenthal cheese similarly depends on a bacterial fermentation, real and spurious, occurring throughout the whole cheese mass, and this apparently at first is aided by galactase.

Relation of Rennet-Enzymes to Ripening of Cheddar Cheese.*—S. M. Babcock and H. L. Russell, who have made experiments on American Cheddar cheese with rennet, thus summarise their conclusions. Rennet extract exerts a proteolytic effect on the casein of cheese, due to the presence of peptic enzymes contained in rennet extracts, the action of which is intensified by the development of acid in the curd. The soluble nitrogenous by-products formed in Cheddar cheese by rennet are the albumoses or higher peptones that are precipitated by the tannin.

Formation of Enzymes in Alcoholic Ferments.†—A. Klöcker, after discussing whether the formation of enzymes in alcoholic ferments may be used for distinguishing species, comes to the conclusion that Dubourg's contention that yeasts which do not contain a certain enzyme may be induced to produce it if cultivated according to his method, is wrong. Hence the inference drawn by Duclaux is equally wrong, for he says that the action of alcoholic ferments on sugar cannot be used in determining the species. The contrary is the case; for in this action exists the most constant character of the species.

γ. General.

Aphides and Flowers.‡—Prof. L. Macchiati points out that the relation between aphides and the plants they infest is not always one detrimental to the latter. Many species, no doubt, are exceedingly destructive; but others assist the plant in one of two ways:—In some cases they serve the purpose of an extra-nuptial nectary, attracting ants and other insects away from the flowers which they would otherwise destroy. In others, they serve, when in the winged condition, as a floral nectary; visiting the flowers themselves, their sweet excrement attracts Hymenoptera and other pollen-carrying insects in the same way as an ordinary nectary. Various examples are cited of both these uses of aphides.

Myrmecophilous Plants.§—Dr. W. Taliew furnishes a list of about twenty Russian myrmecophilous plants, i.e. such as are furnished with extra-nuptial nectaries or other means for the attraction of ants.

Effect of Annular Decortication on Herbaceous Plants.‖—From experiments made chiefly on species of Cruciferæ and Solanaceæ, L. Daniel suggests that decortication of a zone of the stem may be made use of in practice for increasing the size of the fruit, and bringing about other changes also in its substance, flavour, &c.

* Centralbl. Bakt., 2te Abt., vi. (1900) pp. 817–25 (3 figs.).
† C.R. Trav. Laborat. Carlsberg, v. (1900) pp. 58–63.
‡ Bull. Soc. Bot. Ital., 1900, pp. 284–90.
§ Bot. Centralbl., lxxxiv. (1900) pp. 222–4.
‖ Comptes Rendus, cxxxi. (1900) pp. 1253–5.

Slime on Trees.*—F. Ludwig gives a list of the animal and vegetable organisms observed on the slime of various trees—apple, beech, horse-chestnut, &c., during 1898. The latter include Algæ, Schizomycetes, and several families of Fungi. The author regards lightning as a frequent cause of this flow of slime.

Stigmonose.†—Albert F. Woods has determined that this disease of pinks is due, not, as has hitherto been supposed, to a schizomycete, *Bacterium Dianthi*, but to the attacks of insects, especially of *Rhopalosiphon Dianthi* and of species of Thrips.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Fertilisation in Aspidium and Adiantum.‡—C. Thom has followed out the process of impregnation in several species belonging to these two genera of ferns. As the spermatozoid enters the mouth of the archegone, it consists of a proximal cytoplasmic portion of about one and a half coils, and a distal nuclear portion of about two spiral coils. The cytoplasmic portion is derived from the blepharoplast, and bears numerous long cilia. It either becomes entirely disconnected from the rest of the spermatozoid before entering the oosphere, or becomes functionless and is dragged passively along. The sperm-nucleus consists of an outer homogeneous chromatin mass and an inner ground-substance derived apparently from the nucleoles of the spermatid. The whole body is surrounded by a cytoplasmic envelope. As soon as the nucleus has entered the archegone, it is attracted by the oosphere-nucleus independently of its ciliated anterior end. Before fertilisation the spermatozoid is found coiled in a depression in the oosphere. The oosphere-nucleus has a branching irregular form extending through the cytoplasm in all directions. It contains one or more prominent nucleoles, and a network bearing extremely minute chromatin-granules. The nuclear coils of the spermatozoid lying in the concavity of the oosphere make their way towards its nucleus; and, as soon as it reaches the nuclear membrane, it breaks through it, and, escaping from its cytoplasmic envelope, passes unchanged into the oosphere-nucleus. After entering the oosphere-nucleus, the sperm-nucleus at once assumes a resting stage by breaking up into the nuclear network, bearing fine chromatin-granules. This network is from the first so fused or entangled with the network of the oosphere-nucleus that it is impossible to distinguish any difference between the sexual elements after the form of the spermatozoid has disappeared.

Regenerating Buds of Cystopteris.§—J. Palisa states that the regenerating buds of *Cystopteris bulbifera* and *montana* originate exclusively from epidermal cells; all the epidermal cells near the base of the leaf on its upper side possess the property of regeneration. Comparing the formation of the adventitious buds on fern-fronds (*Cystopteris*

* Zeitschr. f. Pflanzenkrank., ix. (1899) p. 10. See Bot. Centralbl., lxxxiv. (1900) p. 295.

† U.S. Dptmt. Agric. (Div. Veg. Phys. & Path.), Bull. No. 19, 3 pls. and 5 figs., 1900.

‡ Trans. Acad. Sci. St. Louis, ix. (1899) pp. 285–314 (3 pls.).

§ Ber. Deutsch. Bot. Ges., xviii. (1900) pp. 398–410 (1 pl.). Cf. this Journal, 1900, p. 611.

bulbifera, *Asplenium bulbiferum*, &c.), with that of regenerating buds on isolated scales of the adventitious buds of *C. bulbifera*, and on the detached bases of the fronds of various species of *Cystopteris*;—the former begins with the activity of a single epidermal cell; the latter with divisions in a larger number of epidermal cells. The adventitious buds or gemmæ are formed occasionally and singly at definite spots on the plant; the regenerating buds may arise in large numbers in close proximity to one another. Transitional forms occur between the two kinds of bud.

Achromatic Spindle in the Spore-mother-cells of Osmunda. *—R. Wilson Smith has followed out the formation of this structure in the case of *Osmunda regalis*; the following are the more important points brought out.

The achromatic spindle arises wholly from cytoplasm, which accumulates about the nucleus in the synapsis or spirem stage in the form of an indefinite granular mass of stainable matter. The kinoplasm becomes distinctly granular; then the granules arrange themselves into short rows concentric with the nuclear membrane; finally the rows of granules are massed in greatest abundance on opposite sides of the nucleus. The spindle is bipolar from the beginning; usually one pole is formed considerably in advance of the other. The fully formed spindle shows no distinction of central and mantle fibres, and no bodies which can be interpreted as centrospheres. The dissolution of the nuclear membrane is attended by a sudden narrowing and a corresponding increase in length. During the anaphase new secondary fibres are put forth about the poles, and meet in the equatorial region of the cell. In the late anaphase the primary fibres, and soon after them the secondary fibres, begin to disintegrate, taking the appearance of beaded threads, and then of granules. The spindles of the second division are constructed out of the granular products arising from the disintegration of the first spindle. The phenomena of the second spindles exactly repeat those of the first, except that four secondary spindles are formed by the union of the secondary fibres put forth during the anaphase. Cell-plates are formed across the six spindles, and in connection with them the separating walls of the spores are laid down.

Fructification of Palæozoic Lycopods. †—Dr. D. H. Scott states that the bodies from the Coal-Measures described by Williamson under the name *Cardiocarpon* are really the fructification of a Lycopod, which occupies the boundary line between Spermaphytes and Sporophytes. He proposes for it the generic name *Lepidocarpon* g. n., with the following characters. Strobilus with the characters of *Lepidostrobus*, but microsporanges and megasporanges each surrounded by an integument, growing up from the upper surface of the sporophyll; megasporange completely enclosed in the integument except for a slit-like micropyle along the top; a single functional megaspore developed in each megasporange; sporophyll, together with the integumented megasporange, detached entire from the strobilus, the whole forming a closed seedlike reproductive body.

* Bot. Gazette, xxx. (1900) pp. 361-77 (1 pl.).
† Proc. Roy. Soc., lxvii. (1900) pp. 306-9. Ann. of Bot., xiv. (1900) pp. 712-6.

Muscineæ.

Ephemeropsis Tjibodensis Goeb.* — M. Fleischer gives a full description of this little-known moss, the protoneme of which forms round greenish-yellow or reddish-brown spots on the leaves and stems of ferns and flowering plants in Java. He regards it as the type of a distinct family nearly related to the Hookeriaceæ in the structure of the sporogone and peristome.

Braithwaite's British Moss-Flora.—Part XX. of this work is just published, and continues the description of the Hypnaceæ. The genus *Hypnum* (including Brachythecium) is completed, numbering 43 British species, and is followed by the small genera *Lesquereuxia* (4 sp.), *Isothecium* (2 sp.), *Pterogonium* (1 sp.), and *Pterygynandrum* (1 sp.). The six plates, Nos. 103–108, are of the usual excellence.

Cell- and Nuclear-Division in Hepaticæ.†—J. M. Van Hook finds the process of the formation of the cell-plate to be essentially the same in *Anthoceros* and *Marchantia*. In the cells of the stalks of the archegoniophore of *Marchantia*, the first noticeable evidence of nuclear division is the pulling out of the nuclear membrane, generally in the direction of the long axis of the cell, into two points which are opposite to each other, and around which the chloroplasts tend to collect. At each point from which conspicuous radiations extend is a minute body. These are the centrospheres, which seem undoubtedly to exert a great attractive force. The centrosomes appear as dark round bodies at the centre of the centrospheres. They become invisible as soon as the polar radiations have disappeared. As the nucleus increases in length, the radiations become exceedingly distinct, and extend further over the nuclear membrane, which they penetrate. Before they meet at the middle from the two centrosomes to form the spindle, the linin threads have become more conspicuous, with thickened or knotty portions appearing as chromatin. The number of chromosomes appears to vary between five and eight. When the spindle-fibres have extended to the region of the equator, the nuclear membrane disappears, and the spindle is formed.

In the formation of the spore-mother-cells of *Anthoceros* no centrosphere could be detected.

Algæ.

Agardh's Analecta Algologica.‡—The last of the contributions of the late Prof. J. G. Agardh to our knowledge of the Florideæ consists of a number of detached articles, the most important of which is a detailed review of the sub-genera and species of the genus *Gigartina*. In the course of the remaining papers, the following new genera are established.

Dactylymenia, nearly related to the Kallymenieæ. Cystocarpia nucleolis pluribus invicem disjunctis, intra cellulas rotundatas singulis, sensim in nucleum validum, in media fronde nidulantem conjunctis constituta, gemmidia plurima sine ordine distincto conglobate foventia

* Ann. Jard. Bot. Buitenzorg, xxvii. (1900) pp. 68–71 (2 pls.).

† Bot. Gazette, xxx. (1900) pp. 393–9 (1 pl.).

‡ Continuatio v., Acta Univ. Lund, xxxv. (1899) 160 pp. and 3 pls. Cf. this Journal, 1899, p. 307.

sphærosporæ intra cellulas strati corticalis extimas generatæ, validæ, zonatim quadradivisæ.

Gloiohymenia, near to *Gloiocladia*. (*Gloiohymenia ornata* = *Callophyllis ornata* J. Ag.)

Hymenophlæa (separated from *Halymenia*). Cystocarpia intra pericarpium demum subglobosum, supra frondem eminens, apice carpostomio pertusum, nucleum subglobosum simplicem a plano basali erectiusculum, filis tenuissimis, invicem superne quasi liberis simpliciusculis, moniliformibus, quoquoversum sursum radiantibus contextum, gemmidiis intra articulos elliptico-oblongos numerosis seriatis.

Collinsia; a new genus with the habit of *Iridæa*, but nearly related to *Grateloupia* in the structure and arrangement of the cystocarps.

Heterocystis; founded on *Chrysimenia Enteromorpha* Harv.

Helminthiopsis, separated from *Helminthocladia*. Cystocarpia intra stratum filorum corticalium immersa, corymbo ramellorum involucrantium cincta, gemmidia dense conglobata foventia.

Ardissonea g. n. Helminthocladiacearum. Cystocarpia certo loco—infra apices acuminatos ramulorum conspicue intumescente—circumcirca generata, intra stratum filorum corticalium, hoc loco magis evolutum, nidulantia, subglobosa, demum in gemmidia pauca sine ordine bene conspicuo secedentia.

Endosira, allied to the Helminthocladiaceæ. No reproductive organs; the vegetative organs only are described.

Haliacantha g. n. Wrangeliacearum. Cystocarpia a ramo nudo lateraliter erumpente transformata, fasciculum terminalem, gemmidiis pyriformibus quoquoversum radiantibus validis contextum, ramellis elongatis melioribus involucrantibus cinctum continentia; sphærosporæ in ramellis monosiphoneis externæ et subsingulæ, demum in ramo adparenter proprio inter cellulas ejusdem provenientes immersæ, triangule divisæ.

Micropeuce g. n. Rhodomelearum, most nearly related to *Trigenea*. Sphærosporæ inter apices ramorum polysiphoneos provenientes, ob adparatum ramulorum bracteantium in stichidium quasi strobilaceum conjunctæ, intra cellulas stichidii brevissimas, spirali ordine parum conspicue dispositas, singulæ provenientes, demum eruptæ in axilla ramulorum receptæ, validæ, quasi granulis formatæ, triangule divisæ.

Some general remarks are appended on the structure and arrangement of the cystocarps, sphærospores, and antherids in the Florideæ.

The following new genera are also described.

Pyropia g. n. near to *Porphyra*.

Scænophora g. n. Fucacearum, most nearly related to *Cystosira*. Frons pinnatim decomposita, caule proprio ramisque firmioribus teretiusculis, ramulisque conspicue diversis, capillaceis, ex tereti compressis, dichotome subpinnatis, corymbos laterales et terminales formantibus; vesiculæ nullæ; scaphidia in ramulis capillaceis, aliter non transformatis, inflata, sparsius v. densius superposita, interjecto spatio sterili longas series plus minus conspicue moniliformes formantia, singulis sub utrinque prominulis, ubi densiora in seriem moniliformem conjuncta.

Rhodochorton islandicum, a new terrestrial Floridea.*—L. Kolderup Rosenvinge makes an addition to the very small number of terres-

* Bot. Tidsskr. xxiii. pp. 61–78 (4 figs.). See Bot. Centralbl., lxxxiv. (1900) p. 378.

trial Florideæ at present known, in *Rhodochorton islandicum*, a species nearly allied to *R. Rothii*, forming a dense violet-red felt on the walls and roofs of dry caves. It puts out both erect and horizontal branches, but the latter are not organs of attachment, but simply stolons.

Rings in Œdogonium.*—Karl E. Hirn has paid special attention to the structure of the rings or cushions which are found in connection with cell-division in the filament of the different species of *Œdogonium*. Treatment with chemical reagents shows that each cushion is composed of a central mucilaginous mass, surrounded by a coating of cellulose, which does not arise from an infolding of the original cell-wall, but is formed, after the protoplasm has excreted the mucilage, as an inner cell-wall layer, which becomes intimately concrescent with the old membrane above and below the ring.

Lessonia.†—In *Lessonia littoralis* Prof. C. MacMillan finds no important difference from other Laminariaceæ, either in the structure of the tissues or in the distribution of the sori. The zoned appearance of a section of the stem is due to the increase in thickness being the result of the activity of a hypodermal cambium; this rhythmical growth does not necessarily correspond to an annual period. The species has two kinds of leaf, broader and narrower, of which the former only bear sori.

Nuclear Division in Spirogyra.‡—C. van Wisselingh has continued his researches on the mode of division of the nucleus in *Spirogyra*, which differs, in several interesting particulars, from that in other plants. The species employed were *S. setiformis*, and a form nearly allied to *S. polytæniata*, described as a new species under the name *S. triformis* sp. n. The fixing material used was a strong solution of chromic acid.

In *S. setiformis* the division of the nucleus is never accompanied by the formation of segments, the process differing in some points from that in *S. crassa* and in *S. triformis*, in which respectively 12 and 6 segments are always formed. The form of karyokinesis seems to be always constant for the nuclei of the same filament, as well as the number of segments when segmentation takes place. Whether the filaments remain sterile or conjugate does not affect the process. In *S. triformis*, when segmentation takes place, of the 12 or 6 segments, 10 or 4 respectively are always formed from the substance of the nucleus, the other two either from it or from the nucleoles; for when one nucleole is present it always contains two threads; when there are two nuclei, each contains one. The remaining constituents of the nuclei become absorbed in the nucleoplasm when karyokinesis takes place; while in *S. setiformis* balls are also formed.

Multinucleated Cells of Spirogyra.§—From culture experiments on *Spirogyra triformis* sp. n. (*vide supra*), C. van Wisselingh has arrived at somewhat different results from those of Gerassimoff.‖ The following

* Acta Soc. Scient. Fennicæ, xxvii. (1900) pp. 4–8 (2 figs.). Cf. this Journal, *ante*, p. 65.
† Bot. Gazette, xxx. (1900) pp. 318–34 (3 pls.).
‡ Flora, lxxxvii. (1900) pp. 355–77 (1 pl.). Cf. this Journal, 1899, p. 186.
§ Tom. cit., pp. 378–86 (13 figs). ‖ Cf. this Journal, 1892, p. 829.

are the chief points in which his conclusions differ from those of the previous observer.

By the method of culture employed, in glass vessels, a uninucleated gave rise to a binucleated cell when karyokinesis took place, but the formation of septa was partially or entirely suppressed. In the multinucleated cells the nuclei lay in the axis of the cell, as in the normal uninucleated cells. No specially large or compound nuclei were obtained. When karyokinesis was repeated in the binucleated cells, and the formation of septa still suppressed, cells with 3, 4, or more nuclei were obtained. Cells with 1, 2, 3, 4, or more nuclei occurred in the same filament, and the number of nuclei did not affect the thickness of the filament. No evidence was obtained of an hereditary transmission of the abnormal condition. The phenomena were not necessarily connected with a retardation of karyokinesis.

Branching of Cladophora and of some Monosiphonous Algæ.*—M. Nordhausen regards the basal branching of the cells in a filament of *Cladophora* as a peculiar process, to which there is nothing strictly comparable in other Algæ. In monosiphonous Algæ—*Ceramium*, *Griffithsia*, &c.—the angle made by branches of the same order varies in size; it increases, on the whole, towards the base of the plant. This difference is the result of a constant variation in each angle. These changes follow a distinct law, and are dependent on processes of growth connected with the life of the plant, especially with its growth in thickness.

Polarity and Regeneration of Bryopsis.—H. Winkler † criticises Noll's explanation ‡ of the fact that the reversal of the position of a filament of *Bryopsis muscosa* converts the aerial root into a rhizoid, and *vice versa*. He refers it to heliotropic influences rather than geotropic, as Noll does.

Replying to this paper, F. Noll § says that Winkler's conclusions and his own are not out of harmony. He further points out the confusion that arises from the use of the term cell both for a dead structure and for a mass of living protoplasm inclosed in a cell-wall. He proposes to adopt Sachs's term "energid" for the latter, retaining Kölliker's term "protoblast" for the protoplasmic constituent of an energid. An energid is bounded by a single continuous parietal utricle, and may be uninucleated or multinucleated.

Nuclei of the Lower Algæ. ‖—Prof. R. Chodat and Mlle. Cretier have determined the position of the nucleus and pyrenoid in a number of the lower green Algæ. A plurality of pyrenoids was observed in *Raphidium pyrenogerum* sp. n., but this does not carry with it an increase in the number of nuclei, of which there is only one. In *Actinastrum* the original position of the nucleus is central; on division it becomes basilar in the daughter-cells, and divides laterally (longitudinally) in this position. In *Botryococcus* there is also one nucleus in the cell, but the chromatophore contains a smaller body resembling a nucleus, but which is rather a pyrenoid without an amylosphere. The same is the case with *Hydrurus*.

* Pringsheim's Jahrb. f. wiss. Bot., xxxv. (1900) pp. 366–405 (1 pl.).
† Tom. cit., p. 449 (3 figs.). ‡ Cf. this Journal, 1889, p. 421.
§ Ber. Deutsch. Bot. Ges., xviii. (1900) pp. 444–51.
‖ Arch. Sci. Phys. et Nat., x. (1900) pp. 387–8.

Pure Cultures of the Lower Algæ.* — Prof. R. Chodat and M. Grintzesco find a medium containing gelose very favourable for pure cultures of many of the lower Algæ, which were obtained free from Fungi and Schizomycetes. The authors were able to confirm Chodat's previous statement of the polymorphism of many of the Protococcaceæ, especially of *Scenedesmus acutus.*

Variations in the Structure of a Green Alga in Different Media.† —L. Matruchot and M. Molliard describe the changes effected by growth in or on various media in a unicellular alga, *Stichococcus bacillaris.* They extend to the form and size of the cells, to their grouping in colonies, and to the number and form of the chloroleucites, there being only one in the normal aerial form of the alga. No septation of the cell was in any case observed, and there was never more than a single median nucleus.

Fungi.

Reproduction of Polyphagus Euglenæ.‡ — Prof. P. A. Dangeard gives a detailed account of the life-history of this parasite on *Euglena.* The discovery of cysts with a single nucleus, but externally like the zygospores, is interesting; the occurrence of both cysts and zygospores in one species has not been previously observed in Chytridineæ. The gametes are at first without any sexual attraction, which developes after a vegetative period, and Dangeard finds in this a confirmation of his view that sexual phenomena merely express a particular phase of the general nutritive life. In regard to the nuclear fusion, it is pointed out that the two nuclei of the zygospore appear to be mutually indifferent for a long time; attraction is manifest only at the moment of germination.

New Genera of Fungi. — In an account of the parasitic algæ and fungi of Java, M. Raciborski § describes a large number of new species, and the following new genera, of fungi:—

Goplana g. n. forms a connecting-link between the Uredineæ and the Auriculariaceæ, between *Stypinella* and *Coleosporeum*. *Balladyna* g. n. (Perisporiaceæ) is characterised by stalked peritheces containing a single ascus. *Anhellia* g. n. (Myriangeæ), parasitic on leaves of a *Vaccinium*, producing black hypodermal apotheces. *Lambro* g. n. (Hypocreaceæ), allied to *Polystigma* and *Valsonectria*. *Konradia* g. n. (Hypocreaceæ), epiphytic, with rusty black fructification, and ascopores at first filiform, then breaking up into spherical fragments. *Mendogia* g. n. (Hysteriaceæ), distinguished from *Hysterographium* by having several peritheces in the stroma. *Iridyonia* g. n. (Phacidiaceæ) ascospores fusiform, 2-celled, with one or two spines at the end. *Skierkia* g. n. (Uredineæ), allied to *Hamaspora*, but with 1-celled sessile teleutospores. *Kordyana* g. n. (Exobasidieæ), founded on *Exobasidium Tradescantiæ*. *Lelum* g. n. (Exobasidieæ), producing galls on a *Persea*. *Beniowskia* g. n. (Fungi imperfecti), parasitic on leaves of *Panicum nepalense.*

* Arch. Sci. Phys. et Nat., x. (1900) pp. 386–7.

† Comptes Rendus, cxxxi. (1900) pp. 1248–51.

‡ Le Botaniste (Dangeard), vii. (1900) pp. 213–57 (2 pls. and 3 figs.).

§ Parasit. Algen u. Pilze Javas, ii. and iii., 46 and 49 pp., Batavia, 1900. See Bot. Centralbl., lxxxiv. (1900) p. 316.

In the collection made by Bornmüller in Syria in 1897, P. Magnus * finds a number of new species of Fungi, and a new genus of Perisporiaceæ, *Pampolysporium*, distinguished from the other genera of the order by the large number (up to 32) of 2-celled hyaline spores in the ascus.

On the rhizome of *Carex vesicaria*, in swampy situations, T. Plöttner † has found a fungus which he names *Leotiella caricicola* g. et sp. n.; the genus, which belongs to the Leotieæ, having the following diagnosis:—Receptacle gelatinous, the portion which bears the hymenium flatly capitulate, bulbous, recurved downwards at the margin; spores filiform, undivided.

Experimental Aspergillosis.‡—Dr. T. A. Rothwell has found from experiments that both *Aspergillus niger* and *A. fumigatus* are capable of producing lesions which resemble one another histologically; but whereas the injection of *A. fumigatus* caused the death of the animal, that of *A. niger* never did. Both organisms are capable of germinating in the living tissue, but *A. fumigatus* much more so than *A. niger*. The animals experimented on were guinea-pigs and rabbits. The organs contained nodules (pseudo-tubercles) composed of epithelioid cells, giant-cells, and leucocytes. The giant-cells were scattered throughout the nodules, and many presented phenomena of phagocytosis, containing either particles of mycele or spores.

Movements of the Protoplasm and Formation of the Reproductive Organs in Ascophanus carneus.§—Charlotte Ternetz has studied the interesting phenomena in this fungus, which made its appearance in Myxomycete-cultures, and which is readily cultivated on the ordinary media.

Ascophanus carneus produces glycogen on all media, whether solid or fluid. On all substrata and in the air it forms gemmæ, which possess a great power of resistance to deficient nutriment or moisture.

The movement of the protoplasm, which is clearly seen in cover-glass cultures, is neither a circulation nor a rotation, but a streaming. The current passes without difficulty through the cell-walls, possibly through a central opening, and always maintains the same direction. The motion ceases in the gemmæ, where the cell-walls are closed. Its purpose appears to be the counteraction of differences of turgor in different parts of the filament.

Light and a saturated atmosphere are essential to production of the ascus-fructification. The quality of the light is indifferent, but fructification takes place only when the direct supply of nutriment is checked or suspended. A nitrogenous substratum is, however, essential. The differentiated initial organ, the ascogone, archicarp, or carpogone, closely resembles the vermiform body, or "scolecite" of Tulasne.

Structure of the Melanconieæ.‖—Prof. L. Montemartini has studied the structure of this group of Fungi, and its relation to the Hyphomycetes and the Sphæriaceæ. The differential characters of the three

* Verhandl. k. k. Zool.-bot. Ges. Wien, 1900, p. 444.
† Hedwigia, xxxix. (1900) Beibl., pp. 197–8 (1 fig.).
‡ Journ. Pathol. and Bacteriol., vii. (1900) pp. 34–52 (1 pl. and 4 figs.).
§ Pringsheim's Jahrb. f. wiss. Bot., xxxv. (1900) pp. 273–312 (1 pl.).
‖ Atti Ist. Bot. r. Univ. Pavia, vi. (1899) 44 pp. and 2 pls. See Bull. Soc. Bot. France, xlvii. (1900) p. 381.

groups are presented as follows:—The Hyphomycetes have superficial free conidiophores; in the Melanconieæ the conidiophores are united at the surface into the stroma, a kind of hymenium; in the Sphæriaceæ the more or less reduced conidiophores are included in receptacles known as pycnids. The Melanconieæ, as at present limited, comprise more than 850 species; the genera *Glœosporium*, *Myxosporium*, *Hypodermium*, *Blennoria*, *Trullula*, *Bloxamia*, *Colletotrichum*, *Cryptosporium*, *Melanconium*, *Thyrsidium*, *Bullaria*, *Marsonia*, *Stilbosporia*, *Coryneum*, *Scolecosporium*, *Asterosporium*, *Pestalozzia*, *Septoglœum*, *Steganosporium*, *Phragmotrichum*, being described in detail.

The author concludes that a large proportion of the Melanconieæ should be reunited to the Hyphomycetes, of which they appear to be forms adapted to parasitic life by the following modifications:—a diminution in the number of conids; a reduction and fasciation of the conidiophores for a mechanical purpose; a tendency to the formation of pycnids by the excavation of the proliferous stroma; a development of paraphyses which assist the dissemination of the conids; the formation of special mechanical organs (columel of *Melanconium*); interweaving of the mycele into a rounded mass.

Parasitic Fungi.—Under the name *Neovossia iowensis* sp. n., E. R. Hodson * describes a new fungus gathered in Iowa, parasitic on the ovary of *Phragmites communis*.

The parasitic fungus which devastates onion plantations is now regarded by L. Mangin † as a form of the polymorphic *Fusarium roseum*.

An exceedingly destructive disease of violets cultivated in America, known as the spot disease, and believed to be of American origin, is described by P. H. Dorsett,‡ and is attributed by him to a hitherto undescribed parasitic fungus which he names *Alternaria Violæ* sp. n.

Dr. M. Woronin § deals in detail with the two allied species of parasitic fungus, *Sclerotinia fructigena* Schröt., which attacks all kinds of stone-fruit, and *S. cinerea* (Bon.) Schröt., to which the cherry is especially liable, and decides them to be distinct species, both belonging to the genus *Sclerotinia*. The infection of the flower takes place through the stigma. The plates, which are 4to size, are beautifully executed.

A disease which is becoming very destructive in Canada to *Abies alba* and *balsamea* is referred by Mr. W. Doherty ‖ to a new species of *Trimmatostroma*, *T. abietina*, belonging to the Hyphomycetes. It attacks chiefly the leaves.

After reviewing the conclusions of previous observers on the subject, P. Magnus ¶ gives the results of his own most recent researches, viz. that on the alpine species of *Primula* belonging to the section Auriculastrum, there are four distinct species of parasitic Uredineæ, viz. a species of *Aut-eu-Uromyces* on *P. viscosa*; a species of *Uromycopsis* on

* Bot. Gazette, xxx. (1900) pp. 273–4 (1 fig.).

† Comptes Rendus, cxxxi. (1900) pp. 1244–6.

‡ Bull. No. 23 U.S. Deptmt. Agric. (Div. Veg. Phys. and Pathol.), 16 pp. and 7 pls.

§ Mem. Acad. Imp. Sci. St. Pétersbourg, x. (1900) 38 pp. and 6 pls.

‖ Bot Gazette, xxx. (1900) pp. 400–3 (3 figs.).

¶ Ber. Deutsch. Bot. Ges., xviii. (1900) pp. 451–60 (1 pl.).

P. integrifolia; an isolated æcidium on *P. Auricula* and nearly related species; and a *Micro-Uromyces* on *P. minima*.

Fungus Diseases of Conifers.* — H. von Schrenk treats in detail of some of the more destructive diseases to which Conifers are liable in New England, the nature of the injuries inflicted, the fungus parasites by which they are caused, and the best remedies. The species of fungus to which special attention is drawn are *Polyporus Schweinitzii*, *P. pinicola*, *P. sulfureus*, *P. subacidus*, and *Trametes Pini*, *forma Abietis*.

Fungi Parasitic on Green Algæ.† — Prof. C. Gobi finds, on *Chloromonas globulosa*, a very destructive parasitic fungus, which he describes as a new species under the name *Rhizidiomyces ichneumon*. The swarm-spores of the parasite settle on both the motile and resting cells of the alga, and establish a connection between their protoplasm and that of the host. Dead and dying filaments of a *Vaucheria* were found to be attacked by a species of *Pythium*, *P. tenue*, chiefly noticeable from the fact that the end of the antheridial filament is not cut off by a distinct wall.

Variation of Saccharomyces.‡—E. C. Hansen gives a succinct *resumé* of his previous writings on the variation of *Saccharomyces*, and deals with the shape of the cells, the formation of spores and budding, the chemical actions, and the variation in brewers' yeast. New observations on asporogenous varieties are also recorded, in the course of which the author goes into the fundamental question whether the variation is due to transformation or selection, and decides in favour of the former, on the ground that it is a general phenomenon always present when the cultivations are made under certain given conditions.

Cytology of the Gasteromycetes.§ — R. Maire has studied the cytology of this order of fungi, chiefly in the following genera :—*Scleroderma*, *Geaster*, *Lycoperdon*, *Nidularia*, *Cyathus*. In all cases the fusion of two nuclei was observed only in the young basids; the sub-hymenial cells always contain two nuclei. Many old cells belonging to other tissues contain also a varying number of nuclei, but these are the result of amitotic fragmentation of the two primitive nuclei; the number of chromosomes was an even number in all the species studied.

The study of the basids is especially interesting in *Scleroderma vulgare*. At the commencement of the prophase of the first division, the cytoplasm contains a number of granules stained black by ferric hæmatoxylin, round which radiate the microsomes. It would appear that two of these granules become the centrosomes, for a little later two of these only are seen as centres of radiation; they are then placed one on each side of the nucleus; the nucleole and the nuclear membrane soon disappear, while the chromatic network is transformed into two irregular knotted rods which represent two chromosomes, and which soon stretch from one centrosome to the other. A spindle is at the same time formed

* Bull. No. 25 U.S. Deptmt. Agric. (Div. Veg. Phys. and Pathol.), 56 pp., 15 pls., and 3 figs.

† Script. Bot. Hort. Univ. Imp. Petropol, xv. (1899) pp. 211, 251–92. See Bot. Gazette, xxx. (1900) pp. 426, 427.

‡ C.R. Trav. Lab. Carlsberg, v. (1900) pp. 1–38 (5 figs.).

§ Comptes Rendus, cxxxi. (1900) pp. 1246–8.

between the centrosomes; the two chromosomes then divide longitudinally. They then move towards the poles, and reunite into a chromatic mass which masks the centrosome, and from which the rays of the aster now seem to radiate. The spindle soon disappears, and the second division commences almost immediately. This takes place in the same way as the first division; the four centrosomes appear to determine the formation of the four spores.

The same process takes place in the other genera, with slight modifications.

Boring Growth and the Abnormal Formation of Conids in Dematium pullulans.*—A. Klöcker and H. Schiönning state that their researches lead to the conclusion that the phenomena of boring growth are of frequent occurrence in *Dematium pullulans* de Bary and in certain species of *Oidium*, just as happens in many other fungi. Conids are formed within certain cells, and the conditions for the formation of these conids are defective nutriment and too much air and moisture. True endospores are not formed in these corpuscles, as Weleminsky asserted, and his inference that *Dematium pullulans* should be placed among the Ascomycetes † near to *Saccharomyces* and *Exoascus* was wrong.

Dematium pullulans should, as heretofore, be classed with "Fungi imperfecti." Like Weleminsky, the authors had no success in their endeavour to discover a genetic relation between *Saccharomyces* and *Dematium*.

Endotrophic Mycorhiza of Neottia nidus-avis. ‡—Werner Magnus has made an exhaustive study of the mycorhiza of the birds'-nest orchis, which differs in several points from that of other Orchideæ.

In the root it is exclusively the 3–4 outermost layers of cells beneath the exoderm that are infected; in the rhizome and aerial stem as many as six layers may be attacked. In the root-cells the fungus is differentiated into two perfectly distinct forms, with no transitional grades. In the "host-cells" (*Pilzwirthzelle*) the fungus exhibits no degeneration; thick-walled hyphæ run along the cell-walls, and send out finer thin-walled hyphæ which traverse the entire cell and are adapted for nutritive purposes. In the "digestive cells" (*Verdauungszelle*) the fungus is always degenerated; thin-walled hyphæ rich in protoplasm permeate the cell in dense balls, which die, and the contents of the hyphæ are absorbed and digested by the cell, leaving a perfectly indigestible and unchangeable residue, which becomes transformed into a cellulose-like substance. The digestive cells occupy the outer and inner, the host-cells the central layers. In the rhizome there is not the same regular differentiation. A third symbiont, a parasitic fungus (undetermined), lives on the undigested residue.

The protoplasm forms a continuous layer round the fungus in the cell, and is copiously renewed. The digestive cells seem to serve exclusively for the nutrition of the more highly organised of the two symbionts; the host-cells for that of the fungus-symbiont, which carries on in them a parasitic existence, and forms organs which can hibernate outside the plant.

* C.R. Trav. Laborat. Carlsberg, v. (1900) pp. 47–57 (6 figs.).
† Cf. this Journal, 1899, p. 520.
‡ Pringsheim's Jahrb. f. wiss. Bot., xxxv. (1900) pp. 205–72 (3 pls.).

Myxomycetes.

Cell and Nuclear Division in Fuligo varians. * — Prof. W. A. Harper has followed out these processes in detail, and finds that they differ considerably from those described by Strasburger in *Trichia*. The following are among the more interesting points brought out.

The author dissents altogether from Rosen's statement that there are two kinds of nucleus, believing the apparent difference to be the result of inequalities in fixation. In the formation of the æthalium the segmentation is very clearly a progressive process proceeding from the periphery toward the centre. There is no such thing as a simultaneous breaking up of the protoplasm into uninucleated fragments. Nuclear division proceeds during the whole process of cleavage, but without any relation to the latter process. Karyokinetic figures can be found oriented in all possible ways to the cleavage furrows. The difference in this respect is striking between *Fuligo* and *Trichia*. With the formation of uninucleated segments whose nuclei divide no more, the process of cleavage is complete.

In spite of their very small size, the structure of the resting nuclei conforms to that in fungi and the higher plants; but the prophases in spindle-formation cannot be clearly followed. All stages of the separation of the daughter chromosomes and their migration to the poles of the spindle can be found in the greatest abundance.

The æthalium and the sporanges of the Myxomycetes differ from the sporanges of *Synchytrium*, *Pilobolus*, and *Sporodinia*, in that the multinucleated condition in the former originates at least in the formation of the plasmode. The plasmode is clearly equivalent physiologically to the multinucleated masses of protoplasm in these and other fungi. *Fuligo* differs from these fungi in the fact that the uninucleated segments formed by the completion of the cleavage process (protospores) become the functional spores directly without further growth or nuclear division.

Crown-Gall.†—J. W. Toumey has studied the disease to which this name is given, and which causes fleshy outgrowths on the roots of deciduous fruit-trees, usually at the crown. He attributes it to an undescribed Myxomycete which he makes the type of a new genus *Dendrophagus*, somewhat resembling the *Plasmodiophora* which causes club-root in cabbages. The species is named *D. globosus*. The plasmode is found in the enlarged cells of the wen, where it destroys the protoplasm, and induces the formation of a mass of spongy parenchyme, in the cells of which the plasmode multiplies. Under favourable conditions sporanges are formed on the outside of the wen, appearing at first like small transparent drops. The sporange is about 1 mm. in diameter, nearly globular, and dark orange. The orange-yellow spores germinate almost the moment they are placed in water.

Protophyta.

β. Schizomycetes.

Influence of One Organism on the Growth of Another.‡—Dr. A. Cantani, jun., records some observations which indicate that the growth

* Bot. Gazette, xxx. (1900) pp. 218–51 (1 pl.).
† Arizona Agric. Exp. Stat. Bull. No. 33, 1900, 64 pp., 1 pl., and 31 figs.
‡ Centralbl. Bakt., 1[te] Abt., xxviii. (1900) pp. 743–7

of one organism in a certain medium is facilitated by the presence of other bacteria both in the living and in the sterilised condition. For example, the influenza bacillus was found to be easily cultivable, even on pepton-agar plates, in conjunction with *Gonococcus* and *B. diphtheriæ*. Sterilised cultures gave similar results, but the inoculations had to be made directly, otherwise the growth was poor. From this the author is inclined to think that the composition of the medium has little to do with the promotion of growth, and that the influence is due to something existing in the bodies of the bacteria.

Bacterial Self-Purification of Streams.* — Dr. E. O. Jordan, who has made numerous and important observations on the bacterial self-purification of streams, discusses the chief causes which are adduced as the essential factors in the process. These are mechanical agitation and aeration, dilution, the action of sunlight, the influence of plankton, sedimentation, and the exhaustion of the food supply. Most importance is assigned to the last two factors, and the author believes that in the causes connected with insufficiency or unsuitability of the food supply is to be found the main reason for the bacterial self-purification of streams.

Vitality of Acetifying Bacteria.†—E. C. Hansen, in a third memoir on acetifying bacteria, deals with the limit of vitality of three species, viz. *B. aceti*, *B. pasteurianum*, and *B. kützingianum*. In media such as beer, double beer, 10 p.c. cane sugar, and distilled water, the limits of vitality were found to be from over ten years (beer) to a few months (water). Then follow some observations on the variation of these three species, the test of variation and of their transformation being whether the cells stained with iodine solution or not.

Biology of Peptonising Milk Bacteria.‡—The results of the researches of O. Kalischer on the action of an aerobic peptonising milk bacterium are as follows. The milk-sugar is slowly diminished. The bacteria did not produce a soluble ferment capable of inverting lactose; but a ferment which inverted cane-sugar was formed. The presence of volatile acids, valerianic and acetic, was detected. Grape-sugar was more strongly attacked by the bacteria than milk-sugar. In grape-sugar solutions the bacteria grew throughout the whole depth of the medium, but in lactose solutions only on the surface. The fat was not attacked, and a diastatic ferment not formed. Casein was converted into albumose, and later into pepton, ammonia, leucin, tyrosin, aromatic oxyacids, volatile acids, and a mixture of bases, but no indol or phenol. The ferment produced by the bacteria is practically identical with trypsin. The rennet ferment formed by the bacteria had similar properties to those of the ordinary rennet ferment.

New Chromogenic Micrococcus.§—Mary Hefferan describes a coccus, *Micrococcus roseus flavus*, producing a salmon-pink pigment, which was isolated from Mississippi river water on plates composed of "Nährstoff Heyden" agar.

* Journ. Exper. Med., v. (1900) pp. 271–314 (1 pl.).
† C.R. Trav. Laborat. Carlsberg, v. (1900) pp. 39–46. Cf. this Journal, 1895, p. 90.
‡ Arch. f. Hygiene, xxxvii. p. 30. See Beih. z. Bot. Centralbl., ix. (1900) p. 14.
§ Bot. Gazette, xxx. (1900) pp. 261–72 (4 figs.).

M. roseus flavus grows well and is easily cultivated at room temperature in broth and milk, and on all ordinary solid media except potato. Gelatin is slowly liquefied.

The coccus stains well, but is decolorised by Gram's method; it is nearly 1 μ long and about 0·6 μ broad. It is non-motile, and divides in only two planes (staphylococcus grouping). In the course of a month or more milk showed traces of peptonisation without coagulation. The tint of the pigment was estimated by means of the Bradley colour wheel and Maxwell disks, the following percentage being obtained: red 72, white 13, yellow 9, orange 6.

Lactic Acid Bacteria and Cheese Ripening.*—Prof. R. Chodat and N. O. Hofman-Bang, who have devoted much attention to the question of cheese ripening, have recently shown that the lactic acid bacteria isolated from Emmenthal cheese are not able to dissolve the coagulated casein. They therefore contest the statement of de Freudenreich, who inclined to the view that lactic acid bacteria play the most important part in the ripening of Emmenthal cheese.

The authors, however, admit that they used casein which had been washed and heated to 120°, and that it might be objected that the results obtained from casein thus treated had only a relative value.

The value of this objection, which might also be raised against experiments made with sterilised milk, remains to be seen.

Variability in Lactic Acid Bacteria in relation to their Fermentative Power.†—The experiments of N. P. Schierbeck were intended to ascertain whether the variation of fermentative power of microbes in general, when retained through generations, could be excited experimentally. For this purpose lactic acid bacilli were selected, since the manifestation of fermentative power could be easily measured in terms of the acidity produced in the medium. Experimentally, variation was influenced by the addition of carbolic acid to the milk, and cultures were obtained which excited fermentation in varying degree, and less than that of the original culture.

The impaired fermentative power was associated with a diminished reproductive energy, and with increased resistance to extrinsic agents, such as carbolic acid. These artificially produced cultures do not correspond to those found in milk naturally and spontaneously coagulated. Hence the formation of new races is only an apparent one, due to extrinsic deleterious substances in the nutritive medium.

Bacterial Flora of the Sydney Water Supply.‡—R. Greig Smith has isolated from Sydney water the following new species and subspecies.

Bacterium janthinum ii. subsp. n.—The main differences between this subspecies and Zopf's organism are the rapid liquefaction of the gelatin (24 hours), the diffuse growth on agar, and the absence of an alkaline reaction in milk.

Bacterium album mesentericum sp. n.—A slender rod with rounded ends, averaging $0·3 \times 1·5\ \mu$. It is motile, is decolorised by Gram's

* Ann. Inst. Pasteur, xv. (1901) pp. 36–48.

† Kgl. Danske Widenskab. Selskabs Oversigt, 1900, pp. 113–37.

‡ Proc. Linn. Soc. N.S.W., xxv. (1900) pp. 436–61.

method, grows well, reduces nitrates to nitrites. Its affinities are with *B. Fairmontensis* Wright, *B. aquatilis communis*, and *B.* No. 46 Conn.

Bacterium-aerofaciens sp. n.—An oval organism $0 \cdot 4 \times 0 \cdot 8$–$1\ \mu$. It is motile, does not stain by Gram's method, grows well, forms gas, reduces nitrates. It is nearly allied to the hog-cholera group, but most closely to *B. sinuosum.*

Bacterium minutum sp. n.—A cocco-bacterium $0 \cdot 4 \times 0 \cdot 5$–$0 \cdot 7\ \mu$. Is actively motile, does not stain by Gram's method, grows well, forms gas, reduces nitrates. On potato the growth is yellow, the medium becoming bluish.

Bacterium croceum sp. n.—An actively motile rodlet with rounded ends, measuring $0 \cdot 5 \times 3\ \mu$, and occurring singly, in pairs, chains, and threads. It is stained by Gram's method. Its optimum temperature is 22° C., but it grows well at 37°. It grows well on agar and gelatin, and on bouillon, but not on potato. The growth on agar is deep yellow.

Bacterium palæformans sp. n.—A rodlet with rounded ends, measures $0 \cdot 5 \times 2\ \mu$, or less, occurs singly, in chains and threads, is actively motile, and is stained by Gram's method. A yellow pigment is formed on gelatin and agar. Gelatin is liquefied. This microbe appears to be a motile form of *B. dormitator* Wright, though it is closely allied to *B. croceum.*

Bacterium subflavum teres sp. n.—The cells are oval and actively motile; they measure $0 \cdot 6 \times 1 \cdot 5\ \mu$. They do not stain by Gram's method. The growth is yellowish or buff-coloured.

Bacterium arborescens amethystinum subsp. n.—A thin rodlet with rounded ends. It measures $0 \cdot 2$–$0 \cdot 3 \times 1 \cdot 5$–$2 \cdot 3\ \mu$. It is not motile, and is not stained by Gram's method. It grows best at from 22° to 30°. This organism appears to be a subspecies of *Bac. arborescens* Frankland, from which it differs in the appearance and colour on agar stroke.

Bacillus stellatus sp. n.—A rodlet with rounded ends 2–3 μ long $\times\ 0 \cdot 8$–$1\ \mu$ broad. It is non-motile and stains by Gram's method. It forms oval central spores, quickly on potato, but slowly on agar. It appears to be an ally of *Bac. verticillatus* Rav.

Bacterial Flora of New Mexico.*—J. Weinzirl has made a study of the bacterial flora of the semi-desert region of New Mexico, paying special attention to the bacteria of the air. The chief results of the investigation were that the flora, while somewhat limited, was widely distributed. The number of air-borne bacteria, though not small, is less than in fertile and cultivated regions.

Many of the species, mostly micrococci, were chromogenic. The flora is characterised by its inertness towards saccharated media, and its failure to peptonise gelatin. The characters of ten species are given in detail. In the course of the investigation it was found that *B. acidi lactici* and *B. lactis acidi* were invariably present in the samples of milk examined. *B. mesentericus vulgatus* was regularly obtained from native grown potatoes. All attempts to discover *B. tetani* and *B. subtilis* failed.

Bacteriology of Ozæna.†—Dr. W. Stein detected *Bacillus mucosus* in 44 out of 51 cases of atrophic rhinitis, and holds that it is in the

* Journ. Cincinnati Soc. Nat. Hist., xix. (1900) pp. 211–12 (4 figs.).
† Centralbl. Bakt., xxviii. (1900) pp. 726–36, 769–78.

highest degree probable that *B. mucosus* is the exciting agent of ozæna. The observations and opinions of other writers on the ætiology of ozæna are fully discussed by the author.

Diagnosis of Bacterium typhi from Bacterium coli.* — J. Rambousek, who made a comparative and critical study relative to the distinguishing criteria for arriving at a determinate diagnosis between *Bacterium typhi* and *B. coli*, found that the most important difference between these two organisms is that the latter forms gas in saccharated media, while the typhoid bacillus does not.

Antagonism of the Bacillus coli and the Bacillus typhosus.†— Dr. L. Rémy contests the view maintained by Wathelet and others that the bacillus of typhoid is overpowered in the intestine by the coli bacillus. It is true, however, that the commensalism may materially affect the characters and properties of the two organisms, the typhoid losing its sensibility to agglutinins, and the coli bacterium becoming unable to form gas and indol. Some coli colonies, when three or four weeks old, approximate in size and appearance to the typhoid; they are distinctly blue, while the latter are bluish-white.

While the agglutination by strong antityphoid serum of a bacillus having the characters of the typhoid may be regarded as proof of its typhoid origin, the absence of agglutination would not be regarded as disproof. Bacilli having typhoid characters, but which are not agglutinated by antityphoid serum, must be regarded as typhoid if a guinea-pig injected every two days with 2 ccm. of a 48 hours' culture furnishes after 15 days a serum capable of agglutinating the typhoid bacillus at a minimum dilution of $\frac{1}{40}$. Some undoubted typhoid bacilli fail to become agglutinated by the antityphoid serum: it is impossible to determine their typhoid nature by the foregoing or any other known method.

Relations of Bacillus X, Bacillus icteroides, and the Bacillus of Hog-Cholera.‡—W. Reed and J. Carroll, who have made a comparative study of the biological characters and pathogenesis of *Bacillus X*, (Sternberg), *Bacillus icteroides* (Sanarelli), and the hog-cholera bacillus (Salmon and Smith), have arrived at the following conclusions. *Bacillus X* belongs to the colon group. *B. icteroides* is a member of the hog-cholera group. The various channels of infection, the duration of the disease, and the gross and microscopical lesions in mice, guinea-pigs, and rabbits, are the same for *B. icteroides* and the hog-cholera bacillus. The clinical symptoms and lesions observed in dogs inoculated intravenously with *B. icteroides* are reproduced in these animals by infection with the hog-cholera bacillus. *B. icteroides*, when fed to the domestic pig, causes fatal infection, accompanied by diphtheritic, necrotic, and ulcerative lesions in the digestive tract, such as are seen in hogs when infected with the hog-cholera bacillus.

This disease may be acquired by exposing swine in pens already infected with *B. icteroides*, or by feeding them with the viscera of infected pigs. Guinea-pigs may be immunised with sterilised cultures of *B. icteroides* from a fatal dose of the hog-cholera bacillus, and *vice versa*.

* Arch. f. Hygiene, xxxviii. p. 382. See Bot. Centralbl., lxxxiv. (1900) pp. 375–6.
† Ann. Inst. Pasteur, xiv. (1900) pp. 707–22.
‡ Journ. Experim. Med., v. (1900) pp. 215–70 (1 pl.).

Rabbits may be rendered immune by gradually increasing doses of a living culture of *B. icteroides* of weak virulence, from a fatal dose of a virulent culture of the hog-cholera bacillus. The sera of animals immunised with *B. icteroides* and with the hog-cholera bacillus, respectively, show a marked reciprocal agglutinative reaction. While the blood of yellow fever practically does not exercise an agglutinative reaction on *B. icteroides*, the blood of hog-cholera agglutinates this bacillus in a much more marked degree, thus pointing to the closer ætiological relationship of this bacillus to hog-cholera than to yellow fever.

Morphology of the Plague Bacillus and Transmission of the Bacterium by the Fleas of Mice and Rats.* — Prof. B. Galli-Valerio calls attention to the likeness existing between the form and shape of many of the elements of *B. pestis* and *B. mallei*. These forms, usually called involution, rather suggest that the development of the plague bacillus is analogous to that of the glanders bacillus.

With regard to the transmission of plague by rats and mice, the author remarks that we should be careful about assigning to rats an almost exclusive part in the dissemination of plague, more especially as such a view might draw attention from other more important causes of infection, such as the transmission from man to man or from inanimate objects.

The author's view is founded on the negative effects on his own person from the presence of rat and mouse fleas. On this ground he contests the validity of the conclusions of Simond and Leloir, and points out that these savants do not make any statement as to the kind of insects they had to deal with.

Behaviour of Anthrax in the Peritoneal Sac.†—Dr. J. B. van Leent found that anthrax, when injected, even in enormous numbers, into the peritoneal sac of guinea-pigs, perished. Immunity to anthrax was not thereby imparted. Even when the animal is dying from subcutaneous injection, the peritoneum can kill the microbes. While the absorption of the bacilli is dangerous for the infected organism, the absorption of peritoneal fluid may be favourable. The bactericidal influence of the peritoneum may be impaired by foreign bodies, by excess of fluid, or by a combination of both. Migratory cells have no great influence on the bacteria, and no marked phagocytosis is to be observed in these elements. The endothelial cells, however, undoubtedly perform phagocytic functions. The peritoneal fluid does not appear to exert a bactericidal action.

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* Centralbl. Bakt., 1[te] Abt., xxviii. (1900) pp. 842–5 (1 fig.).
† Tom. cit., pp. 737–42.

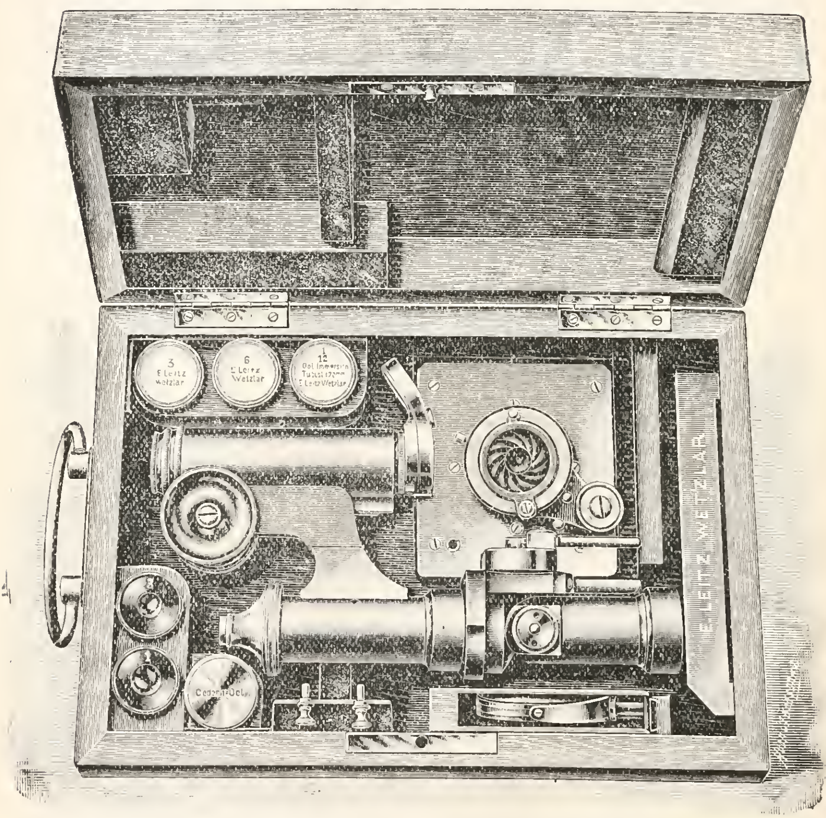
MICROSCOPY.

A. Instruments, Accessories, &c.*

(1) Stands.

Leitz' Large Travelling Microscope.—This instrument (figs. 20, 21), when set up, corresponds to Leitz' No. II. Stand. It is intended for

Fig. 20.

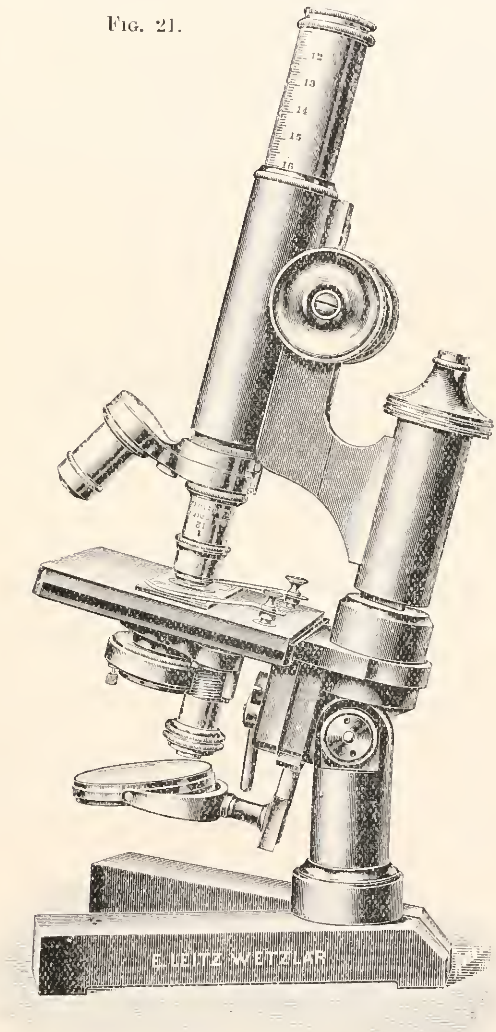


study of epidemics and diseases in their own habitats. In order that the apparatus may be packed in the case with the greatest economy of space, the two claws of the foot fold together, the stage and mirror rotate into a vertical position, and the draw-tubes completely telescope.

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

When in use the square stage is clamped firmly by a lever. The coarse adjustment is by rack-and-pinion, and the fine by a micrometer-screw. The Abbe illuminating apparatus and iris diaphragm are the same as in

Fig. 21.

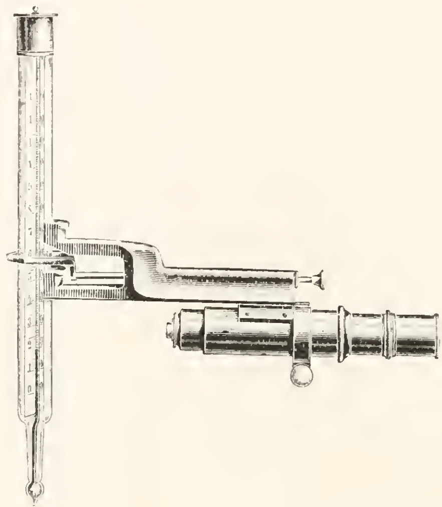


stand No. II. The stand is jointed for inclination of tube. The whole packs away in a mahogany case measuring 27·5 by 18·5 by 8 cm., as shown in fig. 20.

The instrument is also suitable for the highest laboratory work.

Leitz' Thermometer Microscope. — This apparatus (fig. 22) has been made by the Wetzlar firm to the design of Fridtjof Nansen, and is intended for the accurate reading of a thermometer. The nickelled draw-tube is attached to a black lacquered stand, whose foot ends in

Fig. 22.



two incisions into which thermometers of different sizes may be clamped by means of a holder acting on a spiral spring. The instrument is fitted with a micrometer eye-piece and a low-power achromatic objective.

Leitz' New Cheap Stand. — In this stand, No. III. in catalogue (fig. 23), economy has been especially studied. It is intended for ordinary laboratory use, and can take high-power dry objectives, but not immersion lenses. The coarse adjustment is by rack-and-pinion, and the fine by micrometer-screw. The mirror is plane and concave. The price of the stand, with the two adjustments and the revolving diaphragm disc, in mahogany case, is 2*l.* 10*s.*

(3) Illuminating and other Apparatus.

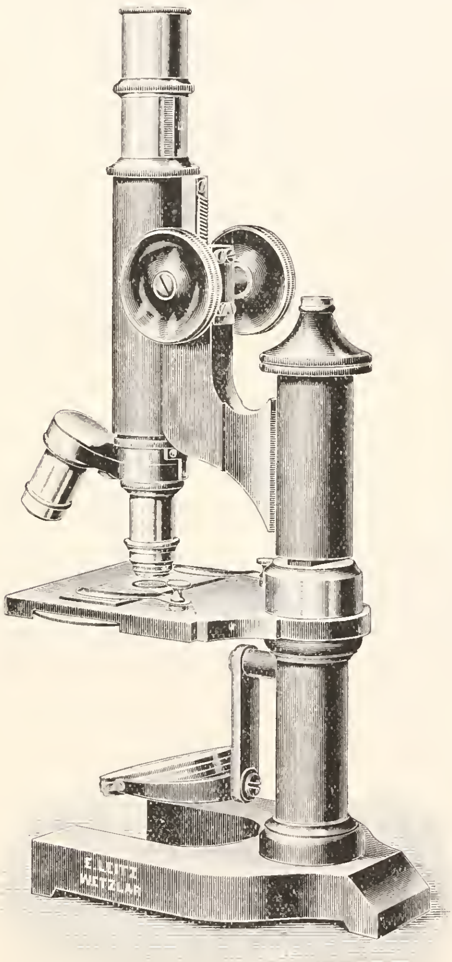
Drüner's New Magnifying Stereoscopic Camera.* — Dr. Drüner prefaces the description of his apparatus by a historical sketch of stereomicroscopy.

His instrument (fig. 24), which consists of a double aluminium camera encased in black leather, has, at its reduced lower end, the slide apparatus for the reception of the twin objectives. The optical axis of each of the two combined cameras coincides with the optical axis of one of the two systems of the twin objectives, and stands perpendicularly on the plane of one of the two reception screens *v*. These screens

* Zeitschr. wiss. Mikr., xvii. (1900) pp. 281–94 (1 pl. and 1 fig.).

are inclined to one another at 165°, the optical axes being at 15°. The screens work in grooves *p*, and are stopped off by two circular stops of 50 mm. in diameter. Thus the projected image also has a diameter of 50 mm. The width of the camera is 150 mm. The screens are the

Fig. 23.



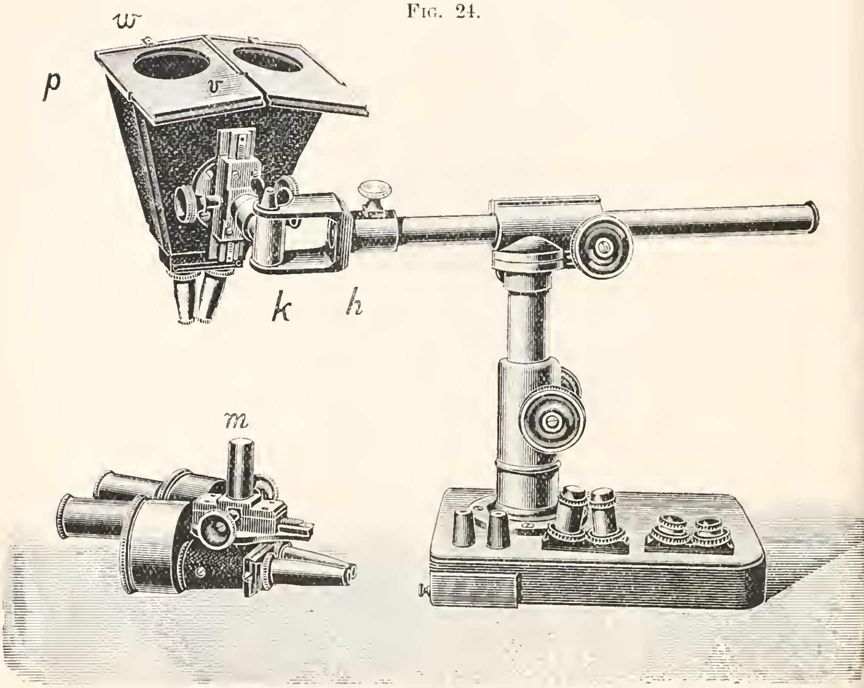
ordinary commercial slides of 9 by 6 cm.; they are secured in their frame by a buckle *w*.

The camera can be exchanged for the tube of a preparation-Microscope on the same stand. For this purpose the plug *m* fits into a hollow cylinder, which, itself, is an arm of the cylinder *k* working between the points of the fork *h* and rotatory about an axis perpendicular to those points. It will be readily seen that the arrangement permits of adjustment in any position. The set of five twin objectives of the preparation-Microscope can be used with the camera.

Each of the slides introduced into the camera presents a real inverted image of the object.

The magnification varies from 1·6 to 7 diameters. This appears

Fig. 24.



disproportionately small, but the stereoscopic magnification, in reality supplying the ocular magnification, has to be reckoned in addition.

Details of stops and light sources used are supplied; and a coloured plate illustrating some of the results obtained is appended.

Ross' "No. 1 Model" Projection Lantern.—This is an exceedingly small-bodied lantern fitted with lime-light jet (see fig. 25). It has many novel points of construction, and is very portable, rigid, and effective.

At the exhibition of Messrs. Ross' new apparatus for lighting purposes at the meeting of the Society on December 19th, 1900, this instrument was also shown mounted on an extra and detachable base-board on which may be placed any ordinary table Microscope having its optic axis central with that of the lantern. The object of this combined apparatus

Fig. 25.

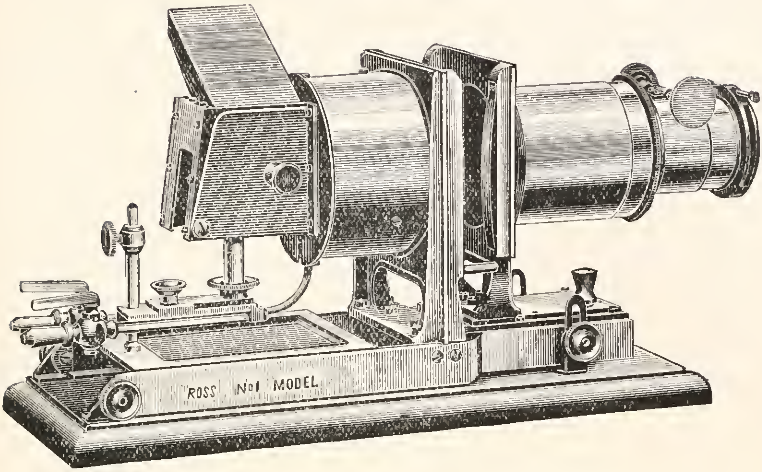
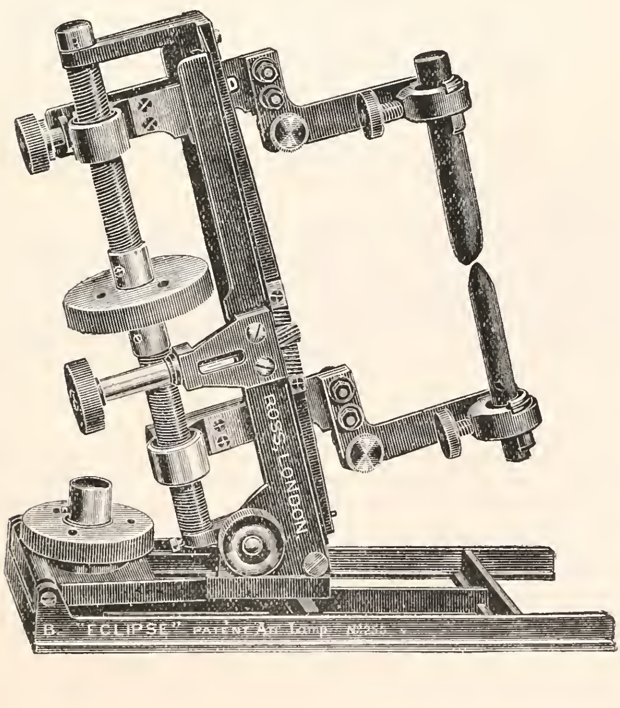


Fig. 26.



is to show how any ordinary Microscope can readily be used as a projection apparatus by the addition of the small lantern and baseboard.

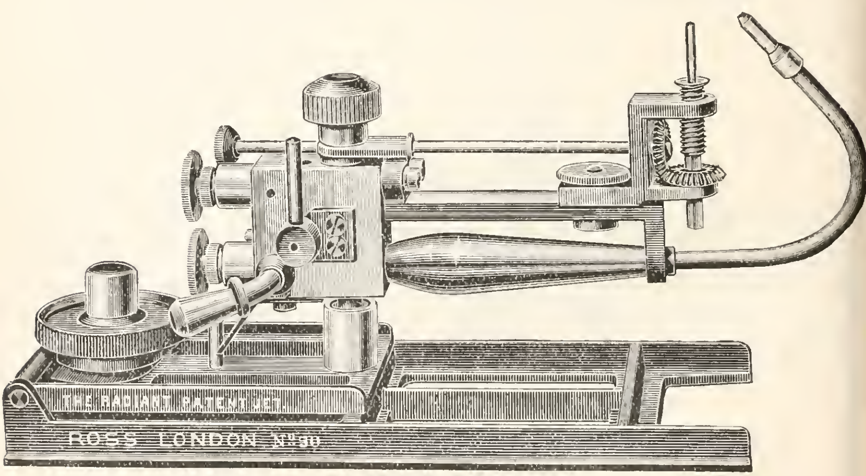
Ross' Arc Lamp "A".—This lamp (fig. 26) is designed expressly for lantern projection work, and is suitable for a current of 5 to 15 amperes. It has all motions for centering, &c., and these are very easily controlled, and the light kept very steady.

Ross' Arc Lamp "B".—This lamp is similar in general design to the lamp "A," and is designed to meet the requirements of those who wish for a lamp which can be used either for projection or for laboratory purposes. It is very solidly and substantially made, and has all the motions and adjustments necessary to this class of instrument.

Both this lamp and the lamp "A" were exhibited to the Society on December 19th, 1900.

Ross' "Radiant" Jet.—At the exhibition of Messrs. Ross' illuminating apparatus at the meeting of the Society on December 19th, 1900,

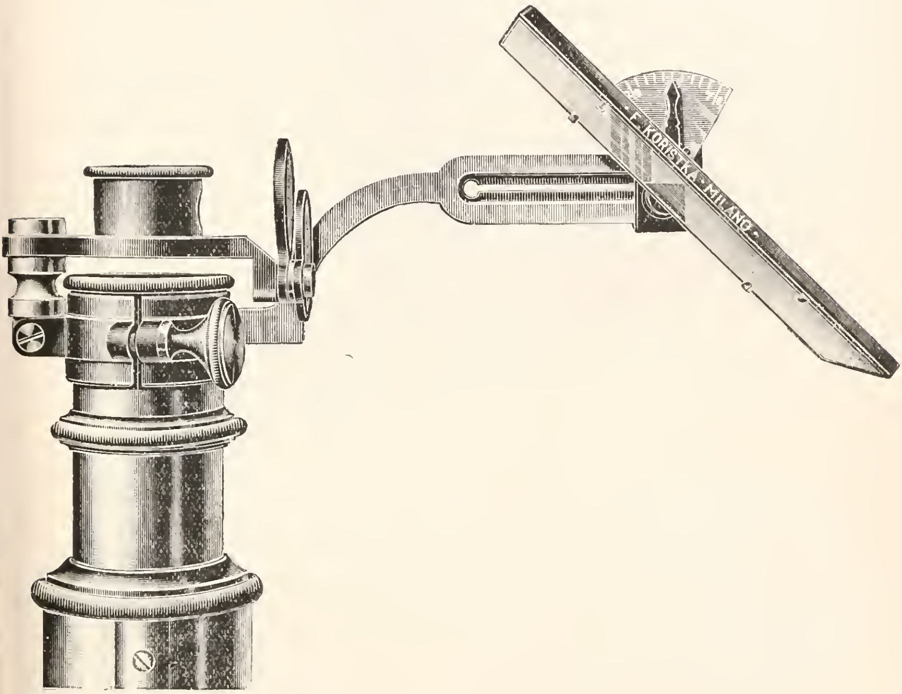
Fig. 27.



this jet (see fig. 27) attracted considerable attention by reason of the splendid light produced, together with its perfect silence. It can be regulated to give any desired amount of light according to the amount of gas consumed. It is entirely novel in form, and has very complete motions for centering, &c.

Koristka's Abbe Camera Lucida.—An improved form of this accessory has been brought out by Sig. Koristka, of Milan (fig. 28). The mirror is fitted with a graduated arc, and there is a slot in the stem holding the mirror, so that the distance between the eye-piece prism and the mirror can be regulated. Diaphragms of coloured glass are also attached to the stem, and can be rotated into position, as required.

Fig. 28.



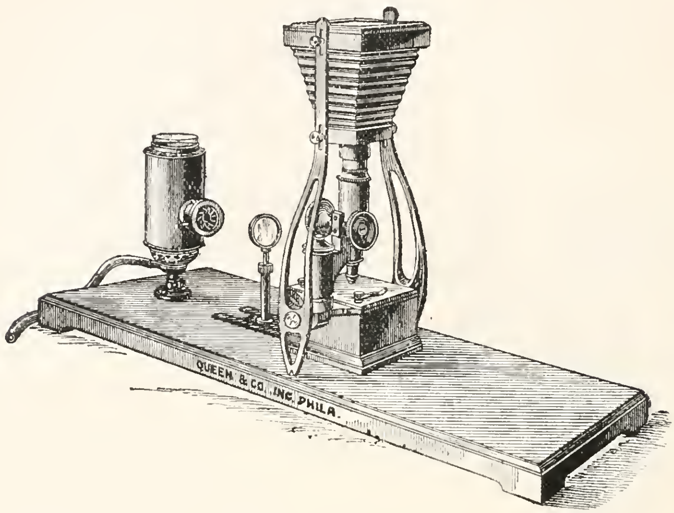
(4) Photomicrography.

Queen's Photomicrography of Metals.*—The camera arrangement shown in fig. 29 has been designed by Messrs. Queen, of Philadelphia, for the photomicrography of metals. The camera is so hinged that it may be tilted aside for ocular examination of the object, selection of spot to be photographed, adjustment of light, &c.; then replaced vertically and connected with the tube of the Microscope. The source of light is a Welsbach gas-burner completely surrounded by a metallic cylinder leaving only the necessary aperture for the illumination of the object. The emergent pencil of light may be controlled by an iris diaphragm fastened to the burner. The light is received by a condensing lens adjustable in height, and then by a vertical illuminator screwed between the body of the Microscope and the objective. The Zeiss model of vertical illuminator, consisting of a totally reflecting

* Metallographist, i. (1898) p. 167 (1 fig.).

prism, covering half of the aperture, is furnished with the instrument; but any other form of illuminator may be used, if preferred.

Fig. 29.



B. Technique.*

(1) Collecting Objects, including Culture Processes.

Culture of Mycetozoa. — A. Lister † gives some useful hints in respect to the cultivation of various species of Mycetozoa from spores for the purpose of following the whole cycle of development.

Clara Langenbeck ‡ describes a convenient method of cultivating the plasmodes of Mycetozoa in an infusion of hay.

Medium for the Bacteriological Examination of Water.§—Dr. J. Thomann, after an examination of various nutrient media for the bacteriological examination of water, advocates the following, which constantly gave the best results. Liebig's meat extract 6 grm., pepton Witte 10 grm., salt 5 grm., diphosphate of potassium 2 grm., are dissolved in 1000 grm. of distilled water in a water-bath, and to the solution 100 to 120 grm. (according to the time of year) of gelatin are added. When the gelatin has dissolved, the mixture is neutralised with normal caustic soda solution, blue litmus paper being used as indicator, and then to the neutral fluid 1–5 grm. of soda (=15 ccm. of 10 p.c. soda solution) are added. After boiling for half an hour in a steamer,

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

† Journ. of Bot., xxxix. (1901) pp. 5–8.

‡ Journ. Applied Microscopy, iv. (1901) pp. 1119–21 (3 figs.).

§ Centralbl. Bakt., vi. (1900) pp. 796–800.

or better, for a quarter in an autoclave at 110°, the gelatin mixture is filtered, and distributed in the usual way.

Simple Method of Cultivating Anaerobic Bacteria.*—Dr. J. H. Wright describes the following method for cultivating anaerobic bacteria. After the culture medium in the test-tube has been inoculated, the cotton stopper is pushed in so far that its upper end is about 1 cm. from the mouth of the tube. Then a small quantity of an aqueous solution of pyrogallic acid and of sodium hydrate is run in.

The tube is at once closed air-tight by a rubber stopper. The pyrogallic acid and water are mixed in equal bulks, and one part of sodium hydrate with two of water. For test-tubes 6 in. by $\frac{3}{4}$ in., $\frac{1}{2}$ ccm. of the pyrogallic acid solution and 1 ccm. of the sodium solution are about sufficient. This simple method has given satisfactory results with tetanus and other essential anaerobic bacteria.

The author notes that the following points are highly important for anaerobic cultivations:—

(1) The medium should contain 1 p.c. of glucose, and should be boiled, and cooled immediately before inoculation.

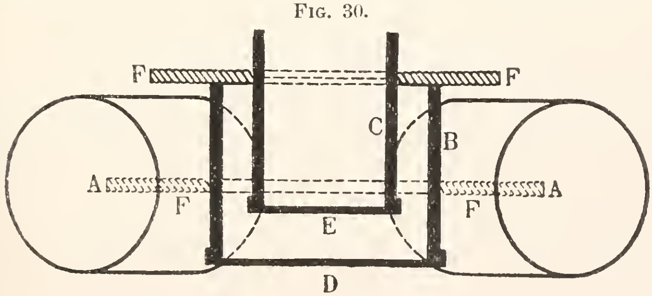
(2) The medium and reagents should be freshly prepared.

(3) The reaction should not be more acid to phenolphthalein than +1·5 of the scale of the Bacteriological Committee of the American Public Health Association.

(2) Preparing Objects.

Dialyser for Histological Purposes.†—Dr. R. Kolster has devised a dialyser for the purpose of dehydrating preparations at a regular and uniform rate from first to last. The apparatus is composed of the following parts (figs. 30, 31):—C and B are glass tubes, the outer one being

FIG. 30.



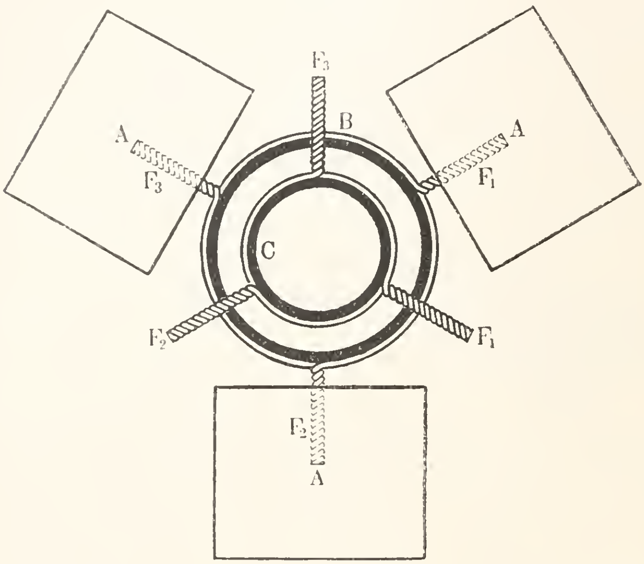
but a little longer than the inner one. To each are fixed twisted wire supports, F_1, F_2, F_3, arranged in the manner indicated in the illustrations. The projecting arms rest on cork blocks A A. The tubes C and B are closed by membranes made of very thin paper and stuck on with albumen. Into the tube C the specimen to be dehydrated, along with distilled water, is placed. The outer tube B is filled with 25 p.c. alcohol. The whole apparatus is placed on a large glass dish, half filled with 50 p.c. alcohol.

* Journ. Boston Soc. Med. Sci., v. (1900) pp. 114–5 (1 fig.).

† Zeitschr. wiss. Mikr., xvii. (1900) pp. 294–8 (2 figs.).

The dish is then covered, and the apparatus allowed to rest for 24 hours. On the next day the apparatus is placed in another dish, on the bottom of which is a layer ½ centimetre high of dried copper sulphate. This dish is half filled with 96 p.c. alcohol. The B tube is now filled with 75 p.c. alcohol, and the glass dish having been again covered up, the

Fig. 31.



apparatus is allowed to work for another 24 hours. By this time the preparation is completely dehydrated.

Synthetic Alcohol as a Fixative.* — T. E. Oertel recommends synthetic alcohol as a fixing agent for tissues. It is cheaper, and fixes quite as well, if not better, than ordinary alcohol made by distillation from grain.

Fluid for Softening Chitin.† — Dr. C. Hennings uses the following fluid for softening chitin:—Nitric acid 16 parts; chromic acid 0·5 p.c. 16 parts; saturated solution of sublimate in 60 p.c. alcohol 24 parts; saturated aqueous solution of picric acid 12 parts; absolute alcohol 42 parts. The solution is allowed to act for 12 to 24 hours, according to the size of the object. The object is then washed in 60 p.c. iodine-alcohol, and afterwards passed through alcohols of increasing strength; then to xylol and paraffin.

Depigmenting the Eyes of Arthropoda.‡—For removing the pigment from the eyes of Myriopoda, Dr. C. Hennings uses a mixture composed of 2 parts 80 p.c. alcohol, and 1 part of glycerin, to which 2 vols. p.c. of strong sulphuric acid are added.

* Journ. Applied Microscopy, iii. (1900) p. 1061.
† Zeitschr. wiss. Mikr., xvii. (1900) pp. 311–2. ‡ Tom. cit., pp. 326–7.

The solution acts best at a temperature of about 35° C., and the time required varies from 10 minutes to about 12 hours, according to the kind of pigment. The prolonged action of the fluid is not at all detrimental to the eye-tissues.

Technique for Malaria Blood.*—Dr. J. W. W. Stephens and Dr. S. R. Christophers describe the following simple method for preparing and staining films of malarial blood. The finger is pricked with a triangular surgical needle, and a clean glass slide made to touch the exuding drop of blood. The drop thus received on the slide is then spread by the shaft of the needle in a broad even streak along the slide. On first touching the drop with the needle-shaft, a little time should be given for the drop to run along the needle for some distance by capillarity. The most perfect films are thus obtained. The slides are then placed in a pot of absolute alcohol for 5 minutes. The films are stained with a saturated alcoholic solution of hæmatein. To every 10 ccm. of this solution are added 50 ccm. of alum solution (alum 50 grm., water 1000 ccm.). The slides are immersed in the solution for 5 to 20 minutes, or even hours. The slide is examined by applying oil directly without the intervention of a cover-glass. If it be required to preserve the specimen, the oil is washed off with xylol, and the preparation mounted in balsam. The slides, however, will keep for a year if merely wrapped in clean paper and placed in a closed box.

Cleaning Desmids.†—G. H. Bryan describes the procedure he adopts for cleaning desmids. The apparatus consists of one or two saucers or porcelain dishes, an old pomatum-pot, and a pen-"filler," while a gauze strainer is useful for getting rid of large pieces of dirt. The material is strained into a saucer, and after an interval not exceeding half a minute the dish is inclined, a gentle rocking motion being given at the same time. Along the edge of the receding water the desmids collect in a bright green line or patch, from which they are picked up by the filler. They are next transferred to the pomatum-pot, and fixed with Zenker's fluid. A repetition of the rocking enables the desmids to be again collected and taken up in the filler, to be transferred to a dish containing clean water, in order to remove the fixative. The washing, together with the rocking, is repeated. The whole process takes from a half to one hour, and this procedure involves less loss of specimens than the decantation method.

Method for Isolating Bacterial Flora from Water.‡—R. Greig Smith, when isolating the bacterial flora of the Sydney water supply, used Abba's gelatin (Liebig's extract 6 grm., gelatin 150 grm., and distilled water 1000 ccm.; after neutralising, 0·5 grm. anhydrous sodium carbonate are added) and dextrin-meat-agar. The latter is prepared by dissolving 20 grm. of agar in 1000 ccm. of meat extract in the autoclave. After clarification with white of egg, 10 ccm. of the mixture are pipetted into warm water, and neutralised to phenolphthalein with tenth-normal sodium hydrate. The sodium hydrate, together with 0·5 grm. sodium carbonate, is added to the bulk, and then 20 grm. of dextrin or gum

* Roy. Soc. Reports to Malaria Committee, 3rd series, 1900, pp. 5–6.
† Journ. Applied Microscopy, iii. (1900) pp. 1026–7.
‡ Proc. Linn. Soc. N.S.W., xxv. (1900) pp. 438–40.

acacia dissolved in a small quantity of water; after which the mixture is boiled, filtered, placed in test-tubes, and sterilised. The water was allowed to flow from the tap for half an hour upon a sterilised watch-

Fig. 32.

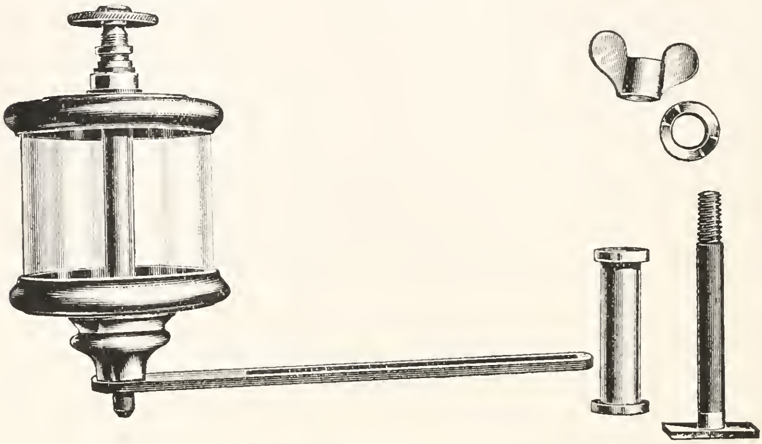
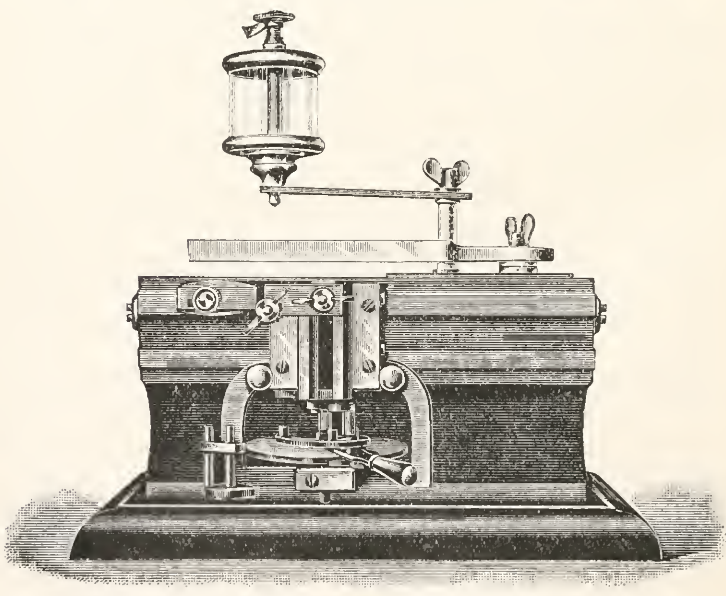


Fig. 33.



glass supported upon a tripod. From the watch-glass the water was taken up into a sterilised graduated pipette and added to the previously melted and cooled gelatin (30° C.) or agar (42° C.). The tube was then shaken, and the contents poured into Petri dishes, which, after setting, were inverted, and inoculated at the requisite temperature (15°, 18°, or 22°). When the colonies were sufficiently grown, inoculations were made upon agar slopes and in gelatin stabs. When a pure culture was obtained inoculations were made on many other media.

(3) Cutting, including Imbedding and Microtomes.

Irrigating Apparatus for Celloidin Sectioning.* — Dr. P. M. Hickey devised an irrigating apparatus (figs. 32, 33), the essential points being a modified oil-cup such as is used in automatic machinery, and the attachment of this cup by means of a suitable support to the sliding block which carries the knife. In this way the alcohol can be dropped on any part of the knife. By means of the needle plunger in the cup the number of drops per minute can be regulated to a nicety.

Method of Procuring Ribands with a Microtome working Horizontally.†—C. Brookover made ribands of sections with a sliding microtome, by placing the edge of the knife parallel to the surface of the block to be cut. On that part of the knife where the cutting was to be done, a visiting-card was placed to receive the riband. The card was pierced by two pins sticking down over the back to keep the card from sliding out of position and over the edge of the knife. In transferring the ribands from the card, it is advisable to place the slide over the card, so as to be able to see the sections while they are arranged.

Imbedding in Celloidin.‡ — Herr Pokrowski dehydrates pieces of tissue which have previously been in alcohol above 55° by means of ether. The procedure depends on the fact that ether is miscible with alcohol of 55°. In this way the alcohol along with the water is extracted and replaced by ether. It is not necessary to use much ether at a time, but it is preferable to change it frequently. The extraction of all the water may be demonstrated by the fuchsin test. Fuchsin being insoluble in ether the slightest trace will stain the fluid if any water remain. In this way tissue may be more rapidly dehydrated than if alcohol had also been used. The dehydrated pieces may be at once transferred to thin and afterwards to thick ethereal solutions of celloidin. Blocks prepared in this way must not be kept in alcohol but in ether to which chloroform ($\frac{1}{4}$ vol.) has been added.

(4) Staining and Injecting.

Simple Method for Staining Bacterial Flagella.§ — Sig. De Rossi has obtained most excellent results from the following method. An agar culture less than four days old is used. A minute particle is diluted in a little distilled water, and from this a second dilution in $\frac{1}{2}$–1 ccm. of distilled water is made. A loopful is placed on a cover-glass and dried in a sulphuric acid exsiccator. The mordant consists of a solution composed of tannic acid 25 grm. and 1 per cent. KHO 100 grm. The stain

* Journ. Applied Microscopy, iii. (1900) pp. 994–5 (2 figs.).
† Tom. cit., pp. 987–8 (3 figs.).
‡ Mediz. Obosrenie, 1900, Mai. See Zeitschr. wiss. Mikr., xvii. (1900) pp. 331–3.
§ Arch. per le Sci. Med., xxiv. No. 15. See Brit. Med. Journ., 1901, i. Epit. 36.

is Ziehl's carbol fuchsin. On the unfixed film are poured one drop of the mordant and four or five drops of the stain. The mixture is allowed to act for 15, 20, or 25 minutes. The preparation is then washed, dried, and mounted.

Staining and Mounting Urinary Deposits.* — The editor of the *National Druggist* gives the following outlines of the procedure he has successfully adopted for some sixteen years for collecting, preserving, staining, and mounting tube-casts, epithelia, and other urinary deposits. If the urine has to come from a considerable distance a crystal of naphthalin should be placed in the bottle. This will preserve it for several days from decomposition. When received, the urine is placed in a cool place, e.g. a refrigerator, to settle. When the upper two-thirds have become clear this portion is siphoned or decanted off. A few drops of 2 p.c. osmic acid are then added, and afterwards sufficient eosin solution to make the whole strongly red. The urine glass is now exposed to a strong light which turns the liquid black. When the sediment has settled, the supernatant fluid is withdrawn and replaced by distilled water. This last process is repeated until the water no longer shows a trace of colour. The water is then drawn off, the last drops being removed by blotting-paper. To the moist sediment a few drops of glycerin are added, and intimately mixed by stirring and by rotating the vessel. The sediment is now ready for mounting. Instead of glycerin, glycerin-jelly may be used. The cell-walls should be old and thoroughly dry. The best cement for this purpose is made of zinc oxide in a solution of dammar in chemically pure benzol to which about $\frac{1}{4}$ p.c. of old gilder's size and a much smaller quantity of castor oil have been added. Such cells take from eight to twelve months to dry properly, but are then as "permanent" as any mount can be made.

Staining Embryonic Cartilage.† — A. Moll stains embryonic cartilage with Tänzer's orcein solution (orcein 0·5, absolute alcohol 40, distilled water 20, hydrochloric acid 10 drops). The preparation (embryos or pieces thereof) must be hardened in alcohol, and celloidin sections immersed in the above solution for 6–24 hours. The sections are then washed in 80–90 p.c. alcohol until the celloidin is almost colourless; after which they are dehydrated in 98 p.c. alcohol, cleared up in origanum oil, and mounted in balsam. This method imparts a double stain, the preformed hyaline cartilage having a blue-violet hue and the rest of the tissue being brownish-red. The stain affects the cartilage matrix, the nuclei being red. Embryonic elastic cartilage does not give the double stain. In adult cartilage the matrix is reddish and the cartilage cells dark-blue.

Staining Fluid for Counting Leucocytes.‡ — Dr. R. Zollikofer uses the following staining solutions to facilitate the counting and recognition of the varieties of leucocytes. Solution A:—Eosin W.G. 0·05; formalin 1·0; distilled water 100. Solution B:—Methylen-blue 0·05; formalin 1·0; distilled water 100. When required for use equal quantities of

* Amer. Mon. Micr. Journ., xxi. (1900) pp. 308–10.
† Centralbl. f. Physiol., xiii. (1899) pp. 225–6.
‡ Zeitschr. wiss. Mikr., xvii. (1900) pp. 313–21.

the two solutions are mixed together. The blood is sucked into a Thoma-Zeiss pipette up to the 0·5 mark, and then diluted with the staining solution up to 1–20. Five minutes are allowed for the mixing of the blood and stain in the pipette, after which the contents are blown into an Elzholz counting chamber, the capacity of which is 0·9 of a cubic millimetre. The total number, when the blood has been diluted twenty times, is multiplied by $\frac{200}{9}$ or $22 \cdot \dot{2}$, the product being the number per cubic millimetre. The solution may be used for film preparations, and is specially adapted for differentiating the varieties of leucocytes.

New Staining Method for Red Corpuscles in Sections.* — The method adopted by N. Petroff for staining red corpuscles depends on the fact that they pick up pigment from the malachite-green group when they are also treated with picric acid and alcohol. The preparations are fixed in Müller's fluid or in formalin, and imbedded in paraffin. The sections are stuck on the slide with water. The paraffin is removed with xylol, and they are then washed with alcohol and xylol. Thereafter follow:—(1) Staining with Bismarck-brown (saturated solution in 1 p.c. acetic acid) 10–15 minutes, or with lithium or borax-carmine for 20–30 minutes. (2) Washing in water and then staining for 10–15 minutes with 20 p.c. aqueous (i.e. five times diluted alcoholic) solution of malachite-green, brilliant green, or Victoria-green. (3) Washing with water, followed by staining for 1–1½ minutes by Van Gieson's method, or with aqueous solution of picric acid five times diluted. (4) Washing with water, followed by rapid dehydration in absolute alcohol; lastly xylol and balsam. By this method, which is really quite simple and easy of execution, the red corpuscles are stained emerald-green, the rest of the tissues being yellowish-brown or yellowish-red.

Fat-Staining.†—Dr. J. Lewinson stains fat by a modification of Wolters' method. The material is fixed in Müller's fluid for 2–6 weeks, and, after dehydration in 70 p.c. and 85 p.c. alcohol, is imbedded in celloidin. The sections are stained in hæmatoxylin solution (2 grm. hæmatoxylin dissolved in a little absolute alcohol and added to 100 ccm. of 2 p.c. acetic acid) for 12 hours at a temperature of 40° C. After washing in water, they are treated with a 1 p.c. aqueous solution of permanganate of potash for 10–15 minutes. The sections are again washed in water, and then immersed in 2 p.c. oxalic acid or a mixture of 2 parts 2 p.c. oxalic acid and 1 part 2 p.c. sulphite of potash for 5 minutes. They are next washed in water, and mounted in the usual way, or may be contrast-stained with borax-carmine and picric acid to show the nuclei and protoplasm of the cells.

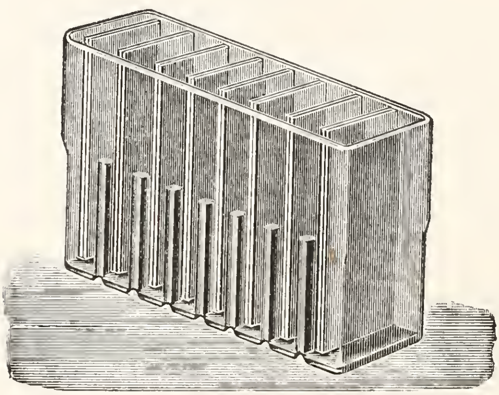
By the foregoing procedure even the smallest particles of fat are distinctly stained.

Modification of Pitfield's Method for Staining Flagella.‡ — Dr. J. B. Smith has found the following modification of Pitfield's method for staining flagella very reliable and easily carried out. The mordant is made as follows:—A saturated solution of perchloride of mercury, made

* Bolnicznaja Gazeta Botkina, 1899. See Zeitschr. wiss. Mikr., xvii. (1900) p. 359.
† Zeitschr. wiss. Mikr., xvii. (1900) pp. 321–7. Cf. this Journal, 1891, p. 425.
‡ Brit. Med. Journ., 1901, i. pp. 205–6.

by boiling, is poured while still hot into a bottle in which crystals of ammonia-alum have been placed in quantity more than sufficient to saturate the fluid. The bottle is well shaken, and then allowed to cool. To 10 ccm. of this fluid, 10 ccm. of a freshly made 10 p.c. solution of tannic acid and 5 ccm. of carbol-fuchsin are added. The mixture is filtered. The cover-glasses are washed in strong hydrochloric acid, and when removed therefrom are wiped with a clean cloth and thoroughly heated over a Bunsen burner. The traces of acid left on the slips help to prevent precipitation of mordant or stain. The bacilli are placed on the cover-slip and fixed. The mordant is then filtered, poured on the film, and heated until steam is given off. The heating, without boiling, should be continued for about three minutes. The preparation is then washed in distilled water, and, after adding the stain, is heated in the same way for three or four minutes. The stain is made by adding 1 ccm. of a saturated alcoholic solution of gentian-violet to 10 ccm. of a saturated solution of ammonia-alum. This is filtered and poured on the preparation.

FIG. 34.



Double Staining of Spores and Bacilli.*—R. Greig Smith advises the following modification of Klein's method for staining spores. Four drops of normal saline solution are pipetted into a small test-tube, and the spore-bearing material is rubbed up with this until a homogeneous suspension is obtained. Four drops of carbol-fuchsin are pipetted into the tube, and the mixture shaken. A plug of cotton-wool is inserted, and the tube placed in a beaker of boiling water. The boiling is continued for a quarter of an hour, when the tube is taken out and shaken. A loopful of the bacterial suspension is withdrawn and spread uniformly over a cover-glass, which is dried either in the air or high over a Bunsen flame. The film is next fixed by passing the cover-glass thrice through the flame in the usual manner. The bacilli are decolorised in methylated spirit containing 1·5 p.c. by vol. of strong hydrochloric acid. When the film appears colourless, the cover-glass is withdrawn and the alcohol removed with water, after which the film is stained with carbol-

* Proc. Linn. Soc. N.S.W., xxv. (1900) pp. 394–7. Cf. this Journal. 1899, p. 346.

methylen-blue in the usual way. It is then washed, dried, and mounted. By the foregoing process the most refractory spores are stained.

New Staining-trough for Serial Sections.*—Dr. H. Hellendall has devised a trough for staining simultaneously a large number of sections (fig. 34). It is made of glass, is 8 cm. long, 3 cm. broad, and 8 cm. high. Along each side are seven ribs or fillets, each being 5 cm. high and 0·5 cm. thick. These fillets are blown into the vessel, and thus eight open compartments are formed, in each of which a couple of slides placed back to back can be located.

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

New Fixative Solution, and Method for Restoring Old Specimens.†—Prof. M. Lavdovsky has found the following fixative give especially good results:—1 p.c. acetic acid 500 ccm.; chemically pure bichromate of potash 20–25 grm.; saturated aqueous filtered solution of sublimate 5–10 ccm. This combination acts well not only with fresh tissues, but also with old material, acting thereon like a restorative. The solution may be used as given, or diluted with an equal quantity of water. Fixation is completed in two or three days, the pieces being afterwards hardened in alcohol for 2–7 days.

The more important points in the restoration method are as follows. The slide is immersed for 24–48 hours, or longer, in turpentine oil, xylol, or toluol, until the cover-glass is easily separable from the slide. The slides, provided that the sections are not too firmly adherent, are placed in 95 p.c. to 100 p.c. alcohol for 15 minutes, and then in water for 5 minutes. The slides are then immersed for 6–24 hours in the chromaceto-sublimate solution diluted with half its bulk of water. After having been carefully washed with water, the slide is transferred to Weigert's acetic acid-copper solution for 6–24 hours. The preparation is again washed with water, and then placed in Weigert's hæmatoxylin solution, diluted with an equal bulk of water, for 6–12 hours, after which it is decolorised in the borax-ferrid-cyanide solution. This must be diluted with one or two volumes of distilled water to prevent too rapid decoloration. When the preparation has been thoroughly washed, it is dehydrated in 95 p.c. alcohol, cleared up in oil of cloves and xylol, and mounted in balsam. The foregoing procedure is suitable for animal and vegetable tissues.

Formalin as a Wet Method for Blood-Films.‡—The method described by the Hon. G. Scott is as follows:—Hold the film, wet side down, in the mouth of a wide bottle half filled with 40 p.c. solution of formic aldehyde for about 5 seconds. Drop, while still wet, film downwards, into absolute alcohol; leave for 15 minutes to 48 hours. Mop up on blotting-paper, and then before any drying occurs, drop on a few drops of eosin-methylen-blue stain, cover with a watch-glass, stain for not longer than 2 minutes. Run off excess of stain, and rinse in distilled water twice. Mop off excess of water. Dehydrate rapidly in absolute alcohol; then treat with xylol three times rapidly, and mount in balsam. The film must not be allowed to dry at any stage.

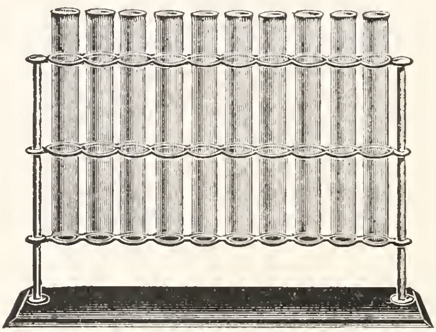
* Zeitschr. wiss. Mikr., xvii. (1900) pp. 299–300 (1 fig.). † Tom. cit., pp. 301–11.
‡ Journ. Pathol. and Bacteriol., vii. (1900) pp. 131–6.

Mounting Desmids.*—G. H. Bryan uses a small box made of parchment-paper. The water containing the desmids is placed in the box, which is floated on glycerin. In two days the water will have diffused into the glycerin and sufficient glycerin into the desmids. They are then ready for mounting in glycerin.

(6) Miscellaneous.

New Test-tube Stand.†—Dr. R. J. Petri has devised a convenient stand for ten tubes (fig 35). It is made entirely of metal, the base

Fig. 35.



and uprights consisting of iron or zinc. The new stand is more compact and takes up much less room than a wooden one, and is specially adapted for laboratories.

Quickly-made Glass Cell.‡—H. A. Doty places a cover-glass of the desired thickness on a turn-table together with a minute drop of water, by means of which the cover-glass is held firmly enough to permit circles being cut upon it with a diamond. As it is rarely possible to free the circle from the ring without breaking the latter, it is advisable to cut the ring across with the diamond, after which it is more easily detached. The cross-cut does not impair its efficiency as a cell when it has been cemented on to the slide.

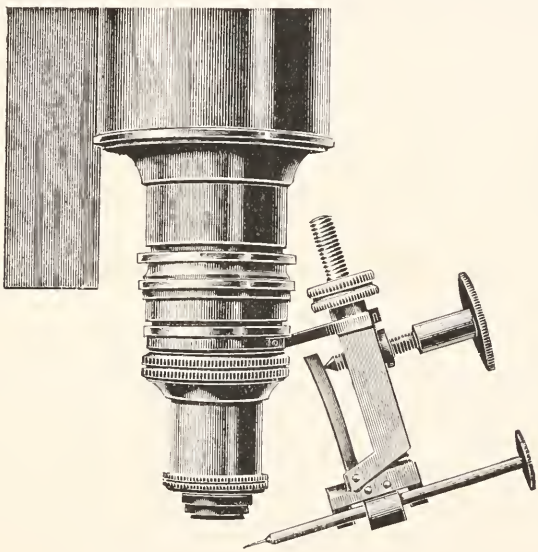
Mechanical Finger. § — H. A. Doty has devised a mechanical finger which allows the rod carrying the bristle to be instantly removed (fig. 36), the pin in the end of the rod being also removable, so that several sizes and forms of bristles may be employed, without loss of time, upon the same piece of work. The other adjustments are so clearly shown in the illustration as to need no further description.

Measurement of Bacteria.‖—R. Greig Smith states that the method he employs in determining the breadth of an organism is to fix on a bacterium in the microscopic field and measure its length. He then compares the organism with a series of diagrams representing bacteria, the breadths of which have been accurately measured in terms of the

* Journ. Applied Microscopy, iii. (1900) pp. 1027–8 (2 figs.).
† Centralbl. Bakt., 1te Abt., xxviii. (1900) pp. 747–8 (1 fig.).
‡ Journ. Applied Microscopy, iii. (1900) pp. 990–1.
§ Tom. cit., pp. 991–3 (2 figs.).
‖ Proc. Linn. Soc. N.S.W., xxv. (1900) pp. 533–6 (3 figs.).

length. From this series one group that appears identical with the organism fixed upon is noted, and the number of this group is multiplied by the length of the organism. The result is the breadth. The breadth of another organism in the same film may be calculated in a similar manner, and the second result will generally be identical with the first. For example, the rodlet measures $1 \cdot 5\,\mu$, and on comparison with the diagrammatic table it appears identical with the group whose type number $\left(\frac{\text{breadth}}{\text{length}}\right)$ is $0 \cdot 4$. On multiplying $1 \cdot 5\,\mu$ by $0 \cdot 4$, the breadth $0 \cdot 6\,\mu$ is obtained. The result may be checked by measuring with the

Fig. 36.



micrometer eye-piece. The diameters of cocci, streptothrix, &c., might be confirmed after micrometer measurement by comparison with lines ruled at intervals of 1·2 mm. (the length of the smaller diagrammatic organisms) upon a cover-glass which is superposed over the shorter diameter of the diagrammatic types. Such rulings can be made upon a cover-glass by dipping the latter into a dilute solution of gelatin (0·5 p.c.), and ruling the lines with Indian ink upon the thin dry gelatin film.

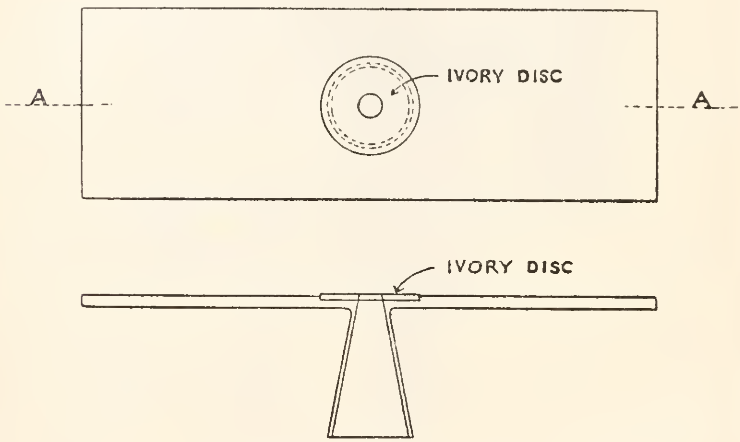
Examination of Arsenical Sublimates. * — M. H. Stiles has found that the examination of the arsenical sublimate under the Microscope is much facilitated by the adoption of the following method. A strip of copper foil, after having been boiled with 200 ccm. of the suspected fluid (beer) and 30 ccm. of pure hydrochloric acid for 45 minutes, is washed successively with water, alcohol, and ether, and dried. The strip is then placed in a dry test-tube $3\frac{1}{2}$ in. by $\frac{1}{2}$ in., containing

* Pharmaceutical Journ., lxvi. (1901) p. 4.

a strip of glass 3 in. by $\frac{3}{8}$ in. This is held in position by a flat steel spring about $\frac{1}{4}$ in. wide, folded like a pair of tweezers, and having just strength enough to keep the slide firmly pressed against the side of the test-tube. The lower part of the tube should be carefully and uniformly warmed, the copper strip being kept at the other end of the tube by tilting the latter. After the warming the tube is again inclined, and the sublimation effected at as low a temperature as possible. When the sublimation is completed, the copper foil and the spring are removed and the tube corked. By this procedure the sublimate is deposited on a plane surface, so that it can be examined under high powers and the slip preserved for future reference.

Micrographic Fly-Cage.—Fig. 37 represents the apparatus exhibited at the meeting of the Society on Feb. 20th (see p. 224), devised by

FIG. 37.



SECTION ON LINE A A.

Mr. G. H. J. Rogers, and made by Mr. C. Baker, for exhibiting the proboscis of the common house-fly as an opaque object. It is large enough for the blow-fly, but can be made any size. It consists of a brass cone soldered to a brass plate with a hole in it, just large enough to admit the head of the fly, which is surrounded by a disc of ivory, let into the plate. The fly is gently pushed into the cone with a little piece of wool behind it, and is ready for examination. A little treacle or honey is put on the ivory disc; the fly puts out its proboscis, which is kept flat and in one position. It is very easy to focus, and does not require any adjustment of the object more than an ordinary slide. The idea was taken from the well-known paper disc and stage forceps, the ingenious invention of Mr. Macer.

Metallography considered as a Testing Method.*—In an article with above heading Mr. Osmond illustrates (*inter alia*) the question of

* Metallographist, i. (1898) pp. 5–27 (17 figs.).

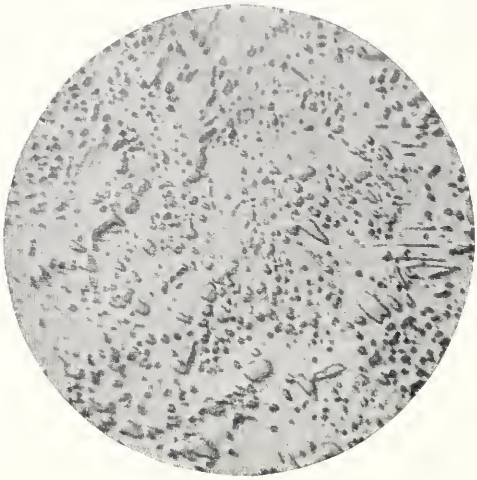


Fig. 1.

Fig. 2.

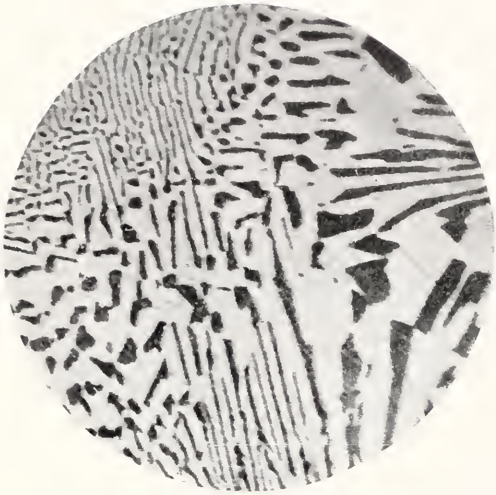


Fig. 1.

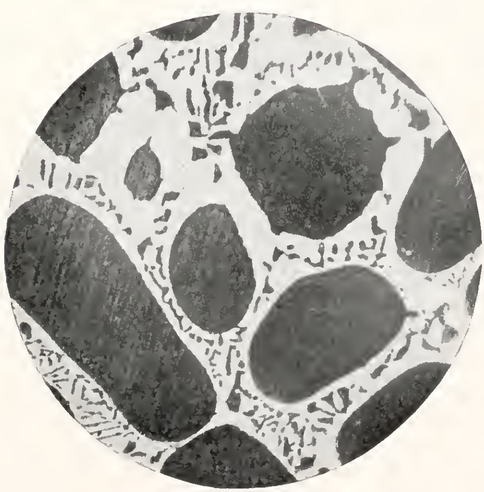


Fig. 2.

identifying an alloy of two constituents of different colours by citing an alloy of 54 p.c. of gold and 46 p.c. of aluminium. This contains a compound of a beautiful purple colour, discovered by Prof. Roberts-Austen, and having the definite composition of $AuAl_2$. It possesses the very rare property of having a melting-point superior to the melting-point of the less fusible of the two constituents. During solidification it separates first as crystallites, which appear black in the photograph (plate II. fig. 1); the interval being filled by a matter of subsequent solidification, whose proportion and nature vary with the composition of the alloy.

Plate II. fig. 2 illustrates the process of testing by abrasion upon a soft foundation by the assistance of very fine powders. The sample was a hard steel bar (1·24 p.c. of carbon), forged into a round bar, 12 mm. in diameter, the forging having ended at a dark red. A cross section was polished, and the polishing continued upon a piece of wet parchment covered with a very small quantity of rouge. The iron became dug out, placing in relief the carbide Fe_3C, which in this sample is divided into a multitude of small rounded grains, which appear dark upon a light background, or light upon a dark background, according to the position of the objective.

The same method is convenient for resolving clearly the mixture of iron with the carbide Fe_3C which was discovered by Dr. Sorby to be a constituent of all slowly-cooled steels. The mixture is in layers, usually curved, the thickness of a pair of lamellæ averaging about 0·001 mm. From the irisated effect of the lamellæ the name of pearlyte is given to the structure.

If the fusibility curve of a two-metal alloy (such as copper and silver) be studied, it is found to contain two descending branches crossing off at a certain temperature (770° C.), where they are simultaneously crossed by a horizontal branch. Thus at this temperature there is a triple point. The explanation appears to be that above the triple point the metal in excess separates out, while below the eutectic alloy (i.e. the alloy in which the metals are mutually saturated) separates. Inasmuch as Leval found that this alloy had a definite composition Ag_3Cu_2, and as it crystallises in a distinct form, it was long thought to be a chemical compound. But when reheated it is not found to be homogeneous. Some of it (Cu) takes an orange coloration, and some (Ag) remains white. The orange metal is distributed as small dots or as plates (straight or curved) alternating with the white plates of silver. (Plate III. figs. 1, 2,; plate IV. fig. 1.) These alternations moreover produce a pearlyte-like effect. The evidence therefore seems to show that the eutectic is a mechanical mixture and not a chemical compound; although it is singular that its formation never begins until the unsolidified mass has reached the definite composition of Ag 72 p.c. and Cu 28 p.c.

Slowly cooled steel shows a similar fusibility curve, but the branches above the eutectic point correspond to the separation of pure iron (ferrite), or of Fe_3C (cementite), whichever is in excess, and the horizontal branch to a simultaneous separation of the two constituents in alternating layers. This eutectic point (670° C.) is sometimes called the point of recalescence, as the diminution of volume is interrupted and a sudden evolution of heat takes place, sometimes evident to the naked eye.

If the highly heated steel be suddenly cooled by quenching in ice-cold water, ferrite, pearlyte, and cementite disappear. Two cases now present themselves, according as the carbon content is inferior or superior to that of the eutectic alloy. Thus, in a piece of steel containing 0·45 p.c. of carbon, and cooled as described, we find a constituent, probably homogeneous, made up of needles, parallel in the same region, but frequently crossing one another along three principal directions. It is called martensite. The needles of martensite, other conditions remaining the same, become smaller and less distinct as the composition of the eutectic alloy is reached. Its hardness increases simultaneously up to its maximum. Above that point the metal does not remain homogeneous. A steel with 1·5 p.c. of carbon, quenched at 1050° C. in ice-water, breaks up into two constituents (plate IV. fig. 2). One of them (austenite, the light portion) possesses the unexpected property of being soft enough to be scratched by a sewing-needle.

Microscopic Study of Metallic Alloys.*—M. Charpy, of Paris, describes his experiments with alloys. In preference to working with commercial alloys, which are apt to be of complicated composition, he selected those of the simplest known type, which were more likely to yield phenomena in a more suggestive form. His conclusions with regard to eutectic alloys were that they were analogous to cryohydrates, which Ponsot ascertained, in 1895, were composed of juxtaposed crystals alternately of ice and of solid salt, the latter anhydrous or hydrated. Thus in examining the eutectic alloy of tin and bismuth (Sn 53·9, Bi 46·1 p.c.), the crystals were found extremely minute, but the metals were simply juxtaposed. Plate V. fig. 1 shows one of these preparations magnified 200 diameters; the black portions indicate the bismuth, the white areas the tin which had been dug out by the dilute hydrochloric acid. Fig. 2 shows an alloy of silver and antimony (Ag 66, Sb 34 p.c.) magnified: the preparation has been treated with hydrosulphuric acid, which darkens the silver without affecting the antimony. The silver is represented by the white portions. The alloy is made up of large areas of silver surrounded by the eutectic alloy, which clearly exhibits the alternate layers of silver and antimony.

The conclusion, therefore, is that eutectic alloys exist in the solid state as simple mixtures of their constituents.

The author also describes similar experiments with alloys having normal curves of fusibility.

The second portion of the paper deals with alloys with abnormal curves of fusibility. These include alloys of copper and tin, antimony and tin, antimony and silver, copper and zinc, silver and tin, and silver and zinc. These are all discussed, and 17 excellent photomicrographic figures illustrate the relations of the respective eutectic alloys to the matrices.

Crystalline Structure of Metals.†—In the Bakerian Lecture, Messrs. Ewing and Rosenhain discuss fully their previous experiments on this subject, and confirm their conclusion, to the effect that the plasticity of metals is due to the sliding over one another of the crystalline elements

* Metallographist, i. (1898), pp. 87–106 (12 figs. and 2 diagrams); pp. 192–210 (17 figs.).
† Proc. Roy. Soc., lxv. (1899) pp. 172–7.

Fig. 1.

Fig. 2.

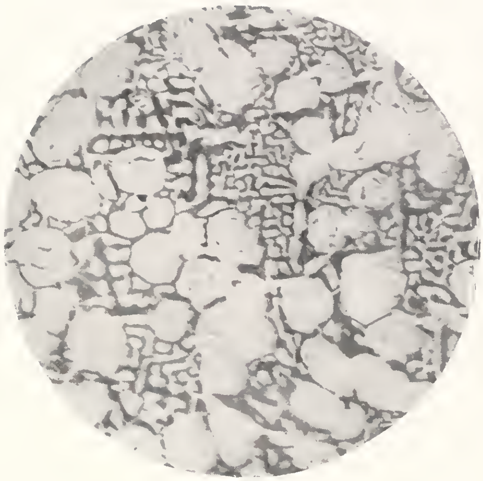


Fig. 1.

Fig. 2.

composing each grain, without change in their orientation within each grain, except in so far as such change may occur through the production of twin-crystals.

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Leipzig, W. Engelmann, 1900, iv. and 96 pp., 4 pls.

Bütschli, O.—**Untersuchungen über die Mikrostruktur künstlicher und natürlicher Kieselsäuregallerten (Tabaschir, Hydrophane, Opal).** (Investigations upon the Microstructure of Artificial and Natural Colloid Silicic Acids (Tabascheer, Hydrophane, Precious Opal.)
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[A study of the Microstructure, together with the physical properties of metals, has given rise to the science which has been designated Metallography.] *Technology Quarterly*, xiii. (1900) pp. 29–314 (11 figs.).

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Berlin, 1901, 8vo, 476 pp.

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5 Lieff., Würzburg (Stuber), 1900.

PROCEEDINGS OF THE SOCIETY.

MEETING

HELD ON THE 20TH OF FEBRUARY, 1901, AT 20 HANOVER SQUARE, W. A. D. MICHAEL, ESQ., F.L.S., VICE-PRESIDENT, IN THE CHAIR.

The Minutes of the Meeting of 16th of January, 1901, were read and confirmed, and were signed by the Chairman.

The List of Donations to the Society received since the last Meeting (exclusive of exchanges and reprints) was read, and the thanks of the Society were voted to the Donors.

	From
Braithwaite, R., British Moss Flora. Pt. xx. (4to, London, 1900)	*The Author.*
Pierce, Newton B., Peach Leaf Curl. (8vo, Washington, 1900)	*United States Department of Agriculture.*
"Double Reflecting Microscope" by P. and J. Dollond	*Mr. J. J. Kern.*
Two Objectives, 2 in. and 1/6 in., by Andrew Ross	*Mr. F. R. Dixon-Nuttall.*

A remarkably well-taken photograph of *Amphipleura pellucida* was sent for exhibition by Mr. Brewerton, and was handed round for the inspection of the Fellows.

Mr. E. M. Nelson said the photograph was very interesting, because it showed the transverse striæ as thin in comparison with the spaces between them; the striæ also were carried quite up to the apex. This was another instance in which some optical theorists were proved to be wrong. They said that the striæ and the spaces must be of equal width, whereas he had affirmed that the striæ were much finer. In many photographs of this object they appeared to be of equal width, but that was only because the object had been badly photographed. In the example before the Meeting the photograph had been properly taken, and therefore exhibited a difference in the thickness of the lines and of the interspaces.

The Chairman said he did not remember to have ever seen a more remarkably clear photograph of this very difficult object than the one now shown by Mr. Brewerton.

Mr. G. H. J. Rogers, of Maidstone, exhibited a contrivance, differing to some extent from that of Mr. Macer, for exhibiting the proboscis of a fly, and read a short note describing it (see p. 220, fig. 37).

The Chairman thought the Fellows present would be very pleased to see this very pretty little apparatus. Various devices had been adopted for this purpose, and he remembered that Mr. Suffolk at one time exhibited the proboscis in a similar way, although perhaps not with exactly the same apparatus.

Mr. Beck said Mr. Macer's method had the further advantage, that being held in a pair of forceps, the object could be rotated so as to get a view of it from different aspects. At one of their soirées Mr. Macer showed, in a very satisfactory manner, a fly eating honey, the honey being held in one pair of forceps and the fly in another. He remembered this as being one of the most attractive objects shown on that occasion.

Mr. E. M. Nelson gave an interesting *resumé* of his paper on the Tube Length of the Microscope, explaining the difference between the mechanical and the optical tube length, and freely illustrating the subject by drawings and formulæ upon the black-board. The paper is printed in full in the present number of the *Journal*.

The Chairman, in moving a vote of thanks to Mr. Nelson for his extremely interesting and useful communication, said there was no subject connected with the technique of the Microscope about which ideas were vaguer than that of tube length, because most people thought that it was the length of the brass tube. Although it had often been pointed out in that room that what was really meant was the optical tube length, the subject did not seem yet to be very well understood; indeed very little practical information had hitherto been published as to how a person was to ascertain what the tube length of his Microscope really was. Mr. Nelson had now given them a method by which this could be found, and their cordial thanks were due to him for bringing the matter before them.

The thanks of the Society were cordially voted to Mr. Nelson for his communication.

Mr. F. W. Millett's paper 'On the recent Foraminifera of the Malay Archipelago,' Part X., was taken as read, it being intimated that it would be found printed, with a plate in illustration, in the current number of the *Journal*.

The Chairman said he should like, before the business of the Meeting was finished, to call attention to the very beautiful set of slides of bacteria and blood parasites which were exhibited under the Microscopes on the table, and for which they were indebted to Mr. Conrad Beck; and at the same time to thank him for the great trouble he had taken in getting up this exhibition. He was quite sure that these examples of a class of bodies which appeared to play such an important part in questions of health and disease would be examined with extreme interest.

He had great pleasure in moving that the best thanks of the Society be given to Mr. Beck for his trouble and attention in the matter.

The motion, having been put from the chair, was carried by acclamation.

Dr. Hebb said that Mr. Rousselet was also exhibiting under the Microscope some Rotifers which had been sent from Natal.

The Chairman said it had been resolved by the Council to present an Address to the King, who, before he became King, was the Patron of their Society. Their Secretaries had prepared an Address for the purpose, and would now read it for approval and adoption by the Fellows present. Dr. Hebb then read the proposed Address as follows:—

To the King's Most Excellent Majesty.

"May it please Your Majesty,—

"We, Your Majesty's dutiful and loyal subjects, the President, Council and Fellows of the Royal Microscopical Society, in General Meeting assembled, humbly beg leave to offer our most sincere and respectful Condolences to Your Majesty on the loss which you and the

Nation have suffered on the death of Your Royal Mother, our late beloved Sovereign, whose manifold virtues must ever render her memory dear to all the inhabitants of the British Empire, and whose loving thoughtfulness for the benefit of her subjects will be remembered by their posterity for all time.

"Permit us also, Sire, to present our unfeigned and heartfelt congratulations upon your Majesty's Accession to the Throne of Your Ancestors, and allow us who are already indebted to Your Majesty for having been our Patron for so long a period to earnestly and respectfully entreat that you will continue to accord to the Royal Microscopical Society the same protection and favour.

"That Your Majesty's Reign may be long, happy, and glorious, and that you may ever Rule over an affectionate and grateful people, is the earnest wish and ardent prayer of Your Majesty's loyal and dutiful subjects the Fellows of the Royal Microscopical Society.

"Signed on behalf of the Society," William Carruthers, *President.* W. H. Dallinger, Richard G. Hebb, *Secretaries.*"

The Chairman then asked if it was the pleasure of the Fellows of the Society that the Address now read should be adopted and presented to the King as from the Royal Microscopical Society, and the motion thus put was carried unanimously.

The Chairman intimated that the Address would be engrossed and sent on in due course.

The following Instruments, Objects, &c., were exhibited:—

The Society:—The following slides of mounted Rotifers prepared by the Hon. Thos. Kirkman, of Natal: *Cyrtonia tuba*, *Pterodina trilobata*, *Scaridium eudactylotum.*

Mr. Conrad Beck:—A collection of Bacteria and Blood Parasites.

Dr. Gilbert:—Photograph by Mr. Brewerton, *Amphipleura pellucida.*

Mr. G. H. J. Rogers:—Fly-cage for exhibiting the proboscis of a fly.

MEETING

Held on the 20th of March, 1901, at 20 Hanover Square, W.
A. D. Michael, Esq., F.L.S., Vice-President, in the Chair.

The Minutes of the Meeting of 20th of February last were read and confirmed, and were signed by the Chairman.

The following Donation was announced, and the thanks of the Society were given to the donor:—

	From
An Engraved Portrait of Peter Dollond	*Mr. Chas Lees Curties.*

The Secretary called attention to an excellent portrait of Mr. Peter Dollond, which had been presented to the Society by Mr. C. L. Curties.

The Chairman said that, apart from the fact that this was a portrait they were very glad to possess, he thought it was of great interest as being an extremely beautiful specimen of the style of engraving which was in vogue at the period when this was printed, and which was of high excellence.

The thanks of the Society were, upon the motion of the Chairman, unanimously voted to Mr. Curties for his donation.

Mr. E. M. Nelson said that two old Microscopes which had recently come into the Society's possession were of considerable interest. The first Microscope, a non-achromatic, was purchased by the Society; it has the name of Carpenter, 24 Regent Street, engraved upon it, and its date may be assigned to about 1825. It is especially interesting from the fact that the late Hugh Powell, before he began to make Microscopes on his own account, used to make them for the trade, and there was no doubt that they had an early specimen of Hugh Powell's work before them. It was a great acquisition to the Cabinet of the Society, as they did not already possess one of this particular type.

The other Microscope, kindly presented to them at the last Meeting by Mr. Kern, was one of the Scarlet and Culpeper type, and is in a remarkably fine condition, seeming as if quite new from the hands of the makers. It is signed "Dollond," and in the box in which it is packed there is a printed description, which bears the names of John and Peter Dollond of St. Paul's Churchyard. John Dollond, the father, was a silk-weaver by trade, but, having turned his attention to mathematics, he gave up silk-weaving and joined his son, who was an optician; in 1758 he received the Copley medal for the invention of the achromatic telescope, and died in 1761. If, therefore, this Microscope was made in his life-time, its date is fairly well determined.

The Secretary said they had received from Messrs. Staley and Co., the agents of the Bausch and Lomb Optical Company, for exhibition, a Bausch Camera Lucida, which was described in the *Journal* last year (volume for 1900, p. 734). It was only indirectly connected with the Microscope, and was apparently intended to help people to draw small objects which they were unable to copy otherwise.

Mr. E. M. Nelson read his paper on 'The Working Aperture.'

The Chairman invited discussion upon the subject of this very interesting paper, which he ventured to think was one which most microscopists had greatly neglected.

Dr. Tatham said he was very glad that Mr. Nelson had brought this matter before them in his usually concise and practical way. Dr. Tatham had himself experienced the difficulties described, and had tried to overcome them, but although he had not formulated his own difficulties in the same way as Mr. Nelson, he had often experienced the uncomfortable feeling that when, after a great effort, he had obtained a particularly good resolution of a difficult object, it was uncertain whether he should be able to reproduce it on a subsequent occasion. By showing them how this could be done with accuracy and certainty, Mr. Nelson had added one more to the many services which he had rendered to practical Microscopy.

The thanks of the Society were cordially voted to Mr. Nelson for his communication.

Mr. H. G. Madan's paper, 'On a Method of Increasing the Stability of Quinodine for Microscopical Purposes,' was read by Mr. Nelson, in the absence of the author.

Mr. Karop said it would be of great assistance to diatom-mounters if Mr. Madan's method should prove to be effective. Quinodine was, of all media, the best on the whole yet discovered for the purpose, but it had hitherto been very troublesome on account of its tendency to crystallisation. His own specimens had all gone wrong in that way, and though he had tried re-heating and other means, they all became crystallised again after a short time, and thus rendered useless. He hoped the material prepared as Mr. Madan suggested would be marketed, when he should be glad to give it a trial.

On the motion of the Chairman, a vote of thanks was unanimously voted to Mr. Madan for his paper, and to Mr. Nelson for reading it.

The Hon. Thos. Kirkman's paper, 'On Some of the Rotifera of Natal,' was read by Mr. Rousselet, and illustrated by specimens exhibited under Microscopes in the room.

Mr. Rousselet had himself added to this a technical description of *Pterodina trilobata*, an excellent drawing of which, by Mr. Dixon-Nuttal, was exhibited at the Meeting.

The thanks of the Society were unanimously voted to Mr. Kirkman for his paper, and to Mr. Rousselet for reading it.

Mr. W. H. Merrett read a paper 'On the Metallography of Iron and Steel,' demonstrating the subject by the exhibition of a large number of lantern slides of sections of different classes of these metals under various conditions of hardness, strain, &c. The methods by which these sections had been prepared and polished were also explained.

The Chairman said it was almost superfluous to ask the Fellows present to return their thanks to Mr. Merrett. He had given them a most excellent demonstration of a very important subject, in which scientific research and commercial interests worked hand in hand.

The thanks of the Meeting were voted to Mr. Merrett by acclamation.

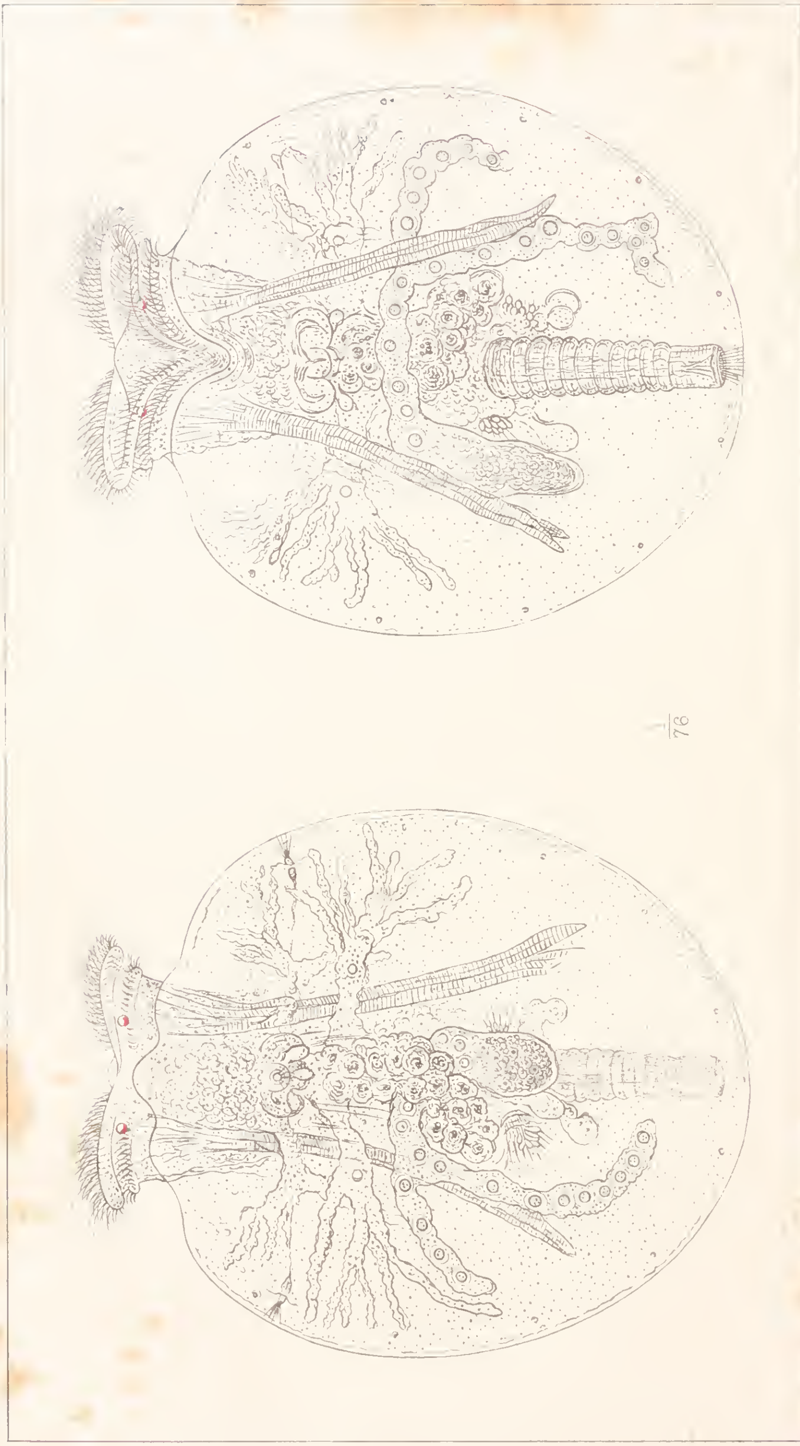
The Chairman said they had been indebted to Messrs. Baker for having kindly provided and worked the lantern by which the slides had been shown, their own lantern having been found unsuitable.

The thanks of the Society were accordingly voted to Messrs. Baker.

The following Instruments, Objects, &c., were exhibited:—

The Society:—An Old Microscope, by Carpenter. The following Slides of mounted Rotifers, prepared by the Hon. Thos. Kirkman, of Natal, to illustrate his paper: *Cyrtonia tuba*, *Pterodina trilobata*, *Scaridium eudactylotum*.

Messrs. A. E. Staley and Co.:—A Bausch and Lomb Camera Lucida.



Pterodina trilobata

F. R. Dixon-Nuttall del. ad nat.

West, Newman lith.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

JUNE 1901.

TRANSACTIONS OF THE SOCIETY.

IV.—*List of Some of the Rotifera of Natal.*

By Hon. Thomas Kirkman, F.R.M.S.

(*Read* 20*th March*, 1901.)

Plate VI.

In any paper treating of the fauna or flora of Natal, it is necessary to bear in mind that the land rises rapidly from what is called the coast belt, which is sub-tropical in climate and, as a rule, is very broken country, inland up to the boundary of the Drakensberg.

Pietermaritzburg, the capital, or Maritzburg, as it is usually called, though lying in a hollow surrounded by high land, is 2300 feet above the level of the sea, and the climate there is more temperate, though only about fifty miles from Durban, the seaport town.

Being a member of the Legislative Council, the Upper House of Parliament here, I have had opportunities during the sessions for the past three years of studying the Rotifera about Maritzburg, as well as those on the coast belt on the edge of which I live, about eight miles from the sea.

The habitats of the Rotifera which I have found near home are chiefly the pools, hollows, basins, and fissures in the rocky broken beds of streams and rivers, which, owing to the configuration of the country, run in some places very rapidly, creeping in and out amid boulders, &c., and in others form placid pools, which in droughty years, as the year 1900, are more or less shallow, the water only just moving, and abound in microscopic life.

The Inkifa, or Equeefa, is a tributary of the Umzinto, both of

EXPLANATION OF PLATE VI.

Fig. 1.—*Pterodina trilobata* Shephard. Dorsal view. × 250.
" 2. " " Ventral view. × 250.

them streams or small rivers in Alexandra county, and more or less rich in rotiferal life according to the season.

Round about Maritzburg the haunts of these little creatures are ponds, marshy places, and the edges of the river Umsindusi.

Many rotifers, more or less rare in England according to Messrs. Hudson and Gosse, are more or less common here, and *vice versa.*

Judging from my own experience, the commonest rotifers here are *Brachionus militaris* and one of the *Philodinæ*, apparently *P. erythrophthalma. Scaridium eudactylotum* I have taken from rather widely different habitats, but in every instance it has been from cool water and shaded by grass. The names of others more or less rare will be seen in the appended list.

The only books that I have on the subject, of any authority, are *The Rotifera*, by Hudson and Gosse, 1889, with Supplement, and the second volume of the *Cambridge Natural History*, 1896.

The Microscope that I have was bought in 1896, and is simply one of Chas. Baker's "advanced student's" instruments, which I am able to carry to Maritzburg with me, and is fitted with Baker's 1½-in. objective and Zeiss achromatics A and C, with compensating Huyghenian eye-piece 3, and apochromatics 8·0 mm. and 4·0 mm., with eye-pieces 8, 12, and 18, also his condenser and camera lucida, &c., suitable for the same.

On page 97, vol. i., Hudson and Gosse make the statement that "All the Rotifera seem to possess the power of secreting a viscous fluid, which they put to various uses. The Rhizota form their cases of it; the Ploima and Scirtopoda draw it out in long threads from spots to which they have adhered, and thus moor themselves to external bodies; while the Bdelloida, by coating themselves all over with it, not only resist the extremities of heat and drought, but set at defiance old Time himself." It is not enough to say this, as it does not give the whole facts of the case.

So far as I have seen, *no* rotifer that has a foot or toes moves in its natural and unalarmed state without spinning this thread as it moves, lengthening it as required, whether swimming or crawling over algæ, weeds, &c., or glass. There is always one thread from each toe. It is difficult to see in some species, because of their peculiar motions, as in *Synchæta pectinata* and *Actinurus Neptunius*, but easy to see in such as use it as a cable by which to moor themselves, while rotating at the end of it, like *Brachionus militaris*, *Synchæta tremula*, and another that I have mentioned further on.

The Pterodinadæ also spin this thread as they move, fastening it at the start after the manner of a spider, and lengthening it as required. *Copeus Ehrenbergii* always binds its eggs with it on to threads of *Spirogyra*, preferring the finer species. *Scaridium longicaudum* and *Scaridium eudactylotum* in all their graceful movements spin this thread.

In the case of the Bdelloida, the thread can nearly always be seen as they crawl over the glass or the debris that may be with them.

The thickness of the thread does not appear to be in proportion to the size of the animal, but, apparently, depends more on the use to which it is put. According to my short experience, the term "free swimmer," when applied to rotifers having either a foot or toes, is a misnomer, as they invariably spin a thread and are moored to something either fixed or floating.

I am in no sense an artist, and find it impossible to portray, even with the camera lucida of Zeiss, the image of a rotifer satisfactorily as it appears to me. Still I have made attempts at sketching a large *Pterodina* that measures $\frac{1}{84}$ in., and at giving an outline of a rotifer that is a puzzle to me. This "puzzle" is a small illoricate rotifer, tapering in an irregular manner to the toes. The corona is apparently set on at an angle somewhat after the manner of *Microcodon clavus*, as seen in the illustration given by Hudson and Gosse. It has only one eye, which is situated at the bottom of the brain. The trophi are sub-malleate, there being nine teeth in each uncus; the toes are small, pointed, and furcate; and the foot I have never seen in any way retracted. There is a brush of setæ distinctly seen on each side. The creature is as clear as crystal, the internal parts being well defined, and it is always rotating at the end of its thread after the manner of *Synchæta tremula*, but in an eccentric manner. It takes from eight to fourteen turns in one direction, then reverses and goes in the other. It is never fixed or quiet, at any rate under the influence of light, for a single moment. It is impossible to sketch it correctly, as it is never quiet, and pressure on the compressorium destroys its appearance, and, for the same reasons, it is exceedingly difficult to measure.

Messrs. Hudson and Gosse, on page 36, vol. i., speak of the Pterodinadæ and Euchlanidæ as "dwellers in clear ponds and rather solitary in their habits." I have not found it so here. They certainly like clear water, whether the quantity be small or great. I have found what I take to be *P. patina* in numbers in various kinds of small pools, from the size of one's hat to one which is in fact the hoof-print of an ox in soft ground by the road side. I have collected *Euchlanis triquetra* from a depression in a flat after heavy rain, and also from a fissure measuring about 6 in. deep, 6 in. wide, and 18 in. long, in a rock in the middle of a rapid stream after a day or two's rain, and in considerable numbers along the edges among grass, &c., of the placid pools of the river Umzinto, by merely plunging a bottle into the water when the river is low after a period of rather severe drought, as the last ten months have been in Natal.

During our summer months, I intend to make some trials at preserving and mounting rotifers according to the formula of Mr. C. F. Rousselet, F.R.M.S., and if I succeed, I will, later on, send what appear to be new ones to the Royal Microscopical Society.

P.S.—*Jan.* 10, 1901.—Since writing the above I have made some attempts at preserving and mounting, and am sending four slides, containing in all nine specimens of the large *Pterodina*, two slides containing five specimens of the "puzzle" mentioned above, and two slides containing five specimens of what I take to be *Scaridium eudactylotum.*

Rhizota.

Floscularia cornuta Dobie.—This appears to be the only species of floscule I have seen here during the summer months, and only two or three times.

Melicerta ringens Schrank.—I have found this both in the rocky pools of the Equeefa, and also in various habitats near Maritzburg. I have not seen any very large ones, or clustered ones, and no other species of *Melicerta* yet.

Limnias Ceratophylli Schrank. — This seems rare, as I have only seen it in one habitat in 1899, growing on the tubes of the fresh-water Polyzoon *Fredericella sultana,* in the rocky pools of the Equeefa.

Limnias annulatus Bailey.—I have found this in considerable numbers at times, growing on bits of dead wood, stems of water-grasses, &c., both here and about Maritzburg.

Cephalosiphon limnias Ehrbg.—This was found in 1898, growing along with *L. annulatus*, on bits of dead wood, in the rocky pools of the Equeefa; I have not seen it since.

Œcistes.—One species only have I seen, consisting of only two or three specimens growing on the stems of water-grasses in pools in the Umzinto early this year, 1900. The specimens were very small and I could not identify them.

Bdelloida.

Philodina. — There is one very common both here and about Maritzburg; it seems to be *P. erythrophthalma* Ehrbg., but I do not feel certain. *P. roseola* Ehrbg. I think I have seen in hollows in rocks where rain water has collected.

There is also another species of *Philodina* here, always found seated on threads of algæ, and having much the appearance of *P. megalotrocha* Ehrbg., as figured by Hudson and Gosse, but certain y the antenna is not unisetate.

Rotifer vulgaris Schrank.—This is more or less common.

Rotifer macrurus Schrank.—I believe I have seen this, but it does not seem common.

Actinurus neptunius Ehrbg.—I have found this in considerable numbers, attached generally to pieces of dead wood, lying at the bottom of two or three very dark small pools in the rocky bed of the Equeefa, but not anywhere else. They seem to dislike the light very much, but are more amenable to examination on a dull drizzling day, or when the light is subdued by a yellow screen under the stage. The threads from the toes are difficult to distinguish, owing to the movements of the foot, but they can be seen sometimes hanging down, festoon like, from the two uppermost toes when crawling.

Ploima Illoricata.

Synchæta pectinata Ehrbg. — This appears to be a very rare rotifer here. I have only seen it once, having obtained a number of specimens in a bottle in September 1899, from a little slack water in one spot in the rocky broken course of the river Equeefa, at very low water, under some long grass, protected by a big boulder from the running water close by. (Seven months after, in April 1900, in the very same spot, I found some *Scaridium eudactylotum.*) It is very difficult to see the thread of this creature, its movements are so rapid and unceasing; but I saw the thread easily of the young ones. I had left some *S. pectinata* in a trough all night, and in the morning I found eggs, also young ones, some just being born coming out foot first.

Synchæta tremula Ehrbg.—I found this species in a pond near Maritzburg in July and August, both in 1898 and 1899; and this year, 1900, being at home during the same months, I found it in quantity along the edges of the river Umzinto. I have not seen it at all during the hot season—November to February—when I find most of the others.

Polyarthra.—About the same time that Mr. Tyrrell and I found *Brachionus Bakeri,* in September 1900, we found also in the pools in the rocky bed of the Umzinto, a species of the above which seemed to be *P. platyptera* Ehrbg., having the same serrated spines in four clusters of threes, with two brushes of setæ behind (after the manner of *S. tremula*, but more distinct) of which one seta in some specimens was three or four times the length of the others, and of much the same form of body. Each carried as a rule a single egg. We did not see any with clusters of eggs.

Taphrocampa annulosa Gosse (?) — A few specimens of what appears to be this were found by me in February 1900, in grass and weeds at edges of pools in the river Umzinto. I have not seen it before or since.

Notommata aurita Ehrbg. — This was picked up along with some *Euchlanis,* along the edges in some slack water of the river Umsindusi, Maritzburg, in June 1899.

Notommata cyrtopus Gosse.—A rotifer answering to this description I found in March 1900, along the edges in pools of the Umzinto. The eyes of this are evertile, and when visible, show a clear lens in pink pigment, but when withdrawn, present the appearance described by Hudson and Gosse, as being a pair of colourless specks like air-globules, this being their usual appearance. The eyes seem to be very rarely everted, but I saw it so clearly as to make me certain of it.

Notommata naias Ehrbg.—The description of this answers to one I found very often in the marshes just above Maritzburg. It seemed common in 1898.

Copeus.—One species, fairly common in the marsh above Maritzburg, seemed to agree with the description given of *C. spicatus* Hudson, except that in this case the toes were always straight and the lumbar antennæ were different, as they had a brush of setæ. It was transparent, and its stomach full of desmids, &c., and had no mucus round it. I have not yet seen it down here on the coast. [The curved toes as depicted by Dr. Hudson, is not a normal condition; the toes are usually slightly decurved.—C. F. R.]

Copeus Ehrenbergii Ehrbg.—I feel confident that this is the same as the one I find in small pools of clear water among the rocks in the Equeefa river, always on threads of *Spirogyra.* I saw it in November 1898, and again this year, 1900, in February. It breeds readily in a bottle if supplied with *Spirogyra,* and the sucked threads taken away. The eggs are smooth, and are bound on to the cells of *Spirogyra* by its own thread. This is systematically and carefully done, the finer species of *Spirogyra* being preferred. The young from their birth are enveloped always with a coating of mucus, which is clear and transparent then, becoming dirty looking and darker as it grows older and bigger. They breed in considerable numbers on suitable *Spirogyra,* the collapsed state of the cells bearing witness to the presence of this *Copeus,* which once seen can easily be detected a second time, looking as they do like green bits of jelly, their stomach being full of the green food. This one nibbles through the cell-wall, the opening or perforation being easily seen, and then sucks out the contents rapidly. The one mentioned above, found near Maritzburg, was seen to contain small but entire desmids and diatoms. *C. Ehrenbergii* will feed on the cells of *Zygnema* also, but refuses *Œdogonium.*

Proales decipiens Ehrbg. — One answering to the description of this was found in July 1898, near Maritzburg, generally inside the empty cases of Entomostraca. The crystalline lens was very conspicuous.

Proales petromyzon Ehrbg.—I found one specimen along the edges of the Umzinto river, which appears to be this species, in December 1899, under the shade of grass; it was free.

Furcularia longiseta Ehrbg.—In the same spot as the *Proales* above, I found a rotifer which was evidently *F. longiseta,* in January 1900; also in pools, September 1900, among rocks.

Eosphora aurita Ehrbg. — The description and illustration of plate xvii. fig. 10 (not 17), Hudson and Gosse, tally with one I found in Maritzburg in July 1898, of which there were only a few specimens. I have no doubt whatever about it.

Eosphora naias Ehrbg. (?)—In a draining trench along the edges of a road on a flat near Maritzburg, was a rotifer which I concluded to be *E. naias*, January 1899.

Diglena forcipata Ehrbg. — In December 1899, along the edges of the Umzinto river in pools, I found several specimens, which, judging from the mastax, jaws, and wide-spread toes, I believe to be this species.

Diglena (?) *biraphis* Gosse.—The description given by H. and G. of the above tallies exactly with some I found in very small pools in the rocky bed of the Equeefa along with green Stentors, &c., in February 1899. The toes ended in points.

Loricata.

Mastigocerca.—There are two species of this genus to be found along edges of pools in river Umzinto, one of which, at first sight, agrees with the description and illustration given by H. and G. of *M. carinata;* but this had a double ridge nearly half-way down its back with several sub-styles, one of which appeared to be about a quarter as long as the main toe, and was carried in a slightly spiral manner round it. Another found both near Maritzburg (June 1899), along edges of river Umsindusi, and also here along with *Copeus Ehrenbergii*, agreed with the description given of *M. bicristata* Gosse, but is not so large.

Rattulus tigris Müller.—This was found in a pond on high land outside Maritzburg, in July 1899. There appeared no doubt about the species.

Cœlopus porcellus Gosse.—I found a species which I concluded to be *C. porcellus* along edges of a small stream near here last August 1898.

Dinocharidæ.—In a very slight depression about the size of one's two hands, at the edge of the river Equeefa, was found in September 1900 an apparently quite new rotifer which seemed, on examination, to belong to the family *Dinocharidæ*, judging from the pink spot on the mastax, the stout lorica covered with raised points, the mode of closing over the withdrawn corona, and the fairly well developed jointed foot and toes. It is quite different from any genus of that family mentioned by Messrs. Hudson and Gosse. There were not many specimens, but Mr. Tyrrell and I made some attempts to sketch it by means of the camera lucida. On returning to the spot about a week afterwards, the water was dried up, and I have not been able to add to my slight knowledge of it. [From the figures sent it is not possible to identify or diagnose this animal.—C. F. R.]

Dinocharis.—A few specimens were taken from edges of pools, Umzinto river, that agreed with the illustration given by Hudson and Gosse of *D. tetractis* Ehrbg. (plate xxvi. fig. 2) in which the trunk is about the same length as the foot and toes together, but does not agree with the written description of same, which says the foot and the toes together are more than twice the length of the trunk.

Dinocharis Collinsii Gosse.—A considerable number of what appeared to be the above were for two or three weeks in January 1900 found along edges of pools in the Umzinto, but with this difference: there were no spurs on any single specimen, nor were the edges of the lorica as much serrated as is depicted in the illustration. I also saw a solitary specimen taken from some marshy ground near Maritzburg in May 1898. [This animal is now known as *Polychætus Collinsii*.—C. F. R.]

Scaridium longicaudum Ehrbg.—This I found in very considerable numbers during the months of November, December, and January, our summer months, of 1899 and 1900, and it is now beginning to appear again, i.e. in September, still in the same spots as before, near edges of pools in Umzinto river. The eye is not adherent to the mastax, as believed by Hudson and Gosse. I had many opportunities of observing these animals in various positions, with bright white cloud illumination, under Zeiss 4 mm. apochromatic. There is a distinct space between the eye and the mastax, alterable at the animal's will; and, under close pressure in the compressorium, the mastax is twitched from side to side without in the slightest degree moving the eye. *S. longicaudum* appears to love the light, constantly appearing and reappearing on the field of view of the Microscope, and basking in the sunlight over the water-weeds in shallow places of the pools near the edges. *S. eudactylotum*, on the contrary, seems more partial to the shade.

Scaridium eudactylotum Gosse.—In February 1899, in a depression on a flat containing water left by a very heavy rain, I discovered this rare rotifer under some long grass. Again, in April 1900, in the company of a young friend (Mr. Harcourt Tyrrell), this rotifer was found, but in a very different position, this time in some slack water in the rocky bed of the Equeefa river, under long grass and protected by a boulder from the rapidly running water. The characteristics of these two species of *Scaridium* are so clear and distinct, as given by Hudson and Gosse in their written description and illustration, that we had no hesitation in identifying them. (In the very same spot, a few months before, I found *Synchæta pectinata*.) Again, in October, I found it on visiting the same spot. The trophi are of the malleate type, with eight teeth in each uncus. The egg is covered with spines.

It is somewhat difficult to get *S. eudactylotum* in the compressorium to lie in a position favourable for the examination of the mastax and eye. I tried eight or ten one day in succession before I could get one to lie as I wanted it. There is a distinct space between the mastax and the eye; the mastax can be moved in a twitching manner from side to side without in any degree affecting the eye, and the eye also can be moved slightly, independently of the mastax. I had several opportunities of viewing the trophi clearly, and found them of a normal sub-malleate type with eight teeth in each uncus.

Salpina.—One species is fairly common here, as I have seen it in various habitats both on the coast and in Maritzburg, from the spring to the summer months. It is very like the description of *S. macracantha* Gosse, but the head end, or collar, is always stippled, and I think it may be *S. ventralis* as described by Hudson and Gosse, Supplement. The spines appear to be the spines of *S. macracantha.*

Diplois propatula Gosse (?) [now called *Euchlanis propatula,* C. F. R.].—I have only seen about three specimens of what I believe to be *D. propatula.* It was in company with *Euchlanis triquetra,* in the hottest month of the year—February 1900—along edges of pools in the Umzinto.

Since the foregoing was written, I again found, in October 1900, what appeared to be *D. propatula,* judging from the size, the foot and toes, the three acute spines behind, and its general similitude with that described and illustrated by Hudson and Gosse. This time, however, I had a beautiful white cloud illumination, and was able to make out clearly, after the lorica had been cleansed from all internal matter and washed, that the lorica was covered all over with raised points, and that there were five teeth in each uncus. There were a few specimens only, found in company with *Scaridium eudactylotum* in the rapidly drying-up water, in what had been a miniature inlet or creeklet, overhung more or less with grass, in the middle of the rocky bed of the river Umzinto, a few miles below where I found it in February 1900. The toes end in points, and are not blunt as the one described by Hudson and Gosse.

Euchlanis.—There are several species of this genus in Natal. In Maritzburg, along the edges of the river Umsindusi, among reeds, &c., I found what appears to be *E. macrura* Ehrbg., which was fairly common.

Euchlanis uniseta (?)—Another, fairly common about Maritzburg, was one agreeing with the description and illustration of *E. uniseta*, from June to August 1899. [This is a very doubtful species, C. F. R.]

Euchlanis triquetra Ehrbg.—On the coast along the edges of Umzinto river, from February to April, were considerable numbers of what I took to be *E. triquetra,* judging from the occipital notch, the position of the setæ on the foot, and general appearance. I also found it, though more sparsely, in other places.

Euchlanis dilatata Ehrbg.—I have only just found what appears to be this species (December 1900), along the edges of pools in the river Umzinto, judging from the shape of the lorica, the broad gap, instead of the notch as in *E. triquetra,* and the five unusually distinct teeth in each uncus. There were always a pair of setæ on the foot, I saw none without.

Cathypna luna Ehrbg. — There appear to be two species of *Cathypna* here, one of which is evidently *C. luna*; the other is smaller and more common, and is often to be found in water lying in small pools which are on the point of drying up, the water beginning to smell badly owing to decaying vegetable matter.

Monostyla.—I have seen two or three species of this genus, but do not seem to have made any notes as to identification.

Metopidia.—I think I have seen several species, but have not paid them much attention.

Metopidia solidus Gosse.—This was found near Maritzburg in a small garden pond full of *Nitella*, and also along edges of the river Umzinto.

Metopidia acuminata Ehrbg.—I think I have seen this also frequently, and also another one, rather common, that has three wings after the manner of *M. triptera*, but it is evidently not that.

Pterodina.—There are four species in Natal that I have seen. One appears to be *P. patina*, which is common both near Maritzburg and on the coast; another that draws in its sides, as depicted in *P. valvata*, but its lorica is rough and covered with raised points, not smooth as described by Hudson and Gosse. It is rare, I think, as I have only seen a few specimens taken from a very small clear pool in the rocks of the Equeefa, along with some *Copeus Ehrenbergii.* [According to the mounted specimen sent this is *P. intermedia* Anderson.—C. F. R.]

Pterodina reflexa Gosse.—Only one or two specimens of this were found near Maritzburg, June or July 1899. It seems to be very rare here.

The fourth *Pterodina* is one very much larger than the others, and measures $\frac{1}{84}$ in. across. The lorica is nearly circular, slightly roughened and transparent, and has five bosses on each side, but is not stippled round the edge as in *P. patina*. A distinct feature of its internal organisation is what seems to be a long branching yolk gland. (See plate VI.) [This is *P. trilobata* Shephard.—C. F. R.]

Brachionus Bakeri Ehrbg. — Up to September 1900, I had not seen any other species of *Brachionus* except *B. militaris*. In company with a companion, Mr. Harcourt Tyrrell, I found in September what appears to be *B. Bakeri*. Several specimens were obtained from small shallow pools on the rocky portion of the beds of the river Umzinto and its tributary the Equeefa. In each case the water was shallow, sometimes extremely so. Under examination it was seen that the two large lateral spines behind were distinctly flexible, and not fixed and hard as in *B. militaris*. It is evidently rare about here.

Brachionus militaris Ehrbg.—This agrees with the description and illustration given by Hudson and Gosse in the Supplement. The thread or "anchoring cable" mentioned by Hudson and Gosse is easy to see as it rotates after the manner of *Synchæta tremula*. It is partial to pools and edges of streams where there is plenty of decaying vegetation, and is found all through the year, except during the cold weather. I have seen it in incredible numbers in the drifts, as we call them, i.e. the fords of rivers on sugar estates, where sugar-cane has fallen from the wagons in crossing and been crushed under the wheels. It generally has a couple of eggs hanging from it. I consider it to be the commonest rotifer in Natal.

Noteus quadricornis Ehrbg. — This handsome rotifer is fairly common here, and in some spots is found in considerable numbers; like most of the rotifers here, it is not seen during the cold months.

Copeus cerberus Gosse.—A small pool with water quite warm and full of algæ, at the edge of the river Equeefa, among the boulders, contained, in November last, 1900, an enormous number of a rotifer that tallied with the description and illustration given of *Copeus cerberus.* It was quite free from mucus, and had small toes, no tentacles, small auricles, minute but distinct tail, a three-lobed brain, of which the two outer lobes particularly contained opaque granular matter. The trophi had five distinct teeth in each uncus. It was considerably smaller than *Copeus Ehrenbergii.* This is the only time that I have seen it, and I have not had an opportunity of looking for it again.

Jan. 1901.—Since the above was written I have found a rotifer that answers to the description of *Rotifer tardus* Ehrbg., with the exception of the eyes. Also one that is evidently *Diglena grandis* Ehrbg.

Note by C. F. Rousselet, F.R.M.S.

A few remarks seem advisable on the Hon. Thos. Kirkman's interesting paper, which is the first contribution to the rotiferous fauna of any part of South Africa, particularly with regard to the species which the author was unable to identify. The sketches accompanying the paper are too slight and rough for publication, but the slides contain four very well mounted species which make their identification easy.

The "puzzle" is *Cyrtonia* (*Notommata*) *tuba* of Ehrenberg, a rare rotifer, but found occasionally in various localities. The figure Mr. Gosse has published of *N. tuba* is not recognisable, and it is impossible to say what this drawing really represents, whilst Ehrenberg's figure of this species is fairly good. In 1894, I gave a new figure and description of this animal in the *Journal Quekett Micro. Club,* vol. v. p. 433.

The *Pterodina* which the author calls *patina* is *Pt. intermedia* of Anderson,* being a slight variety of *patina*, of same size, with a

* H. H. Anderson, Notes on Indian Rotifers, Journ. Asiatic Soc. Bengal, 1891.

rounded projection on the frontal part of the lorica, stippled round the edge, and having ten "bosses" round the margin; previously found in India and Australia.

The giant *Pterodina* is evidently *Pt. trilobata* of Shephard,* a very fine rotifer, the internal organisation of which had not previously been recorded. Mr. J. Shephard gives the size of the lorica as $\frac{1}{250}$ in. long by $\frac{1}{200}$ in. wide, which is either a mistake, or else a remarkably small specimen; nor does this size agree with his drawing, which is said to be magnified 315 times. The shape of the lorica of the Natal specimen agrees perfectly with Shephard's figure, and as size alone is not a sufficient reason for a new species, I have no hesitation in identifying this Natal specimen with Shephard's species.

Mr. F. R. Dixon-Nuttall, with his usual skill, has made two excellent drawings of this animal from the mounted specimen sent from Natal, which are reproduced in the accompanying plate (plate VI.) The figures represent the dorsal and ventral aspect of two different animals found in the same slide. The size of the mounted specimens sent by Mr. Kirkman varies slightly between $\frac{1}{78}$ in. and $\frac{1}{72}$ in. (326 μ and 350 μ), which, however, is nearly double the size of the largest *Pterodina patina.* The lorica is quite flat, almost circular in shape, transparent, and finely and evenly stippled. The frontal edge shows three more or less pronounced rounded lobes, while the mental edge has a V-shaped sulcus; round the edge there are ten bosses at regular intervals, but there is no "milling" round the outer edge. The animal being so large, flat, and transparent, displays its internal organisation better than any other species of the genus. The head is of the usual form, with two red eyes containing a minute spherical crystalline lens; the dorsal antenna above the mastax and the two lateral antennæ in their usual position on the shoulders are readily found. The mastax is of usual shape and structure. At the junction of the short œsophagus with the stomach arise a pair of large gastric glands which spread right and left in numerous irregular tubular branches to near the margin of the lorica, the branching being different in every individual; near the middle of each gland there is a large nucleus, as if it consisted of a single cell. At the base of the mastax there are four or five very short tubular glands, which may be considered salivary glands, similar to those found in all other *Pterodinæ.* In addition to these there are a pair of large salivary glands of finer structure arising above the mastax, and spreading right and left parallel with but above the gastric glands, and in much finer granular threads, while one broader band crosses the gastric glands, and runs backwards a short distance, parallel with the retractor muscles. The development of the œsophageal and gastric glands is very striking in this species, and quite unlike that of any other known *Pterodina.* The stomach is fairly large, saccate, and is made up of large nucleated cells. The

* H. H. Anderson and J. Shephard, Notes on Victorian Rotifers, Proc. Roy. Soc. Victoria, 1892, pp. 69–80 (2 pls.).

ovary is roughly horse-shoe-shaped; the left branch is narrow, containing about 15 to 20 nucleated germ cells in single row, and always bifurcates, giving off a shorter arm, whilst the right branch is shorter and stouter, and it is here that the egg is formed and constricted off. This peculiarly formed ovary is also unlike that of any other known species of *Pterodina.* The two great retractor muscles are bundles of strongly striated muscle-threads; their position is ventral to the other organs, but posteriorly the band divides, and some of the threads are attached to the dorsal and some to the ventral plate of the lorica. Lateral canals and vibratile tags could not be found in the mounted specimen, but near the base of the stomach, on each side, I observed a cluster of peculiar organs, looking like flagellate cells, the nature of which I cannot determine, if they do not belong to the water-vascular system. It will be necessary to examine the living animals in order to decide this point. No similar cluster of cells have been noticed in other *Pterodina.* The opening for the foot is circular, and near the centre of the lorica on the ventral side, and the foot cylindrical and of usual structure.

Pterodina trilobata has not yet been found in Europe, and seems to be a tropical form.

The fourth species contained in the slides sent from Natal is *Scaridium eudactylotum*, a rare rotifer in England.

I do not think it is quite correct to say that all rotifers having a foot and toes always spin a thread as they move; they can do so when they like and when it serves their purpose, but they do not all do so always. These threads, when present, are readily seen under a good dark-ground illumination.

Since the above was read Mr. Kirkman has sent me another slide containing some specimens of a small variety of *Notops brachionus*, possessing two small hollow spines at the latero-posterior angles of the body, which seems to be widely distributed in South Africa, for last year I bred a single specimen of it out of dried pond mud received from Rhodesia.

The size of this animal, which I propose to call *Notops brachionus* var. *spinosus*, is $\frac{1}{67}$ in. (379 μ) in total length, and $\frac{1}{100}$ in. (254 μ) the body alone, and this is not more than about two-thirds of the size of the European type of *Notops brachionus.*

V.—*The Working Aperture.*

By Edward M. Nelson.

(*Read 20th March*, 1901.)

It will be generally recognised that it is important to distinguish more accurately than hitherto has been the practice, the precise ratio of the diameter of that part of the objective which is utilised to the diameter of the lens itself; in other words, vague generalities such as "about $\frac{3}{4}$ cone," "about $\frac{5}{6}$ cone," &c., are now not sufficiently explicit. A microscopist has only to work a short time with large axial cone illumination before he will become aware how great a difference in the image is produced by a trifling alteration in the size of the illuminating cone.

It is obvious, therefore, that in recording delicate observations with the Microscope it is advisable that the precise ratio of the utilised diameter of the objective should be stated.

Hitherto it has been customary to record the N.A. of the objective on the nose-piece; but this, in many instances, is not only a useless piece of information, it is often actually misleading. The information really required is the amount of the working aperture actually utilised during an observation, and not the total amount of the aperture available for utilisation. Similarly, a record of the actual weight of a body would be more important than the information that it was weighed in a balance capable of weighing 1000 grains. There are numerous recorded observations with oil-immersion $\frac{1}{12}$ of $1 \cdot 3$ N.A., where the aperture utilised has been less than $0 \cdot 3$ N.A.; hence these records, to say the least of them, are misleading; an ordinary $\frac{1}{2}$-in. objective with a $\frac{3}{4}$ cone would probably have given a better and more truthful picture. It is a dangerous practice to use an objective of large aperture when only a small portion of its available aperture is employed; for this is one of the most ready means of producing false images by the doubling of structure, or by the insertion of false intercostals, &c. Now, as the golden rule for obtaining truthful images is to employ as large a proportion of the total aperture as possible, it becomes a matter of importance that the amount of that proportion should be known.

It is of little avail to say that a great many histological objects do not contain periodic structures, and therefore do not lend themselves to the manufacture of false images; because, however elementary the object may be, its image will always be improved when the objective employed has a large proportion of its total aperture utilised. Further, microscopists, as a class, are accustomed to use powers higher than are necessary; for example, an oil-immersion $\frac{1}{12}$ with a small cone is used instead of a $\frac{1}{4}$ with a large cone, and so also is a $\frac{1}{6}$ used in place of a $\frac{1}{2}$-in. It would add importance and strength to the truthfulness of a picture if it were accompanied by a statement of the precise ratio of the utilised aperture to the total aperture of the lens through which it was drawn. Many ways in which this might be carried out will readily suggest themselves; thus the ratio might be called the working ratio, and be represented by the letters W.R. For example, under a drawing might be written, apo. $\frac{1}{4}$ N.A. 0·95, W.R. 0·75, which would mean that an apochromatic $\frac{1}{4}$-in. objective of 0·95 N.A. illuminated by a $\frac{3}{4}$ cone of axial illumination was used.

If this fraction should appear less than 0·5, all intelligent microscopists will know what value should be accorded to the picture. For example, the well-known Zeiss photograph † of *Pleurosigma angulatum*, taken with the view of confirming Prof. Abbe's diffraction image theory, would come out like this:—*P. angulatum*, apochromatic $\frac{1}{12}$ 1·3 N.A. 0·23 W.R.

Hitherto the measurements of this working ratio have been merely rough estimations by the unaided eye; it may be as well now to consider some alternative and more accurate method. One of the simplest is the measurement of the Ramsden disc in front of the eye-lens of the eye-piece by means of a magnifying-glass and a micrometer. It should be borne in mind that the size of the disc is inversely proportional to the power of the eye-piece; i.e. the lower the power of the eye-piece the larger will be the disc. For this purpose a divided lens dynamometer, such as is used with telescopes, would answer admirably; but then this piece of apparatus is somewhat expensive, and is hardly a part of a microscopist's outfit.

As a guide to the size of the images obtained by this means, an apochromatic $\frac{1}{2}$ with a No. 2 compensating eye-piece gives a disc whose diameter is about $\frac{4}{10}$ in. Another simple and efficient method is to use the draw-tube as a second Microscope, and fit an adapter at the bottom to carry a low-power objective, the eye-piece being an ordinary micrometer eye-piece, having a graduated scale in the plane of its diaphragm. The Zeiss large a* is a convenient objective to use for this purpose, as its power can be readily altered by merely turning the adjustment collar. Perhaps it is better that this second Microscope should be mounted separately with a tube to itself, for then it can be inserted into the Microscope, like an ordinary eye-piece, without disturbing any of the adjustments.

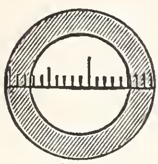
This secondary Microscope is for the purpose of magnifying the back of the objective, just as if it were an object upon the stage. The size of the central illuminated disc is measured, and this is divided by the size of the diameter of the total aperture, the quotient being the Working Ratio or W.R. It will be noticed that it is unnecessary to convert the micrometer readings into actual measurements in either inches or mm., as only a ratio is required to be determined; therefore

† This photograph has lately been withdrawn.

one need not proceed farther than to read the number of the divisions on the micrometer scale, which may be a purely arbitrary one. For example, let the total aperture equal 18 divisions, and the utilised aperture 13, then $\frac{13}{18} = 0 \cdot 72$ W.R. (fig. 38).

The N.A. of the central illuminated portion can be readily found from the W.R. by multiplying the W.R. by the total N.A. of the objective; this might be called the Working Aperture, or W.A.

Fig. 38.



If the W.R. is written after a lens, it is better to supplement this information with the N.A. as well, because a W.R. of say $0 \cdot 75$ with a half-inch of $0 \cdot 3$ N.A. means something very different from the same W.R. of $0 \cdot 75$ with an apochromatic 12 mm. of $0 \cdot 65$ N.A. In the first case the W.A. is only $0 \cdot 23$, but in the second it is $0 \cdot 49$, or more than twice as much. Some microscopists, in recording their work, may perhaps prefer to give only the W.A., while others will give both the W.R. and the N.A. of the objective they employ.

When objectives are being compared, it is of the greatest importance that the W.R. should be identically the same in each case; if not, the objective that was used with the larger W.R. would be much handicapped in the trial.

Summary:—

The W.R. is the diameter of the disc of light seen at the back of an objective (the source of light being accurately focussed by the substage condenser upon the object) divided by the diameter of the back lens * of the objective.

The W.A. is the W.R. multiplied by the N.A.

If it is required to set off with a given objective a given W.A., it is only necessary to divide the required W.A. by the N.A. of the objective and then multiply the quotient by the diameter of the back lens. Example:—Required the diameter of the bright disc in order that an apochromatic 4 mm. of $0 \cdot 96$ N.A. may have a working aperture of $0 \cdot 6$, the diameter of the back lens being 18 divisions of the micrometer. Then,

$$\frac{0 \cdot 6}{0 \cdot 96} = 0 \cdot 625 \, ; \qquad 0 \cdot 625 \times 18 = 11 \cdot 25.$$

Therefore if the iris of the substage condenser is adjusted so that it will give a diameter to the bright disc of $11 \cdot 25$, then the objective will have $0 \cdot 6$ W.A.

Most microscopists are painfully aware, after they have caught

* Provided that the diameter of the back lens is not larger than that required by the full aperture of the objective. The correct diameter of the back lens is found by multiplying twice the N.A. by the focus.

some particularly fine diatom resolution, or minute structure in a nucleus, or a barely visible flagellum, how difficult it is to reproduce the conditions so that on a subsequent occasion the same delicate structure may be made visible to some fellow worker in that line of research. Although they are using the same Microscope and object, with the same objective, eye-piece, and substage condenser, with the same tube-length and collar correction, and the same lamp and light filter, yet the image may for a long time elude their grasp. The reason for this is not far to seek; for microscopists in yearly increasing numbers have iris diaphragms instead of a wheel of diaphragms fitted to their substage condensers; and as it is well known that a minute difference in the position of the handle of the iris will cause a considerable difference in the size of the disc of light at the back of the objective, it comes to pass that one of the conditions, and that a most important one in the visibility of minute detail, viz. that of an identically similar working aperture, is not reproduced, and hence the failure of the demonstration.

If the working aperture be accurately measured in the manner indicated above, and recorded in addition to the other necessary conditions, there is little doubt that much time and labour will be saved in the reproduction of any particular microscopical image.

VI.—*On a Method of Increasing the Stability of Quinidine as a Mounting Material.*

By H. G. Madan, M.A. F.C.S., Fellow of Queen's College, Oxford.

(*Read 20th March*, 1901.)

The allotropic colloid into which ordinary crystallised quinidine is converted by exposure to a temperature slightly above its melting point, has been for some time used by microscopists as a very excellent mounting material for diatoms, &c., possessing as it does a fairly high refractivity ($\mu = 1 \cdot 602$ for yellow sodium light), and giving exceptionally clear and brilliant images. The one great drawback to its use (apart from its brittleness) appears to be its instability, or tendency to become opaque owing to its reversion to the crystalline form.

In a paper on mounting materials which I was kindly permitted to present to the Society in April 1898,* I suggested two possible reasons for this tendency to change:—

(1) The presence of solid particles of dust, &c., which would serve as nuclei and promote crystallisation.

(2) Exposure to warmth, such as that of a hot room or sunlight; since at a temperature of about 90° C. the conversion of the colloid (as hitherto obtained) into the crystalloid form is certainly rapid and complete.

Since then a third reason has occurred to me, which may very probably be the principal one in determining the change, viz. insufficient duration of the heat employed in effecting the conversion into the colloidal form.

In the case of sulphur, which at temperatures above 150° C. passes into the allotropic form known as "plastic sulphur," the change is certainly associated with the transfer of a large amount of kinetic energy (supplied in the form of heat) to the molecules of the plastic substance, where it is stored up as statical energy (in the obsolete phraseology of the older physicists, "a large amount of heat becomes latent"). This is proved by the two following observations:—

(*a*) That when ordinary sulphur is melted and the application of heat steadily continued, the temperature of the liquid at first rises uniformly by equal increments in equal times; but at a point a little above 150° a pause takes place, the temperature rising with extreme slowness, most of the heat passing into some other form of molecular

* Journ. Roy. Micr. Soc., 1898, p. 273.

energy. After a time, however, the temperature of the now colloidal sulphur rises at approximately the same rate as at first.

(*b*) That, when the conditions are reversed, and a mass of plastic sulphur at a temperature of, say, 200° C. is allowed to cool steadily, the temperature at first falls at a uniform rate; but at a point near 155° it almost ceases to fall for a time, the evolution of the stored-up statical energy being sufficient to maintain the temperature (as if by an internal furnace), in spite of the continued emission of heat from the cooling mass. After a time the temperature recommences to fall in accordance with the usual law of cooling.

Now it seemed likely that something of the same kind might occur in the case of quinidine, and that prolonged heating might be necessary to effect the *complete* conversion of the crystalline into the colloidal form.

To investigate this point, some quinidine in crystals was placed in a beaker and heated in an oil-bath maintained at a steady temperature of 186°–188° C. As soon as it was thoroughly melted and the liquid had attained the temperature of the bath, a portion was poured off and allowed to cool on a slip of glass. This portion was labelled "A." The remainder in the beaker was kept at a steady temperature of 186° (approximately) for half an hour, at the end of which time some of it was poured off upon a slip of glass and labelled "B." The rest was kept at the same temperature of 186° for a further half hour (making the whole period of heating one hour), and then poured upon a slip of glass and labelled "C."

These experiments were made on March 10, 1900, and the specimens were preserved in a tray under a bell-jar and examined at intervals.

The results up to the present date are as follows:—

March 29, 1900.—Specimen A showed already signs of crystallisation when examined under the Microscope. Specimens B and C, which were dark red in colour, showed no signs of any change, and were quite transparent.

March 12, 1901.—Specimen A had become quite opaque and crystalline. Specimen B was still transparent and unaltered. When a little of it was heated on a slip of glass, it remained unchanged up to the melting point, but then tufts of crystals began to appear in it. Specimen C was quite unchanged; it was dark red and transparent. When a portion of it was heated upon a slip of glass, it did not turn opaque and crystalline either before fusion or when it became liquid. It was allowed to cool, and then re-heated; and this cooling and re-heating was repeated three or four times, but no sign of crystallisation appeared, and no crystals were visible under the Microscope. The substance, in fact, behaved like a permanent resin, though it never became quite so fluid, when melted, as the other specimens.

The inference which we seem entitled to draw from the above and other corroborative experiments is the following:—That in order to effect with even approximate certainty the conversion of crystalloid quinidine into colloid quinidine, an exposure to a temperature of about 180° C. for a period of not much less than one hour is required. Whether even then the tendency to revert to the crystalloid form is entirely overcome, time alone can show; but at any rate it seems proved that the stability of quinidine as a mounting material is very considerably increased by the above process.

Enough quinidine for a large number of preparations may be thus treated and poured out on a slab; when cool, it may be broken up and kept in a bottle for use.

I may just add that I have treated piperine in a similar way with precisely similar results; and I have a hollow prism filled with piperine, and also a detached lump of it, made in October 1898, which have remained quite unaltered up to the present time, though the surface has been scratched to promote crystallisation if possible. But piperine, though interesting to physicists on account of its very high refractivity and its quite extraordinary dispersive power, is, owing to the latter property, not very suitable for mounting objects for the Microscope, requiring, as it would do, specially corrected objectives.

OBITUARY.

George Shadbolt.

Died 6th May, 1901, aged 83.

George Shadbolt was elected a Fellow of the Microscopical Society of London in 1845, and was President for the years 1856–57.

His first contribution to the Society was in October 1848. He there described an instrument for cutting the circular discs of cover-glasses, also a collecting stick for pond life. On March 20 and April 17, 1850, he gave a description of M. Nachet's illuminating prism, together with a formula for its construction. On April 17, 1850, Mr. Wenham described his improvements on the Nachet illuminating apparatus: first, by achromatising it; secondly, by mounting two of them opposing one another, oblique illumination in a single direction was avoided; thirdly, how by means of a silvered parabolic mirror he had secured achromatic all-round illumination (it is interesting to note that the first parabolic reflector made is in the Society's cabinet of apparatus). On June 26, 1850, Mr. Shadbolt described his annular condenser, which consisted of a ring of glass having its upper edge bevelled and polished both inside and out; this may be regarded as a simplification of the Wenham parabolic mirror. On March 19, 1851, he described his sphæro-annular condenser, an instrument differing only from the glass paraboloid of recent times in that its outer curve was spherical and not parabolic. The above papers will be found in the *Transactions* of the Microscopical Society of London, iii. 1852.

Mr. Shadbolt also wrote upon diatoms, and on November 14, 1849, described the structure of *Arachnoidiscus* (illustrated pl. XI.). In 1857 he had movable stops placed at the back of his objective to cut down the aperture. This was done with the view of carrying out some of the erroneous ideas of Dr. Carpenter, one of which was that a wide-angled lens was only suitable for the examination of the "surface markings on the Diatomaceæ," and that, in order to render the lens "useful for histological purposes," it was necessary to reduce its aperture by a stop. (This is now known as a Davis shutter.) In 1858 he introduced the paraffin lamp to the notice of microscopists, an illuminant which for general purposes has never been superseded.

It was during the Presidency of Mr. Shadbolt that the Society's screw was introduced. After this he seems to have retired from active microscopical work for about 20 years, but in 1876 he contributed a letter to the *Monthly Microscopical Journal* controverting a statement of Dr. Pigott's concerning the identity of chromatic and spherical aberration. His last communication appeared in the *Journal* of the Royal Microscopical Society, iii. (1880) p. 1089, in which he joins issue on the aperture controversy which was raging hotly at that time.

With one exception Mr. Shadbolt was the senior Fellow of the Royal Microscopical Society.

SUMMARY OF CURRENT RESEARCHES

RELATING TO

ZOOLOGY AND BOTANY

(PRINCIPALLY INVERTEBRATA AND CRYPTOGAMIA),

MICROSCOPY, ETC.*

ZOOLOGY.

VERTEBRATA.

a. Embryology.†

Sexual Dimorphism among Animals.‡ — J. T. Cunningham has made a careful study of the problem of sexual dimorphism in the animal kingdom. His book contains seven chapters discussing and interpreting particular cases, arranged according to the various classes, and an introductory chapter expounding the general theory which the bulk of the volume is intended to confirm. We shall try to indicate briefly what the author's evolutionary position is.

(1) Observed hereditary differences may be included in three categories:—diversity (of species, genera, &c.), polymorphism (including dimorphism), and metamorphosis (marked differences between different stages in the life-history). The problem is to discover the causes which have produced these three kinds of structural difference in animals.

To those structural differences which are due to "modifications," i.e. the structural results of environmental and functional influences operating upon the body, but not proved to be transmissible, Mr. Cunningham refers later on, and postulates their transmissibility.

(2) The diagnostic characters which express what the author calls diversity cannot all be regarded as of use or significance in the struggle for existence, as is illustrated by the cases of dab, flounder, and plaice, in regard to which it is stated that the theory which refers the specific peculiarities of these three fishes to the natural selection of indefinite variations is "unsupported by any evidence." Such specific characters are "the necessary consequences of growth and the conditions of life." [We may note (*a*) that fuller knowledge has shown the advantageous character of many minute features which did not at first suggest the

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

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

‡ 'Sexual Dimorphism in the Animal Kingdom. A Theory of the Evolution of Secondary Sexual Characters,' London, A. & C. Black, 1900, xi. and 317 pp., 32 figs.

feasibility of this interpretation; see Herdman's illustration of this in reference to Tunicates; and (*b*) that it is not inconsistent with a selectionist position to suppose, what Heincke's work on the herring, for instance, seems to us to bear out, that the organism may sometimes at least vary as a corporate unity and not piecemeal, and that selection may operate not directly on the number of rays in a dorsal fin, but on the organism as a whole, as it unconsciously experiments with different modes of constitutional equilibrium.]

(3) If a sufficiently wide induction be taken both of existing adaptations and of their individual development, it seems to the author that we stand in our own light if we refuse the interpretation that the external conditions of life have had a direct effect in producing adaptive hereditary variations. [It appears to us that some of the objections urged by the author against the selectionist interpretation have been at least partially met many times, e.g. in Weismann's "Germinal Selection." In the light of that essay and others, we cannot agree to Cunningham's statement of the selectionist position in such a sentence as this: "The fitness of a structure or structural mechanism for its function is thus originally accidental."]

(4) After critically discussing various interpretations of secondary sex characters, Mr. Cunningham points out that on two almost universal peculiarities the theory of sexual selection throws no light whatever: (1) the characters do not begin to appear in the individual until it is nearly adult and sexually mature, and (2) they are inherited only by the sex which possesses them. [The author is forcible and interesting as a critic, but we cannot agree with all his summaries of the views of others, e.g. "Geddes and Thomson regard the male animal as, so to speak, made up of spermatozoa." Is this not too terse to be quite fair?]

(5) It seems to the author to have been generally overlooked that the special employment of each special secondary sexual organ subjects it to special, usually mechanical, irritation or stimulation, to which other organs of the body are not subjected. These strains, contacts, and pressures must affect development and mode of growth. And multitudinous facts all agree with the hypothesis that secondary sexual characters are due to the inheritance of acquired characters.

Mr. Cunningham does not here propose to attempt to prove that acquired characters are inherited; his object is to show that the hypothesis is more effective than any other. [There should be no question of regarding this Lamarckian position with the "more or less courteous contempt" which the author anticipates; the hypothesis is used as an interpretation throughout the seven chapters of the book, and it seems to work fairly well; the difficulties which prevent those who side with Weismann from accepting it do not weigh with Mr. Cunningham; and so the question will remain—one opinion against another—until conclusive experimental evidence is forthcoming.]

(6) "It is obvious," the author says, "that if the removal of the testes can affect the development of tissues in the head, the development of the latter may affect the properties of the testes," and thus future offspring. [The unity of the organism being what it is, it would be rash to deny that any one part may not affect any other, but must we not adhere to what is demonstrable? We know that the testes affect the body,

but do we know that the growth of antlers can affect the gonads in a specific and representative way, which is what requires to be proved if "modifications" are transmissible? The gonads affect the nasal organ in man in many ways, but is it really "obvious" that the nose affects the properties of the gonads?]

(7) "If, as Weismann supposed, the germ-cells were entirely unaffected in their essential properties by the history and circumstances of the body in which they were contained, it is impossible to conceive how the removal of the generative organs could affect the development of the tissues of that body." [We must protest again that the author is too brief in his way of stating the views of others. Has not Weismann most explicitly said that he does *not* hold that the germ-cells lead a charmed life unaffected by somatic conditions? Is it not one of Weismann's theories that germinal variations may be evoked as the result of local fluctuations in nutrition?]

(8) Why should secondary sex characters appear at sexual maturity, and why should those of the male be restricted to the male offspring, and those of the female to the female offspring? "The true explanation in my opinion is, *that heredity causes the development of acquired characters for the most part only in that period of life and in that class of individuals in which they were originally acquired.*" [The underlined words of this "explanation" seem to us to say that certain components in the inheritance are not expressed unless the appropriate bodily conditions are present, and that the time and conditions of their ontogenetic expression correspond to those of their phylogenetic origin. The first clause is a truism; the second, as the author clearly points out, is a hypothesis.]

(9) "I believe I may claim that my theory is, in its special details, new and original. The theory of the inheritance of acquired characters is, of course, old, and is regarded by many as extinct. But, so far as I know, I have not been anticipated in my elaboration of this theory into the form in which I present it, namely, *that the direct effects of regularly recurrent stimulations are sooner or later developed by heredity, but only in association with the physiological conditions under which they were originally produced*, and that this is the explanation of the limitation of particular modifications, not merely to particular species or kinships, but to particular periods in the life of the individual, to a particular sex, and even to a particular season of the year in that sex."

Mr. Cunningham's work is always interesting and forcible, and, apart altogether from his particular theory, the 250 pages devoted to the discussion of particular cases form a useful and welcome contribution to the ætiology of sex. We have suggested some criticisms because the author invited them, and not with any confidence that the problem of sexual dimorphism has been solved by any of the interpretations which the author rejects.

Sexual Season in Mammals.* — Walter Heape devotes the introductory part of his paper to a much-needed definition of terms:—reproductive period, breeding season, sexual season (the particular time or times of year during which the sexual organs exhibit special activity), gestation period, nursing period, and so on.

* Quart. Journ. Micr. Sci., xliv. (1900) pp. 1–70.

The male sexual or rutting season implies a period of special activity of the generative organs of the male, during which he is desirous of coition and normally capable of inseminating the female. Rutting males, e.g. stags, have a special sexual season; those which do not rut experience sexual capability all the year round.

In the case of the female the activity of her generative organs and the form which that activity takes is modified by conception, and it is necessary to distinguish what occurs when reproduction does not take place (i.e. in absence of a male or when coition is not followed by conception) and when reproduction does take place. When reproduction does not take place, the simplest form of the female sexual season includes (*a*) the pro-œstrum or pro-œstrous period ("coming in season"), and (*b*) the œstrus or climax ("heat," "season," "brim," &c.). Sometimes œstrus occurs without the pro-œstrum, e.g. in pregnancy; there is in this abnormal œstrus a congestion of the copulatory organs, but the changes in the uterus which are evident in normal œstrus are apparently absent.

If conception does not occur during œstrus the activity of the generative organs gradually subsides during a definite period (the metœstrum), followed by a fallow or resting period (the anœstrum). The four periods pro-œstrum, œstrus, metœstrum, and anœstrum constitute an "anœstrous cycle."

A more complicated form occurs when the metœstrum is followed not by an anœstrum but by a brief diœstrum, usually lasting but a few days; and Mr. Heape distinguishes monœstrous mammals, e.g. wolf (which experience a single œstrus during each sexual season, or, in other words, those in which the anœstrous cycle only occurs) from polyœstrous mammals, e.g. mare (whose sexual season is occupied by a series of diœstrous cycles, or, in other words, those who experience a series of recurrent œstri).

When reproduction does take place, the pro-œstrum is followed by œstrus; during this period insemination and fertilisation occur, gestation results, and persists until parturition. After parturition there may be a considerable interval of rest, even beyond the limits of an anœstrous period, or, on the other hand, parturition may be followed almost immediately, and in spite of the nursing period, by pro-œstrum, œstrus, insemination, and renewed gestation. In the same animal, moreover, there may be recurrent gestation at one time of year, and a resting period after parturition at another. The author maintains that the different types of breeding phenomena conform to one plan.

In regard to the sexual season of male mammals, Mr. Heape notices a number of interesting facts. Wapiti stags have naturally a special limited rutting season, but in the Gardens of the Zoological Society they rut all the year round except during the casting and re-growth of the antlers. The male camel in the Gardens ruts at much the same time as the female camels experience œstrus in Mongolia, even when there are no female camels in the Gardens. While there is no doubt that the proximity of the two sexes (dog, *Semnopithecus entellus*, rabbit) may stimulate both œstrus and rutting, the general reproductive cycle persists apart from this.

The pro-œstrum of female mammals is always associated with hypertrophy and congestion of both external and internal sexual organs and of the uterus, and with a discharge from the generative orifice. Complications may include rupture of the congested vessels of the hypertrophied superficial uterine mucosa, and extravasation of the blood contained therein, or a discharge of this blood into the uterine cavity and thence to the exterior, or more or less denudation of the mucosa leading to the formation of a menstrual clot.

The rupture of the vessels of the mucosa and the subsequent phenomena are supplementary to the essential factors of pro-œstrum; they occur in part rarely in some animals, in part always in some animals, but in a complete sequence only, so far as is known, in the Primates.

Mr. Heape discusses at some length the relations between "heat" and menstruation. There is a congestion of the generative organs in both; there may be a recurrence of "heat" as there is a recurrence of menstruation; the discharge during "heat" may be of a menstrual character, and from a phylogenetic point of view the homology of the two processes is to be expected. Seven objections by those who deny the homology are considered, and the author concludes that the evidence of the homology, not only of pro-œstrum and menstruation, but of each of the various sexual phenomena in the different mammalian types, is incontrovertible.

Speaking generally, the rhythm of the sexual season and the power of breeding are seasonal; they are governed by external forces which are exerted in consequence of seasonal change, and by internal forces which are dependent upon individual powers. Further, there is abundant evidence that nutriment and the capacity for storing nutriment, and the energy resulting therefrom, are essential factors. The author does not agree with Beard that the ovary is the seat of the governing power of the breeding function; thus ovulation and the œstrus cycle are not necessarily coincident, nor are their initiatives mutually dependent.

Heape suggests the probability that there is in the blood from time to time an œstrus toxin, that its presence is due to the external and internal forces mentioned above, and that to it may be referred the power which stimulates the activity of the sexual season and brings about the actual production of those generative elements which nutrition has enabled the animal to elaborate. Perhaps research in this direction would lead to increase of knowledge regarding some of the causes of sterility.

Eggs of Myxine.*—A. S. Jenson obtained from the Faroes some eggs of *Myxine glutinosa*, which were attached to the free ends of a felt-work woven around a dead branch of *Cellepora*. The clusters were obtained in the beginning of June, 8 (Danish) miles from land, at a depth of 125 fathoms, on a bottom apparently of sand. It is inferred that the hag lays its eggs on solid bodies which are enveloped in slime, that the eggs are fastened to this slime by means of the anchor-shaped stalks from the opercular pole, and that the anchors of the opposite pole are also enveloped in slime, and serve for the attachment of a second egg, and so on, so that short chains of three or four eggs result. The opercular pole is perforated by a fine micropylar canal, but the eggs were unfertilised. It is supposed that the eggs are not laid on the muddy

* Vidensk. Meddel. Nat. For. Kjöbenhavn, 1900, pp. 1–14 (1 pl.). See Zool. Centralbl., viii. (1901) pp. 125–6.

ground which the creatures frequent, but on stony or rocky ground covered with shells. It is suggested that the adults cease to feed when sexually mature, but the basis of certain fact remains very narrow.

Blastoderms without Embryos.*—G. Loisel distinguishes (*a*) those cases in the development of the fowl's egg where the blastoderm having begun to form an embryo is arrested in this respect, and (*b*) those in which there is no hint of embryonic development. In the latter there has been no fertilisation of the female pronucleus by the sperm-nucleus, but the blastoderm may proceed to grow over the yolk, from an equatorial band towards the pole—the inverse of the opposite direction. The author suggests that the zonal blastoderm is due to vagrant spermatozoa which have lodged in that region, and have multiplied parthenogenetically at the expense of the reserves of the egg.

Merogony and Ephebogenesis.†—Prof. Th. Boveri points out that these two terms, invented by Delage and Rawitz respectively, are new names for an old discovery. He refers to his papers of 1889 and 1895, and to the criticisms of Verworn, Morgan, and Seeliger, which he thinks Delage has misrepresented. He seeks to vindicate his original position.

Influence of Saline and Saccharine Solutions on Frogs' Eggs.‡—Madame Rondeau-Luzeau has observed that eggs of *Rana fusca* immersed for two hours in equi-osmotic solutions of NaCl 1 p.c., and of sugar 10 p.c., show similar effects. The superficial aspects of a four-cell stage are seen on some, but usually there is a very irregular apparent cleavage of the upper hemisphere. There is no evidence of nuclear division; the effect is wholly physical. The egg seems much more affectable before fertilisation than afterwards. After fertilisation, solutions of $CaCl_2$, 1·4 per 100, allow the formation of morulæ; solutions of NaCl, 1 per 100, kill the egg at the four-cell stage; sugar solutions, 10 per 100, have no marked influence until the closure of the blastopore, which is a very critical moment.

Artificial Incubation of Alligator Eggs.§—A. M. Reese records an unsuccessful and a successful attempt to hatch the eggs of the Florida alligator. In the first case, the eggs only survived for about a week, although the temperature range was only from 32° C. to 40° C.; in this experiment the eggs were placed in an artificial nest which was exposed to the sun by day, and brought into a closed room at sunset. In the successful experiment the eggs were kept in an incubator at 37° C., and after a fortnight the contained young began to make the squeaking sounds believed to act as a warning to the mother. The sound was audible at a distance of over 15 yards. At hatching, the young are 20 cm. in length.

Lecithoblast and Angioblast in Vertebrates.||—Prof. W. His, under this title, discusses some general points connected with yolk, yolk-absorption, and germ-layers in the different groups of Vertebrates. In developing meroblastic eggs, there can be distinguished the organised

* Comptes Rendus, cxxxii. (1901) pp. 350–3.
† Anat. Anzeig., xix. (1901) pp. 156–72.
‡ Comptes Rendus, cxxxii. (1901) pp. 997–9.
§ Amer. Nat., xxxv. (1901) pp. 193–5.
|| Abth. k. Sächs. Ges. Wiss., xxvi. (1900) pp. 173–328 (102 figs.).

substance, consisting of blastoderm and lecithoblast, and the unorganised substance in yolk. As lecithoblast he includes all germ-material, whether in the form of cells, or in a syncytium, which is laden with yolk, but takes no direct part in the formation of the germ-layers or the primitive embryonic organs. Such are the periblast of Teleosteans and Selachians, the germ-wall of bird and reptile eggs, the cellular contents of the yolk-sac in the reptilian egg, and the so-called yolk-nuclei of Amphibian eggs. In mammals the lecithoblast is functionally replaced by the trophoblast. In the fowl the germ-wall (yolk-sac wall) consists of cells which ramify through the outer layer of yolk and absorb it. The periblast of Selachians is formed by the union of the blastomeres lying next the yolk; they take up a large amount of yolk, and the cell-boundaries disappear so that a syncytium is formed. The periblast, together with the endoderm and the mesoblast, constitutes the so-called hypoblast; and for the cells left after the separation of the periblast, the author suggests the term *endoblast*. The endoblast includes the gut-endoblast and the yolk-endoblast. From the former arise the embryonic mesoblast and the endoderm of the gut; from the latter the extra-embryonic mesenchyme, the angioblast, or rudiment from which the blood-vessels arise, and the yolk-sac epithelium. The author does not, therefore, recognise mesoblast in the ordinary sense. He draws up the following general statement of the parts played by the germ-layers. The epiblast yields nerve-tissue, and the epidermal tissues; the hypoblast is differentiated into (1) the embryonic mesoblast, which is the common rudiment of the striped and unstriped muscular tissue, of the genital epithelia, and of the embryonic connective-tissue; (2) the extra-embryonic mesenchyme; (3) the angioblast, from which the blood and blood-vessels arise; (4) the endoderm, from which originates the epithelium or glands of the gut. Finally, the lecithoblast, when it is present, also originates from the hypoblast. The paper includes much more than can be indicated in a brief summary, and is copiously illustrated.

Fixation of Egg in Mouse.* — Dr. G. Burckhard has studied the fixation of the egg to the uterine mucous membrane, and the formation around it of the decidua in the white mouse, and discusses the general bearing of his results. When the earliest stages only are considered, two types of mammalian development can be distinguished. In the one at the end of segmentation, a large embryonic vesicle is formed, on the surface of which the rudiment of the embryo is placed, while the primitive streak is also formed upon the surface of the embryonic vesicle. The embryo does not become sunk below the surface until the formation of the amnion. In the second type the embryonic vesicle is small, and the primitive streak does not arise at the surface, but after the peculiar fashion inappropriately termed inversion of the germinal layers, while at a very early stage the egg becomes attached to the uterine wall by means of its surface. In the first type, on the other hand, fixation takes place relatively late. To the second group belong the mouse and man; and although the early stages have not been observed in man, there is reason to believe that they occur after much the same fashion as in the mouse. In the mouse the small segmented egg begins to act

* Arch. Mikr. Anat., lvii. (1901) pp. 528–69 (3 pls. and 4 figs.).

upon the uterine mucous membrane as soon as it reaches the uterus. It sinks into a small cavity in the uterine wall, and this, the decidua-cavity, is shut off from the lumen of the uterus by a portion of the egg which forms the ectoplacentar cone. Then the epithelium lining the decidua-cavity degenerates, and the ectoplacentar cone gives rise later to the fœtal placenta. The point of special importance in the author's results is the absence of epithelium lining the cavity in which the egg lies, which is in direct opposition to the usual view that the decidua-capsule is formed by the growth of a fold of mucous membrane over the egg.

Development of Acusticofacial and Semilunar Ganglia.*—Dr. K. Weigner has studied this in embryos of pig, souslik (*Spermophilus citillus*), and man. The ganglia in question grow out from the dorsal zone of the medullary region; no connection with the ectoderm could be established; the ganglion geniculi separates off from the acustico-facial; between them a secondary transitory connection was seen at certain stages (in souslik and pig). The cells of the ganglion geniculi are largest; those of the vestibular ganglion come next; those of the cochlear ganglion are smallest. They are also distinguishable by staining reactions.

Epiphysis and Paraphysis in Salamandra atra.†—Prof. H. Blanc finds that the epiphysis developes at the expense of the roof of the mid-brain in the form of a hollow and flattened diverticulum, while the paraphysis arises as a tubular evagination between the fore-brain and the mid-brain. At the outset the two are similar structures made of simple epithelium, but the epiphysis soon undergoes modification dependent upon its rapid growth. Its walls thicken and display layers of different kinds of cell, and its lumen becomes filled with cells arranged in cross-bars. From this point the epiphysis displays degeneration. The paraphysis elongates, and its distal surface grows out into a number of hollow buds, while at the same time the adjacent connective-tissue, with its numerous capillaries, grows in among these buds. and about the lips of the gaping orifice by which the paraphysis opens into the ventricle. In this way the first rudiment of the choroid plexus is laid down, and it developes at the expense of the two lips of the opening of the paraphysis. From the course of development, and the histological peculiarities, the author believes that the paraphysis is not a degenerating organ, but is of great importance in connection with the development of the choroid plexus. Like the last-named, it has probably to do with the gaseous interchanges which are carried on in the cavities of the ventricles.

Two Epiphyses in a Four-Day Chick.‡—Dr. Charles Hill demonstrated in 1891 and 1894 the occurrence of two epiphysial vesicles in Teleosts. He notes that others have done the same for Amphibians and Reptiles. In order to see if the duplicity might not occasionally persist in higher Vertebrates, he examined some six hundred chick embryos in the fourth day of incubation. Among that number two were

* Anat. Anzeig., xix. (1901) pp. 145–55 (3 figs.).
† Arch. Sci. Phys. Nat., x. (1900) pp. 571–2.
‡ Bull. Northwestern Univ. Med. School Chicago, 1900, 7 pp. and 6 figs.

found with double epiphyses. It seems plausible to regard this as atavistic rather than pathological. Even in mammals, some trace of duplicity may be looked for.

Development of Eye-muscles in Duck.* — H. Rex finds that the cells of the walls of the head-cavity in the duck undergo progressive differentiation, and finally become converted into a distinct almost cubical epithelium. The epithelium of the anterior wall gradually loses its epithelial character, and is converted into embryonic connective-tissue. This connective-tissue preserves for a long period its distinctive character, and does not fuse with the ontogenetically older connective-tissue in its vicinity. Its ultimate fate is uncertain. The epithelium of the posterior wall partly shares in the formation of the muscles, and partly degenerates. The eye-muscles originate from the epithelium of the lateral walls. The dorsal part of the posterior wall takes part in the formation of the M. rectus superior, the ventral circumference of the cavity in that of the common rudiment of the rectus inferior and the rectus internus. The obliquus inferior has an independent origin, but its relation to the head-cavity can easily be made out. The rectus superior has a distinctly epithelial origin, and arises later than the recti inferior and internus; the origin of the obliquus superior was not clearly made out. The connective-tissue which arises from the anterior wall of the head-cavity plays an important part in filling up the degenerating head-cavity.

Development of Skull in Falconidæ.† — M. Chomjakoff has been able to make some observations on the osteology of embryos and nestlings of *Buteo vulpinus*, *Pernis apivorus*, *Astur palumbarius*, *Accipiter risus*, *Milvus ater*, and *Circus cineraceus*. He finds that nestlings of *Buteo vulpinus* have a well-developed processus basipterygoidei, as the more primitive Falconiformes have throughout life; the process aborts in the late stages of development. All the forms investigated have an independent jugal, and in all the nestlings the lachrymal is firmly united to the prefrontal, but the orbital and nasal cavities are incompletely separated. There is a distinct superciliary bone. In *Buteo*, *Milvus*, *Astur*, and *Accipiter* the skull is directly desmognathous, in *Circus cineraceus* it is indirectly desmognathous, in *C. æruginosus* it is schizognathous throughout life, and in *Pernis* it is schizognathous in the young bird and indirectly desmognathous in the adult.

Dentition of Hatteria.‡ — H. Spencer Harrison has studied the development and succession of the teeth in this form. He finds that the first dentition consists of about thirty-six minute teeth, originating immediately below the epidermis, labial to the dental lamina. They are never functional, are shed before hatching, and resemble the first teeth of some Selachians. The teeth which are developed on the dental lamina, and which function during the early life of the animal, are members of two dentitions (the second and the third), the later teeth coming to alternate with the earlier teeth instead of displacing them. Successional teeth appear first in the premaxillæ after hatching, and,

* Arch. Mikr. Anat., lvii. (1901) pp. 229–71 (2 pls. and 2 figs.).
† Anat. Anzeig., xix. (1901) pp. 135–40 (3 figs.).
‡ Quart. Journ. Micr. Sci., xliv. (1901) pp. 161–213 (3 pls.).

beginning with the embryonic series, five distinct sets of teeth are represented in the premaxillæ up to the time when the body-length is 21·2 cm. Each adult "incisor" tooth has two components. The vomerine teeth are in course of suppression, and in most cases are completely absent. A remarkable fact is, that after the completion of the alternating series of teeth, there is a more or less cessation of tooth development in the main dentigerous regions. Subsequently a renewed formation of teeth takes place from behind forwards, and these are uniform in size. These facts, together with some others observed by Dendy, the author regards as a proof that the long period of incubation is a recent acquisition. Its result has been to render the early dentition functionless, to crowd the second and third dentitions together both in time and space, and to produce fusion of teeth both in the premaxilla and the mandible. The uniform teeth appear to be a recent acquisition. Except the first dentition, all the teeth have a coating of enamel.

Intermaxillary Tooth in Vipera aspis.*—Dr. H. Martin finds this tooth for some time after birth. It corresponds to that which Sluiter has described in oviparous forms as of service in perforating the egg-shell. But in the viviparous viper it seems to be of no use; it is not fixed to the bone; and the mucous layer which covers it is intact after birth. It seems necessary to fall back on the supposition that the tooth in question had a function in ancestral forms. While Röse described two tooth-germs in the same position in *Vipera berus*, and noted that the left one underwent rapid retrogression, Martin finds three germs, of which the median one persists to form the tooth referred to.

Development of Pancreas in Mammals.†—Dr. K. Helly finds that the dorsal part of the rudiment of the pancreas originates as an unpaired outgrowth along the suspensory ligament of the gut, and is differentiated from the gut in the caudo-cranial direction. It frequently becomes paired in the later stages of development. The ventral rudiments arise not from the gut, but only from the lateral walls of the primary hepatic duct before this opens into the gut. They are paired in origin, but the left rudiment degenerates. The right usually becomes further differentiated, but may also at times become degenerate. The fusion of ventral and dorsal rudiments is accompanied by clear indications of activity in the gland-cells.

Development of Excretory System in Dipnoi.‡—Dr. R. Semon finds that in his stage 29 the rudiment of the pronephros first appears in *Ceratodus*, as a solid swelling of the parietal mesoblast near myotomes 5 and 6. Later this swelling acquires a lumen, and appears to consist of two segmentally-arranged parts, each opening by a funnel into the unsegmented body-cavity. At the same time a small ventro-lateral portion of the pronephric rudiment is differentiated, and constitutes the "ventral portion of the pronephros" of Fürbringer. This becomes continuous with the pronephric duct, which, according to the author, has no ectodermic element. In stage 39 the glomerulus is developed. Its longitudinal extent is determined by the position of the two pronephric

* Journ. Anat. Physiol., xxxvii. (1901) pp. 80–9 (9 figs).
† Arch. Mikr. Anat., lvii. (1901) pp. 271–335 (3 pls. and 20 figs.).
‡ Zool. Anzeig., xxiv. (1901) pp. 131–5.

funnels, for it extends from slightly in front of the one to slightly behind the other. The whole pronephros lies in a region which is subsequently included in the skull. In stages 44–45 the mesonephric tubules appear, usually about 13–15 segments behind the pronephros; their origin is somewhat uncertain. Generally, in regard to the development of the pronephros, *Ceratodus* resembles Amphibia, especially the Urodela, and the research confirms the close relationship of Amphibia and Dipnoi, which is rendered probable on other grounds.

Reproduction of Salmon in Fresh Water.*—Jousset de Bellesme has succeeded in showing, after ten years' experimenting, that salmon may be reared to maturity in fresh water, and may reproduce successfully. He succeeded with two pairs, but he looks forward to rearing an entirely fresh-water race.

b. Histology.

Centrosome and Centriole.†—Prof. Th. Boveri publishes an important paper on this subject. The paper is divided into three sections: the first discusses the value of iron-hæmatoxylin staining in the study of the centrosome; the second includes minute descriptions of the changes undergone by the centrosome in cell-division in four cases (spermatocytes and segmenting eggs of *Ascaris*, ovocytes of *Diaulula*, segmenting eggs of *Echinus*); while the third is a general comparative discussion of the significance of the centrosome. Limitations of space render it necessary to confine attention to this third section. While in many cases the centrosome can be distinguished by its high refracting power, in others it is differentiated only by its relation to the sphere; iron-hæmatoxylin cannot be relied on as a differentiating reagent. In the general *centroplasm* a central corpuscle, or *centriole*, is distinguishable, and has in certain cases been mistaken for the centrosome itself. The size of the centrosome varies with that of the cell, and more nearly with that of the spindle in a dividing cell; the occurrence of a rhythmic series of variations in size is indeed a marked characteristic of the centrosome. Division of the centrosome is preceded by division of the centriole; but while the latter process appears to occur after one fashion only, there is much variation in regard to the division of the centrosome. The centriole appears to bear the same relation to the centrosome that the latter bears to the cell in the process of division. As to the relation of centrosome and centriole to sphere, the author finds that it is the centrosome itself which generates the sphere; the centriole initiates division, but neither serves as a point of insertion for the radii, nor as the originator of the sphere. These facts serve, with others, as means of distinction between centrosome and centriole. As to the function of the centrosome, it is to be regarded as an apparatus which automatically (*maschinenmässig*) brings about cell-division, by reason of the fact that it is capable of responding to stimuli received through the cell. The effect of such stimuli is to permit the centrosome to resume its inhibited cycle of changes, which culminate in the *kinetic* phase, leading to division first of centrosome and then of cell. But all cell-division is not dependent

* Comptes Rendus, cxxxii. (1901) pp. 272–4.

† Jenaische Zeitschr. f. Naturwiss., xxxv. (1901) pp. 1–220 (8 pls. and 3 figs.).

on the presence of an obvious centrosome, and to the nucleus, so-called, of Protozoa, which is the equivalent of centrosome + nucleus in the metazoan cell, the author gives the name of *centronucleus*. Such a centronucleus may be supposed to have become differentiated into nucleus and extra-nuclear centrosome in higher forms. But it is conceivable that, even after the differentiation of the true centrosome as an independent body, a diffuse *cytocentrum* may persist in the nucleus, which in such a case would still deserve the name of centronucleus. Such a hypothesis explains the observed phenomenon of regeneration (or better *reparation*) of a lost centrosome in metazoan cells. The paper concludes with a discussion of terminology; the more important of the new terms are indicated in the above.

Development of Ciliated Cells.* — Dr. Alexander Gurwitsch has studied the histogenesis of various types of ciliated epithelial cells, as a means of solving the problem of the function of the different parts of the cell. He finds that the course of development is very different in different types of such cells, but in those cases investigated by him (oviducts of rabbit, buccal epithelium of toad and salamander, gut of *Lumbricus*), two main types are distinguishable. In the one the nodes of a cytoplasmic reticulum are occupied by corpuscles, which become the basal corpuscles of the cilia, and give rise directly to the cilia. In the second type, the cilia appear before the row of basal corpuscles, which seem to arise secondarily from the cilia themselves. These facts the author believes to be explicable only on the ground that cilia and basal corpuscles are morphologically distinct elements derived from a common substance. He suggests that basal corpuscle and cilium may bear to one another the relation of hair-bulb to hair, but considers that the method of origin excludes the hypothesis that the basal corpuscles are in any sense "kinetic centres." The prime origin of the whole motor apparatus is to be sought in the differentiation from the general cytoplasm of plasma characterised by its power of movement; from this mother-substance, which forms a layer at the free margin of the cell, the cilia and related structures are differentiated.

In another communication† the author replies to a note by Heidenhain,‡ who believes the cells described by Gurwitsch as developing ciliated cells (in the buccal cavity of salamander larvæ), to be rather developing mucus cells. Gurwitsch points out the difference as regards position exhibited by mucus cells, and maintains that there is no possibility of confusing the two types of cell.

Central Nervous System of Rabbit.§—Dr. R. Krause and Dr. M. Phillippson have studied the spinal cord of the rabbit by the aid of intravenous injection of methylen-blue, and have been able to make out the distribution of the nerve-cells in the anterior horn. The great majority of the cells send neurites into the anterior nerve-roots, and are either polygonal or spindle-shaped. The cell-body is very varied in shape, the shape depending upon the number and arrangement of the dendrites.

* Arch. Mikr. Anat., lvii. (1901) pp. 184–229 (2 pls.).
† Anat. Anzeig., xix. (1901) pp. 44–8 (4 figs.).
‡ Cf. this Journal, *ante*, p. 18.
§ Arch. Mikr. Anat., lvii. (1901) pp. 488–527 (4 pls.).

These vary in number from three to twelve. The authors believe that their distribution proves that they are certainly of nervous nature, and that their function is to conduct to a cell stimuli either from the collaterals or from another cell-body. The neurites arise from the body of a nerve-cell or from the dendrites of a cell.

Hypophysis Cerebri in Man.*— Waldemar Thom has sectioned a series of brains in which the hypophysis was sometimes normal and sometimes abnormal, and finds that cyanophil and eosinophil cells are normal constituents. The so-called chief cells (*Hauptzellen*), he divides into feebly cyanophil, feebly eosinophil, and "chromophobe" cells which take up no stain. The secretion which fills the inter-follicular spaces is produced as follows. The strongly chromophil cells produce a chromophil secretion in the form of very fine granules. The cell-boundaries become indistinct, the nucleus travels to the periphery, the granules leave the cell and mingle with a non-staining secretion produced by the chromophobe elements. This mixture either diffuses through the membrana propria, or the marginal cells degenerate and the membrana propria disappears. In pathological conditions the amount of colloidal substance so produced may be greatly increased.

Nerves of Hard Palate in Mammalia.†—Dr. Eugen Botezat has investigated this subject, especially in the domestic cat. He finds that the nerve-endings can be divided into two sets, those which end in taste-menisci, and those which end in terminal swellings. The fibrils which lead to these two kinds of nerve-endings arise from the same branches, and there is no marked difference in function. The taste-menisci are present everywhere where Merkel's taste-cells occur, and these are arranged according to the shape of the papillæ. The taste-menisci, as their position shows, react to pressure, while the terminal swellings, which penetrate into the epithelium sometimes as far as the stratum corneum, are specially sensitive to chemical stimuli and to temperature, as well as to pressure. Of the nerve-endings with terminal swellings several modifications exist, those most characteristic of the cat being the brush, or pencil endings, found in the large papillæ.

Primitive Fibrillæ of Retina.‡—Gustav Embden has applied Bethe's method to the study of the nerve-cells of the retina, but has not been very successful in demonstrating primitive fibrillæ within the cells. The material was chiefly the eye of the horse. He was most successful in staining the horizontal cells and their prolongations, and found both in the cell-body and in the processes very fine primitive fibrillæ clearly differentiated. In some cases he succeeded in demonstrating the anastomoses of the processes of adjacent cells, and then found that the primitive fibrillæ were continuous from the process of one cell to that of another. He was also successful in the large ganglion-cells of the ganglion nervi optici and their processes, obtaining in some cases clear preparations of the fibrillæ. In some cases these fibrillæ passed from a cell-prolongation to the axis-cylinder, in other cases from one process to another of the same cell.

* Arch. Mikr. Anat., lvii. (1901) pp. 632–52 (2 figs.).
† Zeitschr. wiss. Zool., lxvi. (1901) pp. 429–443 (2 pls. and 1 fig.).
‡ Arch. Mikr. Anat., lvii. (1901) pp. 570–83 (1 pl.).

Structure of Stratum Corneum in Man.*—Dr. Franz Weidenreich has continued his researches on the eleidin and pareleidin of the superficial layers of the human epidermis, and the relation of these to the fat believed to occur in the stratum corneum. He finds that the blackening with osmic acid which occurs in the case of the skin from the palms and soles, is not due to impregnation with fat from without, i.e. from the sebaceous and sudorific glands, nor is the fat produced within the cells from eleidin or pareleidin, but the pareleidin itself possesses the peculiarity of reducing osmic acid, although after a much longer period of action than a true fat. Neither eleidin nor pareleidin is of fatty nature, but pareleidin must be included among the non-fatty substances which have the power of reducing osmic acid. It is possible that in the hairy parts of the skin, the blackening with osmic is due to fatty impregnation by the secretion of the sebaceous glands. As to eleidin and pareleidin, the author finds that the former originates from the keratohyalingranula formed in the stratum granulosum. In the basal cells of the stratum corneum the eleidin keeps its fluid character, but later it dries up, becomes of tenacious and colloidal consistency, and forms pareleidin. The stratified appearance of the stratum corneum is due not only to this transformation, but also to the existence of zones of tension and zones of relaxation, which affect the optical appearance.

Histological Effects of Prolonged Fast.†—Prof. E. Yung has made a long series of observations on vertebrates and invertebrates as to the effect of inanition, and finds that death takes place when the body has been reduced to about one-half the normal size. In Protozoa the protoplasm becomes increasingly transparent, and diminishes in amount more rapidly than the nucleus, within which the chromatin becomes indistinct. In fishes and Amphibians all the cells do not suffer to the same extent, the intestinal epithelium being more affected than the blood-corpuscles or nerve-cells. As in Protozoa, the granules of the protoplasm disappear, and the nuclear chromatin is absorbed; the general reduction of the size of the body or of special organs is associated with a corresponding reduction in the size of the cells. The author believes that death results from the reduction of the cells below the minimum at which their functions can be carried on, this minimum varying with the different kinds of cell.

c. General.

New Zealand Lancelet.‡—Prof. Blaxland Benham has examined the *Amphioxus* of New Zealand, hitherto regarded as identical with the European form, and finds that it belongs to the genus *Heteropleuron*, and constitutes a new species, *H. hectori*. The preoral hood with its cirri is unsymmetrical on its two sides, as in the larva. The two specimens examined were not in sufficiently good condition for much of the structure to be made out.

New Amphioxus.§—Dr. Arthur Willey describes a new Acraniate from the Indian Ocean which he regards as constituting a new sub-

* Arch. Mikr. Anat., lvii. (1901) pp. 583–622 (2 pls. and 1 fig.).
† Arch. Sci. Phys. et Nat., x. (1900) pp. 572–4.
‡ Quart. Journ. Micr. Sci., xliv. (1901) pp. 273–80 (1 pl.).
§ Tom. cit., pp. 269–71 (2 figs.).

genus of *Branchiostoma*, and calls *Dolichorhynchus indicus* g. et sp. n. It is remarkable for the great length of the preoral lobe, which is as long as the first six myotomes. None of the specimens were sexually mature.

Hibernation of Dormouse.*—Hector Rulot has reached the following conclusions :—(1) the proportion of water in the body of the hibernating dormouse increases from November to April, but there is absolute diminution especially towards the beginning of the sleep; (2) the fat diminishes absolutely and relatively, with especial rapidity in the later months; (3) the glycogen also decreases, but the total amount is so small that it cannot be regarded as an important reserve; (4) the proteid-consumption is slight in the early months, but great in the later months; (5) as the quantity of carbon-combustion increases from November to April, it may be inferred that the sleep is deepest at the beginning.

Persistent Thymus.†—Dr. Eugen Fischer describes a case of persistent thymus in a well-nourished man of thirty years of age. It consisted of large right and left lobes, the left the larger, and showed microscopically the ordinary structure of the child's thymus, the characteristic thymus corpuscles being present. The organs of the body were all healthy, and showed no trace of pathological change.

Ciliary Ganglion.‡—Prof. A. Onodi has sought for this ganglion in a large number of Selachians, and has been able to find it only in *Mustelus lævis*, *Galeus vulgaris*, and *Carcharias glaucus*. He is of opinion that it is to be regarded as a peripheral sympathetic ganglion, and not as a spinal ganglion. In *Galeus* the ciliary ganglion gives off three nerve-trunks which form a fine network over the great vessel. This the author regards as of great importance, for he believes that ganglion and vascular network constitute the first visible trace of the cephalic sympathetic in Selachians, and therefore in Vertebrates.

Theories of the Origin of Antarctic Faunas and Floras.§—Prof. A. E. Ortmann makes a table of all the theories advanced :—

I. Theories assuming a land connection between the respective parts. This general idea was first expressed by Hooker (1847) and has been accepted by all subsequent writers except Wallace.

1. The land bridge is placed across the present Antarctic continent, first by Rütimeyer (1867) and by Hutton (1873). It was accepted by Von Ihering, Forbes, Hedley, Osborn.
    (*a*) Forbes constructs his immense Antarctica (1893).
    (*b*) Hedley restricts it to reasonable limits (1895).
    (*c*) Osborn takes an intermediate standpoint (1900).
2. Gill constructs his Eogæa, a continent uniting Africa, South America, and Australia, but leaving out the Antarctica (1875).
3. Hutton connects Australia and South America by his mid-Pacific continent, but denies the existence of an Antarctic connection (1884).

* Bull. Acad. Belg. Cl. Sci., 1901, pp. 17–30.
† Anat. Anzeig., xix. (1901) pp. 113–15 (1 fig.).
‡ Tom. cit., pp. 118–24.
§ Amer. Nat., xxxv. (1901) pp. 139–42.

II. Theory of Wallace (1876) rejecting any land connection whatever between the respective parts.

Ortmann accepts Hooker's general idea, as well as Rütimeyer's Antarctica theory, with the restrictions put upon it by Hedley.

Influence of Alterations in Salinity.* — Erland Nordenskiöld has made an interesting study of the changes which occur in the fauna of shore-pools when the salinity is increased or decreased. Thus the Copepod *Harpacticus fulvus* passes into a state of latent life when the salinity exceeds about 9 p.c., may remain so for at least a week, and becomes active again if the water is once more diluted. A somewhat similar capacity is exhibited by *Litorina rudis*.

Action of Neutral Salts on Ciliated Cells.†—Dr. M. Genkin finds that the behaviour of ciliated cells (of the nasal mucous membrane) affords an approximate test of the tonicity of solutions. If the dissolved salt, &c., has no chemical effect on the proteid molecules of the cell-plasm, and if the concentration admits of the ciliary movement continuing, the period and the character of the movements show whether the solution is isotonic or not, and shrivelling or swelling is a sign of hyper- or hypo-tonicity respectively.

Behaviour of Nucleated and Non-Nucleated Red Blood-Corpuscles ‡ —R. Quinton relates experiments showing that when the two kinds of red blood-corpuscle are placed in a solution of urea, an equilibrium is established as regards the nucleated, but not as regards the non-nucleated corpuscles. The hæmoglobin diffuses out from the latter, as was shown by Hamburger, Gryns, and Hedin. With nucleated corpuscles, Quinton shows that this does not occur; an equilibrium is established. But this lasts for a limited time, varying with the concentration. Then hæmatolysis sets in.

Permeability of Branchial Membranes.§ — Léon Fredericq distinguishes three types of branchial membranes, according to their degree of permeability. In the first, the membrane is permeable to water, to diffusible substances dissolved in water, and to gases, and is entirely comparable to the membrane of a dialyser. This is exemplified in the gills of the octopus and those of the crab *Maia*, where the blood has the same molecular concentration, and is as rich or as poor in salts as the surrounding water. In the second type the branchial membrane is permeable to water and to gases, but not to dissolved diffusible substances. It is comparable to the "semi-permeable" membranes of Moritz Traube. In such cases the blood has the same molecular concentration and the same osmotic tension as the surrounding medium, but is much poorer in salts. This is exemplified in certain plagiostome fishes, where the blood is poor in inorganic salts, but rich in organic diffusible substances. In the third case, the branchial membrane is permeable only to gases, but impermeable to water, dissolved diffusible substances, and colloids. It is then comparable to a thin sheet of caoutchouc, and the blood possesses a different molecular concentration, osmotic tension, and

* Öfversigt k. Vetensk. Akad. Förhandl., 1900, pp. 1115–27 (1 fig.).
† Biol. Centralbl., xxi. (1901) pp. 19–22.
‡ Comptes Rendus, cxxxii. (1901) pp. 347–50.
§ Bull. Acad. Roy. Belg., 1901, pp. 68–70.

saline content from the surrounding water. The blood in this case, as in the crayfish, may be richer in salts than the surrounding water, or, as in certain marine bony fishes, may be poorer.

Phylogeny of Anthropomorpha.*—Arthur E. Brown supports Cope's theory of a common origin for the Anthropomorpha directly from the Eocene lemuroids, independently of the line by which monkeys arose from the same stock. Cope relied especially on the tendency in certain races of men to the production of tritubercular upper molars. Brown discusses the dentition, but refers also to the processes of the vertebræ and the nature of the sacrum. Moreover, "the fact that before monkeys, as now known, began to exist, man-like apes were far advanced in development, and that the earliest evidence of existing genera of apes is coeval with that of existing genera of catarrhines, tells enormously in favour of the early and independent origin of Anthropomorpha."

Descent of Man.†—Prof. H. Klaatsch maintains that the human race had its roots in a very primitive Mammalian stock from which lemurs and monkeys also diverged. That is to say, he places the origin of the human twig from the *Stammbaum* lower down than usual.

Plankton of Gulf of Trieste.‡ — Prof. C. J. Cori and Dr. Adolph Steuer give lists of the contents of the tow-net for the years 1898, 1899, with a table showing the relative proportions of the organisms found in the different months. In most cases the results show the occurrence of very striking seasonal variation. Copepods and *Sagitta* are always present; Flagellata, *Diphyes*, *Pluteus*-larvæ, and Copelata are absent only during a brief period; but most others are limited to certain seasons of the year, when they occur often in vast numbers. The Radiolaria *Acanthometra* and *Sticholonche* exhibit interesting relations, for they replace one another at certain seasons, the former being, generally speaking, a summer form, and the latter a winter one. Apart from the regular plankton-forms of the Gulf, the sporadic appearance of other forms from a distance is not uncommon. Thus in August 1899, the Gulf was invaded by *Cotylorhiza* and *Salpa africana maxima*, which remained until the middle of November. Broadly speaking the *winter* plankton consists of Diatomaceæ, *Sticholonche*, Tintinnæ, larvæ of *Polygordius, Salpa mucronata-democratica*; in *spring* these are replaced by larvæ of Actiniaria, *Tornaria*, and larval molluscs; in *summer Actinometra*, *Nausithoe*, zoeæ, and young fish occur; the water in *autumn* contains chiefly the large Medusæ.

Southern Plankton.§—P. T. Cleve reports on an interesting series of 35 plankton samples from the southern Atlantic and the southern Indian ocean. The collection affords a good insight into the plankton of the seas near the limit of drifting ice. He finds 57 forms probably belonging to the "*Styli-Plankton*" ‖ of the southern hemisphere, of which 86 p.c. also occur in the northern hemisphere, chiefly between the Azores and Iceland. Some of them have been found in the region of

* Proc. Acad. Philadelphia, 1901, pp. 119–25.
† Ber. Senckenberg. Ges., 1900, pp. cxxix.–cxxxiv.
‡ Zool. Anzeig., xxiv. (1901) pp. 111–6 (1 table).
§ Öfversigt k. Vetensk.-Akad. Förhandl., 1900, pp. 919–38 (12 figs.).
‖ The terms are not defined in this paper.

Ascension and near Cape Verde, which seems to prove that the water containing "*Styli-Plankton*" moves as an under-current below the water of the tropical Atlantic that contains "*Desmo-Plankton*." Of forms probably belonging to the Antarctic "*Tricho-Plankton*," Cleve found 25 in all, of which 48 p.c. also occur in the Arctic regions. These figures seem to the author to afford very strong evidence of the correctness of Chun's theory that there is a connection between the Arctic and Antarctic seas by means of under-currents.

Red Sea Plankton.* — P. T. Cleve gives a list of 99 plankton organisms from the Red Sea. Of the Copepods 8 p.c. and of the Diatoms 3 p.c. have not hitherto been found outside of this area, but this is probably due to insufficient research. Almost all the Copepods (92 p.c.) occur also in the Indo-Pacific region, 38 p.c. also in the tropical Atlantic; of the Diatoms 22 p.c. only occur in the tropical Atlantic, but 64 p.c. in the temperate and northern Atlantic. There can scarcely be any doubt that the water which spreads in the spring north of the Azores and during the summer moves towards Iceland and the Färöe Channel, is derived from the southern Atlantic, in part from the Antarctic Ocean. The same is probably the case, to some extent at least, with the water that enters the Red Sea. Thus we find there *Thalassiothrix longissima*, an Arctic and Antarctic species, which can hardly live permanently in water of so high a salinity and temperature as that of the Red Sea.

Fauna of Hot Springs.†—Dr. R. Issel has made a useful study of the animal life of hot springs and the like in Italy. So far his communication is only a series of lists, with the physical data of the waters, but it shows that the fauna is larger than might have been expected.

Fauna of Mountain Torrents.‡—Prof. F. Zschokke points out the peculiar conditions of life in the Swiss glacial torrents, and the way in which the animals are adapted to their special surroundings. The locality is possible only for such forms as can tolerate low temperature, can withstand the force of the currents, and are carnivorous to a great extent, at least in habit, for plants are few. The waters of such streams are abundantly oxygenated, and all the inhabitants appear to be sensitive to any impurity in the water. The fauna is singularly compact, including *Planaria alpina*, a series of Hydrachnids (*Sperchon*, *Feltria*, *Thyas*, *Partnunia* and *Panisus*), two water-snails (*Lymnæa truncatula* and *L. peregra*), and a large number of insect larvæ, especially Ephemeridæ, Perlidæ, Phryganidæ, and some Diptera (*Simulia*, *Liponeura*, *Chironomus*). In the insects especially the variety in the organs of fixation is remarkable.

Coloration of Marine Animals. § — Prof. W. C. McIntosh surveys the chief groups of marine animals in reference to their colour phenomena, and concludes that while certain cases lend some support to such theories as those involved in the terms protective resemblance, warning coloration, and so on, there are nevertheless many other cases where the application of such explanations is a matter of great difficulty.

* Öfversigt. k. Vetensk. Akad. Förhandl., 1900, pp. 1025–38 (3 figs.).
† Atti Accad. Sci. Torino, xxxvi. (1901) pp. 53–74.
‡ Arch. Sci. Phys. et Nat., x. (1900) pp. 557–60.
§ Ann. Mag. Nat. Hist., vii. (1901) pp. 221–40.

Thus, in regard to sponges, he states that the bright colours ("warning colours") of certain forms are not associated with the inedibility, and that there is great colour variation. Again, the common cross-fish, together with other common Echinoderms, is brightly coloured, is conspicuous in natural conditions, but is attacked by birds, fish, and by the related sun-star. The difficulties in regard to the coloration of the Nudibranchs are also discussed in some detail.

New Theory of Coloration.*—Georges Bohn suggests a new point of view in regard to coloration. Carnot has shown that pigment granules are not mere precipitates in the cell-plasma; they are *mobile chromogenic* elements. They can migrate within the organism and even pass from one organism to another. Here the author refers to Miss Newbigin's *Colour in Nature*, and to a book of his own. The Crustaceans parasitic on *Ascidiella* and *Botrylloides* are invaded by the pigment granules of their host. There seems to be a struggle between chromogenic granules unequally or diversely coloured, for the corpuscles have some measure of vitality. The homochromic colouring of plants and animals living in close association, and the changes of pigmentation in the course of development, are among the facts which Bohn seeks to interpret by his hypothesis. He seems to regard the pigment as originally the result of a nuclear excretion or emission, and the pigmentation as in part the result of a struggle among the granules.

Tunicata.

Heart of Salpa.†—Dr. L. S. Schultze has made an extended series of observations and experiments on the action of the heart in *Salpa*, and the causation of the periodic reversal of the circulation. Observations on intact specimens showed not only the existence of individual and specific variation in the number of similar beats, and so on, but also the sensitiveness to alterations of environmental conditions, especially as regards the amount of oxygen in the water. Further, a series of experiments showed that (1) the isolated heart beats normally; (2) the contractions are not dependent on the presence of blood in the heart; (3) the nerve-ganglion is incapable of affecting the pulsations; (4) the heart itself contains no nerve-cells or fibrils capable of influencing the contractions. The author's conclusion is, therefore, that the spontaneous contractions of the heart are entirely myogenic in origin, depending upon stimuli which originate in the course of the metabolism of the muscle-cells, which are exceedingly rich in sarcoplasm. All parts of the heart are capable of originating a series of rhythmic contractions, but under normal conditions it is the two ends only which constitute the centres of origin of the stimuli. If these centres be called A and B, it is obvious that there are three elements in the phenomenon of reversal: (1) the inhibition of the peristaltic wave (originating from A); (2) the pause; (3) the commencement of the antiperistaltic wave (originating from B). Briefly put, the problem is then the means by which centre A periodically gains the mastery over centre B, or *vice versa*. The author's

* Comptes Rendus, cxxxii. (1901) pp. 173-5.
† Jenaische Zeitschr. Naturwiss., xxxv. (1901) pp. 221-328 (3 pls. and 5 figs.).

experiments lead him to give the following explanation. The two centres of stimuli are physiologically equivalent, but both exhibit periodicity, the stimuli passing through a cycle of variations in intensity, not synchronous in the two centres. The stimuli are capable of being transmitted from muscle-cell to muscle-cell, but the cells periodically enter into a "refractory" state when they refuse to respond to certain stimuli. The period of diminished irritability in centre A coincides with the period of diminished power of transmission of the related muscle-cells, so that it is centre B which controls the contractions. But during this resting period, centre A recovers as B becomes exhausted, and after a period of antagonism, corresponding to the pause, the action of the heart is reversed. As this is regularly repeated, the action of the heart can be represented thus:—B—>A, pause, A—>B, and so on. The importance of the phenomenon is that it shows how a perfectly co-ordinated mechanism may exist in muscle without the intervention of nervous elements.

Pigmentation in Tunicates.*—Antoine Pizon observes that much, if not all of the pigment in *Distaplia rosea*, *Botrylloides rubrum*, *Botryllus violaceus*, &c., results from the histolysis of the individuals which die within the corm; that the larvæ, at first almost colourless, receive pigment granules by migration from the maternal body; that the pigmentation increases as more ascidiozoids die off; and that there is a slow elimination of pigment *via* the tunics, especially in Diplosomidæ and *Distaplia*.

Excretory Organs of Tunicates.†—Wilhelm Dahlgrün briefly summarises the results of a series of observations which he has made on this subject. He regards as the most primitive condition that found in *Botryllus*, *Polycyclus*, and *Ciona intestinalis*, where an excretory organ is represented by a small number of unmodified mesenchyme cells, in whose protoplasm the excretory products form dark granules. In *Salpa democratica-mucronata* and *S. runcinata-fusiformis*, quite similar conditions occur, which the author regards as confirmation of the view that *Salpa* has arisen from a primitive and not from a specialised sedentary stock. The next stage in the development of the excretory organ is illustrated in the Ascidiinæ, where the excretory cells form an envelope round the gut. The cells are united to form closed vesicles, into whose lumina the excretory products are shed, and these vesicles are imbedded in a connective-tissue stroma which surrounds the gut. In the Cynthiadæ the excretory organ consists of a small number of sacs of considerable size, which lie immediately beneath the body-epithelium. Each is surrounded by a connective-tissue capsule, and the constituent cells secrete crystalline rods which are shed into the lumen of the sac, and ultimately form an amorphous mass of concretions. The highest stage in development is represented in the Molgulidæ, where there is a large kidney-vesicle with a double-layered wall. The outer wall is of connective-tissue, the inner of glandular epithelium. These cells, as also to a less extent those of the kidney in the Cynthiadæ, showed the rod-like structure seen in the protoplasm of the kidney-cells in Cephalopoda.

* Comptes Rendus, cxxxii. (1901) pp. 170 2.
† Zool. Anzeig., xxiv. (1901) pp. 149–51.

Social and Compound Ascidians.*—Wm. E. Ritter has a note on Maurice Caullery's recent formation of a new genus—*Synclavella*—to contain a species of *Clavelina* in which the ascidiozooids are not merely connected by a stolon, but have also a common test. Ritter opposes the new genus on the ground that in *Perophora annectens*, on the coast of California, both the social and compound conditions occur, sometimes on the same rock or even in the same colony. Of the two conditions the social seems the commoner, but transitional forms are frequent. Ritter first described this remarkable phenomenon seven years ago.

Protostigmata of Molgula manhattensis De Kay.†—Dr. Arthur Willey finds that the succession of stages known in the nepionic period of Ascidiidæ also occurs in at least the above-mentioned representative of the Molgulidæ. He describes the distigmatic, tetrastigmatic, pentastigmatic, and hexastigmatic stages, and compares them with those of *Ciona intestinalis.* The first two stigmata (A and B) produce by abstriction (C and D); a fifth (E) arises by independent perforation; the sixth (F) is abstricted from the fifth.

INVERTEBRATA.

Mollusca.

γ. Gastropoda.

Structure of Pleurotomaria beyrichii.‡—M. F. Woodward has had an opportunity of examining three specimens of this interesting Mollusc, and compares his results with those obtained by other authors for the other species. Generally, he finds that *Pleurotomaria* is a typical example of a zygobranchiate Diotocardian. As in *P. quoyana*, there are no sharply marked specialised regions in the radula, so that the members of the genus are to be regarded as primitive members of the Rhipidoglossa. In the reduction of the right gill an approach is made to the azygobranchiate Diotocardia. As regards the nervous system, the ganglionic cells are uniformly distributed through the connectives, the commissures, and even the large nerves, and there are therefore no distinct ganglia—an extremely primitive condition. The visceral loop originates, roughly speaking, half-way between the cerebral and pedal regions, and in this respect *Pleurotomaria* approaches the archi-tænioglossate *Paludina* and *Nassopsis.* The author finds no special concentration of ganglionic cells just above the position which would be occupied by the pedal ganglion, as described by Bouvier and Fischer, but regards a slight concentration of ganglion cells at the point of origin of the visceral loop as indicating the position at which the pleural ganglion would occur if it were differentiated. He believes that the position of the gill skeleton, and the possession of a special stomach-cæcum, indicate an ancestry common to that of the Cephalopoda, and that *Pleurotomaria* may be regarded as a form very closely related to the stock from which the Monotocardia originated.

Cleavage in Trochus.§—A. Robert has studied the segmentation of the ova of *Trochus magus* and *Tr. conuloides.* It is very similar in the

* Amer. Nat., xxxv. (1901) pp. 230–1. Cf. this Journal, 1900, p. 453.
† Quart. Journ. Micr. Sci., xliv. (1900) pp. 141–60 (1 pl.).
‡ Tom. cit., pp. 215–68 (4 pls.).
§ Comptes Rendus, cxxxii. (1901) pp. 995–7.

two species; the first two cleavages result in an anterior, a posterior, and two lateral blastomeres, and the subsequent cleavages are closely similar to what Conklin has described in *Crepidula*.

While such facts as the three generations of ectomeres and the origin of the primitive mesoderm cells point to hereditary predetermination, the regularity of certain planes of cleavage and their angles point to extrinsic physical factors, probably in great part capillary.

Monograph on Pleurobranchidæ.* — Prof. A. Vayssière completes his monographic account of this family with a discussion of the genera *Oscaniopsis* and *Pleurobranchæa* and their species.

Ganglion-cells in the Gullet Musculature of Pulmonates.† — Dr. H. Smidt points out that hitherto ganglion-cells in the muscular tissue of Invertebrates have been found only in the heart. He has examined the buccal cavity and gullet of *Helix*, and finds scattered ganglion-cells in the musculature of the radula and cartilaginous cushion, arranged along the fibrils which arise from the buccal ganglion. They are ovoid in form, are surrounded by a nucleated investment, and are mono-, bi-, or multi-polar; they appear to be quite analogous to the ganglion-cells previously described in the heart of various Invertebrates.

δ. Lamellibranchiata.

Development of Dreissensia polymorpha Pall.‡ — Dr. J. Meisenheimer, who adopts this form of the name in preference to the more familiar *Dreissena*, has followed this development in great detail. The process of segmentation strongly recalls that of *Unio*; but while *Dreissensia*, which, despite the present habitat, is essentially a marine form, retains the trochophore-stage, *Unio* has lost this, and its development has become correspondingly modified. The author, on the basis of his investigations, discusses the value of the "germ-layers" in Mollusca in general, and the phyletic significance of the trochophore. From his point of view the development consists in a progressive differentiation of *organs*, which appear in rudiment even at the first segmentation-stage. From the primitive indifferent cell-masses the organs are differentiated by invagination and by proliferation, especially by the latter. As differentiation goes on, two influences are clearly discernible, the inheritance of ancestral peculiarities, and the recently acquired special peculiarities, and it is the interaction of these two which gives the development its peculiarities. What is called "entoderm" is merely the rudiment of the mid-gut, and this is homologous from Cœlentera to Mollusca. Generally, the germ-layers are primitive rudiments (*Primitivanlagen*) which may be simple, as when they give rise to one organ only, or compound, when they give rise to several. In regard to the phyletic position of the trochophore, the author believes that this larval form undoubtedly links molluscs closely to annelids, and that both arose from a trochophore-like ancestor. The early trochophores resemble one another closely; but while in the annelid the posterior region becomes elongated and segmented, in the mollusc the larval body increases equally in all directions except in the velar region. That the point of

* Ann. Sci. Nat. (Zool.), xii. (1900) pp. 1–85 (6 pls.).
† Arch. Mikr. Anat., lvii. (1901) pp. 621–31 (1 pl.).
‡ Zeitschr. wiss. Zool., lxix. (1901) pp. 1–137 (13 pls. and 18 figs.).

origin of the two stocks must be put far back is shown by the absence in the annelid trochophore of any specifically molluscan trait, no less than by the entire absence of segmentation in the molluscan trochophore.

Development of Cyclas.*—Dr. J. Meisenheimer has studied the development of the heart, pericardium, nephridia, and genital cells in *Cyclas*, as a continuation of his work on *Dreissensia*. He finds that the first trace of these organs is a cluster of cells which arises in connection with the external body-wall. This rudiment comparatively late in development becomes separated from the body-wall, and a few cells are differentiated as genital cells. Next the nephridial vesicle is separated off at either side, and as it develops further, the remaining portion of the rudiment shows first the lower and then the upper pericardial space. The genital cells increase in number, the nephridium opens into the pericardial space and also to the exterior, the right and left halves of the pericardial space fuse above and below the gut, and the parts gradually acquire the adult condition. The special point is that there is no "mesoblastic streak" in Ziegler's sense, but merely a common rudiment of genital cells, nephridium, pericardium, and heart, which are differentiated in this order. A similar condition of affairs is now known to occur in *Dreissensia*, *Cyclas*, and *Paludina*, which justifies the conclusion that in Mollusca generally, apart from Cephalopoda, the four structures, heart, pericardium, nephridia, genital cells, originate from a common rudiment which arises from the external cellular wall, and behaves as an independent unit throughout its development. In the four genera named the order of development varies, as does also the place of origin of the individual organs, but these are to be regarded only as special modifications of a primitive type.

Malformed Specimens of Anodonta cygnea.†—Mr. H. H. Bloomer concludes from an examination of three strangely malformed specimens, that the animal is able to repair even extensive damage to the mantle lobes, but is not able to make good injuries to the gills. The mussel seems able to live and thrive with very much aborted respiratory organs, and with considerable displacement of the various internal organs.

Arthropoda.

a. Insecta.

Oogenesis in Queen Bee.‡—Wilhelm Paulcke has studied the ovarian tubes in *Apis mellifica* ♀, with special reference to the relations of epithelial cells, yolk-cells, and ova. The proximal ends of the tubes contain undifferentiated nuclei imbedded in a common protoplasm. Following this region is one called the synapsis-zone by the author, from the condition of the nuclear chromatin; in this region the undifferentiated nuclei which later give rise to the cells of the follicular epithelium, are distinguishable from the primitive germ-nuclei which give rise to yolk-cells and ova. The zones are not separated by any line of demarcation, so that the synapsis-zone shows the beginning of a process clearly marked in the next or

* Zeitschr. wiss. Zool., lxvi. (1901) pp. 417–28 (1 pl. and 9 figs.).
† Journ. Malacol., vii. (1900) pp. 136–8 (1 pl. and 2 figs.).
‡ Zool. Jahrb., xiv. (1900) pp. 177–202 (4 pls. and 1 fig.).

zone of differentiation, the origin from the primitive germ-nuclei of the yolk-cells and the ova. In the next region of the tubes, by the intervention of the follicle cells, successive chambers are formed consisting alternately of a single ovum and a group of yolk-cells; it would appear that 48 of these nutritive cells correspond to one ovum. In regard to the fate of the nutritive cells, an important point is that for a time they increase rapidly in size, secreting food-material which is transmitted to the ovum by means of a prolongation of the ovum, which perforates the follicular wall, and so enters the yolk-cell chamber. There is, however, no gradual diminution in size of the yolk-cells, for just before the eggs enter the oviduct the whole contents of the yolk-cell chamber is suddenly evacuated into the egg-chamber. The egg in consequence exhibits within its cytoplasm the degenerating remnants of the yolk-cells. In commenting upon his results, the author notes the rarity of karyokinetic figures in the zone of synapsis, in spite of the fact that active cell-division is going on there. He believes that, as already indicated by others, the yolk-cells divide by an amitotic process, as is generally true of actively assimilating cells. The peculiar engulfing of the yolk-cells by the ovum he explains as necessitated by the rapid production of eggs in the queen-bee. Further, he is of opinion with Weismann, that the distinction between future yolk-cells and future ova is determined by heredity and not by differences of nutrition.

Studies on Ants.*—Prof. A. Forel describes (1) a number of ants from Japan, including several new species; (2) the nests of *Camponotus senex* Sm. and *Macromischa sallei* Guérin; (3) *Strongylognathus huberi* Forel and its related species; (4) a natural triple colony, *Formica pratensis*, *Polyergus rufescens*, and *F. fusca*; (5) *Cyphomyrmex wheeleri* sp. n., whose mushroom-gardens Prof. W. M. Wheeler has discovered; and (6) some foreign ants imported into Hamburg.

Symbiosis of Caterpillars and Ants.†—Prof. H. Shomann finds that the caterpillars of *Lycæna argus* live in company with *Formica cinerea* on *Oxytropis pilosa* and *Hippophaë rhamnoides*, the ants continually crawling over the bodies of the caterpillars. The chrysalids also often occur in the nests of the ants, and the butterflies may be observed emerging from the nests without interference on the part of the ants. The symbiosis apparently protects the caterpillars from the attacks of ichneumons, while they secrete from the third body-ring a thick liquid, of which the ants are very fond. Similar cases of symbiosis have been observed in India and America, but this is the first time it has been noticed in Europe.

Artificially-produced Colour-change in Butterflies.‡—Dr. T. Fischer subjected chrysalids of *Arctia caja* L. to a temperature of $-8°$ C., and obtained a number of aberrant imagos. He was successful in breeding from these, and found that the new generation exhibited the parental characters, and did not revert to type, although their chrysalids were not subjected to an abnormal temperature. This interesting phenomenon the author regards as explicable only on Weismann's theory, maintaining that the low temperature affects the sex-cells at the same time and

* M.T. Schweiz. Entom. Ges., x. (1900) pp. 267–87.
† Arch. Sci. Phys. et Nat., x. (1900) pp. 565–6. ‡ Tom. cit., pp. 562–5.

in the same manner as it affects the wings. He believes that this theory also explains the fact that the wings of the new generation showed in some cases *more* deviation from type than those of the parents. Further, the author finds that in nearly all species of *Vanessa* the same aberrations which can be produced by cold, can also be produced by a high temperature (38° to 40° C.); this he regards as clear proof that variations in temperature have no direct or specific action, but only an indirect effect.

Stridulating Organs in Rhynchota.*—Anton Handlirsch criticises Swinton's (1877) description of the stridulating organs of *Naucoris cimicoides.* Swinton figured and described two "limæ" on the anterior surface of the mesothorax, but the author finds in this position nothing but grooves clothed with hair. He also sharply criticises other similar observations of Swinton's, whom he characterises as a *phantasievolle Engländer*, but some other authors fare little better at his hands. He himself finds a stridulating organ in *Naucoris* on the upper surface of the abdomen in the male, on the posterior border of segment-lines 5 and 6, in the form of deep notches, which overlie specialised areas on tergites 6 and 7. Segments 6 and 7 are very freely movable, and by their movements probably produce the sounds. These stridulating organs are entirely absent in the female, a fact regarded by the author as of considerable importance.

Collembola from Caves.† — Prof. K. Absolon finds that the postantennal organ can be studied in subterranean Collembola much better than in surface forms, and that the evidence clearly points to its being an olfactory organ. He describes various new species, notably *Aphorura gigantea* sp. n., a relatively very large form in which the postantennal organ bears 28–32 tubercles of very characteristic shape.

New Kerguelen Insect.‡—Dr. Günther Enderlein describes as *Meropathos chuni* g. et sp. n., a member of the Helephorinæ taken by Prof Chun's Antarctic expedition. Closely related to *Ochthebius*, the genus differs in the 8-jointed antennæ (segments 3 and 4 being fused), and the 4-jointed tarsus (segments 1 and 2 being fused). The antennæ have a remarkable appearance, for the second segment is globose and furnished with two hairs. The elytra are ornamented with nine longitudinal rows of dots.

Diet of Hydrophilus piceus.§ — Dr. C. Rengel finds that in the neighbourhood of Berlin, whatever it may be elsewhere, the imago of this aquatic beetle is in natural conditions wholly vegetarian. About 100 alimentary tracts were examined, without showing any animal food. The carnivorous habit with which *Hydrophilus* has often been credited, is an artificial result of life in aquaria.

β. Myriopoda

Cell-division in Myriopoda.‖— Fr. Meves and K. v. Korff have studied the division of the spermatocytes of the first order in *Lithobius forficatus*,

* Verh. Zool.-bot. Ges. Wien, l. 1900 (1901) pp. 555–60 (7 figs.).
† Zool. Anzeig., xxiv. (1901) pp. 82–90 (10 figs.).
‡ Tom. cit., pp. 121–4 (6 figs.).
§ Biol. Centralbl., xxi. (1901) pp. 173–82.
‖ Arch. Mikr. Anat., lvii. (1901) pp. 481–6 (1 pl. and 5 figs.).

and found them specially favourable objects for the study of the central corpuscles, which here occupy a remarkable position. At the beginning of the mitosis two central corpuscles with their rays are present, and lie at some little distance from the poles of the nucleus. Before any change takes place in the nucleus, they travel in opposite directions outwards to the cell-periphery. The cytoplasmic rays radiate out from the central corpuscles, but these have no connection with the threads of the nuclear spindle, which end free. The later stages of the mitosis were not followed, but the authors compare their observations with those of various authors (Hirasé, Webber, Ikeno), on the sex-cells of Cycads, where again central corpuscles (blepharoplasts) occur, which are not related to the nuclear spindle.

γ. Protracheata.

Spermatogenesis of Peripatus balfouri.*—Dr. T. H. Montgomery finds that there is much similarity between the spermatogenesis of *Peripatus* and that of Insects, and that the synaptic stage is shown in *Peripatus* with exceptional clearness. As in *Pentatoma*, the synapsis is a part of the anaphase of the spermatogonic mitosis, and is followed by a complete rest stage. In connection with his observations on the chromosomes, the author makes some remarks on the use of the term chromosome. He regards the nuclear network as composed of linin and chromatin, while there are in addition achromatic threads which may connect the chromatin granules with the nuclear membrane, and are provisionally called "secondary linin fibrils" by the author. When the chromatin granules are densely concentrated on the linin threads, a "chromosome" is formed, but the linin connections between the granules persist, and form the matrix of each chromosome. In *Peripatus* the author finds reason to believe that in spite of the changes undergone by the chromosomes, a continuous linin spirem persists continuously from the prophase of the last spermatogonic division, through the rest stage of the spermatocytes, up to the monaster of the first maturation division. He therefore regards linin spirem and chromatin as constituting together a single nuclear element, whose component parts—the chromosomes—are continuous from generation to generation of the cells. He believes that the presence of a persistent and continuous linin spirem furnishes an explanation of some hitherto obscure cytological phenomena.

δ. Arachnida.

Palæophonus hunteri sp. n.†—R. I. Pocock has examined this form, the Scottish Silurian scorpion of Mr. Peach, which proves to be distinct from the hitherto described Swedish Upper Silurian scorpion. From the position of the specimen it is possible to study the under surface, and this leads to the conclusion that *Palæophonus* is to be regarded as occupying an intermediate position between *Limulus* and the Eurypterids on the one hand, and recent scorpions on the other. Indeed, *P. hunteri* affords additional proof of the descent of scorpions from marine Limuloid ancestors. The author doubts the existence of stigmata, and believes that *Palæophonus* lived in the sea, breathing partly by means of the

* Zool. Jahrb., xiv. (1900) pp. 277–368 (7 pls.).
† Quart. Journ. Micr. Sci., xliv. (1901) pp. 291–311 (1 pl. and 3 figs.).

appendages of the second mesosomatic somite, possibly also by the ventral plates. The second mesosomatic appendages have inner and outer branches, like the corresponding appendages of *Limulus*, and the outer branch, though in some respects resembling the pecten of a scorpion, also resembles the outer branch of a mesosomatic limb in *Limulus*.

Genera of Hydrachnids.*—F. Koenike discusses the species of the genera *Arrenurus* and *Eylais*, and criticises Piersig's treatment of these species in his work on German Hydrachnids.

Adaptation of Instinct in a Trap-door Spider.†—R. I. Pocock puts on record a case (from Western Australia) of a spider making the lid of its hole out of a sixpence. There was only silk thread on the top of the coin, but underneath mud and silk thread were coated on and shaped convex as usual.

Mites and Tardigrades.‡—Prof. F. Richters, in studying the moss-fauna around Frankfurt, came across the rare Oribatid *Cepheus ocellatus* Michael, and he gives a description of it, accompanied by some beautiful figures. He acknowledges with some enthusiasm his indebtedness to Michael's work. A second section is devoted to the eggs of Oribatids. Thirdly, the author describes *Ophiocamptus muscicola* sp. n., a moss-inhabiting Copepod. The fourth section of the communication describes a new Tardigrade, *Macrobiotus ornatus*.

ε. Crustacea.

Antennal Glands and Shell-Glands in Crustacea.§—Prof. F. Vejdovsky finds that in the antennal glands of the Gammaridæ the secreting tubule, which he regards as the nephridium proper, opens by a narrowed orifice into the end-sac, or cœlom-sac as he regards it. Into this orifice large cells project, forming a funnel which communicates on the one side with the nephridium, and on the other with the cœlom-sac, nephridium and funnel being the homologues of the similar structures in an Annelid. In the shell-glands of Isopods he finds similar large cells at the junction of canaliculus and end-sac (cœlom-sac), constituting a similar funnel apparatus. So striking is the resemblance in both cases to the Annelid nephridium, that the author states that, from the standpoint of comparative anatomy, there is no difference between the excretory organs of Annulata and Crustacea. The funnel in Crustacea certainly differs in the small number of its component cells and the absence of cilia; but these the author regards as modifications due to functional change in the method of discharge of the waste-products.

Habits of Cambarus immunis Hagen.‖—J. A. Harris has some notes on the burrows constructed by this American crayfish during the period when the shallow pools in which it lives dry up, and also at the approach of winter. He finds that the burrowing habit has no apparent connection with the hatching of the eggs. The burrows are of considerable size; one was followed up for 4 feet without reaching the end,

* Zool. Anzeig., xxiv. (1901) pp. 90–6 (1 fig.). † Nature, lxiii. (1901) p. 466.
‡ Ber. Senckenberg. Ges., 1900, pp. 21–44 (4 pls.).
§ Zeitschr. wiss. Zool., lxvi. (1901) pp. 378–97 (2 pls. and 1 fig.).
‖ Amer. Nat., xxxv. (1901) pp. 187–91.

and consisted of a chimney, a narrow passage, and a basal expanded chamber, but the author believes that the chimney is due only to the mud thrown out in excavating, and has no special significance. After being made, the burrows are sealed with mud for some distance from the top.

Palæarctic Isopods.*—Prof. Karl W. Verhoeff continues his notes on this subject. In the present instalment he gives a key to the species of the imperfectly known genus *Trichoniscus*, and describes some new species.

Professor Verhoeff further discusses *Armadillidium*, *Porcellio*, and some other related genera. In regard to distribution, he notes that north and central Europe are poor in land Isopods, those present are widely distributed forms, and there are few or no characteristic species. On the other hand, the Mediterranean sub-region is rich in land Isopods, as it is also in Chilopoda and Diplopoda.

New Entozoic Copepod.† — Alice L. Embleton describes *Goidelia japonica* g. et sp. n., from the rectum of *Echiurus unicinctus*, an almost unknown Japanese Gephyrean. The parasites most resemble the Hersiliidæ (for which and for *Hersilia*, it seems necessary to substitute the names Clausidiidæ and *Clausidium*). The body is flattened, segmented, and cyclopoid; the sexes are equal in size, and dimorphism is only apparent on closer examination of the appendages; the male is not attached to the female; there are no eyes. Along with the Copepods there were very numerous specimens of a minute Infusorian, apparently a new species of *Trichodina*.

Alleged Hypostomial Eyes in Trilobites.‡—G. Lindström, with the assistance of G. Liljevall, has investigated the visual organs of the Trilobites. There are four types of cephalic eye, which the authors believe to have succeeded one another in the following order, viz.:—the simplest or *Harpes* type, of simple ocelli; the Eurycarid, biconvex or lentiform type; the Megalaspid or prismatic type; and the Phacopsid or "aggregate" type—all duly figured for thirty-six species.

Apart from these, the authors record "maculæ" or hypostomial eyes so-called for some 136 species of 39 genera, but they state that the genera in which they have found them lens-bearing are relatively few, and that the lenses or "granules," even where recognisable, have been found to be present only over the lower third of the macula, with the exception of the Asaphidæ, *Illænus*, and *Lichas*, where the entire macula shows the structure which characterises it as a visual organ. Beyond this, the macula, for which an average diameter of 0·99 mm. is given, is described as oblong or ellipsoidal and for two-thirds of its surface perfectly smooth or rather glossy, and its granules or lenses are estimated to be but 0·055 mm. in diameter at their largest.

The presumed hypostomial eyes are compared with a thin area of the hypostome of *Apus*, with the (according to Packard) originally ventral median eyes of *Limulus*, and with more or less ventral eyes in Lepadidæ. Perhaps, like the living *Apus*, the Trilobites were in the

* Zool. Anzeig., xxiv. (1901) pp. 73–9, 135–49 (4 figs.). Cf. this Journal, *ante*, p. 154.

† Journ. Linn. Soc. (Zool.), xxviii. (1901) pp. 211–29 (2 pls.).

‡ Handl. k. svensk. Akad. Stockholm, 1901, 74 pp., 6 pls.

habit of swimming on their backs. Prof. G. B. Howes, in a review,* notes that "the possibility that the maculæ may have been luminous organs must not be overlooked; and bearing on this surmise, it is well to remember that such organs are known to exist in a lenticulate and aggregated form, and that the probable presence of one of simple type in a sponge, taken in conjunction with the extent to which like organs are functional as a lure to the prey, would dispose of any anomaly in their possession by blind animals." Perhaps, as Howes suggests, the maculæ were only "æsthetes," as in *Chiton*, for their visual function is not proved.

Annulata.

Spermatophores of Oligochæta.†—F. E. Beddard observes that these may be arranged in two classes:—(1) Shorter spermatophores consisting of a chitinous case enclosing a mass of spermatozoa, immobile, attached to body externally, in Lumbricidæ, *Criodrilus*, *Alma*, *Bothrioneuron*; and (2) long spermatophores of more complicated structure, motile owing to the projection of the tails of the spermatozoa, found in the spermathecæ, in Tubificidæ, and *Polytoreutus*. It appears from this that the Limicolæ and Terricolæ cannot be distinguished by their spermatophores, both types occurring in both divisions. Beddard's discovery of the spermatophores in *Alma* (which has no spermathecæ) supports the view that the spermatophores are produced by the spermiducal glands or by the glandular tissue surrounding the orifice of the sperm-ducts. But he does not exclude the possibility that in some cases the spermathecæ may also assist.

New Form of Spermatophore in an Earthworm.‡—F. E. Beddard has found in the spermathecal sac of the Eudrilid *Stuhlmannia* a peculiar form of spermatophore. There is a "head" like that in *Tubifex*, a long "beak" open at the extremity; this is followed by a circumferential swelling, which is again succeeded by a narrow neck; this in its turn gradually widens until at the middle the spermatophore is large and plump. The interior is a mass of uncompacted spermatozoa. The whole of the spermatophore seems to be moulded in the spermathecal sac; the material comes in part from the spermiducal gland and in part from a breaking down of the abundant cells which line the spermathecal sac.

In Lumbricidæ (*Criodrilus*, &c.) the spermatophores are compact cases, generally open at one end, and are found invariably attached to the outside of the body in the neighbourhood of the reproductive orifices, sometimes even slightly imbedded in the skin. In *Tubifex*, &c., the spermatophores are long thin motile bodies found only in the spermathecæ. That of *Stuhlmannia* is evidently somewhat intermediate between the two other types.

Atlantic Palolo.§—Prof. E. Ehlers discusses A. G. Mayer's ‖ interesting discovery of an Atlantic Palolo phenomenon like that of Samoa. It occurs at Loggerhead Key, one of the Tortugas Islands. But the name which Mayer gave the worm (*Staurocephalus gregaricus*)

* See Nature, lxiii. (1901) pp. 535–6.
† Zool. Anzeig., xxiv. (1901) pp. 220–3.
‡ Nature, lxiii. (1901) p. 515.
§ Nachr. k. Ges. Wiss. Göttingen, 1900, pp. 397–9.
‖ Cf. this Journal, 1900, p. 672.

will not do; Verrill * has shown that the worm does not belong to the genus *Staurocephalus* (rectius *Stauronereis*) Verr.; but Verrill's proposal of a new name *Mayeria* is dismissed by Ehlers, who holds that the Atlantic Palolo-worm is clearly a Eunicid, and not far removed from the *Eunice viridis* and the other Eunicid which form the Palolo of Samoa.

Histological Observations on Annelids.†—R. S. Bergh notes some points in regard to the histology of the larva of *Aulastoma*. He now finds that the primitive epidermis consists of a very few large cells containing numerous minute nuclei, whereas he previously regarded each of these nuclei as corresponding to a cell. Also what he previously regarded as small muscle-fibrils prove to be only ridges on the epidermis. He further amplifies and corrects some of his previous observations on the pronephridia. By staining with silver he has also been able to make out cell-boundaries in all regions of the segmental organs of various Lumbricidæ, even in cases where these have not hitherto been observed. He has, however, not been successful in doing this with the segmental organs of the Limicolæ.

Hamingia arctica.‡ — A. S. Skorikow has a note upon this form, which he believes to be identical with Horst's *H. glacialis*. Korén and Danielssen included a rudimentary proboscis among the generic characters of their genus *Hamingia*, but Skorikow figures a specimen of *H. arctica* with a well-developed proboscis bifid at the tip. He also finds two uteri, not one as in Prof. Lankester's specimen. He gives the relations of *Bonellia*, *Thalassema*, and *Hamingia* as follows. In *Hamingia*, as in *Thalassema*, the body is cylindrical, the proboscis is nearly as long as the body, there are two uteri (some species of *Thalassema*). Again, *Hamingia* resembles *Bonellia* and differs from *Thalassema* in having the proboscis bifid at the tip (though *Thalassema lankesteri* shows an approach to this condition), and in having a branched cloacal nephridium; in both also the male is microscopic. In *Hamingia* the genital bristles are absent, which is a peculiar character.

North American Oligochæta.§—Frank Smith describes as *Premnodrilus palustris* g. et sp. n., a new Oligochæte which appears to be related to the Lumbriculid genera *Eclipidrilus* and *Mesoporodrilus*. Each of these three genera includes only a single species, and they have, as common characters, the presence of sperm-reservoirs, simple setæ, an evertible penis, and very extensive sperm-sacs; they may be regarded as constituting a special sub-family Eclipidrilinæ. The new form seems most closely related to *Mesoporodrilus*, and agrees with it in possessing the following characters:—a prostomium, only one pair of nephridia in front of the genitalia, unpaired nephridia posterior to segment xii., one pair of testes, two pairs of lateral vessels in each of the somites posterior to x., and no perigastric vessels ending blindly in the cœlom. In spite of these resemblances, the differences seem sufficiently marked to entitle the new form to generic rank, but this cannot be regarded as certain until more specimens have been studied.

* Trans. Connecticut Acad., x. (1900).
† Zeitschr. wiss. Zool., lxvi. (1901) pp. 444–56 (2 pls.).
‡ Zool. Anzeig., xxiv. (1901) pp. 158–60 (1 fig.).
§ Bull. Illinois State Lab. Nat. Hist., v. (1900) pp. 459–78 (1 pl.).

Blood System of Malacobdella grossa.* — N. H. W. Maclaren has studied the blood-vessels of specimens of this form taken from *Mya truncata* on the Clyde, and finds such differences from the observations of others as to lead to the conclusion that there is local variation. He finds that the "vascular trees" described by von Kennel in the sucker arise from the lateral vessels throughout their length, and also to a less extent from the dorsal vessel. About seven of the trees usually arise from a lateral vessel at either side of the pharynx. Each tree is distinct from its neighbours, and ends blindly; the trees pulsate slowly and rhythmically in the living animal. In the posterior region the trees are more irregular in shape, and anastomose with one another, forming an irregular system of vessel-commissures.

Impregnation in Hæmenteria costata.† — Prof. H. Bolsius faces the difficulty of explaining how the contents of the spermatophore get into the cœlomic cavity. The spermatophore is lodged in the vestibule (between the internal and external male genital aperture), but there is no piercing of tissues. The author suggests that by a kind of suctorial action, due to the partly muscular character of the folds (*plis*) projecting into the vestibular cavity, the spermatophore is passively emptied, and the spermatozoa are drawn into the cœlomic cavity.

Platyhelminthes.

Fresh-water Nemertine.‡—W. Zykoff has found in the Volga near Saratow two specimens of a Nemertine, which is possibly identical with *Stichostemma græcense* Böhmig. The importance of the find is that this is only the third time fresh-water Nemertines have been recorded in Russia. It is probable that the Nemertine has found its way into the Volga from the Caspian as *Dreissensia polymorpha* has done, but as yet no Nemertine has been described in the Caspian.

Avian Cestodes.§ — O. Fuhrmann notes that among Vertebrates, birds are most infested with Cestodes, 370 forms being known to occur among them. Among birds fewest Cestodes occur in Raptores and graminivorous birds. In the family Acoleinæ the author includes four new genera *Diplophallus*, *Gyrocœlia*, *Acoleus*, and *Dioicocestus*, in all of which the female sexual opening is absent. In *Dioicocestus paronai* the sexes are separate, this being the first case described in Cestodes.

Marine Species of Gyrator.||—Prof. Emil Sekera describes a Turbellarian from Trieste which closely resembles the fresh-water species of *Gyrator*, especially *G. hermaphroditus*, but is remarkable for its blue tint. The copulatory organs are also of more simple structure than in the previously known species. The present species is described as *G. reticulatus* sp. n.

Syndesmus echinorum Franc.¶—A. E. Shipley obtained a number of specimens of this interesting Turbellarian parasite from *Echinus esculentus* at Plymouth, and notes some of the peculiarities of structure. The specimens were smaller than those of François, varying from

* Zool. Anzeig., xxiv. (1901) pp. 126–9 (5 figs.).
† Tom. cit., pp. 206–9 (2 figs.). ‡ Tom. cit., pp. 155–6.
§ Arch. Sci. Phys. et Nat., xi. (1901) pp. 204–5.
|| Zool. Anzeig., xxiv. (1901) pp. 79–81 (2 figs.).
¶ Quart. Journ. Micr. Sci., xliv. (1901) pp. 281–90 (1 pl.).

1–2 mm. in length. The mouth is ventral, and the vas deferens, vagina, and uterus open by a common posterior pore. There are no tentacles, papillæ, hooks, spines, nor skin-glands, but cilia appear to be present. The digestive system consists of a spherical pharynx, a short œsophagus with glands, and a rod-like digestive sac lined by a plasmodium. No excretory system was made out. There is a distinct nerve-ganglion and apparently two forward and two backward nerves. Ovary and testis are both paired, and the yolk-glands are large and branching. A penis and paired shell-glands are also present. The uterus contained a large egg. The author also notes the occurrence of Nematode parasites in *Echinus*.

Echinoderma.

Abnormal Sea-urchin.* — W. L. Tower describes a specimen of *Echinarachnius parma* in which the apical system is excentrically placed, having moved away from the anus towards the opposite side, but in a straight line; the aboral surface, further, is almost bilaterally symmetrical, and the ambulacral system v. is represented only by a few scattered pores, which perforate plates of inter-ambulacral rather than ambulacral character. These characters give the urchin considerable resemblance to one of the Petalostichous Echinoids. Further, certain of the plates showed complete fusion, and the genital plates and pores were absent. The variation falls into class 2 of Bateson's classification of echinoid abnormalities.

Holothuria of Pacific Coast.†—H. L. Clark has worked through a collection of 52 specimens of Californian Holothurians, including some 11 species, and reviews what is known of the Holothurians of that area, which have as yet been very imperfectly studied. The *Synapta* of California Clark believes to be merely the Atlantic *S. inhærens*. The commonest Holothurian at Pacific Grove is *Stichopus californicus*. There are several (about seven) species of *Cucumaria*, a new species of *Thyone* (*T. rubra* sp. n.), and a peculiar form resembling both *Psolus* and *Thyone*, which the author places in a new genus—*Thyonepsolus;* it differs from *Psolus* in the presence of pedicels on the dorsal surface. The single species is *Th. nutriens*, which carries its young imbedded in the soft skin of the back.

Cœlentera.

Mesenteries of Actiniaria.‡—Oskar Carlgren describes as *Pentactinia californica* g. et sp. n. an interesting new form, which lends new support to his view as to the order of origin of the fifth and sixth pairs of mesenteries in Actiniaria. In the new form the sixth pair remains in an exceedingly rudimentary condition; the relation of the parts is best indicated by the following extracts from the generic diagnosis. The mesenteries show a bilateral arrangement. There are only five pairs of complete fertile mesenteries, which include two pairs of directive mesenteries. On each side of the dorsal directive mesenteries there is a pair of complete mesenteries with their longitudinal muscles facing

* Zool. Anzeig., xxiv. (1901) pp. 183–91 (3 figs.).

† Tom. cit., pp. 162–71 (14 figs.).

‡ Öfversigt Forhandl. k. svensk. Vet. Akad., lvii. (1900) pp. 1165–75 (2 figs.).

inwards; on each side of the ventral mesenteries is a single mesentery, with its longitudinal muscle facing the outwardly-directed muscle of the corresponding directive mesentery, so that at first sight there appears to be only one pair of directive mesenteries. The mesenteries of the sixth pair are very slightly developed, are without filaments, muscles, or gonads, and are placed in the ventro-lateral spaces.

Nervous System of Lucernaridæ.*—N. Kassianow has studied this especially in *Craterolophus tethys* and *Lucernaria campanulata*, and finds that it consists in the first place of a nerve-plexus in the exumbrellar ectoderm which extends over the whole external surface. There are also nerve-centres belonging to the sub-umbrellar ectoderm which lie at the tips of the arms, the nervous epithelium spreading between the bases of the tentacles. In *Craterolophus tethys* there are also ganglion-cells and nerve-threads in the musculature of tentacle-stalks, while in *Lucernaria* the marginal muscle and the longitudinal muscles contain nerve-threads and probably also ganglion-cells, and there are also nerve-threads in the stinging epithelium of the sub-umbrella. In *Craterolophus* there are sensory cells in the ectoderm of the margin where this borders the bases of the arms. In both forms and also in *Haliclystus octoradiatus* there is a layer of nerve-threads, of ganglion-cells, and of special sensory cells in the knobs of the tentacles, and nerve-centres consisting of sensory epithelium belonging to the batteries of stinging-cells, and arranged round the openings of these. In *Craterolophus tethys* there are also nervous elements in the stinging knobs of the marginal papillæ just as in the tentacle knobs, and similar nerve epithelium occurs in *Haliclystus* at the base of the marginal papillæ. In *Lucernaria* scattered ganglion-cells and sensory cells occur in the endoderm of the gastric cavity. The author does not believe that the arms of *Lucernaria* can be homologised with the sensory lobes of Discomedusæ, nor the nervous system of the former with that of the other Scyphomedusæ. The nervous system of the Lucernaridæ is simpler than that of the other Scyphomedusæ, and has developed along parallel lines but independently. It does not however show any relation to that of the Hydromedusæ.

Plumularidæ.†—Prof. C. C. Nutting has completed a fine monograph on the North American representatives of this family. The minute structure of the trophosome and the gonosome is discussed in detail; the oogenesis, spermatogenesis, and development are likewise described; a special section is devoted to the stoloniferous multiplication; and the interesting question of the possibility of conjugation is discussed in a fair-minded manner. Then follows the systematic discussion. We cannot pretend to summarise a large monograph, but it impresses us as a thorough piece of work, and an admirable achievement.

Porifera.

Ephydatia blembingia.‡—Richard Evans describes this new fresh-water sponge, one of the Meyeninæ, found in a deeply shaded pool in the Siamese Malay States.

* Zeitschr. wiss. Zool., lxvi. (1901) pp. 287–377 (4 pls. and 11 figs.).
† Smithsonian Inst. Special Bulletin, 1900, 142 pp. 34 pls., 121 figs.
‡ Quart. Journ. Micr. Sci., xliv. (1900) pp. 71–109 (4 pls.).

It is an encrusting sponge, growing on vegetable supports; has a pale flesh colour and a loose texture. The skeletal spicules are covered with small spines; flesh spicules are absent, unless small amphioxes belong to this category. Spicule fibres are poorly developed; in the deeper parts the spicules generally lie irregularly disposed in the tissues; there is very little spongin.

The gemmules are numerous, but are not aggregated in groups; they occur—each in a cavity of its own—both near the surface and deeper down. They are oval, and have an opening like that of a bottle, obstructed by a chitinous septum. They are provided with a thick and well-developed coat, in which amphidiscs of equal lengths are arranged in a single layer. The shaft of the amphidiscs is furnished with conical spines, large in size and situated at right angles to the longitudinal axis. The outer surface of the discs is convex, and the margin is slightly serrated. Amphidiscs in all stages of development are scattered about in the sponge tissue where they are formed.

Four classes of cells, each of which is derived independently from the sponge, take part in the formation of the gemmule; first, the mother-cells of the yolk-cells which alone constitute the reproductive portion of the gemmule; secondly, the mother-cells of the columnar cells, which pass back to the sponge; thirdly, the mother-cells of the amphidiscs, "scleroblasts," which become modified and form a part of the intermediate layer of the protective coat of the gemmule; and fourthly, the trophocytes, whose function is to supply both the columnar and the yolk-cells with food-material, and which, like the columnar cells, pass back to the sponge.

The yolk-cells and the columnar cells draw their food-material in solution from the trophocytes; the yolk-cells store it up as a reserve in the yolk-bodies; the columnar cells use it in such a way as to enable them to secrete the inner chitinous layer, to grow and pass out between the outer ends of the amphidiscs, their inner ends being modified to form the greater part of the ground substance of the protective coat of the gemmule, and finally, to secrete the outer chitinous layer; processes which mean that there is an enormous amount of metabolism going on. The amphidiscs are developed in cells, the scleroblasts, which carry them through strands of the sponge tissue to their ultimate position in the protective coat of the gemmule.

The above is the author's summary of his general results. His communication ends with a critical review of previous researches, and opinions on the formation of gemmules.

Antarctic Sponges.*—E. Topsent makes a preliminary note on the sponges collected by the Belgian Antarctic Expedition. Twenty-six species were obtained:—Calcarea (2), Monaxonida (13), Carnosa (1), Hexactinellida (9), Halisarcida (1), Monoceratina (0), Tetractinellida (0)—and thirteen were new.

There is little resemblance to Arctic forms. The author notes that *Leucosolenia lamarcki*, *Halichondria panicea*, and *Dendoryx incrustans*, which are common to both, are really cosmopolitan. The abundance of Hexactinellids—alike in species and individuals—is characteristic of the South.

* Comptes Rendus, cxxxii. (1901) pp. 168–9.

Fresh-water Sponge from Sable Island.*—Dr. A. H. MacKay describes *Heteromeyenia macouni* n. sp. (possibly it will turn out to be *H. ryderi* var. *macouni* *). It is especially interesting because of its abundant occurrence (encrusting submerged stems of *Myriophyllum tenellum*) in a pond or lake between the two parallel ridges of loose grey sand which constitute Sable Island, in the Atlantic, nearly 100 miles from Nova Scotia.

Development of Sponge Spicules.†—Dr. Otto Maas has studied the development of the spicules of a species of *Tethya*. There are three kinds of spicule, the tylostyles, the chiasters, and the spherasters; all originate in a single mother-cell, but, except in the case of the chiasters, other cells take part in the growth and development. The spicule-secreting cells are densely filled with granulations, which originate with the formation of the flinty substance. The chiaster-forming cells are differentiated elements of the parenchyma, but the spherasters and tylostyles are formed in undifferentiated cells with vesicular nucleus and nucleolus. The secondary formative cells arise partly by division of the first formative cell, and are partly ordinary parenchyma cells. The spherasters originate by the fusion of several small tetrasters, and the further development takes place by the aggregation of fresh particles. The tylostyles arise by the union of small irregular concretions within a single cell, and the needle so formed increases by apposition through the agency of epithelial formative cells. In their cells of origin, no less than in the fact that they are completely formed by a single cell, the microscleres or chiasters are sharply contrasted with the spherasters and tylostyles.

Protozoa.

Reproduction of Radiolaria Tripylæ.‡—Dr. A. Borgert has succeeded in finding, among 20,000 specimens of *Aulacantha scolymantha*, a sufficient number in the act of division to permit of a study of the details of the process. He finds that cell-fission as well as the formation of swarm-spores occurs, and in the process of fission the nuclear division may be mitotic or amitotic. The present paper is concerned only with the former process. In the prophase the reticular chromatin of the resting stage forms a coiled thread. In the next stage this thread splits longitudinally and segments; the segments again split longitudinally, but the chromosomes so formed pass into the coiled condition again before the formation of the equatorial plate. A remarkable peculiarity is the enormous number (over 1000) of chromosomes, which is to be regarded as an important point of contrast with Metazoan mitosis, as is also the great variation in number of the chromosomes. Other distinctions are the double longitudinal splitting mentioned above, which occurs during a single division (contrast *Ascaris*, *Salamandra*, &c.), the absence of a true spindle, and the occurrence of a second coil-stage after the splitting of the chromosomes. The occurrence of some of these at least the author is inclined to associate with the absence of a sexual act. Of the many other observations contained in the paper,

* Trans. Nova Scotian Inst. Sci., x. (1900) pp. 319–22.
† S.B. Akad. Wiss. München, 1900, pp. 553–69 (1 pl.).
‡ Zool. Jahrb., xiv. (1900) pp. 203–76 (5 pls. and 33 figs.).

we can only notice that the author finds that the phæodellæ are not of protoplasmic nature, but are excretory products which are retained within the protoplasm in order to increase the size of the organism, and so facilitate the respiratory interchange and the process of nutrition. Special mention should be made of the numerous figures which illustrate the paper.

Foraminifera from the Lagoon at Funafuti.*—F. Chapman has had a good opportunity of examining a foraminiferal lagoon fauna. The prevailing genus is *Amphistegina*, whose specimens are smaller in the middle of the lagoon than within reach of currents from without. The spurred forms *Calcarina* and *Tinoporus* are both common near the rim, but the latter rapidly disappears on travelling across the lagoon, and *Calcarina* only is found in the samples from the lagoon-floor. In the middle of the lagoon only three genera are present, *Sagenina*, *Amphistegina*, and *Heterostegina*. Perhaps the chief interest of the collection is the evidence of environmentally produced variations or modifications.

Trichocysts of Paramœcium aurelia.†—Prof. Jean Massart has studied the discharge of the trichocysts in this Protozoon, and gives the name of *bolism* to the entire reflex action, from the application of the stimulus to the completion of the reaction. The exciting agents may be gentle pressure, an inductive shock, a rapid rise of temperature, or chemical agents. In regard to chemical agents, however, there is much variability, individuals of common descent reacting differently to the same reagent. Typical reactions are shown in the following cases. When the Infusorian is touched by picric acid, it instantly discharges all its trichocysts. On the other hand, methylen-blue of $\frac{1}{400}$ strength produces a very slow and gradual discharge, and some reagents (chrysoidine of $\frac{1}{500}$ strength, picrate of ammonia of $\frac{1}{200}$, iodine in potassium iodide) produce death, slowly or rapidly, without any discharge. Thus the production of the discharge does not depend upon the amount of injury inflicted by the reagent. Further experiments showed that the reflex occurs only at the stimulated points; there is no transmission of the stimulus. By very gradually raising the temperature, it is possible to resolve the reflexes into their elements; thus at one temperature haptotaxism disappears while haptobolism persists, or chimiobolism may persist intact while chimiotaxism persists only in part.

Seasonal Dimorphism of Ceratium furca Duj.‡—R. Minkiewicz notes that there is a distinct difference in the anterior and posterior processes in the summer and winter forms of this species. In summer the processes are longer and the proportions are more "elegant."

Monograph on Tentaculifera.§—René Sand completes his elaborate monograph on the Tentaculifera or Suctoria with an account of the particular observations which he has made on 25 species of *Trichophrya*, *Ophryodendron*, *Urnula*, *Podophrya*, *Sphærophrya*, *Hallezia*, *Tokophrya*, and *Acineta*. There is much that is interesting, but in reference to so many different forms that a summary is beyond our scope.

* Journ. Linn. Soc. (Zool.), xxviii. (1901) pp. 161–210 (2 pls.).
† Bull. Acad. Roy. Belg. Cl. Sci., 1901, pp. 91–106.
‡ Zool. Anzeig., xxiii. (1900) pp. 545–6.
§ Ann. Soc. Belge Micr., xxvi. 1899-1900 (1901) pp. 13–119, 8 pls.

Life-History of Monocystis ascidiæ.* — M. Siedlecki has worked out in detail the following summary of the life-history of this species:—

$$\begin{array}{ccc}
\text{Sporozoite} & & \text{Sporozoite} \\
| & & | \\
\text{mature individual} & & \text{mature individual} \\
\downarrow & \text{conjugation} & \downarrow \\
n \text{ sporoblasts} & & n \text{ sporoblasts} \\
& \text{copulation} & \\
& \downarrow & \\
& n \text{ sporocysts} & \\
& \downarrow & \\
& 8\,n \text{ sporozoites} &
\end{array}$$

Influence of Gregarines on the Cells of their Host.† — Michel Siedlecki adduces a number of facts, especially with reference to *Monocystis ascidiæ* Lank. (which passes most of its growth-period within a cell of the intestinal epithelium), showing that the parasite has at first a hypertrophic influence on its cell-host. The influence is probably chemical, and due to excretory products passing from parasite to host.

Asexual Multiplication of Gregarines.‡ — Maurice Caullery and Felix Mesnil, in discussing this, begin by pointing out that the life-cycle of Coccidia is now fairly clear:—intracellular asexual multiplication (schizogony, with merozoite-stages); growth and differentiation of male and female gametes; "*heterogonic*" conjugation, leading on to the formation of sporoblasts, and thence from sporocysts to sporozoites ("*sporogony*"). The whole period of the growth of the asexual elements and of the gametes is intracellular.

In Gregarines there is much greater diversity, from entirely extracellular development to a growth almost completely intracellular (*Monocystis ascidiæ*, &c.), with possible intracellular schizogony. From the last state of affairs, illustrated by *Gonospora longissima*, there is an approximation to what occurs in Coccidia, in which the growth is wholly intracellular, and schizogony is general. But in Coccidia heterogamy has replaced isogamy.

The authors direct attention to the hypertrophic influence exerted by Gregarine parasites on their cell-hosts.

Plistophora mülleri (L. Pfr.).§ — Dr. W. Stempell has studied the microsporidium found by L. Pfeiffer in the muscles of *Gammarus pulex*, and described under this name by him. Stempell has been able to

* Bull. Acad. Sci. Cracow, December 1899. See O. Dubosq, Notes et Revue, Arch. Zool. Expér., viii. (1900) pp. lx.–lxii.

† Comptes Rendus, cxxxii. (1901) pp. 218–20. ‡ Tom. cit., pp. 220–3.

§ Zool. Anzeig., xxiv. (1901) pp. 157–8.

follow the development, and in this preliminary communication points out that the parasite, on account of its eight spores, should rather be referred to the genus *Thelohania*. The life-history, so far as known, is as follows :—the sporonts divide into eight spores by typical direct division. Mingled with the sporonts occur meronts which probably produce auto-infection, and which divide into two, the daughter-cells again dividing before separation. Meronts and sporonts are connected by transitional forms, but the exact relation, and the occurrence of a sexual act, remain uncertain. The eight spores formed by the division of the sporont are connected together and invested by a gelatinous sheath, within which they ripen.

Genus Hæmogregarina.*—Carl Börner has examined various reptiles for blood parasites, and has found in *Crocodilus frontatus* and *Alligator mississippiensis* a new species of the above genus which he describes as *H. crocodilinorum* sp. n.; in *Clemmys elegans* and species of *Platemys* a form which he calls *H. labbei* sp. n.; and in *Coluber æsculapii* one to which he gives the name *H. colubri* sp. n. The result of his research is to show that representatives of the genus *Hæmogregarina* occur in all the four orders of reptiles, as well as in *Rana esculenta*. A list of the known species and their hosts is included in the paper. The author obtained only negative results with infection experiments, and believes that there must be a second host, probably the mites with which most reptiles are infested. Considerable difficulty was experienced in finding constant specific characters, and the author leaves open the question whether the forms mentioned above may not have merely varietal significance. The life-history was not followed, but during the growth-period two forms occur, a straight form and one sharply bent upon itself. In the first the cytoplasm consists of the so-called intergranular substance and the chromatoid granula; the latter is most abundant in the young stages, and is almost absent in the bent stage. The nucleus is distinct, varies in form, and is without a nuclear membrane. The bent stage results from a growth in length, and a diminution in breadth.

Parasite found in Syphilides.†—H. Stassano records the presence of flagellated Infusoria belonging to the group Monadina in the lymphatic glands nearest a chancre. In shape, these infusoria are round, ovoid, or pyriform, are always flagellated, and contain one or two vacuoles. Though most are free in the plasma, many are adherent to red corpuscles. Multiplication takes place by fission. Frequently their appearance strikingly resembles that of yeast. As the disease advances fission ceases and the parasites attach themselves to red corpuscles, and in this position have much resemblance to trypanosoma.

* Zeitschr. wiss. Zool., lxvi. (1901) pp. 398-416 (1 pl.).
† Comptes Rendus, cxxxii. (1901) pp. 800-2 (44 figs.).

BOTANY.

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

a. Anatomy.

(1) Cell-Structure and Protoplasm.

Movements of the Nucleus.*—From observations made chiefly on the mother-cells of stomates in Monocotyledons, H. Miehe concludes that the changes in position of the nucleus are mainly due to growth-processes in adjoining cells. The polar process may be reversed by the action of centrifugal force, of traumatropic irritation, or of a reversal in the direction of growth. The constant tendency of the nucleus to travel to the upper portion of the cell is connected with the direction of growth. If pieces of young epiderm are torn or cut off, an immediate movement of the nucleus takes place through the membrane-pores; as is the case also with the mother-cells and the guard-cells of the stomates. Nuclei of *Hyacinthus* under the influence of traumatropic irritation undergo a change in the form and disposition of their contents. Traumatropic movement of the nucleus may be attributed to a renewed growth of the injured zone caused by the injury. Under favourable conditions the epiderm possesses a power of regeneration.

Development of Karyokinetic Spindle in Pollen-mother-cells of Lavatera.†—Miss Edith S. Byxbee thus sums up the results of her observations on the development of the karyokinetic spindle in the pollen-mother-cells of a species of *Lavatera*. The cytoplasm of the young pollen-mother-cell is made up of two constituents, a fibrous network and a granular substance. The following are the steps by which the spindle is formed. The meshes of the network close to the nuclear wall pull out in the direction parallel to the wall, forming a felt of fibres round the nucleus. The granular constituent of the cytoplasm collects in the wide dense zone round the nucleus. The linin increases in quantity. The nuclear wall breaks down, and the fibres outside begin to grow into the nuclear cavity. The cytoplasmic and linin fibres form a mass in which the chromosomes lie. The mass of fibres projects out at a number of points, forming the multipolar spindle. Two of the cones become more prominent than the others, which they finally absorb, thus forming the bipolar spindle. In the second division of the pollen-mother-cells the process is exactly repeated. The granular substance which forms the dense zone is comparable to the deutoplasm of the egg in animals. Finally, the spindle is formed directly from cytoplasmic elements and linin network present in the cell from the first, and not from any special spindle-forming substance, or by the aid of centrosomes.

* Flora, lxxxviii. (1901) pp. 105–42 (1 pl.).
† Proc. California Acad. Sci., ii. (1900) pp. 63–76 (4 pls.).

Connecting Threads of Protoplasm in Pinus.*—Arthur W. Hill has investigated the nature and distribution of the connecting threads in the various tissues of the hypocotyl, cotyledons, and root of the young seedling of *Pinus pinea*, and of the adult stem, leaf, and root of *P. sylvestris*.

Connecting threads were formed in the case of all cells in which the wall retains its cellulose or mucilaginous character, and in all such young tissues as the growing point of the root. In *P. pinea*, the tissue of the endosperm and that of the germinating seedling are well connected by such threads. In the cotyledon the walls of the cells, both of the epiderm and of the subjacent parenchyme, are more richly provided with threads than the similar tissues of the upper side. In the stomates of the cotyledon threads were seen in a few cases connecting the guard-cells with the epidermal cells. The parenchymatous tissue throughout the seedling shows connecting threads of a similar character. The living cells of the pericycle are abundantly connected by long usually curved threads. The root-cap shows numerous threads connecting its cells together, associated, no doubt, with its function as an organ for the perception of stimulus. In *P. sylvestris* the characters of the threads in the cortical tissues of the adult stem and root are similar to those of the seedling. In the phloem no threads can be found directly connecting the parenchymatous cells with the sieve-tubes. The existence of threads in the xylem is doubtful. The leaf of *P. sylvestris* shows a distribution of connecting threads similar to that in the cotyledons.

Centrifugal and Simultaneous Thickenings of the Membrane.†—Having shown the probability that the centrifugal thickenings of the membrane in Peridinieæ, diatoms, and desmids is due to the activity of an extra-cellular layer of protoplasm, F. Schütt now shows that in many cases where a centrifugal thickening of the membrane is *prima facie* assumed, there are no subsequent changes in form or bulk when the portions of the membrane in question have once been formed; that the whole growth takes place simultaneously; and that there is no question of thickening. This is especially the case with the spines and rods of the plankton-diatoms, which often combine the separate individuals into long chains. A favourable example is presented by the genus *Sceletonema*, where tufts of rods from the valves which face one another connect the two frustules with one another. After the division of the mother-cell, the two naked protoplasts of the daughter-cells separate from one another, then again come into contact, and again completely separate, being connected only at certain points, where subsequently the rods are in contact with one another; and, as they retreat from one another, these rods are spun out from the protoplasmic layer.

It is seldom, according to the author, that an actual centrifugal growth of the membrane takes place, but this does occur in the case of the teeth on the spines of *Chætoceras*. The extracellular needles of *Cyclotella socialis* are spun out from the external layer of protoplasm. The chambers in many diatom membranes are also probably formed simultaneously.

* Proc. Roy. Soc., lxvii. (1901) pp. 437–9. Cf. this Journal, 1900, p. 476.

† Pringsheim's Jahrb. f. wiss. Bot., xxxv. (1900) pp. 470–534 (1 pl.). Cf. this Journal, 1900, p. 74.

A new genus of plankton-diatoms is described, *Botellus* g. n., the sausage-shaped cells of which are connected into long slightly wavy chains.

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

Chlorophyllins and Metachlorophyllins.*—M. Tsvett finds in green leaves a second chlorophyllin, besides the blue one already described. In some plants the structure of the chlorophyllins is modified, and they form a group of substances to which the author gives the name *metachlorophyllins*. To this class belong the beautiful green crystals separated by Borodin, the "crystallisable chlorophyll" of Monteverde.

Myrosin.†—Th. Bokorny finds this substance more widely distributed in the vegetable kingdom than has hitherto been supposed. It is readily recognised by giving off the odour of mustard in the presence of potassium myronate and water. It was found in all Cruciferæ examined with the exception of *Hesperis matronalis*; also in the carrot and parsley among Umbelliferæ, and species of *Allium* among Liliaceæ. The ordinary glucoside present is potassium myronate, with the exception of a few Cruciferæ (e.g. *Capsella bursa-pastoris*), and of all plants outside that order which contain myrosin. Myrosin is more resistant to morbific agents than protoplasm.

Digestive Secretion of Nepenthes.‡—The late M. Clautrian appears to have set at rest the controversy respecting the digestive properties of the secretion of the urns of *Nepenthes*, by a series of observations on two species in their native habitat of Java, *N. Sedeni* and *N. melamphora*. Although, owing to the comparative scarcity of small insects, no large numbers are found in the urns, the bodies of those that are captured are more or less completely digested, and not by the agency of microbes, the presence of which was excluded in experiments made with sterilised white of egg. The fluid, while in the urns, is neutral to reagents, but shaking the urns, or introducing any foreign substance, renders it acid. The zymase which performs the active part in the digestion must be regarded as a pepsin rather than as a trypsin.

Manna of the Olive.§—In a district in Algeria, M. Trabut finds an exudation from olive-trees identical in chemical composition with the manna of the ash. The exuding region is limited to the trunk and the larger branches, where the phloem is completely liquefied by an organism which is apparently a bacterium. It produces large cankers and turns the wood black, but the production of fruit does not appear to be affected. M. Trabut attributes the disease to a bacterium capable of living on the cambium, which is brought by insects, probably grasshoppers.

Excretion of Resin by the Leaves of Conifers.—Frau E. Schwabach ‖ defends herself from the objections taken by Tschirch to her previous observations on this subject, and maintains, as the result of a fresh series of experiments, that the drops in question are not a fatty oil, but, as she has before asserted, are resin.

* Comptes Rendus, cxxxii. (1901) pp. 149–50. Cf. this Journal, *ante*, p. 50.

† Chem. Ztg., 1900. See Bot. Centralbl., lxxxv. (1901) pp. 72, 73.

‡ Mém. Couron. Acad. r. Belgique, 1900. See Biol. Centralbl., xxi. (1901) p. 33. Cf. this Journal, 1900, p. 479.

§ Comptes Rendus, cxxxii. (1901) pp. 225–6.

‖ Ber. Deutsch. Bot. Ges., xviii. (1900) pp. 417–21. Cf. this Journal, 1900, p. 214.

In reply, A. Tschirch* gives further details of the resinogenous layer in the leaves of conifers, which is frequently difficult to detect, and is often entirely resorbed at maturity.

Mucin.†—B. Schröder reviews the researches that have been made respecting the pectinaceous substances formed by plants and the mucilages by animals, and concludes that there is a very close resemblance, if not an identity, between vegetable mucin and that of animals.

(3) Structure of Tissues.

Structure of Vascular Plants.‡—G. Chauveaud points out the mode of formation of the primary structures (protoxylem), intermediate structures (metaxylem), and secondary structures, in the root of vascular plants. Take such an example as the radish—there are found at the base of the cotyledons the same structures as in the root, the difference consisting in a reduction of the protoxylem, and a more rapid succession of the different structures. They are less often to be found in the stem and in the leaf, because the arrest of the development of the protoxylem is, in most plants, manifested at a lower level.

"Bicollateral Bundles."§ — J. Baranetzky contests the accuracy of the term "bicollateral" as applied to the vascular bundles of dicotyledons, whether looked at histologically or from the point of view of their development. Bundles may be complete, i.e. composed of both xylem and phloem, or incomplete, composed of phloem alone. It is only in the Cucurbitaceæ and the Melastomaceæ that we get bundles which have on their inner margin a second group of phloem embracing the xylem as does the external phloem. In other families the bundles of internal phloem are always separated from the xylem by a more or less thick layer of parenchyme, and form an autonomous system altogether independent of the normal bundles, and capable of increasing in thickness by the activity of a unilateral cambium of their own. In *Rumex*, *Rheum*, and some other genera, the bundles of the inner ring are complete in the centre of their length, but become gradually incomplete towards their two extremities. In *Campanula* the structure of the bundles varies within the genus. In the Solanaceæ, Asclepiadeæ, Apocynaceæ, Myrtaceæ, Convolvulaceæ, and other orders, the internal bundles never form xylem.

The true nature is then described in detail of the vascular structure in a number of natural orders in which "bicollateral" bundles were said to exist. In all cases the inner bundles originate from the zone of active meristem which produces the normal bundles. The formative cambium ring merely represents an outer layer of the central cylinder, which only gradually loses its properties towards the centre of the stem. The appearance of inner vascular bundles in dicotyledons is not an anomalous, but a normal phenomenon.

Function of Laticifers.‖ — L. Gaucher reviews the arguments in favour of the two views that have been held respecting the function of

* Ber. Deutsch. Bot. Ges., xix. (1901) pp. 25–32.
† Beih. z. Bot. Centralbl., x. (1901) pp. 121–4.
‡ Comptes Rendus, cxxxii. (1901) pp. 93–5.
§ Ann. Sci. Nat. (Bot.), xii. (1900) pp. 261–332 (4 pls.).
‖ Tom. cit., pp. 241–60 (9 figs.).

laticiferous tubes—that their contents are reserve substances, or that advocated by Mdlle. Leblois, that they are excretory products. His observations, made chiefly on species of Euphorbiaceæ, confirm the former and more prevalent theory. The following are the chief reasons assigned for this conclusion. The composition of the latex, which contains peptons, starch, sugar, fatty substances, tannins, resins, and calcium malophosphate, is that of reserve products which the plant stores up for future use. The wide distribution of the laticifers in the leaf, their close connection with the chlorophyll tissue, and certain physiological experiments, tend to show that the latex is drawn from the leaf, and is thence distributed by the laticifers, as is shown by their relation to the xylem-vessels and the reserve-parenchyme. This view is also supported by the reduction of the parenchyme of the veins of the leaf when the laticiferous apparatus is largely developed.

Formation of Sieve-tubes in the Roots of Dicotyledons.* — From the examination of species belonging to a number of different families, G. Chauveaud concludes that the process is essentially the same in Dicotyledons as in Monocotyledons. Primary sieve-tubes are formed, which are either replaced by others, or, less often, retain their existence alone. The primary sieve-tubes are formed by the septation of a mother-cell, producing the sieve-tube and its sister-cell. When the septum which divides the mother-cell is inclined at an angle of 45° on the diametric plane passing through the axis of the sieve-tube, this latter assumes a characteristic lozenge form (*Ranunculus*, *Lamium*, *Auricula*, &c.). When the septum is tangential, the sieve-tube is pentagonal, and is superposed on its sister-cell in a regular manner (*Raphanistrum*, *Trapa*, &c.). When this septum has a different orientation, the detached sieve-tube assumes no special appearance, and it can be recognised with certainty only when it acquires its maximum differentiation.

Duramen and Healing-Tissue.† — According to A. Will, the substance found universally in the cells of healing-tissue (*Schutzholz*, *Wundholz*), is not a gum, but a bassorin-like subtance formed in a special layer, the bassorinogenous layer, closely applied to the inner cell-membranes, and formed from the protoplasmic cell-contents. A similar substance is also usually, but not invariably, present in the cells of the duramen. The colouring matter of coloured woods is a mixture of various substances, gums, resin, oil, &c. A similar substance is contained in the thyllæ, except in *Guaiacum officinale*, where it is replaced by resin.

New Type of Transition from Stem to Root.‡—Miss Ethel Sargant describes a new type of transition from stem to root in the vascular system of seedlings. distinct from the three laid down by van Tieghem, which occurs in the wild hyacinth and some other Monocotyledons. Its characteristic feature is that two bundles only enter the hypocotyl which passes into a root with tetrarch symmetry from the beginning. The

* Ann. Sci. Nat. (Bot.), xii. (1900) pp. 333–94 (4 pls.). Cf. this Journal, 1898, p. 439.

† Beitr. z. Kenntn. d. Kern- u. Wundholzes, Bern, 1899, 92 pp. and 3 pls. See Bot. Centralbl., lxxxv. (1901) p. 295.

‡ Ann. of Bot., xiv. (1900) pp. 633–8 (1 pl.).

stem-bundles which enter the hypocotyl are thus only half as many as those which form the primary root.

Resin-Ducts and Strengthening-Cells of Abies and Picea.*—Herman B. Dorner has examined the minute structure of the leaf in a number of species of these two genera of Coniferæ dependent on the number and position (or absence) of the resin-ducts, and of the strengthening cells or thick-walled cells usually found in connection with the epiderm or with the ducts.

Injury to Vegetable Cells caused by Cold, Plasmolysis, and Desiccation.†—L. Matruchot and M. Molliard have determined, as the result of experiment, that the fatal injury to vegetable cells caused by cold, plasmolysis, and slow or rapid drying in the open air (*fanaison*), is in all cases due to the same cause, viz. an exosmose from the protoplasm, and especially from the nucleus, reducing the amount of water in the protoplasm below the minimum required for carrying on vital processes.

Structure of the Malaxideæ.‡—Among other points, Prof. K. Goebel notes the following as characterising the genera of this small family of Orchideæ (*Malaxis*, *Microstylis*, *Sturmia*). There is no true velamen, as has been stated by other observers; all the cells of the leaf-bases (with the exception of the vascular bundles) form a water-absorbing tissue, corresponding to the velamen of other Orchideæ. Cells adapted for the storing up of water are also found in the central cylinder of the stem. Rhizoids occur on the outer leaves and on the stem. Certain zones of the stem are regularly occupied by fungus hyphæ, which occur also more sparingly in the leaves and root.

Stem-structure of Actinostemma biglandulosa.§—W. Wallace gives the following as the main points of interest in the anatomy of the stem of this plant, a tendril-bearing liane with an annual stem belonging to the Cucurbitaceæ. The vascular bundles are primarily collateral and remain so for a comparatively long period; it is not until secondary thickening has made considerable progress within the bundles that these begin to acquire medullary phloem. At the base of the older stem are a number of accessory bundles; these have a longitudinal course in the cortex, and proceed from a meristem which has its origin in the endoderm.

(4) Structure of Organs.

Influence of Darkness on the Development of Flowers.‖—From a series of observations on many different flowers, L. Beulaygue states that, as a rule, flowers open later in the dark than in full daylight. The colour is most commonly reduced in intensity, varying between a very slight reduction to complete decolorisation. The flowers are mostly smaller, while, on the other hand, their pedicels are sometimes more developed. The weight and size of the flower, including the pedicel, are smaller in flowers developed in the dark, with very rare exceptions.

* Proc. Indiana Acad. Sci., 1899 (1900) pp. 116–29 (11 figs.).
† Comptes Rendus, cxxxii. (1901) pp. 495–8.
‡ Flora, lxxxviii. (1901) pp. 94–104 (7 figs.).
§ Ann. of Bot., xiv. (1900) pp. 639–45 (1 pl.).
‖ Comptes Rendus, cxxxii. (1901) pp. 720–2.

Colour of Apetalous Flowers.* — J. H. Lovell discusses the prevailing colours of the apetalous flowers of the Northern United States as evidence of their descent. He regards the apetalous Apopetalæ (Saururaceæ and Aizoaceæ) as of primitive character; they either are or were autogamous or anemophilous. The absence of a blue colour in the apetalous flowers is noteworthy. Yellow is not common, but occurs in the scales and calyx of *Betula*. Red is very common. A number of genera have become entomophilous, and this has been accompanied by increased conspicuousness in the flowers. The anthers of *Salix*, formerly anemophilous, have become a brighter yellow. In *Aristolochia* and *Asarum*, the calyx is a lurid purple attractive to small Diptera; in *Polygonum* and several other genera it has become white or red.

Divergences in the Capitule of the Sunflower.†—Prof. S. Schwendener gives a detailed account of a number of divergences from the normal in the arrangement of the flowers in the capitule of the sunflower, from which he draws conclusions favourable to his view previously enunciated that the seat of formation of the primordia of the flowers has not been determined a long while previously, but is regulated step by step under the influence of the nearest older primordia.

Amphicarpous Plants.‡ — C. A. M. Lindman finds the following amphicarpous plants in the flora of Southern Brazil:—(1) *Cardamine chenopodiifolia*. The underground flowers are small, cleistogamous, often with a reduced number of stamens, and evidently self-pollinated. The underground pods are short (silicules rather than siliquæ) and abundantly fertile; it is rare for the open aerial flowers to produce seed. (2) *Trifolium polymorphum*. The underground flowers are small, solitary, and completely cleistogamous; they possess all the parts of the open flowers, but reduced in number and size. The very short pods contain one or two seeds. (3) *Dichondra repens* (Convolvulaceæ). The small subterranean cleistogamous flowers are produced on the same stems as the normal open flowers. (4) *Callitriche deflexa*. A terrestrial species with both aerial and geocarpous fruits.

Fruit-scales of Coniferæ.§ — From the evidence afforded by proliferous cones of the larch, and from the arrangement of the vascular bundles in the scales of Abietineæ, L. J. Celakovsky argues in favour of his previously enunciated "axillary bud" theory, as supported by Worsdell,‖ in opposition to the "placentar" theory of Delpino and others. There are, he says, three kinds of greatly reduced axillary shoots which deviate from the normal radiar type, passing over into the leaf-like bilateral and dorsiventral type, viz.:—(1) Cladodes (*Ruscus*, *Danaë*, *Semele*); (2) Symphyllodes (scales of the cones of the Abietineæ and of most other Coniferæ); (3) Shoot-members (*Sprossglieder*), shoots which are reduced not merely to one leaf, but to a single stem, to which

* Amer. Nat., xxxv. (1901) pp. 197–212.

† S.B. k. Preuss. Akad. Wiss., xlvii. (1900) pp. 1042–60. Cf. this Journal, 1900, p. 481.

‡ Öfv. k. Vetensk.-Akad. Förh., lvii. (1900) pp. 939–55 (4 figs.) (German).

§ Pringsheim's Jahrb. f. wiss. Bot., xxxv. (1900) pp. 407–48 (2 pls.).

‖ Cf. this Journal, 1900, p. 600.

the leaf is terminal. The greatest possible reduction of the female flower occurs only in the Coniferæ (Podocarpeæ, *Araucaria*).

Axillary Buds of the Hornbeam.* — J. Velenovsky points out a peculiarity noted in a specimen of *Carpinus Betulus*, indicating that the stipules may sometimes usurp the function of leaves, and that they may then form buds in their axils which must be regarded as serial transverse buds.

Translucency of Leaves.† — Dr. L. Linsbauer has constructed an apparatus which he calls a *diaphanometer* for registering the proportion of sunlight (especially the more refrangible rays) which passes through the leaves; the computations being founded on the lines proposed by Wiesner.‡ The leaves of the same plant differ in their degree of translucency according as they are exposed to the sun or develop in the shade ("sun-leaves" and "shade-leaves" respectively). The former are as a rule smaller and thicker, often crumpled or rolled back at the margin; while the latter are larger and thinner, and usually flat. Both sun- and shade-leaves differ greatly among one another in their translucency. Among sun-leaves the extent of variation in this respect is 20 : 1; among shade-leaves 7 : 1; but the most translucent sun-leaf allows only one-third of the light to pass as compared with the most translucent shade-leaf. The more typical the structure of a shade-leaf, the greater is its translucency. The average proportion of sunlight which passes through green leaves is 0·05–0·06 (5–6 p.c.); while with colourless leaves or portions of leaves it is as high as 0·32 (32 p.c.).

Morphology of Tropical Leaves.§—C. A. M. Lindman describes the form and structure of a number of plants in Paraguay and Brazil which adapt them to the conditions of the climate and of the habitat. In the genus *Alophia* and some other species of Irideæ, the leaves have a number of longitudinal ridges which protect them from too great insolation, and serve also to retain the rain and dew by capillary attraction. In the deep forests the dwarf trees and shrubs have mostly a slender growth with narrow undivided leaves, of an intense green colour which adapts them to the dim daylight. Two genera, *Bomarea* (Alstrœmeriaceæ) and *Pharus* (Gramineæ) are described with resupinate leaves, due to a torsion of the petiole of 180°. The lianes have mostly cordate acuminate leaves, with glabrous surface, allowing the abundant rain to flow freely from them.

Underground Leaves.‖ — J. Thomas has studied the structure of underground leaves or scales as contrasted with those formed in normal positions exposed to the light and air. They are classified as follows:— Scales corresponding to sheaths; to sheathing petioles; to ordinary petioles; to the lamina of a leaf. As a rule the underground scale has, on transverse section, more or less the form of a crescent or of a triangle; its thickness is, in Monocotyledons, generally greater than that of the

* Oesterr. Bot. Zeitschr., l. (1900) pp. 409–11 (1 fig.).
† Beih. z. Bot. Centralbl., x. (1901) pp. 53–89, 143.
‡ Cf. this Journal, 1899, p. 299.
§ Bih. k. Svensk. Vetensk.-Akad. Handl., xxv. (1899) 63 pp. and 20 figs. See Bot. Centralbl., lxxxv. (1901) p. 41.
‖ Rev. Gén. de Bot. (Bonnier), xii. (1900) pp. 369–93, 417–33 (1 pl. and 10 figs.).

aerial leaf; it is often destitute of stomates; collenchyme has usually more or less completely disappeared, and the palisade-parenchyme entirely; the vascular system is much smaller in amount, and of simpler structure. Reserve-substances are often present in abundance in underground scales. Culture experiments showed that underground scales may become transformed into organs having all the structure of ordinary leaves by placing them under the normal conditions of air and light.

Variegation.* — H. Timpe describes in detail the morphological peculiarities of variegated leaves. The colourless areas are thinner than the coloured; this is usually the result of a diminished production of palisade-parenchyme and a reduction of the intercelluiar spaces; these are closely associated with the disappearance of chlorophyll. When young leaves have a red tinge, or when leaves are permanently red, or turn red in the autumn, the coloration is confined to the areas destitute of chlorophyll, or is strongest in them. The colourless areas usually contain more tannin than the green. Starch is, under ordinary conditions, stored up only in the green mesophyll; while reducing sugar is present in both areas, most abundantly in the colourless.

Phyllodes of Acacia.†—P. Ledoux has studied the structure of the foliar organs in those species of *Acacia* in which the leaves are replaced by broad flat petioles of a deep green colour. The earliest leaves usually have, in these species, a small number of pairs of leaflets, which drop early. The older the plant the more completely are the ordinary leaves replaced by these phyllodes, which are persistent from year to year. From their colour, their flat form, and the abundance of stomates, it is clear that they perform the ordinary function of leaves. They present also special characteristics in a thickened cuticle, abundant sclerenchyme, and a well-developed aquiferous tissue, which adapt them to resist excessive transpiration and to store up a large quantity of water in their tissues.

Tendrils of Lathyrus.‡ — K. Fritsch discusses the value of the presence of tendrils as a character for the subgenera of this genus, and decides against it as of any phylogenetic value. Among allied species there are all intermediate conditions between species with well-developed leaf-tendrils and others where they are entirely wanting. The genus *Orobus* must be entirely suppressed. The author adopts five out of the six sections of the genus proposed by Godron.

Outgrowths of Hibiscus vitifolius.§ — A further examination of these structures leads Miss Elizabeth Dale to the conclusion that they develope only when transpiration is reduced, and that they are formed chiefly on organs which are actively assimilating. They occur only on plants in which there is an accumulation of starch; and their formation is accompanied by the production of oil, which is not found in normal leaves.

Tricotyledony.‖—E. Gain gives a long list of Dicotyledons in which the embryo occasionally has a third cotyledon, and then describes the

* Beitr. z. Kenntn. d. Panachirung, Göttingen, 1900, 124 pp. See Bot. Centralbl., lxxxv. (1901) p. 75.
† Comptes Rendus, cxxxii. (1901) pp. 722–5.
‡ Oesterr. Bot. Zeitschr., l. (1900) pp. 389–96.
§ Proc. Roy. Soc., lxviii. (1901) pp. 16–19. Cf. this Journal, 1900, p. 348.
‖ Rev. Gén. de Bot. (Bonnier), xii. (1900) pp. 369–93 (1 pl. and 18 figs.).

anatomical structure of the tricotyledonous embryo in a variety of *Phaseolus vulgaris* in which it is very frequent.

Tricotyledony is hereditary in various degrees, but there is always a tendency to reversion to the normal condition. The ternary arrangement characterises the whole anatomical structure in tricotyledonous seedlings; but there are intermediate forms between the binary and ternary arrangements. The third cotyledon of tricotyledonary seedlings may be inserted on the dorsal or on the ventral face of the hypocotyl, or it may be placed unsymmetrically. Its insertion may be a little above the zone of insertion of the two normal cotyledons, or the three may constitute a true whorl; the position of the supplementary cotyledon determining the anatomical structure. The special anatomical characters of tricotyledonous seedlings are exhibited in the root, the hypocotyl, the epicotyl, and the first whorl of leaves.

Perfect tricotyledony was not observed in *Phaseolus*. Even when the external form was completely symmetrical, the three regions of the ternary structure were not identical. The anomalous number of cotyledons has a tendency to produce other anomalies also in the young plant.

The observations of the author tend to confirm the importance of the number of cotyledons as a starting-point in classification.

Root-Tubercles of the Leguminosæ.* — L. Hiltner discusses at length the causes which determine the size, number, position, and action of the root-tubercles of the Leguminosæ, with special reference to the culture experiments carried out at Tharandt. The roots of Leguminosæ exude certain substances which have an attractive power over bacteria; while, on the other hand, the tubercle-bacteria form "attacking substances" (*Angriffsstoffe*) on the roots of the Leguminosæ, causing the cell-walls of the root-hairs to swell up without becoming completely disorganised. The author draws from the results of these experiments the conclusion that the tubercle-bacteria of various species of Leguminosæ, while differing from one another in their physiological properties, are, for the most part, morphologically identical. The bacteria of *Pisum* and *Robinia* cannot, however, be made to replace one another.

With regard to the infection of individuals already furnished with tubercles, the author lays down the general law that active tubercles endow the plant with immunity against bacteria of the same or of an inferior degree of virulence as compared to those already present in the tubercles; only bacteria of a higher virulence can enter the tubercles. The statement often made that the tubercles are always formed as near to the surface as possible is erroneous.

Root-Tubercles of Medicago sativa.†—According to observations of N. Passerini the roots of the lucerne have abundant root-tubercles during the first year of cultivation; very few during the second, and none at all in the third. He infers that the plant makes use of the atmospheric nitrogen obtained through the tubercle bacteria only during its first year, until the roots have attained sufficient length to obtain the necessary nitrogenous food-materials from the deeper soil.

* Arb. Biol. Abth. k. Gesundheitsamte, Heft 2 (1 pl.). See Bot. Centralbl., lxxxv. (1901) p. 179.

† Bull. Soc. Bot. Ital., 1900, pp. 16–7.

Tuberculisation of the Potato.*—N. Bernard applies his law that the formation of tubercles on roots or underground stolons is the result of the attacks of an endophytic fungus to the case of the potato. The cause here is the well-known fungus *Fusarium Solani*, so frequently found as a saprophyte in decaying tubers. It does not, however, attack the parenchyme of healthy tubers, but infests only the external suberous layers of dead cells filled with air, in which the author always finds the mycele and spores of this fungus. Experiments on the production of tubers by sterilised and non-sterilised potato-plants confirmed this conclusion; and it obtains further support from the fact, that when the potato was first intoduced into Europe, potato-plants grown from seed frequently failed to produce tubers.

Anatomy of Phœnix dactylifera and Chamærops humilis.†—G. B. Petrucci describes in great detail the anatomical structure of these two palms, and argues against the prevalent opinion that they hybridise with one another. The alleged *Microphœnix decipiens*, which has been described as a hybrid between them, he regards simply as a variety of *Chamærops humilis*, a species which is very polymorphic, especially in its fruit.

β. Physiology.

(1) Reproduction and Embryology.

Polyembryony.‡—A. Ernst thus classifies the modes in which more than one embryo may be produced in Angiosperms.

A. Pseudo-polyembryony:—

1. Coalescence of ovules (*Pyrus Malus, Loranthus europæus, Viscum album*).
2. Division of the nucellus (*Morus albus, Orchis Morio, Gymnadenia conopsea, Coffea arabica* (?)).
3. Development of several embryo-sacs in one nucellus (*Cheiranthus Cheiri, Rosa livida, Trifolium pratense, Taraxacum officinale*).

B. True Polyembryony:—

a. Embryos "extra-saccal," arising outside the cells of the embryo-sac.

1. Development of adventitious embryos from nucellar cells (*Funkia ovata, Nothoscordon fragrans, Citrus aurantia, Mangifera indica, Euonymus latifolius, E. americanus, Cœlebogyne ilicifolia, Clusia alba, Opuntia vulgaris*).
2. Development of adventitious embryos from cells of the inner integument (*Allium odorum*).

b. Embryos "intra-saccal," formed from elements of the embryo-sac.

1. Normal existence of two oospheres (*Santalum album, Sinninghia Lindleyana*).
2. Synergid-embryos (*Glaucium luteum, Mimosa Denhartii, Schrankia uncinata, Lilium Martagon, Iris sibirica, Vincetoxicum nigrum, V. medium, Allium odorum, Taraxacum officinale, Aconitum Napellus*).

* Comptes Rendus, cxxxii. (1901) pp. 355–7. Cf. this Journal, *ante*, p. 55.
† Malpighia, xiv. (1900) pp. 306–60 (4 pls.). ‡ Flora, lxxxviii. (1901) pp. 62–70.

Formation of Tetrads.* — Starting from the assumption that the embryo-sac of Phanerogams is homologous to the megaspore of Pteridophyta, H. O. Juel concludes that it must be the product of a tetrad-division, similar to that which gives rise to the spores. This view was confirmed by a series of observations on the development of the embryo-sac mother-cell in *Larix sibirica*. This cell divides, by two successive divisions, into four daughter-cells, of which the largest and basal is the embryo-sac. In the first of these divisions the number of chromosomes is only half as large as those in the nuclei of the nucellus, and the same reduced number is found also in the second division. The first division of the nucleus in the embryo-sac mother-cell is heterotypic, corresponding to the first division of the nucleus in the pollen-mother-cell; the second division is homootypic. The first division of the nucleus in the embryo-sac is typical, agreeing with the divisions of the vegetative nuclei except in the number of chromosomes. It is also distinguished from the two previous divisions in its not being accompanied by cell-division. The conclusion drawn is that the mother-cell of the embryo-sac of *Larix* is homologous to the mother-cell of a spore or pollen-grain, and that the two cell-divisions, by which the embryo-sac and its three sister-cells are produced, are actual tetrad-divisions.

The formation of the pollen was followed out in hybrids, especially in one between *Syringa vulgaris* and *S. persica*; and it was found that the almost perfect sterility in the case of this hybrid was due to a great variety of abnormalities in the tetrad-formation—abortion of the pollen-mother-cells before the period of tetrad-division; irregularities in the tetrad-division itself; or an abnormal number of tetrads or of nuclei in the tetrad-cells.

The Asclepiadeæ and Cyperaceæ differ from the remaining natural orders in the pollen-mother-cells producing each only one pollen-grain. The process was studied in the case of *Carex acuta*, and it was found that the pollen-grain of the Cyperaceæ is a very peculiar structure. The membrane in which it is enclosed is that of the pollen-mother-cell, which has become thickened; the pollen-grain enclosing from an early period an entire tetrad. But in the tetrad it is only a single daughter-cell which developes into a pollen-grain, and this development is in itself perfectly normal. The essential difference from other Angiosperms lies in the fact that in each tetrad the remaining three daughter-cells undergo no further development.

Development of the Archegone and Impregnation in Tsuga canadensis.† — W. A. Murrill records the following observations on the hemlock-spruce. The archegones originate as single superficial cells, in each of which occurs the usual division, cutting off an outer smaller cell that forms the neck; at maturity the neck usually consists of two cells, though the number varies. In the division of the central cell the spindle fibres arise from a large dense fibrous mass beneath the nucleus, and grow into the nuclear cavity, where they are joined by fibres from the very small upper pole. As the oosphere nucleus increases in size, and moves to the centre of the oosphere (egg), the vacuole travels upward towards the apex. Just beneath the ventral canal-cell there

* Pringsheim's Jahrb. f. wiss. Bot., xxxv. (1900) pp. 626–59 (2 pls.).
† Ann. of Bot., xiv. (1900) pp. 583–607 (2 pls.).

may always be found another smaller vacuole, and these vacuoles constitute the receptive spot of the oosphere.

The contents of the pollen-tube which enter the oosphere consist of the vegetative nucleus with some cytoplasm and starch-grains, the stalk-nucleus surrounded by its own scanty vacuolated cytoplasm, and the two unequal sperm-nuclei. The larger sperm-nucleus slips from the cell and conjugates with the oosphere nucleus; the smaller one becomes gradually absorbed. The functional sperm-nucleus and the oosphere-nucleus retain their distinct membranes for a long time after coming into contact; the chromatin of each nucleus collects in the form of a thick knotted thread near the centre of the separating partition, and the two masses remain distinct until the spirem-bands begin to segment. The separating membranes disappear just before the spirems are formed, and the nuclear cavities become united. The spindle then arises in a multipolar fashion, twelve chromosomes being supplied from the chromatin of the sperm, and twelve from that of the oosphere. A second division soon succeeds the first, and the four resulting free nuclei rapidly attain full size, and move to the base of the archegone, where the young embryo becomes established.

Embryo-sac and Embryo of Tulipa.*—A. Ernst has followed out the development of the embryo-sac and ovary in *Tulipa Gesneriana*. The first division of the nucleus of the embryo-sac takes place immediately before the opening of the flower, and, as in other Liliaceæ, a reduction then takes place of the number of chromosomes from twenty-four to twelve, the number in the ordinary vegetative cells being twenty-four. The phenomena attending the development of the embryo-sac do not differ in important points from those in other Liliaceæ. There are, however, frequently, at the time of impregnation, ovules in which the divisions of the embryo-sac nucleus are entirely or partially suppressed. A coalescence also frequently takes place of the vacuoles between the uppermost and the three other nuclei. The antipodals disappear either before or immediately after impregnation, their function of supplying food-material to the embryo being taken up by a string of cells at the antipodal end of the embryo-sac.

An interval of as much as 8–10 days intervenes between pollination and impregnation. The double impregnation of the oosphere and of the embryo-sac nucleus was observed in this species as in other Liliaceæ, and in the genus *Tulipa* itself by Guignard.† The phenomenon of polyembryony is not unfrequent, in consequence of the rudiment of the embryo dividing into a number of rudiments by transverse walls. A similar phenomenon occurs in some Cupressineæ and Abietineæ and in *Erythronium*.‡

Crossing of Varieties.§—K. Sajó discusses the results of a crossing of varieties, chiefly in the cases of the vine and the apple. It is not the seeds only, but the pericarp, &c. (including the flesh of the apple) that is affected by such crossing. It would appear that the pollen of the grape-vine never travels a greater distance than 6–7 m. In apple and pear

* Flora, lxxxviii. (1901) pp. 37–62 (5 pls.).

† Cf. this Journal, 1900, p. 481. ‡ Cf. this Journal, 1896, p. 207.

§ Prometheus, xi. pp. 209–12, 225–31, 241–51 (9 figs.). See Bot. Centralbl., lxxxv. (1901) p. 211.

orchards the wind plays but a very small part in the dissemination of the pollen. The pollinating insects, however—bees, humble-bees, and flies—as a rule visit a large number of flowers in succession on the same tree, and, therefore, do not bring about true cross-pollination. In the case of apples and pears, only a small proportion of the flowers (5–6 p. c. and about 13 p. c. respectively) are habitually fertilised.

Ornithophilous Flowers.*—In addition to species already recorded, Herr F. Johow describes three from the flora of Chile, viz. *Phrygilanthus tetrandrus* and *P. aphyllus*, both parasitic plants belonging to the Loranthaceæ, and *Lobelia salicifolia*. This last species is fertilised by humming-birds attracted by the minute insects which visit the flowers; the first by humming-birds in search of the small quantity of water at the base of the perianth-tube. In both these cases self-pollination is rendered difficult by the structure of the flower.

Gynodiœcism of Myosotis palustris.†—According to K. Fritsch, the small-flowered variety of this plant, which has been described under several names, is in reality a female form. It is distinguished not only by its smaller flowers, but also by the absence of pollen in the anthers, which do not assume the oblique position which they occupy in the perfect flowers, but are always in close contact with the corolla tube. It frequently differs also in its hairiness. A corresponding structure has not been observed in other species of *Myosotis*, but a similar gynodiœcism occurs in *Anchusa officinalis* and *Echium vulgare*.

Proterogyny of Lychnis flos-cuculi.‡—A. J. M. Garjeanne records the interesting fact that in a number of plants of this species, which blossomed for a second time in the autumn, a large number of the flowers were homogamous, while two were distinctly proterogynous, in contrast to the normal proterandrous arrangement. In these flowers the stigma was in a receptive condition, and the pollen-grains were fully developed.

Impregnation in Angiosperms.§—We have from Miss Ethel Sargant a valuable epitome of the important results of recent investigations on this subject, especially in reference to the occurrence of double impregnation, which has now been established in twenty species, representing five natural orders, Liliaceæ, Orchideæ, Ranunculaceæ, Compositæ, and Monotropeæ; the movement of the generative nucleus; the homology of the embryo-sac and its contents; and the nature of the triple nuclear fusion. The bibliography enumerates forty-five different papers on these subjects.

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

Influence of Pressure on Chlorophyll Assimilation.‖ — J. Friedel states more accurately, in the following words, the law at which he has arrived respecting the variations in chlorophyll assimilation caused by changes in the pressure of the atmosphere. Decrease alone of the total

* Verhandl. deutsch. wissensch. Ver. Santiago, v. pp. 1–22 (2 pls.). See Bot. Centralbl., lxxxv. (1901) p. 210. Cf. this Journal, *ante*, p. 58.

† Ber. Deutsch. Bot. Ges., xviii. (1901) pp. 472–80.

‡ Beih. z. Bot. Centralbl., x. (1901) p. 51.

§ Ann. of Bot., xiv. (1900) pp. 689–712.

‖ Comptes Rendus, cxxxii. (1901) pp. 353–5. Cf. this Journal, 1900, p. 693.

pressure promotes assimilation. The isolated action of the pressure of CO_2, and the isolated action of the total pressure, are both modified in a different way by the amount of CO_2 contained in the atmosphere. But these modifications are of such a nature that the resultant phenomenon follows the same law within broad limits. When air containing CO_2 is simply rarefied, the assimilation passes first through a minimum and then through a maximum.

Grafting of the Vine.*—According to A. Tompa, when *Vitis vinifera* is grafted on *V. riparia*, not only the cambium, but also the xylem, phloem, and pith unite by new formation of healing tissue, or less often locally by direct fusion without any new formation. The healing tissue or callus springs only to a small extent from the cambium; an essential part in the formation of the healing tissue is taken by the phloem-parenchyme (the medullary rays take part to a less extent); while the primary cortical parenchyme and the pith do not again form meristem, or only partially. The fusion culminates in the formation of tracheæ and sieve-tubes. The bast-fibre-bundles of the primary cortex and the epiderm are incapable of uniting.

Ripening of Shoots of the Vine.†—M. L. Kövessi points out that a good crop of grapes, as of any other fruit, depends on favourable meteorological conditions, as to temperature and heat, of two successive summers. In order to produce and ripen an abundant crop of fruit, the branch must have been subjected to good conditions for ripening (*aoûtement*) during the previous summer. This ripening consists of a due thickening of the cell-walls and an abundant supply of starch in the cells. An ill-ripened branch is one whose growth has been arrested at an early stage in the differentiation of its tissues. As a rule (in the vine) the first and last buds on a branch (i.e. those nearest to the base and to the apex) are not fertile; it is only the intermediate ones that develope into fertile branches during the following summer.

Vitality of Seeds.‡—Dr. A. D. Waller has carried out an extensive series of experiments for the purpose of determining whether "blaze-currents" may be used as a sign and measure of the vitality of seeds. By a "blaze-current," Dr. Waller denotes "the galvanometrical token of an explosive change locally excited in living matter." He found the physiological effect of the blaze-reaction on germinating beans proved by (1) the influence of raised temperature; (2) its general parallelism with germination tests; (3) the influence of lowered temperature; (4) the influence of anæsthetics; (5) the influence of strong electrical currents; (6) the absence of blaze and the failure of germination in water-logged seeds. There was found to be a general, but not absolute, correspondence as regards magnitude, between the blaze-reaction and the germinative activity.

Sensitiveness of Plants to Mineral Substances.—In opposition to the statement of M. Boehm, P. P. Dehérain and M. Demoussy § find

* Ann. Inst. centr. Ampélologique, i. (1900) Budapest, No. 1 (6 pls. and numerous figs.). See Bot. Ztg., lix. (1901) 2te Abt., p. 26.

† Comptes Rendus, cxxxii. (1901) pp. 647–50, 923–6.

‡ Proc. Roy. Soc., lxviii. (1901) pp. 79–92 (3 figs.).

§ Comptes Rendus, cxxxii. (1901) pp. 523–7.

that seeds will germinate in distilled water which contains no trace of lime. But the growth of the root will be arrested if the water contains the merest trace of copper, such as might be derived from distilling in a copper retort. Growing plants are, in fact, infinitely more sensitive reagents for the presence of metallic salts in the water than the most delicate chemical tests. This has been found to be the case with the white and yellow lupin, the castor-oil plant, wheat, and *Spirogyra*.

H. Coupin * has obtained similar results with the higher, as well as with the lower plants, showing, in all cases, excessive sensitiveness to the presence especially of salts of silver, mercury, copper, and cadmium. With sulphate of copper the limit of sensitiveness is stated to be 1 in 700,000,000, while with calcium chloride it is only 1 in 260.

H. Devaux † confirms these results, and states that both Phanerogams and Cryptogams are poisoned by solutions of salts of lead or copper diluted to the extent of one in ten millions, or even less. The metal is fixed by all parts of the cell, the cell-wall, the protoplasm, and the nucleus; the relative degree in which these different parts are affected differs in different plants. He finds the sensitiveness manifested in a solution diluted to 1 mgr. per hectolitre.

(3) Irritability.

Sensitiveness of the Nodes of Grasses.‡ — Dr. L. Montemartini finds in the nodes of grasses, which are very sensitive to the action of geotropism, a structure closely resembling that of the pulvinus of the leaves of the sensitive plant. The swollen portion of the node—i.e. of the base of the leaf-sheath—consists of cells which are round in transverse, rectangular in longitudinal section, connected with one another by a number of protoplasmic threads. They display the same behaviour to anæsthetics as the foliar organs in *Mimosa*.

Geotropism of the Roots of the Vine.§—According to J. M. Guillon, different varieties of the grape-vine differ materially in the degree in which their roots exhibit positive geotropism, i.e. in the angle which their descending roots make with the vertical (angle of geotropism). The smaller this angle the better can the plant make use of the water of the soil, and the more likely is it to flourish.

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

Respiration of Plants.‖—K. Puriewitsch calls attention to the prevalent error that the proportion $\frac{CO_2}{O_2}$, as an expression of the production of carbon dioxide in the respiration of plants, is always near to unity. The variations in the value of this fraction in germinating seeds have already been pointed out, being higher in starchy and lower in oily seeds. The author's present observations were made on the mycele of *Aspergillus niger*, and a large number of results are tabulated, which

* Tom. cit., pp. 645–7. † Tom. cit., pp. 717–9.
‡ Malpighia, xiv. (1900) pp. 271–4 (1 fig.).
§ Comptes Rendus, cxxxii. (1901) pp. 589–91.
‖ Pringsheim's Jahrb. f. wiss. Bot., xxxv. (1900) pp. 573–610 (1 fig.).

determine that the relation of carbon dioxide given off to that of oxygen absorbed depends largely not only on the quality, but also on the quantity, of the nutrient medium.

Sensitiveness of Ferments and Protoplasm to Physical and Chemical Agencies.*—Th. Bokorny discusses the sensitiveness of unorganised ferments towards light and temperature, salts of alkalis and metals, acids, alkalis, and some organic compounds. The enzymes noticed are diastase, invertase, maltase, pepsin, trypsin, papain, rennet, emulsin, myrosin, zymase. Considerable resemblance is shown by protoplasm to the influence of reagents which have a deleterious action on enzymes, though the latter frequently bear up against a greater percentage quantity.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Spermatozoids of Ferns.†—Dr. A. H. R. Buller has studied the following points in the physiology of the spermatozoids of ferns, the species experimented on being exclusively *Gymnogramme Martensii*:—Chemotaxis; the withdrawal of water from the spermatozoids; the length of the swarming period; and the history of the starch in the vesicle.

The chief chemotactic agents on the spermatozoids of ferns are malic acid and its salts, chiefly one of the latter; but many other organic and inorganic salts present in the cell-sap may exercise a positive chemotactic stimulus upon them. Sugars, alcohols, asparagin, and urea have no attractive influence. The attracting neutral salts do not give an unmistakable tonotactic repulsion at high concentrations; if such a repulsion occurs, it does not prevent the spermatozoids from finally entering concentrated solutions where they are brought to rest by loss of water. The repulsion exercised by malic and maleic acids is chemotactic. The withdrawal of a certain quantity of water from the spermatozoids brings them to rest; recovery takes place on resorption of the water. The protoplasm of the spermatozoids is penetrated very slowly or not at all by sugar and neutral salts, rapidly by glycerin, and very rapidly by alcohol. In the case of *Gymnogramme Martensii* the swarming period lasts for about two hours; in other cases it is shorter. The starch in the vesicle of the spermatozoid disappears during the swarming period.

Schizæa pusilla.‡—Mrs. Elizabeth G. Britton and Alexandrina Taylor give an account of the life-history of this little known fern. The following are the more important points. The spores are small, nearly reniform, and have a cuticularised exospore which is alveolate. It remains attached for some time after the formation of the antherids.

The gametophyte is a filamentous protoneme, irregularly branched, bearing both antherids and archegones on the same filaments. The antherids occur singly or in groups on special branches which do not bear archegones; they are produced in great numbers, though but few

* Chem. Ztg., December 1900. See Bot. Centralbl., lxxxv. (1901) pp. 293–5.
† Ann. of Bot., xiv. (1900) pp. 543–82.
‡ Bull. Torrey Bot. Club, xxviii. (1901) pp. 1–19 (6 pls.).

ripen; they are simple in their structure, and produce a small number of antherozoids, which are enclosed in a membrane when they escape from the antherid. The archegones arise at or near the base of the filaments, either directly on the filament, or, more often, on cushions formed by the division of the cells of the filament. They are characterised by the uniformity of the neck-rows and the large size of the stigmatic cells. The foot is a large well-defined organ, remaining attached to the protoneme for some time after the formation of the third leaf.

The primary root is persistent. The root-cap consists of four large pear-shaped cells. The rhizome is erect, always forming a protective covering over the growing end. The trichomes are large and persistent. There is a central concentric bundle with a well-marked endoderm. Sclerosis takes place in the entire cortex, the cells of which, with the epiderm, are filled with starch. The sterile and fertile leaves have two rows of large stomates, alternating with two or more rows of glands. The leaf-bundles appear collateral, with a well-marked endoderm. The mesophyll tissue is composed of thin-walled cells branched in a stellate manner.

The cells of both protoneme and rhizome are infested by the hyphæ of a fungus which appears to be symbiotic rather than parasitic.

Muscineæ.

Classification of Mosses.*—The only portion completed of an exhaustive work on Mosses by the late Dr. K. Müller is now published under the editorship of Dr. Schliephacke. It comprises the classes Schistocarpi, Cleistocarpi, and Stegocarpi, excluding the Orthotrichaceæ and Pleurocarpi. The classification is founded on that of Müller's Synopsis (1849); the characters of the classes and genera are given in great detail. The Sphagnaceæ are treated as a co-ordinate family belonging to the Acrocarpæ, between the Leucobryaceæ and the Funariaceæ. As many as fifty species are included in the cosmopolitan type *Bryum argenteum*. Müller estimated the number of species of Musci at about 12,000.

Characeæ.

Pseudo-Hermaphroditism in Nitella.†—A. Ernst describes some abnormalities in *Nitella syncarpa*, the most interesting being a pseudo-hermaphroditism resulting from the formation of spermatogenous filaments within the oogone.

Algæ.

Galls on Seaweeds.‡—Miss Ethel S. Barton describes galls found on two British species of seaweed, *Furcellaria fastigiata* and *Chondrus crispus*, produced by a nematode worm, probably an undescribed species not belonging to *Tylenchus*. The cells of the gall contain a granular substance apparently identical with the Floridean starch of van Tieghem.

* Genera Muscorum Frondosorum, etc., Leipzig, 1901, 474 pp. See Bot. Ztg., lix. (1901) 2te Abt., p. 52.

† Flora, lxxxviii. (1901) pp. 1–36 (3 pls.).

‡ Journ. of Bot., xxxix. (1901) pp. 49–51 (1 pl.).

Fucosan.*—B. Hansteen gives further arguments that the substance found in brown sea-weeds, and named by him fucosan, is a carbohydrate, the first product of assimilation, and not, as alleged by Crato,† an independent organism of the nature of a physode. He asserts that it is readily soluble in fresh water. In *Ectocarpus siliculosus* he has observed that the fucosan granules are formed within the phæoplasts, from which they escape, attach themselves to their surface, and then pass into the cell-cavity. Schmitz's "phæophyceæ-starch" is simply a young condition of fucosan. When light is excluded no fucosan is formed (in *Sphacelaria cirrhosa*). The fucosan granules have no amœboid motion, as stated by Crato; their changes in form are simply due to their semi-fluid consistency.

Chambers and Pores in the Cell-wall of Diatoms.‡ — O. Müller recurs to this subject, replying to the objections of F. Schütt § to some of his previous conclusions, and to his claim of priority in others. With regard to the size of the pores, he regards the minimum diameter as certainly higher than $0 \cdot 1\ \mu$, the maximum diameter as probably about $0 \cdot 4$–$0 \cdot 5\ \mu$; structures whose diameter exceeds $0 \cdot 6\ \mu$ are probably not pores but poroids. The occurrence of true pores in the cell-wall of diatoms is thus considerably limited. It is essentially connected with the centrifugal thickening of the cell-wall by extra-cellular protoplasm.

Gelatinous Membrane of Diatoms.‖ — In two plankton diatoms, *Asterionella gracillima* and *Tabellaria fenestrata* var. *asterionelloides*, M. Voigt finds a gelatinous membrane stretched between the frustules of a colony, which obviously assists the floating capacity of the diatoms. In addition to the membrane, a number of very fine threads, consisting mainly of distinct or closely-packed granules, and often anastomosing, connect the rays with one another. These threads take up carbolfuchsin very strongly, while the membrane itself is but slightly stained. The threads are of protoplasmic composition, and the membrane is apparently excreted from them.

The author compares the gelatinous membrane with that of the Foraminifera, Radiolaria, and Heliozoa.

Colourless Diatoms.¶ —W. Benecke has investigated the structure and development of two colourless diatoms which are abundant in Kiel harbour, *Nitzschia leucosigma* and *N. putrida* (= *Synedra putrida* Cohn). With the exception of the complete absence of diatomin, their contents present no peculiarity; nor is there anything peculiar in their motility or other vital phenomena. Both are small extremely motile forms; no formation of auxospores could be detected. There appear to be no transitional forms between the brown and the colourless. The latter occur especially in places where there is abundance of decaying organic matter, and their mode of life is obviously saprophytic.

* Pringsheim's Jahrb. f. wiss. Bot., xxxv. (1900) pp. 611–25 (1 pl.). Cf. this Journal, 1893, p. 218.
† Cf. this Journal, 1893, p. 763.
‡ Ber. Deutsch. Bot. Ges., xviii. (1901) pp. 480–97 (1 fig.). Cf. this Journal, 1900, p. 360.
§ Cf. this Journal, 1900, p. 613.
‖ Biol. Centralbl., xxi. (1901) pp. 36–9 (1 fig.).
¶ Pringsheim's Jahrb. f. wiss. Bot., xxxv. (1900) pp. 535–72 (1 pl.).

Arctic Diatoms.*—H. H. Gran has examined the diatoms collected in the Norwegian North-Polar Expedition of 1893–1896, and classifies them in three groups:—the plankton-diatoms; those found on the ice-floes; and the fresh-water forms. Neither the individuals nor the species are so numerous as might have been expected; the greater number of the forms found were pelagic. None were found in the intestines of Crustacea (*Calanus*, &c.), which occurred in enormous quantities. It is evident that a number of species live actually on the ice, protected by their gelatinous envelopes. A few new species are described, including one belonging to the genus *Xanthiopyxis*, hitherto known only in the fossil state.

Gongrosira.†—W. Schmidle gives a synopsis of the known species of this genus, which he declines to consider, with Hansgirg, as a stage in the cycle of development of *Trentepohlia*, from its containing a pyrenoid, and other characteristics. Ten species are described, but some of these will probably be suppressed when their life-history is more fully known. They are arranged in three subgenera:—(1) Eugongrosira; sporanges terminal, large, swollen, with many megazoospores; (2) *Ctenocladus* (gen. Bzì.); sporanges terminal, scarcely distinguishable from the vegetative cells, swollen or not, containing only a few zoospores indistinguishable from those of the vegetative cells; (3) Mesosporangium; sporanges large, produced only in the middle of a filament. The presence of both mega- and microzoospores is not sufficient to entitle Borzì's genus *Ctenocladus* to an independent existence.

Coccomyxa g. n.‡—Forming a gelatinous mass on moss near Heidelberg, W. Schmidle finds an alga, apparently identical with Wests' *Dactylococcus dispar*, which he makes the type of a new genus *Coccomyxa*, with the following diagnosis:—Cells distributed singly, or in twos or fours in a gelatinous layer, longer than broad, with unequally curved sides, rounded or narrowed at the ends, with a parietal chlorophyll-green chromatophore, finely granular protoplasm, and a nucleus; no pyrenoid; cell-division of the mother-cells oblique, running upwards, usually simultaneously in two intercrossing directions. The genus probably includes some species hitherto referred to *Dactylococcus*, and appears to connect *Raphidium* with *Dactylothece*.

Winter-Plankton of Larger and Smaller Lakes.§ — O. Zacharias draws a contrast between the winter-plankton of larger and smaller lakes. In the former the winter is very poor compared to the summer plankton, both in quantity and in the number of forms; it consists mainly of Copepoda and a few Radiolaria, together with some diatoms, such as *Melosira*. In smaller lakes, however, the case is very different, and the winter-plankton is comparatively rich and varied. Since the light-conditions are the same in smaller as in larger basins, the author attributes this difference to the mode of nutrition of the floating flora being quite different in larger and in smaller lakes. He believes that many chromophilous algæ, including diatoms, have the power of nourish-

* Scient. Rep. Norwegian North Pole Exped., 1893–6, No. xi. (1900) (3 pls. and chart). See Bot. Centralbl., lxxxv. (1901) p. 194.
† Ber. Deutsch. Bot. Ges., xix. (1901) pp. 10–6. ‡ Tom. cit., pp. 20–4 (1 pl.).
§ Plöner Forschungsber., Th. vii. See Bot. Centralbl., lxxxv. (1901) p. 33.

ing themselves saprophytically when occasion requires. This kind of nutriment is presented in much larger quantities on the surface of smaller than of larger lakes.

Primitive Algæ and Flagellata.*—Dr. F. F. Blackman gives a useful *résumé* of the work done with the lower Algæ (including Chlamydomonadeæ and Phacoteæ) since Wille's account of the green Algæ in Engler and Prantl's *Pflanzenfamilien* (1890). Wille's classification is taken as the starting-point, with the additions and alterations rendered needful by recent observations and discoveries. A full bibliography is appended.

Fungi.

Enzymes of Fungi.†—P. Kohnstamm has made a study of the enzymes which attack starch, glucosides, proteids, and cellulose, in those fungi which destroy wood, especially *Agaricus melleus*, *Merulius lacrymans*, and *Polyporus squamosus*. The mode of treatment is described in detail, and the following is an epitome of the most important results obtained.

From all the three fungi named, a starch-destroying enzyme (amylase) was obtained, apparently identical with the diastatic enzyme of malt; it was found in the largest quantity in *Polyporus squamosus*. A glucoside-decomposing ferment (emulsin) was found in *M. lacrymans* and *P. squamosus*, but not in *A. melleus*. A proteolytic enzyme was displayed only feebly by *A. melleus*, more strongly by *M. lacrymans* and *P. squamosus*. A cellulose-decomposing enzyme (cytase, cellulase) was found with certainty only in *Merulius*. It was established that these various ferments may act simultaneously.

In *Polyporus squamosus* it would appear that the fermenting sap is produced only by the receptacle; in *Merulius lacrymans* the mycele has also this property. The action of emulsin is especially seen in the destruction of the coniferin in Conifers, and in the action of *P. squamosus* on the æsculin of the horse-chestnut. It is the hadromal of Czapek‡ that possesses the property of setting free the cellulose, and thus exposing it to the action of a cellulase.

Amylomyces.§—A. Sitnikoff and W. Rommel give the results of a series of culture experiments on different media of the various fermenting forms of *Mucor* included under the term *Amylomyces*, especially those known as *Amylomyces Rouxii*, *β Amylomyces*, and *γ Amylomyces*. Especial attention was given to the fermenting properties of these different forms.

Propagation of Nectria ditissima.‖ — The analogy of the canker of apple-trees caused by this fungus with human cancer has induced M. Descours-Desacre to carry out further investigations as to the mode of propagation of the fungus. The appearance of the disease is, as a rule, preceded by that of *Aphis Lachnus-Erisconia* on the branches and

* Ann. of Bot., xiv. (1900) pp. 647–88; xv. (1901) p. 192 (2 figs.).

† Beih. z. Bot. Centralbl., x. (1901) pp. 90–121. Cf. this Journal, 1896, p. 656.

‡ Cf. this Journal, 1899, p. 515.

§ Zeitschr. f. Spiritus-Industrie, xxiii. (1 pl. and 2 figs.). See Bot. Centralbl., lxxxv. (1901) p. 164. Cf. this Journal, *ante*, p. 68.

‖ Comptes Rendus, cxxxii. (1901) pp. 438–9. Cf. this Journal, 1899, p. 631.

roots; but the appearance of the aphis is followed by the disease only when there are apple-trees attacked by canker in the immediate vicinity; then it appears to be invariable. The *Aphis* appears to be the active agent in the propagation of the mycele and of the spores of the *Nectria*. The best remedies were found to be nicotine and tannin.

Saccharomyces anomalus (?) *—Miss K. E. Golden found on the skin of a lemon a *Saccharomyces* which developes the same kind of spore as *S. anomalus* Hansen. The cells are round or oval, occur singly or in pairs, and measure $2 \cdot 4\ \mu$ in breadth and from $3 \cdot 3$ to $6 \cdot 6\ \mu$ in length. Cultivations were made on wort-gelatin and in Pasteur solution with 5 p.c. sucrose, lactose, and dextrose. Spores formed most readily on wort-gelatin plate cultures. The spores were like those of *S. anomalus* Hansen, being hemispherical in shape with a projecting rim around the flattened surface. From the wort cultures an agreeable ethereal odour was exhaled. The authoress inclines to the opinion that the two yeasts are similar if not identical.

Proteolytic Enzyme of Yeast.†—Miss K. E. Golden records the occurrence of a proteolytic enzyme of yeast. A gelatin-wort culture was found liquefied, and after examination, the presence of a "wild" yeast was detected. It took 30–40 days to liquefy 6 ccm. wort-gelatin. Experiments showed that the enzyme was actively proteolytic, but that it was tryptic in nature, from the fact that it worked well in the presence of neutral and alkaline salts. The authoress identified the yeast with *Saccharomyces liquefaciens* Sacc.

Sensitiveness of certain Yeast Enzymes to Protoplasm Poisons.‡—Th. Bokorny tested the sensitiveness of zymase, invertase, and maltase towards formaldehyd, sublimate, silver nitrate, and phenylhydrazin, and found that the protoplasm of the cells was much more sensitive to the reagents used than the enzymes.

Pathogenic Yeast in Milk.§—Dr. E. Klein describes a yeast which was isolated from milk by means of subcutaneous injection into guinea-pigs. The injections produced a swelling in which were found yeast-cells. Most of these cells were spherical, but some were oval or pear-shaped. The process of germination was distinctly observable. The organism grew well on the usual media, but only feebly in ordinary alkaline bouillon. It did not produce gas, or ferment beer-wort gelatin. On solid media the growth is of a peculiar viscid mucoid character, due to the presence of a gelatinous interstitial substance. Positive results were obtained with guinea-pigs, mice, and rabbits, all cultures proving pathogenic when injected subcutaneously or intraperitoneally. Though this organism belongs to the group of pathogenic Blastomycetes found in cancer, its cultural characters and its pathogenic action on guinea-pigs and rabbits are distinctly different.

Appearance and Disappearance of Glycogen in the Yeast-cell. ‖—R. Meissner has investigated the part played by glycogen in the yeast-

* Proc. Indiana Acad. Sci., 1899 (1900) pp. 141–4 (6 figs.).
† Tom. cit., pp. 129–40 (8 figs.).
‡ Wettendorfer's Zeitschr. f. Spiritus-Industrie, 1900. See Bot. Centralbl., lxxxv. (1901) pp. 70–1.
§ Journ. Hygiene, i. (1901) pp. 90–4.
‖ Centralbl. Bakt., 2te Abt., vi. (1900) pp. 517–25, 545–54.

cell, and paid special attention to the time of its appearance, the period of maximum accumulation, and the time of its disappearance. Glycogen was found in the young buds of the yeast-cell. It increased in quantity till the end of fermentation, when its maximum was attained, and from this time gradually diminished. Even in hungering lees are always found a number of cells, more or less rich in a glycogen. From these observations the author concludes that the formation and consumption of glycogen in yeast take place simultaneously. It is a transitory reserve substance, and the yeast is able to make use of it owing to diastatic non-diffusible ferments.

Oidium lactis.* — M. Guilliermond describes in detail the mould which appears on Neuchatel cheese, when fermented in the open air, and which he identifies provisionally with *Oidium lactis*. It produces in cultivation (Pasteur's fluid) both mycelial and yeast forms; but no ascigerous form was obtained. It inverts saccharose, but does not develope in lactose. All attempts to induce alcoholic fermentation failed. The cells contain a readily stainable nucleus.

Culture of Uredineæ.†—The latest instalment of H. Klebahn's contributions to this subject deals with a very large number of culture experiments made with a view of determining the life-history of the heterœcious fungi belonging to this family. Among the special subjects of investigation are the *Melampsoræ* of the willows, which have their cæoma-form on species of *Ribes*; *Melampsora Allii-fragilis* sp. n.; the *Melampsora* on *Salix alba*; the *Melampsoræ* of the poplars; the species of *Puccinia* of the group of *P. Ribesii-Caricis*; the species of *Puccinia* on *Phalaris arundinacea*, &c.

Decomposition of Glucosides by Mould-Fungi.‡ — A. Brunstein has carried out a series of experiments on the decomposition of different glucosides by species of *Aspergillus*, *Penicillium*, and other fungi, the results being compared in a number of tables. These show that the glucosides employed have very different values for the nutrition of the fungi. None of them, however, show such good results as Raulin's fluid; some of them producing substances which are prejudicial to the growth of the organism. In all cases the glucoside is first split up into glucose and a benzol derivative.

Myceles in Pharmaceutical Solutions.§—According to F. Guéguen, the mycele so frequently found in pharmaceutical solutions, on which Agardh's genus *Hygrocrosis* was founded, belongs almost invariably to *Penicillium glaucum*, in which he includes *P. digitatum* and *P. griseum*. The nature of the solution brings about great diversities in the cell-structure of the mycele, the production of conids, &c.

Sugar-Cane Diseases. — Sir W. T. Thiselton-Dyer ‖ reviews the results at present obtained respecting two diseases which affect the sugar-cane in the West Indies: the rind-disease and the root-disease.

* Rev. Gén. de Bot. (Bonnier), xii. (1900) pp. 465–79 (11 figs.).

† Pringsheim's Jahrb. f. wiss. Bot., xxxv. (1900) pp. 660–710. Cf. this Journal, 1900, p. 494 (7 figs.).

‡ Beih. z. Bot. Centralbl., x. (1901) pp. 1–50.

§ Bull. Soc. Mycol. France, 1898, p. 201; 1899, p. 15 (5 pls.). See Bot. Centralbl., lxxxv. (1901) p. 114.

‖ Ann. of Bot., xiv. (1900) pp. 609–16.

The former is caused by the conidial stage of a fungus named by Massee *Trichosphæra Sacchari*,* to which, however, various other names have been given. The only reproductive form of importance is the *Melanconium* stage producing stylospores. The root-disease is due to a condition of the same fungus (*Colletotrichum falcatum* Went) modified by being more or less buried in the ground.

A. Howard † describes at length culture experiments on the same fungus in its *Melanconium*, megaconidial, and microgonidial stages; the ascigerous stage he has not yet succeeded in cultivating.

Structure of the Lower Fungi.‡—Commenting on the observations of Wager § with regard to the presence of a nucleus in yeast, M. Guilliermond finds similar granulations to those described by him, in moulds, especially in a species of *Dematium*, their presence being associated with a comparative absence of glycogen. They have, however, nothing to do with the true nucleus, which closely corresponds in structure to that of the higher Ascomycetes. Both in yeasts (*Saccharomyces cerevisiæ*) and in moulds the true nucleus is composed of a nucleoplasm surrounded by a membrane, in which are a number of granulations, one of which, larger and more regular than the rest, may be the nucleole.

Development of Terfezia.‖ — In the neighbourhood of Rome *Terfezia leonis*, an underground fungus belonging to the Tuberaceæ, has long been known only in close proximity to *Helianthemum guttatum*. R. Pirotta and A. Albini find that peculiar appendages to the root of this plant are infested with a mycorhizal mycele which is in organic connection with the receptacles of the *Terfezia*.

New Fungus Pathogenic to Tylenchus agrostidis.¶—G. Lagerheim describes galls found on *Tylenchus agrostidis* (Steinb.) Bast., which were filled with a homogeneous yellow mass consisting of bacterium-like organisms. The air-dried cecidia are flask-shaped, and much larger than the normal fruit of the plant. All the fruit-buds of diseased plants were converted into galls, and in most instances no nematodes were observed. The interior of the cecidium is horny and yellow, and consists of numberless small branched forms. From the existence of true branching the parasite is a fungus, probably belonging to the genus *Actinomyces*.

The yellow pigment is a lipochrome.

Mycetozoa.

Type-Specimens of Myxomycetes.** — Dr. W. C. Sturgis gives a very useful description of 27 out of the 33 species of Myxomycetes originally described by Prof. Peck, from personal examination of the type-specimens preserved in the New York State Museum at Albany.

* Cf. this Journal, 1894, p. 380. † Tom. cit., pp. 617–32.

‡ Comptes Rendus, cxxxii. (1901) pp. 175–8.

§ Cf. this Journal, 1899, p. 312.

‖ Rend. R. Accad. Lincei, 1900, 8 pp. See Bot. Ztg., lix. (1901) 2te Abt., p. 6.

¶ Bihang till k. svenska Vetenskaps Akad. Handlingar, 1900, xxvi. Afd. iii. No. 4, 21 pp. (1 pl. and 7 figs.). See Bot. Centralbl., lxxxv. (1901) pp. 282–3.

** Trans. Connecticut Acad. Arts and Sci., x. (1900) pp. 463–90 (2 pls.).

Protophyta.

α. Schizophyceæ.

Polycystin.*—W. Zopf has extracted the pigment from the floating "water-bloom," *Polycystis flos-aquæ*, belonging to the Cyanophyceæ, and finds it to be of the nature of a carotin, but distinct from any yet described. It can be obtained pure in several distinct crystalline forms. Its spectroscopic and other properties are described in detail.

Chlorogloea, a New Genus of Cyanophyceæ.†—Prof. N. Wille has determined Hansgirg's *Palmella* (?) *tuberculosa* from the Adriatic (now found on algæ and shells in Christiania fiord) not to be a green alga at all, but to be the type of a new genus of Chamæsiphonaceæ, *Chlorogloea*, with the following diagnosis. Colony irregular, consisting of a number of round or oval cells, which divide in one direction only and form radiating rows of cells, surrounded by a thin unstratified mucilaginous envelope. Cells without a nucleus, but with a slightly differentiated parietal yellowish or verdigris-green chromatophore; propagation by division only; new colonies formed by the setting free of akinetes by the gelification of the mucilaginous envelope. Epiphytic on algæ or epizootic on Bryozoa in salt water.

β. Schizomycetes.

Myxobacteria.‡—Miss A. Lorrain Smith has found on rabbit's dung a new species of Myxobacteria to which she gives the name *Myxococcus pyriformis* sp. n. The cysts are of a bright pinkish orange colour.

Effect of Physical Agents on Bacterial Life.§—Dr. A. Macfadyen, in a discourse delivered at the Royal Institution, described the effect of physical agents on bacterial life. The action of desiccation, and of sunlight in presence and absence of oxygen, the effect of mechanical agitation, of pressure, moisture, high and low temperatures, were the chief points alluded to. Special attention was given to the effect of raised temperatures and the useful results of pasteurising milk, the lecture concluding with references to the influence of very low temperatures on bacterial life.

Insects as Factors in the Spread of Bacterial Diseases.‖—S. Burrage caused flies previously infected with typhoid and prodigiosus to walk over the surface of Petri plates. The plates developed colonies of the organisms, from which it is evident that the fly can become infected with bacterial filth, and hold on to it for sufficient time to inoculate food materials.

Influence of Ozone on some Pathogenic and other Bacteria.¶—Dr. A. Ransome and A. G. R. Foulerton find that ozone in the dry state has no appreciable action on the vitality of the various bacteria experimented with; nor did a prolonged exposure to the action of ozone

* Ber. Deutsch. Bot. Ges., xviii. (1901) pp. 461–7 (1 pl. and 1 fig.).
† Algol. Notizen, i.–vi., in Nyt Mag. Naturvid., xxxviii. (1900) pp. 1–27 (1 pl.). See Bot. Centralbl., lxxxv. (1901) p. 129.
‡ Journ. of Bot., xxxix. (1901) pp. 69–72 (3 figs.).
§ Nature, lxiii. (1901) pp. 359–62.
‖ Proc. Indiana Acad. Sci., 1899 (1900) pp. 68–75 (5 figs.).
¶ Proc. Roy. Soc., lxviii. (1901) pp. 55–64.

diminish in any way the pathogenic virulence of *B. tuberculosis* in sputum. Single experiments also tended to show that ozone has little if any effect on the pathogenic virulence of *B. mallei* and *B. anthracis*. The authors confirm Ohlmüller's conclusions as to the bactericidal property of ozone when passed through a fluid medium containing bacteria in suspension. The inactivity of ozone in the dry state as a disinfectant, and its action in the presence of water, recall the action of other gases, e.g. chlorine and sulphuric dioxide. In the dry state and under natural conditions ozone appears to exert no bactericidal action; and the purifying effect claimed for it is due to the direct chemical oxidation of putrescible organic matter; nor does it in any way hinder the action of bacteria.

Penetration of the Intestinal Wall by Bacteria. — Dr. A. Scholt,* in a paper on the question whether there are experimental or clinical grounds for believing that pathogenic or non-pathogenic bacteria can penetrate the wall of the healthy gastro-intestinal canal, reviews the extensive literature of the subject, and shows that the evidence adduced is strongly against the probability of such a penetrating power. The paper is also valuable for the bibliography of the subject.

Biology of Marine Bacteria.†—S. Schmidt-Nielsen obtained samples of sea-water from the surface to 25 metres below, and found that, with one exception, the amount of germs was markedly greater at the lower levels than at the higher. The author mentions, as a curiosity, that a chromogenic bacterium was often isolated, and also that in every sample was a rodlet which gave grey liquefying colonies. The latter bacterium was constantly found to cause ammoniacal decomposition of *Pandalus borealis* in less than 48 hours after they were boiled. Reference is then made to the bacteria found in herring-brine. When fresh, brine contains some 100,000 to over 1,000,000 germs per ccm. The numbers diminish with age until the minimum of 1 to 200 per ccm. is reached. A curious feature in connection with the diminution is mentioned, namely, that the number found on bacterioscopic examination seems inversely proportional to the number found on cultural estimation. Numerous species having various forms were found. Some were chromogenic, most were liquefying, and all were potential anaerobes.

New Bacteria.‡—Dr. Teïsi Matzuschita gives an account of a series of hitherto undescribed bacteria.

Pathogenic bacteria:—

(1) *Bacillus rubefaciens pyogenes* sp. n. A small thin rodlet with rounded ends, which was isolated from the heart-blood of a guinea-pig. On agar with 5 p.c. salt thick rodlets and long filaments developed. It is aerobic, is easily stained, but not by Gram's method. It grows well on ordinary media. It is non-liquefying. A pink colour developes in agar and in bouillon, potato, and milk. Indol is formed in bouillon. It is pathogenic to guinea-pigs.

(2) *Bacillus terrestris* sp. n., found in garden earth, is a largish rodlet with rounded ends, is motile and stains well. The growth is

* Centralbl. Bakt., 1te Abt., xxix. (1901) pp. 239–55, 291–7.
† Biol. Centralbl., xxi. (1901) pp. 65–71.
‡ Centralbl. Bakt., 1te Abt., xxix. (1901) pp. 377–90.

white or yellowish on gelatin, which is liquefied. It grew well on other media. Milk was coagulated, the serum turning yellowish green. It grew best at 37°; and is pathogenic to mice.

(3) *Bacillus piscium pyogenes* sp. n., isolated from sea-fish, is a thick motionless rodlet with rounded ends. It grows best at room temperature on ordinary media. Gelatin is liquefied, and indol is formed in bouillon and in pepton solution. It is pathogenic to guinea-pigs.

(4) *Bacillus aquatilis albus* sp. n., isolated from tap-water, is a thick long rodlet with rounded ends, and is remarkable for the variety of its involution forms. It is motile, and stains well by Gram's method. It grows well on most media except potato. On gelatin its appearance is indistinguishable from that of *B. typhosus.* In large doses it is pathogenic to guinea-pigs, causing pneumonitis, pericarditis, and enteritis.

Non-pathogenic bacteria :—

(5) *Micrococcus albus* sp. n. was isolated from the heart-blood of a pigeon. It stains well, and thrives at high and low temperatures. It was cultivated on the usual media.

(6) *Micrococcus subfuscus* sp. n. was isolated from the air. It stains well and also by Gram's method. It grows well at high and low temperatures on the ordinary media. The growth is yellowish on gelatin and on agar.

(7) *Bacillus tolens* sp. n. was isolated from sea-fish ; it is a medium-sized rodlet with rounded ends, and on salinated agar vibrio and spirillum forms occur. It is motile and stains well, but not by Gram's method. It thrives on all ordinary media at room temperature, but grows poorly at incubation. On gelatin the superficial growth is at first bluish-white and iridescent. The deeper colonies are yellowish. Milk is not coagulated. Potato is stained brown. All the cultures exhale a characteristic odour of truffles.

(8) *Bacillus coli non-fervoris* sp. n., isolated from the intestine of a guinea-pig, is a medium-sized rodlet with rounded ends. It does not stain by Gram's method. It grows well at high and low temperatures on all the ordinary media, and very well on salinated agar. Milk is not coagulated.

(9) *Bacillus saliphilus* sp. n. was isolated from the heart-blood of a guinea-pig; it is a thin short somewhat bent rodlet with rounded ends. On 3 p.c. salt-agar capsules appear after three days' cultivation. It grows best at 37°, and thrives on all media, especially on salinated agar. On gelatin the growth was white to yellowish, and on potato yellow or orange.

(10) *Bacillus testudiniformis* sp. n. was obtained from a copper coin, and was only found once ; it is a thin rodlet with rounded ends. It is motile, and grows better at 37° than at 22°. On gelatin plates the colonies are yellowish, and in shape resemble a tortoise-shell surrounded by a shimmering zone.

(11) *Bacillus annulatus albus* sp. n. was frequently isolated from nickel coins ; it is a motile rodlet resembling the typhoid bacillus ; it grows better at 37° than at room temperature. It grows well on gelatin, agar, bouillon, and grape-sugar-bouillon, but badly on potato.

(12) *Bacillus nummorum* sp. n. was often cultivated from copper coins ; it is motile, resembles the hay-bacillus, and often forms long

filaments. On gelatin plates the colonies in one or two days resembled yellowish-white points. On agar the growth was whitish-grey. There was no growth on potato.

(13) *Bacillus annulatus aureus* sp. n. was isolated from a silver coin; it is a thick short rodlet, often forming long filaments. It is motile. Incubation temperature is more favourable to growth and segment formation than room temperature. The growth is yellow on gelatin, agar bouillon, and potato. Gelatin is not liquefied.

(14) *Bacillus odoratus* sp. n. was detected in butter; it is a short sometimes spheroidal rodlet with rounded ends and granular contents. It is motile, and occurs mostly in pairs. It liquefies gelatin. The colonies are grey with a brownish centre. The surface of agar slopes was covered with a thick white smooth overlay, and there was marked gas production. On potato the deposit has a dry greyish appearance, and exhales an odour resembling semen. Bouillon soon becomes turbid.

(15) *Oospora alba* sp. n. was isolated from the heart-blood of a guinea-pig; it is a branching filament fungus, which stains well by Gram's method. It grows better at room temperature than at 37°. On potato it did not develope. On 4 p.c. salt-agar it throve luxuriantly. On gelatin the growth was white, and the medium slowly liquefied. On agar the growth was white, copious, and adherent.

Sarcinastrum Urosporæ g. et sp. n.*—G. Lagerheim describes a marine bacterium parasitic on *Urospora mirabilis*. The organism presents itself as cocci and rodlets, and secretes an enzyme by which the cuticular layer of the host plant is dissolved. The organism forms aggregates or colonies which are held together by a gelatinous substance. This substance gradually dissolves and so sets free the cocci, which in this way are disseminated. The cocci are non-motile. In its action on the cells of the host plant the *Urospora* parasite shows much resemblance to the bacteria which infest Florideæ, and there is considerable similarity between the *Urospora* cecidia and the *Chantransia* galls described by Brandt. The affinities of *Sarcinastrum* appear to be with the Trichobacterineæ on the one hand and with the Myxophyceæ on the other.

Micro-organisms of Nitre-formation.—According to A. Stutzer and R. Hartleb † observations on the development of nitre organisms are best started from pure cultures on nitrite-agar. On solid media and on liquid with total exclusion of air multiplication proceeds by fission, and when observed in hanging drops the division is seen to be accompanied by lively movements. The formation of filaments and their length appears to depend on the composition of the medium. Sometimes these threads exhibit true branching, and usually the plasma migrates to one extremity, so that this end becomes swollen. Occasionally both ends participate in the swelling, from which new individuals arise. Hence these organisms resemble bacteria in certain of their developmental forms, but in others are more like mycele fungi. From the latter, however, they differ physiologically in that carbohydrates are

* Bihang till k. svenska Vetenskaps Akad. Handlingar, 1900, xxvi. Afd. iii. No. 4, 21 pp. (7 figs.). See Bot. Centralbl., lxxxv. (1901) pp. 280–2.

† Mitteil. d. landwirthsch. Inst. d. Königl. Univ. Breslau, 1899, pp. 75–101 (2 pls. and 22 figs.). See Beih. z. Bot. Centralbl., ix. (1900) pp. 542–4.

unsuitable media, and in their sensitiveness to acid reacting media. From both they differ in their dislike to nitrogen compounds such as pepton, gelatin, and broth. Hence this hyphomicrobe takes a separate position intermediate between bacteria and Hyphomycetes.

The authors pursue the subject of the morphology and physiology of the nitre microbe,* and come to the following conclusions. The nitre microbe is not a bacterium, but has a separate position among micro-organisms. It oxidises nitrite to nitrate. Besides nitrates it can use as nutriment ammonia compounds and nitrates, but not the complex organic nitrogen compounds such as pepton, &c. It can profit by free atmospheric carbonic acid, but not by the combined carbonic acid of alkalis and of the alkaline earths or the organic carbon compounds such as sugar. The nitre microbe obtains the necessary energy for the formation of organic substances out of inorganic materials, partly chemosynthetically by the oxidation of nitrites to nitrates, and possibly also thermosynthetically by turning heat to account.

Bactericidal Power of the Blood.†—Prof. A. E. Wright, in a second communication on the quantitative estimation of the bactericidal power of the blood, thus summarises his conclusions. What is measured by the gelatin method is rather the total antibacterial power of the blood than the bactericidal power proper. To determine how much of the result which is registered is referable to an inhibition of the growth of the bacteria, and how much to a direct bactericidal action, it is necessary, after the cultivation tubes have been incubated and examined microscopically, to melt down the gelatin and to blow out the contents of the tubes into sterile nutrient broth. Where it is desired separately to estimate the bactericidal power, this can readily be done by making a series of graduated dilutions of a bacterial cultivation in broth and by mixing one volume of each of these with one volume of undiluted serum. This method may appropriately be employed when dealing with bacteria such as the cholera vibrio or the typhoid and diphtheria bacilli, which are readily killed off by the normal human blood. When the last method is employed and when the bacteria have been counted, a convenient arithmetical expression for the bactericidal power is obtained by specifying the number of organisms which one cubic millimetre of serum is capable of killing. When bacteria are not killed off, or only in small numbers, by normal human blood, or when the blood has lost much of its bactericidal power, the gelatin method may appropriately come into application.

Soluble Ferment in Cultures of Bacillus Tuberculosis.‡ — Dr. G. Carrière finds that there exists in cultures of *B. tuberculosis* a soluble ferment which decomposes monobutyrine. It is analogous to and perhaps identical with the lipase described by Hanriot. Its activity varies with the age of the culture. There is no constant relation between the amount of the ferment and the virulence of the culture.

Pathogenic Microbes in Milk.§—Dr. E. Klein, who has examined a large number of samples of milk and secretions of diseased udders,

* Tom. cit., pp. 197–232. See Beih. z. Bot. Centralbl., ix. (1900) p. 544.
† Lancet, 1901, i. pp. 609–12. Cf. this Journal, *ante*, p. 97.
‡ C.R. Soc. de Biol. de Paris, liii. (1901) pp. 320–2.
§ Journ. Hygiene, i. (1901) pp. 78–95.

records the following conclusions and results of his bacterioscopic and experimental examinations. (1) 7 p.c. of the samples of country milk produced typical true tubercle in the guinea-pig. (2) 8 p.c. of the samples of country milk produced typical pseudo-tuberculosis (non-acid-fast bacillus of pseudo-tuberculosis A. Pfeiffer). (3) 1 p.c. of milk samples produced diphtheria in the guinea-pig, yielding the typical true *B. diphtheriæ*. (4) 1 p.c. of milk samples caused a chronic disease (in most cases with fatal results) due to a pathogenic torula apparently differing in cultural and physiological characteristics from the torula (pathogenic blastomyces) obtained by Sanfelice, Plimmer, and others from human cancer. (5) Out of the secretions of the cow's udder two pyogenic microbes were obtained, *B. diphtherioides* and *Streptococcus radiatus* (*pyogenes*). A description of the last three organisms is given elsewhere.*

Pseudomonas hyacinthi.† — Dr. E. F. Smith confirms Wakker's statements respecting the disease of hyacinths caused by *Bacterium hyacinthi*, now re-named *Pseudomonas*. The disease is induced by wounds, but the parasite also gains entrance through the flowers. The organism is a rodlet with rounded ends measuring from about 0·5–1 μ by about 1–3 μ. It is motile, the flagellum being long and unipolar. In solid and fluid media zooglœæ are developed in a few days. In old cultures chains and filaments are formed. Spores were not observed. The colour of the growth is yellow. Gelatin is liquefied. It is aerobic, and reduces methylen-blue in a few days. Indol is formed slowly in peptonised beef-broth and in peptonised Uschinky's solution, but does not produce nitrite in these solutions. The optimum temperature is 28° to 30°. The germ is pathogenic to hyacinths, and multiplies in the vascular system, filling the vessels, especially those of the bulb, with a bright yellow slime consisting of bacteria. The destructive process is slow.

Bacterial Disease of the Turnip.— Prof. M. C. Potter ‡ describes a bacterial disease of the turnip (*Brassica napus*) under the name of white-rot. The disease results in a softening with discoloration of the root, while the leaves droop, become yellow and shrivelled. From diseased plants a microbe, *Pseudomonas destructans*, was isolated. It is a short motile rodlet 3 μ by 8 μ, with a single polar flagellum. It is aerobic, and grows well on the ordinary media. It is readily stained, but not by Gram's method. It produces the following ferments:—a cytase, causing the swelling and softening of the cell-wall and dissolution of the middle lamella; a diastase and a peptonising ferment, producing liquefaction of the gelatin. Its toxic action is shown by the formation of oxalic acid, which is produced in turnip-juice, and in Pasteur's solution containing cane-sugar. The residual products are always acid. During fermentation there is copious evolution of carbonic acid.

W. Carruthers and Miss A. L. Smith § describe a disease of swedes which results in the formation of a cavity in the bulb, and the destruction of its crown and leaves. From the diseased plants was isolated a motile bacterium 0·65 μ broad and from 1 to 4 μ long; cultures were obtained

* See this Journal, *ante*, pp. 74–5.
† U.S. Depart. Agriculture, Bull. 26, 1901, 45 pp., 1 pl. and 6 figs.
‡ Proc. Roy. Soc., lxvii. (1901) pp. 442–59 (6 figs.).
§ Journ. of Bot., xxxix. (1901) pp. 33–6 (2 figs.).

in a mixture of gelatin and turnip decoction. The gelatin was liquefied. The disease also affects to some extent yellow turnips and cabbages, but not kohl-rabi or mangolds. The disease appears to be the same as the white-rot described by Potter.

Bacillus carotovorus sp. n.* — Prof. L. R. Jones describes a new bacterium, *Bacillus carotovorus*, the cause of a soft-rot in carrots. Microscopical examination of the diseased tissues shows the presence of the organism in the intercellular spaces. The disease was easily reproduced by inoculating the plants (after wounding the epiderm) with cultures. The organism is a bacillus with rounded ends, $0 \cdot 6$–$9 \cdot 9$ μ broad, and $1 \cdot 5$–3 μ long. It occurs singly, in chains, and in filaments. It is easily stained, and also by Gram's method. It is motile, and the flagella are from 2 to 5 in number. It was cultivated with success on numerous media (animal, vegetable, and inorganic), both liquid and solid. Gelatin was rapidly liquefied. Its optimum temperature is 27°–30°. It is a potential anaerobe. It forms acid in carbohydrate media; bleaches litmus milk, but not methylen-blue-pepton solution, except in an atmosphere of carbonic acid. It produces indol in pepton solution and also in meat broth. It is very sensitive to direct sunlight and drying. In carbohydrate media a moderate amount of gas is produced. It is advised that infected soil should be sown with seed crops (wheat, beans, &c.) for some years, and treated with appropriate manures. The roots should be well dried, and exposed to sunlight before storing, when they should be kept in a cold place.

Pigment of Bacillus polychromogenes. † — E. M. Chamot and G. Thiry express the opinion that all the different colours produced by *Bacillus polychromogenes* are simple derivatives of one and the same substance, that is to say, the organism does not produce different pigments in different media, as has been stated of this and many other chromogens. The greens cannot be chlorophyll, nor can the blues be cyanins. The pigment most closely resembles the colouring matters which have been isolated from lichens and from fungi.

New Bacterium found in Yellow Fever.‡—H. E. Durham and W. Myers have found a fine small bacillus in fatal cases of yellow fever. It is about the diameter of the influenza bacillus, and about 4 μ long. The microbe was detected in the glands and in the contents of the large intestine. It is stained and cultivated with difficulty. The most successful reagent was carbol-fuchsin, diluted with 5 p.c. phenol, which was required to act for 12–18 hours. The preparations were then differentiated with weak acetic acid. Some pure cultures were obtained by placing mesenteric glands in broth under pure hydrogen atmosphere. The authors failed to find evidence of parasitic protozoa, and negative the mosquito infection theory. They express the opinion that the evidence in favour of this fine small bacillus is stronger than any that have yet been adduced for any other yellow fever germ.

Production of Acetylmethylcarbinol by Bacillus tartaricus.§ — L. Grimbert announces that among the fermentation products of *Bacillus*

* Centralbl. Bakt., 2te Abt., vii. (1901) pp. 12–21, 61–8.
† Bot. Gazette, xxx. (1900) pp. 378–93.
‡ Brit. Med. Journ., 1901, i. pp. 450–1.
§ Comptes Rendus, cxxxii. (1901) pp. 706–9. Cf. this Journal, 1898, p. 577.

tartaricus from cultivations on carbohydrate media are not only acetic and succinic acids, lævolactic acid, and ethylic alcohol, but also a new body which has not hitherto been met with among microbic products. This body is acetylmethylcarbinol, $CH_3 - CO - CHOH - CH_3$. A full description of the method employed in detecting this body is given by the author.

Cultures of the Microbe of the Soft Chancre.*—Bezançon, Griffon, and Le Sourd state that coagulated rabbit's blood (*sang gelosé*) is an excellent medium for Ducrey's bacillus. In 24 hours round hemispherical colonies appear, and these, as they increase in size, become opaque and grey. The bacilli occur singly, in groups, and in short chains, while in the condensation water the chains are often of considerable length. The bacillus also grows in uncoagulated rabbit's serum.

Bacteriological Investigations on Trachoma.† — C. Addario made cultivations from trachoma granulations, and also from conjunctival secretion on the usual media, and in the vitreous tumour of calves and rabbits. The bacillus of xerosis was found ten times by itself and seven times in conjunction with *Staphylococcus* and *Sarcina*. *Streptococcus* and *Micrococcus minutissimus* were also found once or twice.

The bacillus showed the form of the club-shaped bacillus of Morax and its characteristic fragmentation. In the vitreous cultures short chains or pseudo-filaments appeared. With aqueous gentian-violet the staining was homogeneous, though a few rodlets exhibited polar staining. Not infrequently some of the bacilli resembled both *B. xerosis* and *B. pseudodiphtheriticus*.

The short chains and false filaments which occurred in some cultures suggest that the bacillus is a sport variety of *B. xerosis*, and is perhaps identical with the bacillus of L. Müller.

Resistance of Spores of Actinomyces.‡—L. Bérard and J. Nicolas record observations on the resistance of *Actinomyces* spores. They found that from old spores, which had been kept for six years, excellent cultures were obtainable. The spores were killed by dry or moist heat of 80° acting for fifteen minutes, but withstood 75° for the same period. Spores suspended in bouillon and exposed for $6\frac{1}{2}$ hours to direct sunlight were unaffected, but after $14\frac{1}{2}$ hours were killed, possibly because they had begun to germinate. Exposure to sunlight for a long time, 238 hours altogether, apparently did no harm to dry spores.

Vitality of the Plague Bacillus.§ — N. K. Schultz finds that the *Bacillus pestis hominis*, under suitable conditions, may retain its vitality and virulence for about four years. This maintenance of vitality is apparently favoured by a shrinkage or inspissation of the protoplasm, and is not due to the formation of spores.

Distribution of Leprosy Bacilli.‖—Dr. Uhlenhuth and Dr. A. Westphal made a histological and bacteriological examination of a case of leprosy of the tubercular and anæsthetic type. The chief observation is

* C.R. Soc. de Biol., lii. (1900) pp. 647–8, 1048–51.
† Archiv f. Augenheilkunde, xli. (1900) p. 20 (3 pls.). See Bot. Centralbl., lxxxv. (1901) pp. 115–7. ‡ C.R. Soc. de Biol. de Paris, lii. (1900) pp. 835–6.
§ Centralbl. Bakt., 1te Abt., xxix. (1901) pp. 169–74.
‖ Tom. cit., pp. 233–9 (2 pls. and 13 figs.).

that the bacilli have a universal distribution throughout the tissues and organs, and are not limited to leprosy cells. The paper is interesting on account of the excellent illustrations.

Morphology of the Glanders Bacillus.*—Dr. G. Mayer injected suspension of *Bacillus Mallei* into the peritoneal sac of guinea-pigs, and found that this method of infection produced appearances indicative of a true streptothrix, there being granules, club-shaped elements, and branching filaments.

Smegma Bacilli.†—Dr. L. Neufeld describes two acid-fast bacteria, which inhabit the smegma of man and other animals. One has a strong resemblance to the bacillus of tubercle, and the other to that of diphtheria. The latter is probably identical with the Czaplewski-Laser smegma bacillus.

Micro-organism of Distemper and Distemper Vaccine.‡—Dr. S. M. Copeman states that the specific organism of distemper is a coccobacillus, which stains with ordinary anilin dyes, but not by Gram's method. It is cultivable on the ordinary media, but only with difficulty on potato. Milk is not coagulated, gelatin is slowly liquefied. In broth cultures it forms chains often of considerable length. Inoculation of pure cultures on the nasal mucosa reproduced the disease in a mild form, while subcutaneous injection resulted fatally.

By heating a broth culture at 60° for half an hour, and subsequently adding a small quantity of carbolic acid as a preservative, a vaccine is obtained, 2 ccm. of which is apparently sufficient to protect pups weighing $1\frac{1}{2}$ kilos. Observations as to the length of the protection are being carried out on a large scale.

Immunity of Mice to Micrococcus tetragenus.§ — Prof. A. Lode corrects the commonly accepted opinion that the grey house mouse is naturally immune to the *Micrococcus tetragenus* Gaffky. He shows that these animals die of septicæmia when infected with *M. tetragenus*.

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* Centralbl. Bakt., 1te Abt., xxviii. (1900) pp. 673–83 (6 figs.).
† Arch. f. Hygiene, xxix. (1900) pp. 184–204 (6 figs.).
‡ Proc. Roy. Soc., lxvii. (1901) pp. 459–61.
§ Centralbl. Bakt., 1te Abt., xxix. (1901) pp. 228–30.

MICROSCOPY.

A. Instruments. Accessories, &c.*

(1) Stands.

Wilson's New Heating Stage.†—Leonard P. Wilson has constructed a satisfactory heating stage with water as the medium. The stage (fig. 39) is in the form of a double box, forming a water-jacket to the slide and its carrier. Water of the required temperature is passed in at A, and flows out at B, the temperature being taken by a thermometer passed into the tube C, round which the water passes in the middle of its course. The heating stage is fastened to the mechanical stage by means of the screw D. When using a high power, the objective passes into the upper aperture of the stage, and is below the level of its upper surface; and, in order that the stage may move freely in all directions in conjunction with the movements of the mechanical stage, it is necessary

FIG. 39.

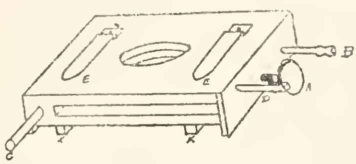
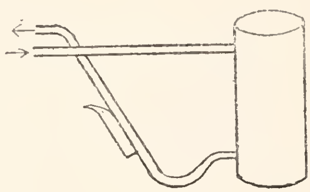


FIG. 41.



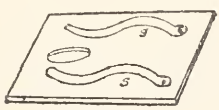


FIG. 40.

that this tubular aperture be greater in diameter than the objective. To prevent the intrusion of cold air, which might take place owing to this difference in diameter, a vulcanite plate, having an aperture which the objective just fits, slides on the surface of the stage under the clips E E. In a manner similar to the objective, the condenser passes up into the lower portion of the stage; spaces for the vulcanite plate in this case being made by the introduction of the two bars X X across the lower surface of the stage, which is thereby raised above the mechanical stage. The slide-carrier, as shown in fig. 40, consists of a brass plate, having a circular aperture through it, and having fixed to it two springs S S. By means of these springs, the slide is held in position on the carrier, and the carrier is also held in position between the upper and lower plates of the stage. The slide can be roughly adjusted by means of the carrier, fine adjustment being made with the mechanical stage.

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous. † Knowledge, 1901, pp. 45–6 (3 figs.).

The heating apparatus is represented in fig. 41; and by slightly raising or lowering the flame, the temperature can be regulated and kept constant within half a degree Centigrade.

(2) Eye-pieces and Objectives.

Malassez' New Micrometer Eye-piece.* — M. Malassez, after describing the defects of many micrometer eye-pieces, relates his attempts to remedy them :—

(i.) His first type has three concentric tubes sliding smoothly in one another (fig. 42). The middle one bears at its two extremities the two eye-piece lenses; it is the ocular proper. This tube has also several

Fig. 42.

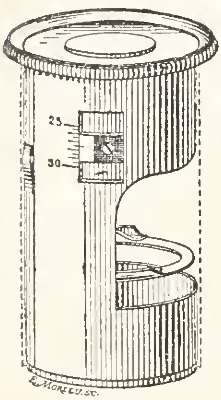


Fig. 43.

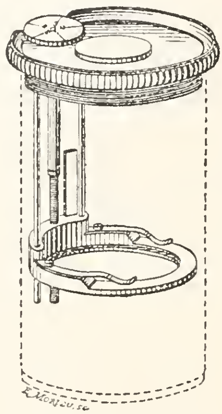
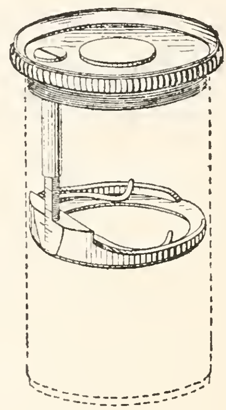


Fig. 44.



lateral openings; one very wide, admitting the micrometer slide; a second, on the same side and higher, near the upper lens; and two others vertically elongated, *vis-à-vis*, by whose means the interior tube can be operated. This inner tube carries the micrometer, and is sensibly less than the middle tube. Near its lower end it has a wide window for admitting the micrometer, which is actually placed on a diaphragm, and is retained in position on a circular rim and clipped by little springs. This inner tube also has two small milled projections, which penetrate the two vertical openings of the median tube, and allow of up-and-down adjustment. The projections are no thicker than the metal, but the milling allows a good grip, and the movement is easily done. The other window of the median tube exposes a mark on the innermost tube, which slides past a millimetre scale. The exterior tube is intended to close all the windows of the median tube.

When the focus has once been obtained, it is only necessary to note what reading on the millimetre scale corresponds to the reading on the tube, and the precise arrangement can be at any time recovered.

(ii.) This type differs much from the last, and is an ordinary ocular, whose upper lens-mount bears on its lower face the arrangement for raising or lowering the micrometer slip. This arrangement (fig. 43) con-

* Arch. Anat. Micr., 1900, pp. 429–35 (3 figs.).

sists of two small vertical stems, which are set near one another in the lower face of this mount, and work in the interior of the ocular. They penetrate the rim of the micrometer diaphragm without being attached to it. The diaphragm is moved up and down by the action of an endless screw which penetrates it, and whose upper extremity terminates in a large milled head. The periphery of the milled head slightly exceeds the periphery of the lens-mount, and so renders possible easy turning of the screw. A millimetre scale, placed inside the ocular, near one of the stems, indicates the height of the focus, and the milled head is divided so as to give fractions of a millimetre.

Fig. 44 shows a simplified form, in which the diaphragm is supported only by the screw, which is flattened on one side, and carries a millimetre graduation. The inconvenience is that if, in focussing, the diaphragm is not properly set, the upper lens must be unscrewed, and the diaphragm raised or lowered. These operations must be repeated until success. But, when once found, the focus is not lost.

The inventor has also tried an intermediate form, which seems the best of all. As in fig. 43, it has an exterior milled head, but, as in fig. 44, it rejects the guide-stems and trusts to the endless screw alone.

Movable Ocular Diaphragms.*—M. Malassez has designed a series of diaphragms applicable to any ocular, and capable of transforming it into any variety of eye-piece, micrometric or otherwise. He describes several of his attempts to attain his object, and the following are the final results:—

(i.) *Indicator Diaphragm.*†—A piece of blackened cork was introduced into an ocular and placed just above the ordinary diaphragm. The indicator was put on its upper surface, and consisted of a sort of watch-hand pointed at one extremity and pierced at the other; an ordinary pin passed through the hole secured the indicator to the cork, but the relative largeness of the hole easily permitted movements of the pin in the plane of the diaphragm. To confine these movements within suitable limits, two pin-heads were set in the cork in proper positions. When the indicator was in contact with one of these stops the point was in the centre of the diaphragm opening; when in contact with the other it was out of the field altogether. By inclining the ocular the indicator could be got to move and assume the desired position. Any slight inequality on the surface of the cork was useful in preserving the indicator in position (fig. 45). In a more perfect form M. Malassez makes everything of metal. The internal diameter is small enough to allow insertion into any current eye-piece, e.g. those of Zeiss. It is fitted with three or four small springs which, starting from the periphery and bending outwards, serve to keep the instrument steady, while the curved upper extremities enable the finger to withdraw it easily. The indicator consists of a small basal piece into a groove of which a fine hair fits. The adjustment of the indicator is as before, and of course it would be necessary to remove the ocular from the draw-tube in order to set the indicator.

(ii.) *Thread Diaphragm.*—Of this there are two models. The first

* Arch. Anat. Micr., 1900, pp. 436–56 (6 figs.).

† Thread diaphragms date from 1838, and indicator diaphragms from 1848. *Vide* Quekett, p. 130 (1st edition).—Ed.

(fig. 46) is a metallic diaphragm surmounted by three or four springs slightly divergent, as in the indicator diaphragm. But the opening is square or rectangular and carries a thread on its upper face, set so as to be nearer to one of the parallel sides than the other. M. Malassez considers that this quadrangular opening affords a surer means of searching a field than a circular one, and the unequal division renders it easier to keep a check on computation.

In the second model (fig. 47) the thread is movable, and, as in the indicator diaphragm, a slight inclination of the ocular causes appear-

Fig. 45.

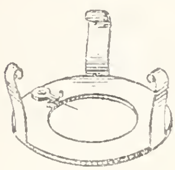


Fig. 46.

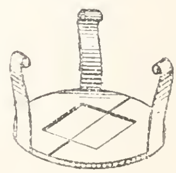
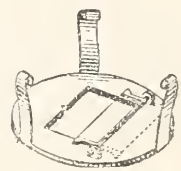


Fig. 47.



ance or disappearance of the thread. As will be understood from the figure, the framework of the thread folds back through an angle of 180°.

(iii.) *Diaphragm with Movable Glass Slip.*—In this case the diaphragm is intended to receive any kind of glass micrometer, squared or otherwise. M. Malassez has designed two types.

The first type (fig. 48) has a general resemblance to the preceding; but the three springs are set at unequal distances around the periphery

Fig. 48.

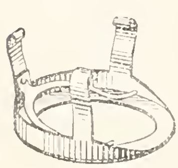


Fig. 49.

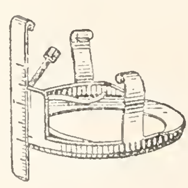
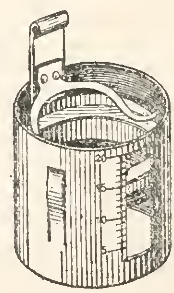


Fig. 50.



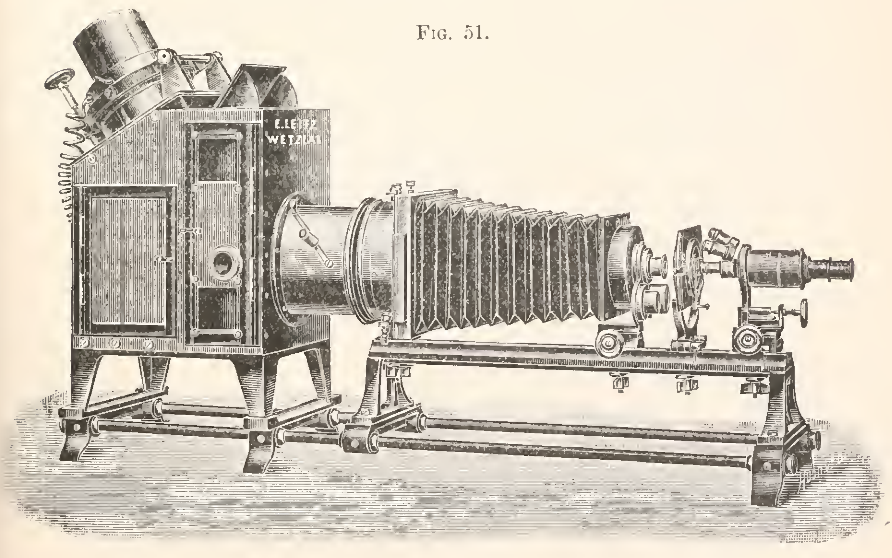
in order to leave a wide space between two for the insertion of the micrometer slip. The periphery also is made with a small vertical flange, except at the above gap. The slip is kept in position by means of a semicircular spring, whose two extremities gently press on it. It is advisable to set the slip with the ruled surface downwards. The arrangement works excellently when the diaphragm is always used by the same person; but if persons of different visual power have to use the diaphragm, or if, for any other reason, the focus has to be varied, further construction is necessary. In one method M. Malassez screws the fixed diaphragm of the ocular up or down, and a millimetre scale and graduations on the flange of the diaphragm itself permit an adjustment to tenths of a millimetre. The focus, once found, should be noted, and can then always be recovered. In another arrangement he pushes the fixed diaphragm down on to the mount of the lower lens, and the movable diaphragm has been so modified (fig. 49) that it rests directly on the displaced diaphragm. The movable diaphragm is slightly altered in construction so as to carry a millimetre scale, and its arrangement will be easily understood from the figure.

In the second type (fig. 50) the three vertical springs are reduced to one, which is rather broad, and its curved extremity is useful for handling the diaphragm. Moreover, this vertical stem is provided with a screw thread, by means of which it may be screwed up or down inside a short tube, which acts as its holder and is dropped down on to the mount of the lower lens. Vertical springs set in the thickness of this tube serve to keep it steady in its place. There is a vertical millimetre scale, and the flange of the diaphragm is also divided, so that adjustment is possible to the tenth of a millimetre. A vertical window permits the exact position of the glass slip to be known.

(3) Illuminating and other Apparatus.

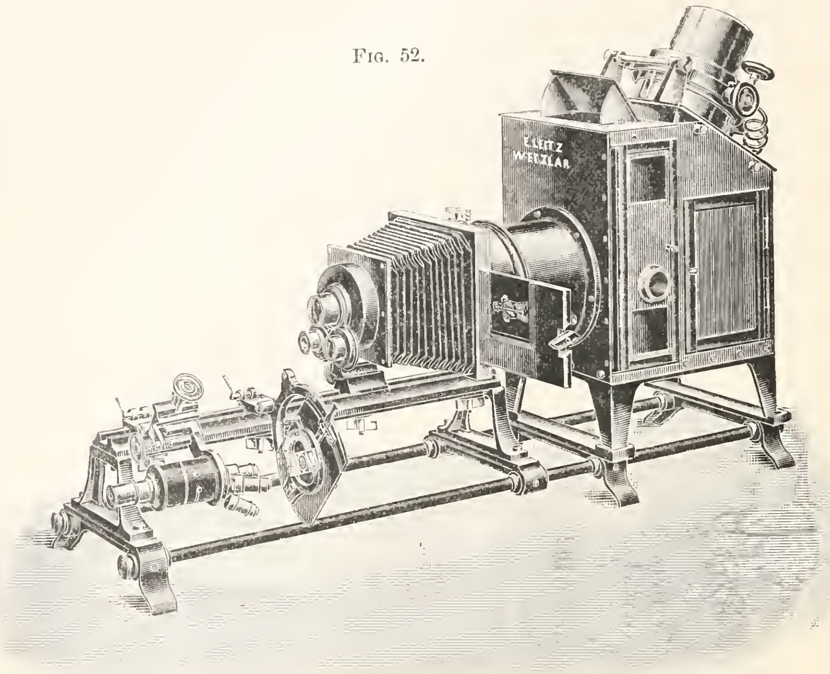
Leitz' Large Projection Apparatus. — In this apparatus (fig. 51) the Schuckert electric projection lamp is employed. The lamp requires

Fig. 51.



a constant electric current of 12–20 amperes, and connected with it is a triple condenser of 150 mm. diameter. Various contrivances permit very accurate adjustment of the lamp and condenser. For example, two thumbscrews control the positions of the carbons, so that the luminous point may be readily brought into the exact optical axis of the condenser; moreover, the two inner lenses of the condenser are movable, and are controlled by two knobs, as shown in the diagram. This adjustment of condenser lenses removes chromatic aberration, and the rays of light emerge in moderate convergence. As ordinarily employed

Fig. 52.



for direct projection from the preparation, the apparatus consists of the optical bench, with the following parts:—

1. A large cooling-cell, kept cool by a current of running water.

2. The bellows, with tube.

3. The Microscope condenser (especially needed when high powers are employed, say $\frac{5}{12}$ to $\frac{1}{12}$) and diaphragm holder (sufficient for low-power work; a small rack-and-pinion suffices for adjustment.

4. The object-stage and small cooler. The preparation rests on the cooler, and protection from heat is thereby afforded to the most delicate specimens; the adjustment of the object permits any desired part to be brought accurately into the field.

5. The objective-carrier, with triple nose-piece, a broad projection-tube, and a diaphragm for the purpose of narrowing the broad tube. A narrow tube, which screws into the broad one, permits use of oculars if desired; the adjustments are by rack-and-pinion and micrometer screws.

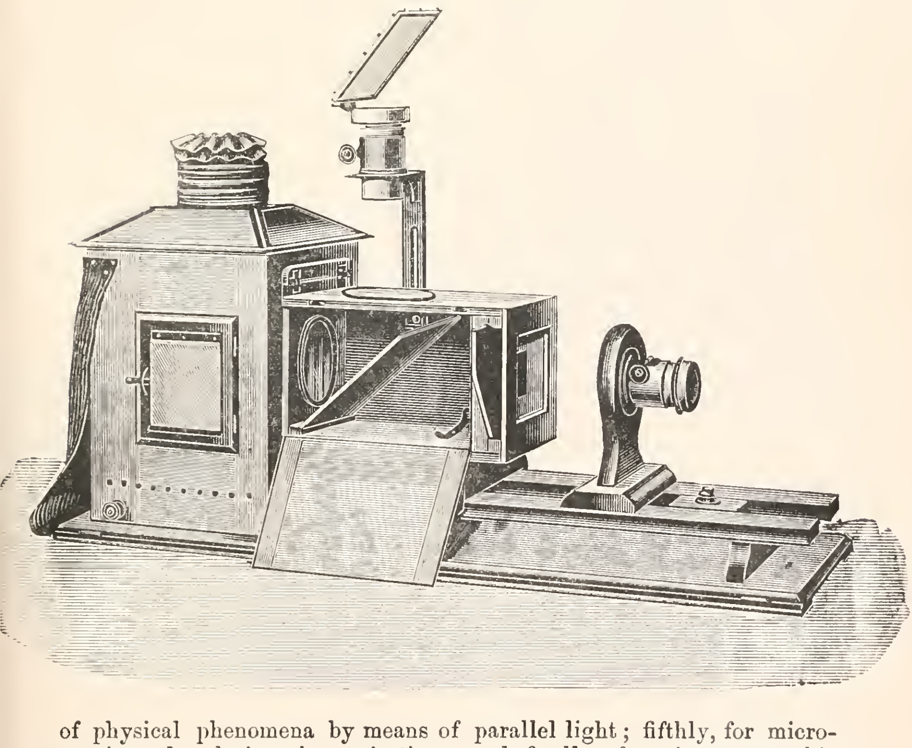
6. Wooden cover, with cloth curtain, which fits over the diaphragm-carrier, stage, and objectives, to shield off any light which might escape at the sides.

With this projection apparatus all powers of Microscope objectives may be employed, including the $\frac{1}{12}$ oil-immersion. The picture, even when the highest powers are used and the screen is at a distance of 12 feet from the apparatus, is of sufficient clearness and brightness to be available for demonstration to a large audience.

For lantern-slide projection the objective-stage and objective-carrier are swung out of the way by means of specially provided joints (fig. 52), and a special projection lens of 300 mm. focal distance is screwed into the diaphragm-holder and a slide-carrier inserted into the bellows-frame. When so arranged the projection can be made upon a screen 30 feet distant, over the heads of the audience.

Liesegang's Universal Projection Apparatus.*—The inventor claims that his apparatus is unique of its kind. It is intended, firstly, for the direct projection of lantern pictures; secondly, for vertical projection; thirdly, for the projection of opaque objects; fourthly, for the projection

Fig. 53.



of physical phenomena by means of parallel light; fifthly, for microscopic and polariscopic projection; and finally, for cinematographic projection.

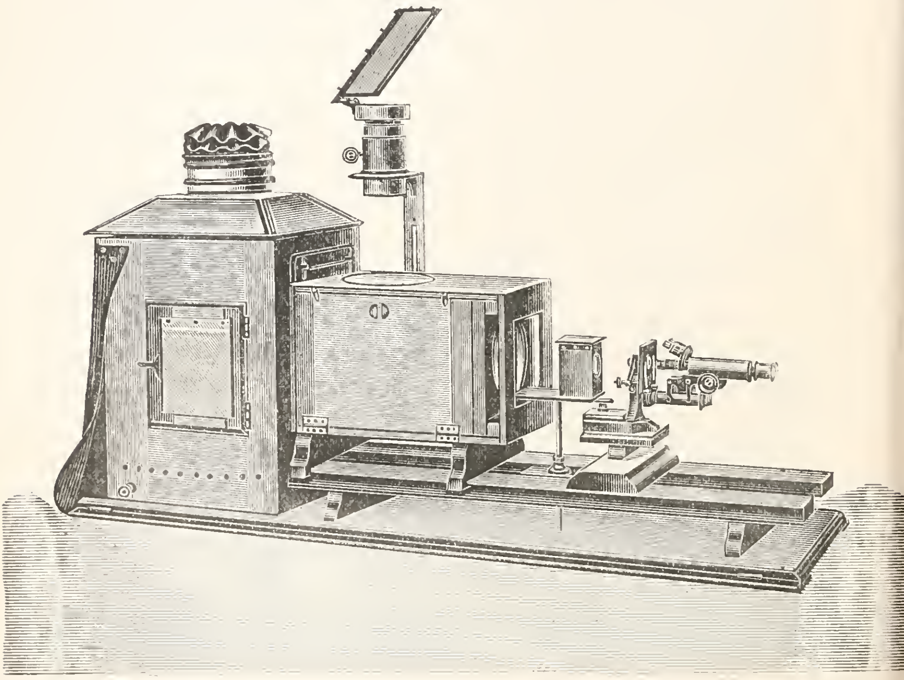
The apparatus consists of a box, which serves for the reception of

* Central. Zeit. f. Optik u. Mech., 1900, pp. 222–6 (8 figs.).

the light source, and in its front wall are two condensing lenses, which render the issuing light rays parallel, or nearly so. The optical bench takes the form of a pair of parallel wooden bars. For attaining the different kinds of projection, two boxes equipped with lenses and mirrors are provided—the vertical box and the episcopic box. These are used, as required, singly or together in line, and are placed in front of the issuing light beams. For direct projection there is also an objective on a suitable carrier.

Figs. 53 and 54 show how direct and vertical and microscopic projections are obtained. The "vertical box" is, in fig. 53, seen *in situ*, the

FIG. 54.



sloping mirror being arranged for throwing the light upwards through a second condenser on to a different projection lens; a sloping mirror above this projects horizontally an image of any object placed in the focus of the projection lens. When the mirror inside the vertical box is clamped down, the whole of the upper part obviously passes out of gear, the light passes out at the side of the box, and there is direct projection. The change in position of the inside mirror is readily and instantaneously effected.

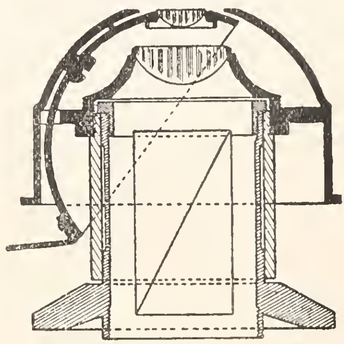
When used for microscopic projection, a lens is required for focussing the light rays on to the substage condenser, and the arrangement will be easily understood from fig. 54. The vertical projection apparatus is a useful auxiliary, as it is always at hand for purposes of small magnification.

Details of the other uses of the instrument are omitted here, as scarcely falling within the province of microscopy.

An arc lamp "volta" is recommended as the best source of light.

Combined Condenser and Polariser for Petrographical Microscopes.*—Mr. W. L. Patterson's arrangement consists of a double lens condensing system, and a Nicol prism mounted as shown in fig. 55. The upper condensing lens is mounted on a revolving arm, so that it may, at the will of the operator, be instantly thrown in or out of the optical axis by a lever: a suitable stop being provided for bringing it to a central position. The lower lens is mounted at the proper distance below the upper surface of the apparatus, so that, when the upper lens is moved out of optical axis, the lower lens focusses upon the slide, thus avoiding the necessity of re-focusing the condenser system when changing from the double to single combination. The Nicol prism is mounted in a revolving sleeve with graduated collar, and a stop to indicate zero, or the position when the prisms are crossed.

Fig. 55.



The author claims the following advantages over other similar contrivances:

1. It is not necessary to increase the size or thickness of the Microscope stage.
2. The attachment is always in focus when one or both lenses are used.
3. Compactness and freedom from liability to disturbance while stage or slide is being operated.

(6) Miscellaneous.

New Form of Loup-holder.†—M. Malassez has aimed at producing a portable and inexpensive loup-holder, of a nature such that a travelling Microscope could be used as it stands. Fig. 56 shows one of his arrangements. The weight of the loup and its holder is counterbalanced by a fairly heavy ball sliding on a quadrangular stem, whose extremity screws into the collar of the holder. The rackwork and micrometric screw of the Microscope are, as is readily seen in the figure, available for focussing and adjustment. In order to be able to fit in loups of different diameters, the inventor makes use of a kind of small vice with parallel grip, actuated by a screw. The whole arrangement allows to the worker great freedom of position, and especially secures his face from contact with the apparatus.

For the convenience of those who may prefer the loup-holder to be

* Journ. App. Micr., 1901, p. 1155 (1 fig.).

† Arch. Anat. Micr., 1900, pp. 424–8 (2 figs.).

quite independent of their Microscope, M. Malassez has arranged (fig. 57) a heavy foot and a parallelogram holder (the same as in fig. 56), which terminates in a toothed wheel engaging in an endless screw fixed on the foot. By turning this screw the parallelogram can be raised or depressed, and thus the loup can be mechanically adjusted.

Fig. 56.

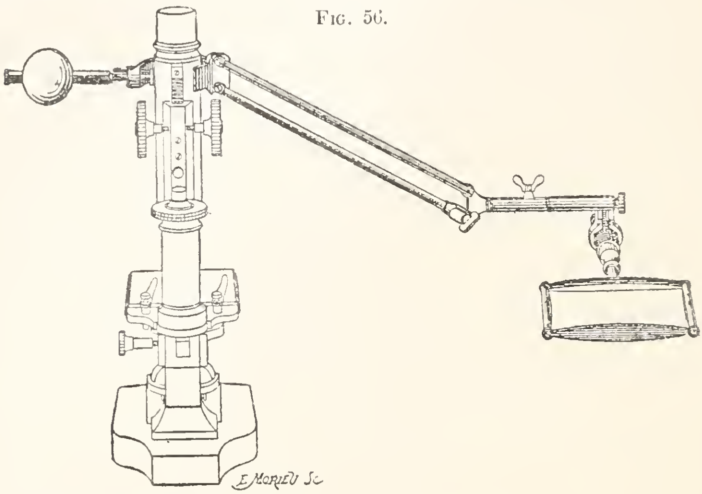
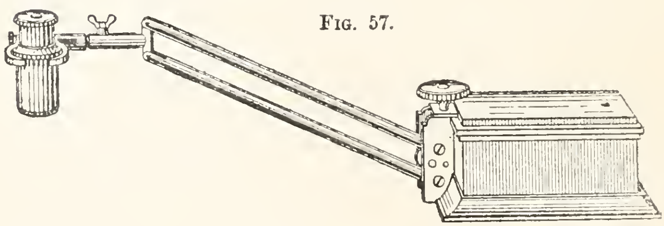


Fig. 57.



B. Technique.*

(1) Collecting Objects, including Culture Processes.

Sand-Filter for Agar.†—Th. Paul has found that sand is an excellent material for filtering agar. He has devised a sand-filter, the construction of which is as follows:—The apparatus consists of a couple of enamelled iron vessels, one of which fits on the top of the other (see fig. 58). The bottom of the vessel is sieved, and this vessel contains five strata of gravel and sand; first, coarse and fine gravel, then sand, and

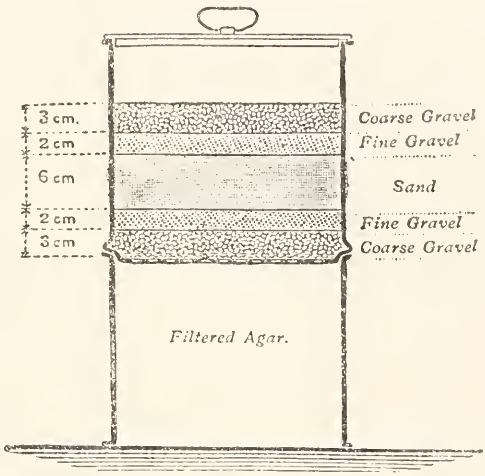
* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

† Münch. Med. Wochenschr., 1901, No. 3. See Centralbl. Bakt., 1te Abt., xxix. (1901) pp. 270–1 (1 fig.).

then coarse and fine gravel again. Each stratum is separated by a layer of gauze.

Boiling hot water is first run through the apparatus. It is then placed in a steamer until the whole is heated to 100°, after which the boiling-hot agar may be introduced. The apparatus acts very rapidly, and turns out quite clear agar.

FIG. 58.



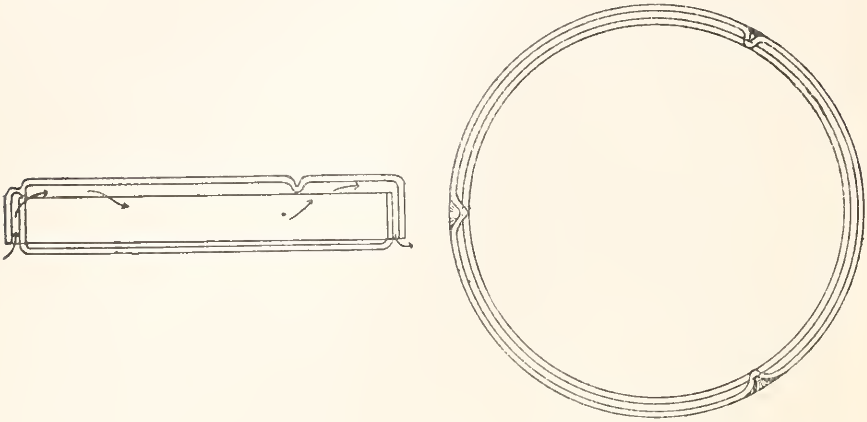
New Method of Obtaining Pure Cultures.* — S. L. Schouten has devised a delicate procedure for obtaining pure cultures of bacteria by selecting an individual cell with the aid of the Microscope. An extremely thin layer of vaselin is spread on a cover-glass. On the cover-glass are placed a drop of very dilute culture and a drop of sterile nutrient medium. The cover-glass is then placed in a moist chamber, which is perforated on two sides. Through the apertures pass two small glass hooklets, by means of which the culture drops in the chamber can be manipulated. The chamber is then placed under the Microscope (oil-immersion), when the culture-drop and the medium-drop will be seen lying close together, and the water in the chamber as minute droplets on the vaselin layer. The bacteria are sought for and isolated by means of one of the hooklets, which are worked by micrometer screws. In this way a single bacterium is fished out and deposited in one of the water-droplets. When the operator is satisfied that there is only one bacterium, the microbe is transferred by means of the other glass hooklet to the drop of culture-medium. The glass needles are about 5 μ thick, and the hooklets about 30 μ diameter.

By this method the fission of a single bacterium, the formation of a colony, and so on, can be observed, and the isolation effected in a liquid medium, which is not possible by Koch's method.

* Verslagen van het Geneesk. Congres, 1899. See Centralbl. Bakt., 1te Abt., xxix. (1901) pp. 363–4.

Ventilated Dish for Bacterial Cultures.*—G. C. Whipple has devised a ventilated dish (see fig. 59), the cover of which is supported about 2 mm. above the lower plate by means of three projections. These projections are indentations in the glass cover, and are obtained by heat-

Fig. 59.



ing the edge and pressing the softened glass with a sharp point. The sides of the cover are made deeper than in the Petri dish by an amount equal to that which the cover is raised above the dish. With the cover thus elevated these obtain free circulation of air. These dishes are suitable for anaerobic as well as aerobic cultivations.

Incoagulable Blood as a Culture-Medium.†—F. J. Bosc recommends incoagulable blood for the cultivation of certain parasites, such as *Coccidium oviforme*, and those of cancer, vaccinia, and syphilis. Blood is rendered incoagulable by means of extract of leech-heads. The powdered extract obtained by hardening the leech-heads in absolute alcohol is boiled with water, and after filtration is preserved in sterilised bottles. It is used either by adding it to the drawn blood, or by injecting it into the veins of animals.

Medium for Cultivating Chromogenic Bacteria.‡—E. M. Chamot and G. Thiry recommend the following procedure for the cultivation of chromogenic bacteria. Large potatoes, and such as are known to become mealy and porous on boiling, are selected. These are boiled with their skins on till cooked through. The water is then poured off and the potatoes allowed to cool, after which they are peeled and cut into slices 1 to 2 cm. thick. The slices are immersed for about 18 hours in a dilute solution of sodium hydroxide. The slices are drained and then transferred to covered glass capsules (100 mm. diam. and 50 mm. deep); a little water is added, and the medium steam-sterilised on three successive days. The strength of the sodium hydroxide solution is given as

* Journ. Applied Microscopy, iv. (1901) pp. 1197–8.
† C.R. Soc. de Biol de Paris, lii. (1900) pp. 1052–5.
‡ Bot. Gazette, xxx. (1900) pp. 380–2.

0·25 to 0·5 per cent., and it also contains a little calcium phosphate. The potato becomes stained throughout of a deep indigo colour. After becoming nearly black the pigment fades, ultimately assuming a dirty-brown hue. The blue pigment is soluble in water and dilute alcohol. Dilute alcohol is used for extracting the pigment from the medium; the alcoholic extract is passed through a porcelain filter. The pigment is purified by precipitation with alcohol and re-dissolving in water, the procedure being repeated several times.

Cultivation of Ducrey's Bacillus.—G. Maréchal* obtained, on ascitic serum, pure cultures of the bacillus found in soft chancres, Ducrey's bacillus. The serum was used alone, and in conjunction with agar, gelatin, ox and horse serum. The microbe had the typical figure of 8 appearance. When transferred to slightly acid urine it became five or six times the usual length, and often presented appearances similar to the streptobacillus of Unna. When pure cultures were injected into the peritoneal sac of guinea-pigs, the animals died in 12 hours, while subcutaneous inoculations reproduced the appearances of soft chancre.

F. Besançon, V. Griffon, and L. Le Sourd † recommend "sang gelose" for cultivating the bacillus of soft chancre, as typical colonies develope in 24 hours, and attain their full growth in 48 hours. The medium is rabbit's blood mixed with agar.‡

Cultivation of Microbes of Vaccinia and Variola. — Dr. S. M. Copeman § used collodion capsules filled with beef-broth. These, having been inoculated with a trace of glycerinated vaccine-lymph, were sealed up and placed within the peritoneal sac of rabbits and dogs. In successful cases (i.e. when the capsules did not rupture) it was found that an appreciable amount of serum albumen had dialysed through. On making film preparations of such unruptured capsules and staining with methylen-blue, numerous zooglœa masses were detected. These masses consisted of bodies resembling spores, only the periphery of which took the stain. These apparently represent the resting stage of the specific microbe. The contents of these capsules produced a typical eruption of vaccinia in the calf. Organisms similar in appearance were observed in the epithelium of vesicles in vaccinia of the calf and in human small-pox.

Dr. M. Funck ‖ has found in vaccinia and variola a protozoon, *Sporidium vaccinale*, which may be conveniently examined in emulsions of glycerinated vaccine with bouillon or physiological salt solution. The organism occurs as—(1) round bodies 2–10 μ in diameter, of a brilliant green colour, and exhibiting slow movements; (2) brilliantly green spherules 1–3 μ in diameter, packed within epidermal cells; (3) raspberry like bodies, with a diameter of 25 μ or more. These cysts are full of spores, and are termed sporoblasts. These sporoblasts were isolated by the following procedure:—Some pure vaccine was spread on a disc of ordinary agar and incubated for 24 hours. The preparation was then placed under a Microscope and the sporoblasts fished out with a platinum wire. The spores were made into an emulsion with bouillon and

* C.R. Soc. Biol. de Paris, lii. (1900) pp. 1115–7.
† Tom. cit., pp. 1048–51. ‡ See this Journal, 1900, p. 391.
§ Brit. Med. Journ., 1901, i. p. 450. ‖ Tom. cit., pp. 448–9.

inoculated on a calf, which about the tenth day exhibited the characteristic pustules.

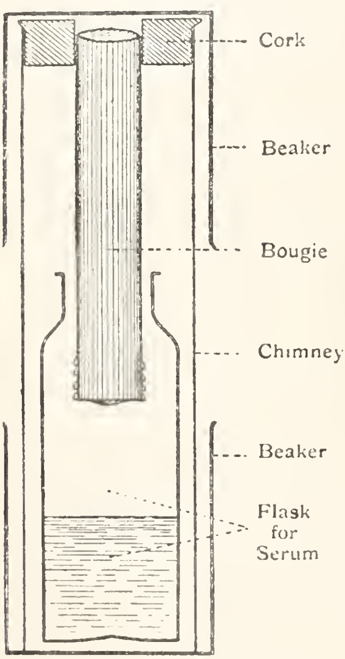
Medium for Bacteriological Examination of Water.* — Dr. P. Müller finds that far more species of water bacteria develope on albumose-agar (Heyden's *Nährstoff*) than on ordinary alkaline nutrient bouillon, and that the difference in the number of germs developed in the two media is greater when the water is less impure than in waters much contaminated.

(2) Preparing Objects.

Permanent Preparations of Bacterial Cultures.† — Dr. Th. Paul makes permanent preparations of cultures in Petri dishes after the following manner:—The cover of the culture-dish is grooved so as to fit accurately into the upper edge of the dish. The cultures are killed with pure formalin. A circular piece of filter paper soaked in formalin is placed over the dish and the lid put on, after which the whole is placed in a tin box. A vessel filled with formalin is also placed inside the box. In a few days the culture is quite dead. The cover is then fastened on. The groove is filled with finely powdered white sealing-wax. The lid is placed in a hot-air steriliser to melt the wax. Meanwhile, the dish is placed upside down on a hot metal plate, so as to heat the edge of the dish. When ready the dish is inserted into the groove and pressed down. When cold the cover and dish are firmly united, and the apparatus is rendered perfectly air-tight.

If a large number of preparations are required a special gas-stove is advisable.

Fig. 60.



Method for obtaining Sterile Blood-Serum.‡ — C. G. Schoneboom obtains sterile serum by filtering through a porcelain bougie without artificial pressure. One end of an ordinary lamp-chimney is plugged with a cork, which is perforated to admit the bougie, the lower end of the latter dipping into a flask or other suitable vessel (see fig. 60). The chimney is placed inside a beaker, and its upper end covered with another. Some dozen or so of these apparatus are put up, and having been placed on a hot-air steriliser at 160° for an hour, are allowed to cool in a quiet room or cellar. The

* Arch. f. Hygiene, xxxviii. (1900) pp. 350–66.
† Centralbl. Bakt., 1te Abt., xxix. (1901) pp. 25–9 (3 figs.).
‡ Tom. cit., pp. 210–1 (1 fig.).

serum may be poured off two or three times a day. The bougies are cleaned by standing them in water, frequently changed, for some days, and then sterilizing them in a muffle furnace.

New Method of Fixing Blood-Films.*—W. F. Whitney recommends a modified Zenker's fluid (potassium bichrom. 2; sodii sulph. 1; water 100; this is saturated with sublimate while warm and 5 p.c. glacial acetic acid added at time of fusing). The author substitutes 5 p.c. nitric acid for the acetic acid. The fluid is dropped on the film and allowed to act for a few seconds, or while counting twenty. It is then washed in running water, and afterwards the triacid stain applied for about 3 minutes.

New Method for Isolating the Typhoid Bacillus from Water.†—Dr. L. Remy's method for isolating the typhoid bacillus consists of two procedures, the direct and the indirect.

A. Direct.—To a tube of differential gelatin, i.e. containing 0·5 per thousand H_2SO_4, lactose 3 p.c., phenol 0·25 per thousand, are added $\frac{1}{20}$, $\frac{1}{10}$, $\frac{1}{2}$ ccm. of water, according to its origin. This makes plate i. Plate ii. is made with the same gelatin, but contains 0·5 per 1000 of carbolic acid. As better results are obtained from large plates, it is advisable to use, instead of 10 ccm. of gelatin, 25 or 50 ccm., and add 2·5 ccm. of water, or more.

B. Indirect.—10, 20, 50 ccm., according to the water to be analysed, are introduced into a flask containing carbolised acidulated bouillon. The proportion should be such that the mixture of bouillon and water contains 0·5 per 1000 of sulphuric and carbolic acids. After 22–24 hours at 25°–30°, differential plates are made. To these 0·25 and 0·5 per 1000 carbolic acid are added. The plates are kept at 20°. On the second or third day the colonies may be examined. Those which are deep bluish or bluish-white usually contain typical typhoid bacteria. If there be few colonies, they should be re-sown in bouillon heated to 35°–37°. When the gelatin cube is liquefied, the tube is shaken and then kept at 25°–30°. It should be particularly noted that typhoid bacteria from water often form scums on bouillon.

(3) Cutting, including Imbedding and Microtomes.

Improvised Microtome.‡—J. L. Powers describes a microtome devised by Dr. Shurtleff, and as it is intended for home manufacture, and possibly for consumption, it may be advisable to adopt the writer's own terms:—"The first essential is, of course, a knife, and while a regular section razor is preferable, an ordinary razor will answer. In the absence of either, however, I have seen a shoe-knife successfully used, but in this case the back was strengthened by soldering a knitting-needle on one side, and a rod cut from a stove-poker on the other. Assuming, then, that a knife is at hand, the next requisite is the holder, which consists of a piece of wood about 4 by 7 in., having a U-shaped cut-out at the top, 2 in. wide and 3 in. deep. This leaves two prongs each an inch wide, into which small wire nails are driven, so that the razor R may rest upon them when it is in

* Journ. Boston Soc. Med. Sci., v. (1901) pp. 341–2.
† Ann. Inst. Pasteur, xv. (1901) pp. 145–60. See also this Journal, 1900, p. 639.
‡ Journ. Applied Microscopy, iv. (1901) pp. 1163–4 (2 figs.).

position. Spring clips of some sort hold the razor firmly in place. For the clips stout wire an eighth of an inch thick is good. Each wire may be fastened to the board by double-pointed tacks. Near the bottom of the board, and in the centre, is the screw S (fig. 61). A common screw will answer, but a fine-threaded screw, passing through a nut, is better. In either case, however, a large disc may be soldered to the screw-head for increased delicacy in operation. The 'holder' complete is now, by means of a pair of hooks and eyes, to be made attachable to the end of a box, so that turning the screw gives a delicate movement to the razor. The screw-point should work against a small metal plate on the box. Tension is secured with a rubber band or spiral spring. Reference to the diagram (figs. 61, 62) will make the idea clear. The 'holder' should be so placed that the razor-edge will be two or more inches higher than the top of the box. Now, when an adjustable object-holder is provided, the microtome is completed. To make the object-holder, a board somewhat shorter than the box, a block, and a straight-grained stick about half an inch in cross-section, are necessary. Fasten the block near one end of the board, nail the stick to the block

Fig. 61.

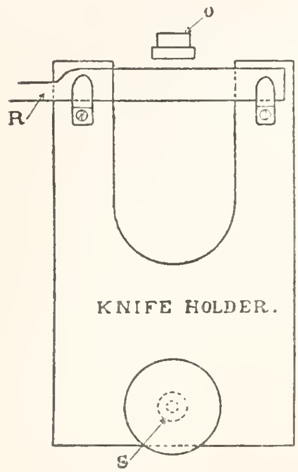
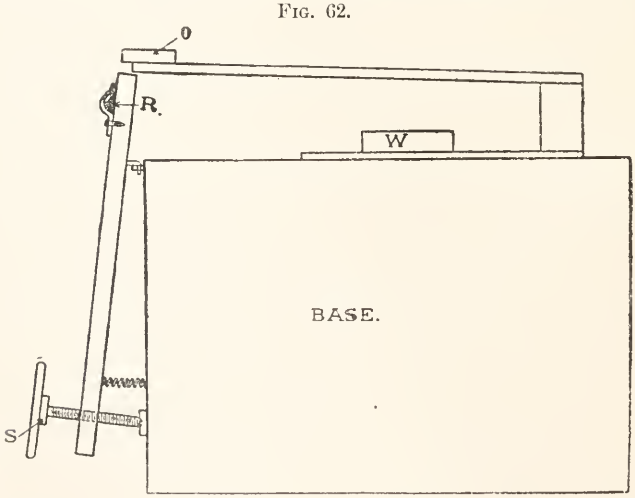


Fig. 62.



(as indicated in the diagram), and the microtome is ready for service. In use the paraffin block O is fastened to the end of the stick with melted paraffin, and proper adjustments are made with reference to the razor. Then downward pressure on the stick cuts the section, while clockwise movement of the screw regulates the thickness. Serial sections are readily made if the paraffin block is carefully squared; but for this work the object-holder should be steadied by a weight W of five or six pounds."

(4) Staining and Injecting.

Spore Staining.* — Dr. H. Marx stains spores in the following simple manner :—A large loopful of culture or the condensation water is placed on a cover-glass and carbol-fuchsin added. The mixture is boiled four or five times successively, after which it is evaporated down to dryness. The preparation is then decolorised in 25 p.c. nitric acid, and after-stained with Loeffler's methylen-blue.

By this procedure are stained not only spores actually formed but such as are in process of formation.

Simple Method for Staining Flagella.†—Dr. A. Peppler describes a method for staining flagella, and gives numerous instances of its success. The mordant is composed of tannin and chromic acid, and is made by adding 15 parts of an aqueous sulphuric-acid-free 2·5 p.c. solution of chromic acid to a solution of 20 parts tannin in 80 distilled water. The latter is prepared by heating in a water-bath and cooling down to 20°. The chromic acid is added in small portions and continually stirred the while. After standing for four to six days the mordant is filtered. The staining solutions recommended are carbol-gentian-violet, and carbol-fuchsin. For all bacteria except the spore-formers it is advisable to use slides and not cover-glasses. Instructions are given that the slides must be perfectly clean, after which follow details for making the films from agar cultures. The films are air-dried and fixed in the usual way. The mordanting and staining are carried out at room temperature. The mordant is poured or filtered over the slide and allowed to act for one to five minutes, according to the age of the culture and other circumstances. The mordant is then poured off and the slide washed in running water. The still wet slide is next stained, the solution being allowed to act for two minutes. The slide is thereupon washed and dried without delay on filter-paper.

Anilin-blue for Staining Bacteria.‡ — MM. Guiraud and Gautié recommend a saturated aqueous solution of anilin-blue for staining bacteria. The films are made in the usual way and then the stain poured on. The cover-glass is heated two or three times successively until the stain vaporises, after which it is washed in water and mounted.

Staining Gonococci with Neutral Red.—R. Herz § uses a 0·5 p.c. aqueous solution of neutral red placed on the slide, and on this is put a cover-glass with a drop of pus.

P. Richter || uses 0·25 p.c. aqueous solution of neutral red, made with the aid of heat. The air-dried unfixed film is stained with a cold solution.

* Centralbl. Bakt., 1te Abt., xxix. (1901) pp. 11, 12 (3 figs.).
† Tom. cit., pp. 345–55.
‡ C.R. Soc. de Biol. de Paris, liii. (1901) pp. 190–2.
§ Prag. Med. Wochenschr., 1900, No. 10.
|| Dermatol. Zeitschr., vii. (1900) No. 2. See Centralbl. Bakt., xxviii. (1900) p. 711.

Method of Distinguishing Bacillus Coli Communis from Bacillus Typhosus by the use of Neutral Red.* — W. Hunter has found that *Bacillus coli communis* possesses, to a marked degree, the power of reducing neutral red, producing a superb canary-yellow fluorescent colour of the medium. The *Bacillus enteritidis* Gaertn. also produces this reaction, and is probably only a variety of *B. coli*. *Bacillus typhosus* and the common pathogenic microbes do not give the reaction. By means of neutral red the presence of *B. coli* can be diagnosed with certainty within from 12 to 24 hours, and it is possible, by means of this reagent, to distinguish members of the coli group from those of the typhoid group.

This method appears to be applicable only to tubes and not to plate cultures. The most satisfactory medium is glucose-agar with 0·3 p.c. of glucose. From 0·1 to 0·5 ccm. of a saturated aqueous solution of neutral red are added to 10 ccm. of the medium.

Diagnostic Staining of the Malaria Parasite.†—Dr. R. Reinhold suggests that the films should be made by having the blood on the back of the cover-slip which is drawn along the slide, so that the blood follows instead of being pushed along.

In fresh films he uses a solution made of 100 ccm. of water and 0·2 p.c. soda. This is heated, and to the boiling fluid 0·3 p.c. methylen-blue (Höchst) is added. The solution is allowed to cool, and filtered 48 hours later.

For films 4 weeks or more old, 1 p.c. methylen-blue must be added.

Staining Diphtheria Bacteria.‡—Dr. Piorkowski recommends the following procedure :—Stain for 1 minute in Loeffler's methylen-blue slightly warmed. Decolorise with 3 p.c. hydrochloric-acid-alcohol 5 seconds, wash with water, and after-stain with 1 p.c. aqueous eosin solution for 5 seconds. The superfluous water is removed by filter paper. The preparations are to be examined in water, as the polar and central granules are better seen.

Modification of the Romanowski-Ruge Method of Staining Protozoa.§—W. Hanna recommends Berestneff's modification of Romanowski's method for staining the *Plasmodium malariæ* and other Protozoa. A 1 p.c. aqueous solution of methylen-blue (Höchst) containing 0·3 p.c. carbonate of soda, is heated for 3 hours in a water-bath and filtered. One ccm. of this solution is mixed with 1·5 ccm. of a 1 p.c. aqueous solution of methylen-blue, and to this mixture are added 5 ccm. of a 1 p.c. aqueous solution of eosin (extra B A Höchst). Old preparations of semilunar bodies and *Halteridium Danielewskii* require 15 to 20 hours at laboratory (? incubator) temperature. Young forms stain in 15 to 20 minutes in alcohol, followed by gentle heating for 15 to 20 minutes. The preparations are placed in the following solution for 2 to 5 seconds :—10 ccm. methylen-blue 1 p.c., 200 ccm. distilled water, and 0·25 ccm. acetic acid. They are next washed and dried, and then dipped for from 5 to 20 seconds in absolute alcohol, after which they are washed again in water.

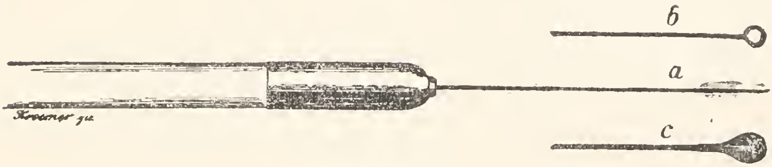
* Lancet, 1901, i. pp. 613–5.
† Deutsch. Med. Wochenschr., xxvi. (1900) pp. 447–8 (1 fig.).
‡ Zeitschr. f. angew. Mikr., vi. (1901) pp. 281–3. § Lancet, 1901, i. p. 1010.

Fresh malaria blood-films fixed in alcohol are stained by this mixture diluted with 2 to 4 volumes of water in 5 minutes without heat, followed by gentle heating for 5 to 10 minutes. For Trypanosoma blood the mixture is used undiluted, or diluted with 2 volumes of water.

(6) Miscellaneous.

Platinum Needles with Capped Handles for Bacteriological Purposes.*—Prof. A. Meyer says that it is advantageous to have a platinum

FIG. 63.



cap to needle-holders. The cap, as shown in the illustration (fig. 63), fits over the end of a glass handle. The needles may be straight, with a loop or with a spatula end.

Convenient Source of Artificial Light for the Laboratory Table.†—W. Krauss has devised an easily adjusted light for the laboratory table which does not interfere with daylight. The device consists in reflecting the light of a ground glass incandescent bulb from a mirror arranged at a convenient angle. The bulb may be placed on the table or beneath it. In the latter case a trapdoor must be cut in the table and the mirror fixed to the under surface of the flap.

Ostwald's Thermoregulator.‡—Th. Paul has adapted W. Ostwald's thermoregulator to incubators. The apparatus, which is extremely easy to manage and of simple construction, consists of two parts, a tube and a top-piece. The tube is filled with 10 p.c. chloride of calcium solution. The top-piece is practically a U-shaped tube containing mercury, one arm of which is connected with the calcium chloride cylinder and the other with the gas arrangement.

The special advantages are that it is easily cleaned and that it works very satisfactorily.

Paraffin Blocks for Celloidin Sections.§—W. W. Babcock has found that paraffin with a high melting-point forms a ready and suitable basis for celloidin blocks. The paraffin cake is scored on one surface by a series of oblique incisions, with another set of incisions at right angles. In this way a surface is covered with slanting teeth sufficient to hold the celloidin block when stuck on in the usual way.

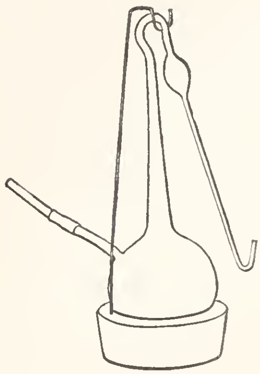
Camera Lucida for Counting Blood-Corpuscles.‖—Dr. A. L. Benedict recommends the camera lucida for counting blood-corpuscles. The lines of a hæmacytometer are drawn on a piece of cardboard by means of the camera, and the count made by reflecting the lines back on to

* Centralbl. Bakt., 1te Abt., xxix. (1901) pp. 260–1.
† Journ. App. Microscopy, iii. (1900) pp. 1086–7 (1 fig.).
‡ Centralbl. Bakt., 1te Abt., xxix. (1901) pp. 129–33 (1 fig.).
§ Journ. App. Microscopy, iii. (1900) pp. 1090–1. ‖ Tom. cit., pp. 1087–9.

the microscopic field. To make the lines as plain as possible, a green background with lines in red is used.

Device for Supporting Pasteur Flasks.*—Miss K. E. Golden has devised a support for Pasteur flasks which as the illustration (fig. 64) shows permits greater freedom and safety in manipulation than is obtained by the ordinary collar support. The device consists of a wooden disc $5\frac{1}{2}$ in. in diameter and 2 in. thick. The disc is hollowed out into a concavity suitable for the bottom of the flask. One end of a piece of heavy brass wire is fastened into the base, the other being adapted to the bend of the tube so that the flask is supported in the erect position.

Fig. 64.



Demonstrating Presence of Bacillus typhosus in the Blood of Typhoid Fever Patients.† — Dr. M. Auerbach and Dr. E. Unger succeeded in demonstrating the presence of *B. typhosus* in blood taken aseptically from the median vein, seven times out of ten trials. They used about 300 ccm. of ordinary bouillon, and added to each flask 10, 20 or 30 drops of blood. Hanging-drops taken from the flasks were examined 18–24 hours afterwards, and if negative again 24 hours later. Identification was further assured by cultivation on agar slopes, milk, and grape-sugar-bouillon.

Margin of Error in Bacteriological Diagnosis.‡ — Dr. J. O. Symes remarks that at the present time there is danger lest undue importance be attached to bacteriological diagnosis. With regard to typhoid it is not generally recognised that all cases do not give the same reaction, that the agglutination phenomenon may not present itself until late in the disease, or that it may be present at one period and absent at another. In diphtheria the finding of the Klebs-Lœffler bacillus is of value in cases presenting doubtful clinical symptoms, but is of less importance when symptoms of disease are absent or when the exact nature of the organism is doubtful. Failure to find the bacillus is only of value when confirmed by repeated observations.

In cases of general blood infection a bacteriological examination is often of the greatest value. The blood (not less than 2 ccm.) should be drawn from a vein by means of a sterile syringe and then spread over the surface of agar or other media and incubated. If rigid aseptic precautions are observed the margin of error is very small, and though a negative result cannot be accepted as proof of the absence of organisms, a positive result is of the highest importance.

In the examination of serous fluids, pus or section of tissues for tubercle bacilli, the margin of error is very great if reliance be placed on negative results. In actual practice the only organism likely to cause

* Journ. App. Microscopy, iv. (1901) p. 1157 (1 fig.).
† Deutsche Med. Wochenschr., xxvi. (1900) p. 796.
‡ Brit. Med. Journ., 1901, i. pp. 451–2.

confusion is the smegma bacillus; hence if the urine is to be examined for tubercle bacilli, it should be drawn off with aseptic precautions, and the acid-decolorised films further treated with alcohol for at least 30 minutes.

Error in diagnosis is frequently due to the fact that cultures only are made and no films prepared. For example, the films may show an organism which has failed to grow because the composition or the environment of the media has been unsuitable. Whenever possible films should be prepared and stab cultures made in glucose media.

Action of Formalin on Foul-brood of Bees.* — Prof. B. Galli-Valerio has found that hives infected with *Bacillus alvei* may be effectively purified by the action of formalin vapour. The applications are frequent and discontinuous. The formalin is applied by means of a spray apparatus specially constructed for the purpose.

Experimental Vaccinia.†—Dr. A. Calmette and Dr. C. Guérin have reinvestigated the observations of Gailleton and others relative to the receptivity of the rabbit for vaccinia. They find that the inoculation of vaccine on a rabbit is always followed by a confluent eruption of lymph-vesicles, provided that the skin be merely shaved and not scratched. The rabbit is an excellent control for ascertaining the virulence of vaccine derived from heifers and infants, and also of glycerinated vaccine. Only the skin participates in the multiplication of the vaccine elements. Aseptic vaccines may be obtained by inserting the virus in the peritoneal sac of rabbits after previous injection of bouillon. After a few hours the vaccine is purified of bacteria by the agency of leucocytes, which do not affect the vaccine virus.

Photography by Means of Photo-Bacteria.‡—R. Dubois has taken photographs by the light emitted from cultures of photobacteria. Ten to twelve hours were required to obtain a good negative, which shows that the number of chemical rays is very small in proportion to the light rays. The same remark applies to the heat rays.

Relation of the Chemical Composition and Microscopical Structure to the Physical Properties of Iron and Steel.§—In the course of his report at the third International Congress of Chemists at Vienna, H. Juptner von Jonstorff summarises the structural characters, which may be microscopically distinguished in pure carbon steel, as follows:—

1. Blow-holes.
   (*a*) If rough, they are empty, or contain air.
   (*b*) If smooth, they contain hydrogen and carbon monoxide.
2. Slag.
3. Graphite, in thick flakes, which in section appear as straight or crooked lines; they are often detached by the polishing, and leave "graphite crevices" easily seen under the Microscope; only found in iron rich in carbon.
4. Ferrite, i.e., pure (or nearly pure) iron; only found in steel poor in carbon.

* Centralbl. Bakt., 1te Abt., xxix. (1901) pp. 127–9 (2 figs.).
† Ann. Inst. Pasteur, xv. (1901) pp. 161–8.
‡ C.R. Soc. de Biol. de Paris, liii. (1901) pp. 133–4.
§ Metallographist, i. (1899) pp. 222–47 (4 figs.).

5. Cementite, i.e. the separated carbide of iron, Fe_3C; occurs in steels rich in carbon.

6. Martensite; probably a solution of Fe_3C in iron; occurs only in steel hardened above 600° or 700° C.

7. Austenite, an alloy rich in carbon, less hard than 5 and 6, and, in the author's opinion, a solution of elementary carbon in iron; as yet has been only found in steel containing over 1 p.c. of carbon, and suddenly cooled from a high temperature.

8. Pearlite, a mixture of ferrite and cementite, to which perhaps may be added sorbite; it may be lamellar or granular.

9. Sorbite appears, under certain conditions in pearlite as a third constituent; it may be some residual martensite, which did not have time to be decomposed into ferrite and cementite.

10. Troostite is found as a jagged and stringy constituent between martensite and cementite, and may hold a relation to these constituents similar to that held by ferrite to cementite in pearlite.

Microstructure of Manganese Steel.*—Mr. F. C. Lau illustrates by four photomicrographs the appearance and disappearance of certain mysterious dark discs in quenched manganese steel. He believes that these discs are composed of cementite which, in the case of manganese steel, would be a double carbide of iron and manganese. He has occasionally noticed a similar appearance in carbon steels, with the difference that the discs appear white and brilliant.

Microscopic Structure of Gold and Gold Alloys.†—Thos. Andrews finds, by means of numerous etchings and micrometer measurements, that pure gold crystallises in the regular cubic system and its modifications.

Gold alloyed with bismuth, lead, silicon, tellurium, or potassium, was also examined, the composition being generally 99·80 p.c. of gold to 0·20 of the baser metal. In all cases crystals of pure gold were found to be imbedded in a more or less intricate meshwork of alloy, thus throwing light upon the known changes in its physical properties. This alloy is the eutectic. The author discusses the views of other writers on gold alloys.

Microstructure of Alloys of Iron and Nickel.‡—M. Osmond finds that these alloys may be divided into three groups:—(1) those not containing above 8 p.c. of nickel; (2) those containing from 12 to 25 p.c. of nickel; and (3) the non-magnetic alloys containing about 25 p.c. of nickel, and those which resume their magnetic properties owing to an excess of nickel (30 to 50 p.c.). The author finds that the study of the microstructure of these alloys confirms the classification based on their mechanical properties. Additional evidence is afforded that the principal properties of steels are a function of the position of their points of transformation on the scale of temperature. Alloys of iron and nickel are also found to acquire the interesting property of schistosity under forging. This is revealed by all etching methods, giving rise to the formation of bands alternately more or less attacked, surrounding each

* Metallographist, i. (1899) pp. 337–9 (4 figs.).
† Tom. cit., pp. 105–25 (10 figs.).
‡ Comptes Rendus, May 9, 1898; and Metallographist, i. (1899) pp. 69–71.

other, and making it possible to follow the distribution of the distortion produced by forging or rolling.

Micro-Chemical Examination of Lead-Antimony Alloys.* — J. E. Stead has made a laborious investigation of these compounds. He finds that the eutectic alloy has a percentage composition of 12·8 of antimony and 87·2 of lead, corresponding nearly with the formula Pb_4Sb. Its fusible point was 247° C., and specific gravity 10·48. Microscopicay examination of the eutectic showed a structure similar to that of other well-investigated alloys. At fairly equable distances apart, what appeared to be laminæ radiated from nuclei and continued in right lines until met by similar radiations from other nuclei. The appearance is similar to that of nodules of pyrites with radial structure or spherulites in obsidian. Further examination showed that these laminæ split up into excessively fine rod-like bodies, which, but for their absolute opacity, might be mistaken for certain forms of bacteria. It appears certain then that the eutectic alloy is composed of alternate laminæ of lead and antimony, each lamina being itself composed of crystals. In spite of the composition Pb_4S, there does not appear to be chemical union between the lead and the antimony.

Study of White Alloys called Antifriction.† — M. Charpy, after an exhaustive investigation, concludes that all the alloys used for anti-frictional purposes possess the same general characteristics; they are composed of hard grains imbedded in a plastic alloy. This constitution fulfils the two requirements of bearing alloys· the load is carried by the hard grains which have a low coefficient of friction, and the "cutting" (*grippement*) of which can take place only with great difficulty; the plasticity of the cement makes it possible for the bearing to adjust itself closely round the shaft, thus avoiding local pressures which are the principal cause of accidents. Such constitution may be produced in binary alloys, the hard grains being made up by a single metal such as antimony, or by a definite compound such as antimonide of zinc. It is generally preferable, however, to use ternary mixtures, because, owing to the complex composition of the cement, the constitution possessing the required qualities may be more readily obtained.

Microstructure of Cementation.‡ — Professor J. O. Arnold, after a thorough micrographic study of cemented iron bars, arrives at the following provisional conclusions:—(1) That the diffusion of carbon in the process of cementation presents two distinct varieties of "interpenetration": (*a*) The interpenetration of the substance corresponding with the formula $Fe_{24}C$ and pure iron; (*b*) the interpenetration of the normal carbide Fe_3C and the sub-carbide $Fe_{24}C$. (2) That the interpenetration of $Fe_{24}C$ and iron is more rapid, and takes place at a lower temperature than the interpenetration of $Fe_{24}C$ and Fe_3C. (3) (*a*) That the interpenetration of $Fe_{24}C$ and Fe begins at Ar_2 (about 750° C.), and is coincident with the evolution *in vacuo* of gases from the iron: (*b*) that the interpenetration of $Fe_{24}C$ and Fe_3C does not take place till a temperature of about 950° C. has been reached.

* Metallographist, i. (1899) pp. 179–92 (2 figs.).
† Tom. cit., pp. 9–55 (29 figs.). ‡ Tom. cit., pp. 56–69 (11 figs.).

Diffusion of Elements in Iron.* — Professor J. O. Arnold and A. M'William have conducted experiments for the investigation of this remarkable phenomenon. It has been known since 1897 that when steel and wrought iron are heated *in vacuo* for some time the steel not only loses carbon to the iron, but that the loss by the steel is exactly equal to the gain by the iron. Hence the question arises whether the carbon exists under such condition in a melted state and passes as an elementary substance, or whether it diffuses as a carbide. The authors have elaborately investigated the subject, and their conclusions drawn from their photomicrographic observations are strongly in favour of the probability of the diffusion of the carbon as a carbide. This property seems also to be shared by the sulphide and oxy-sulphide.

BIBLIOGRAPHY.

Fifth Report of the Alloys Research Committee.
[Professor Sir W. C. Roberts-Austen in this report produces the series of typical photomicrographs of irons and steels, which will form a useful reference set.] *Metallographist*, i. (1899) pp. 186–222 (66 figs.).

The Relation between the Microstructure of Rolled Steel and its Physical Properties.
[Several controversial letters on this subject.]
Metallographist, i. (1899) pp. 71–9.

CLAMER, G. H.—**The Microstructure of Bearing Metals.**
Journ. Franklin Inst., 1898, p. 188; and *Metallographist*, i. (1899) pp. 139–49.

HEYN, E.—**Microstructure of Steel.**
[Contains some 45 photomicrographs, illustrating many aspects of the subject.]
Stahl und Eisen, Aug. 1 and 15, 1899: and *Metallographist*, i. (1900) pp. 52–64, with the complete set of photomicrographs.

MORSE, R. G.—**The Effect of Heat-treatment upon the Physical Properties and the Microstructure of Medium Carbon Steel.**
[The author gives a careful account of his experiments, but thinks that, in the present state of knowledge, it is unwise to draw conclusions.]
Metallographist, i. (1900) pp. 130–45 (23 figs.).

OSMOND, F.—**Influence of Low Temperatures upon certain Steels.**
[Contains a photomicrograph of a cemented carbon steel quenched at 1050° C. in liquid air.] *Metallographist*, i. (1899) pp. 258–61 (1 pl.).

OSMOND, F.—**On the Crystallography of Iron.**
[A very useful treatise on the subject.]
Annales des Mines, Jan. 1900; and *Metallographist*, i. (1900) pp. 181–220 and 275–90 (55 figs.).

OUTERBRIDGE, A. E., JUN.—**A Study of the Microstructure of Bronzes.**
Journ. Franklin Inst., 1899, p. 18; and *Metallographist*, i. (1899) pp. 150–2.

PERILLON, M.—**Microscopic Metallography of Steel.**
[The author describes briefly the microstructure of steel, recognising the presence of six constituents:—ferrite, pearlite, cementite, martensite, troostite, and austenite.]
Bull. Soc. de l'Industrie Minérale, xii. (1898) p. 469; and *Metallographist*, i. (1899) pp. 155–7.

ROBERTS-AUSTEN, SIR W. C.—**Importance of the Microscopical Study of Metals.**
Extract from Presidential Address before Iron and Steel Institute, May 1899; and *Metallographist*, i. (1899) pp. 340–5.

,, ,, **On the Action of the Projectile and of the Explosives on the Tube of Steel Guns.**
[The author discusses some of the difficulties likely to be solved by micrographic analysis.] *Metallographist*, i. (1899) pp. 125–9

* Metallographist, i. (1899) pp. 278–305.

SAUVEUR, A.—**Microstructure of Coke and Charcoal Pig Irons.**
[Discusses whether these can be microscopically distinguished.]
Metallographist, i. (1900) pp. 154–6 (2 figs.).

" " **The Constitution of Hardened Steel.**
[A. Sauveur criticises the experiments and conclusions of Messrs. Arnold and M'William on this subject (see p. 344), and dissents from their views.] *Metallographist*, i. (1899) pp. 305–14 (6 figs.).

STEAD, J. E.—**Brittleness produced in Soft Steel by Annealing.**
[A valuable discussion of the subject, illustrated by excellent diagrams and photomicrographs.]
Metallographist, i. (1899) pp. 85–105 (8 figs. and 1 pl.).

" " **Microstructure of Alloys.**
[The author has continued his study of this subject. He mainly treats of alloys of antimony and copper, and briefly of alloys of antimony-tin and copper-tin. The antimony-copper alloys are of no practical value, and were examined for theoretical reasons only. The results are illustrated by 12 very clear photomicrographs.]
Metallographist, i. (1899) pp. 314–34 (12 figs.).

PROCEEDINGS OF THE SOCIETY.

MEETING

Held on the 17th of April, 1901, at 20 Hanover Square, W. William Carruthers, Esq., F.R.S., President, in the Chair.

The Minutes of the Meeting of 20th of March, 1901, were read and confirmed, and were signed by the President.

A letter was read from the Secretary of the Selborne Society inviting the assistance of Fellows of the Royal Microscopical Society as exhibitors of objects under their Microscopes, at a Converzatione to be held at 20 Hanover Square on the evening of May 16th, at the close of the proceedings on the occasion of the Annual Meeting of the Society.

The List of Donations to the Society received since the last Meeting (exclusive of exchanges and reprints) was read, and the thanks of the Society were voted to the Donors.

	From
Coulter and Chamberlain, Morphology of Spermatophytes. (8vo, New York, 1901)	*The Publishers.*
Lambert, F. C., Lantern Slide Making. (8vo, London, 1901)	*The Publishers.*
Piper, C. W., A First Book of the Lens. (8vo, London, 1901)	*The Publishers.*
Journal of the Board of Agriculture, vol. vii. No. 4. (8vo, London, 1901)	*The Board of Agriculture.*

The President said they were to be favoured with a demonstration by Mr. F. Enock on the metamorphoses of *Æschna cyanea*, one of the British dragon-flies. Mr. Enock's work in tracing out the life-history of insects was well known; he had for many years devoted himself to the study of their development, with the result that his patient investigations had made most important additions to biological knowledge.

Mr. F. Enock said that the slides he was about to exhibit were a sequel to endless failures during the last six years in his attempts to obtain a complete set of photographs from life which would show every stage in the metamorphosis of the nymph of the dragon-fly. In his endeavours to accomplish this he had taken over 1000 photographs before he was successful, and he was glad to say that those which he was going to show were all taken from the same individual, and recorded every stage of the process which only occupied a period of six hours. He thought this was worth mentioning, as it was a very different matter from making up a set from photographs taken at various times of different specimens. The early stages of the life of the dragon-fly were passed in the water, and it was only when it was about to change for the last time and become the perfect insect, that it left the water. It was necessary therefore to provide some kind of stem which stood well up out of the water up which the creature could crawl when the change was about to take place. In making his observations he provided himself with a number of the nymphs, and kept them in a bell-glass in which he fixed a stick perfectly upright, and focussed his camera upon the centre line of the stick. Considerable patience was required and constant watching, because, after the first sign of change was noticed, the dragon-fly might emerge at any time during the next three days; but when once the process of emergence began it went on so rapidly that, if the attention of the observer was called off even for a few minutes, it was more than likely that one, and perhaps several, important movements would take place meanwhile; in fact, so quickly did these sometimes occur, that he might say that three of the photographs forming this set were taken within the space of six seconds. His advice to anyone who undertook such observations was to make sure of no interference or disturbance from any well-meaning adviser. After showing a photograph of one of the woodcuts which did duty in many works on natural history as an illustration of the metamophosis of the dragon-fly, and pointing out wherein it differed from what was actually seen in nature, Mr. Enock gave some useful hints on collecting aquatic larvæ, and showed two views of the pond at Golding's Hill which he had found to be an excellent place for this purpose. Photographs of a nymph in the water were next shown to illustrate the remarkable movements of the mask and the manner in which these enabled prey to be seized. The position taken up by the nymph on the portion of a stick above the water was then shown, and in a remarkable series of about thirty slides every stage of the metamorphosis from this point to the fully developed insect with expanded wings was completely demonstrated.

The President having been obliged to leave the Meeting the chair was subsequently occupied by Mr. E. M. Nelson, who said he had listened with very great pleasure to the most interesting demonstration which Mr. Enock had given them, and he was sure that all present must have been struck by the wonderful display of patience shown in pursuing a subject where the ordinary difficulties of photographing from life were so very much enhanced by the circumstances under which they were taken. He hoped that Mr. Enock would some day give them the other demonstration to which he had referred, and he also hoped that some of the Fellows present would be induced to turn their attention to similar methods of observation. Everyone accustomed to lantern work knew how difficult it was to effect such complete accuracy of registration as they had seen that evening; he had been greatly struck by the perfection with which this had been done.

A hearty vote of thanks to Mr. Enock for his very interesting demonstration was, on the motion of the Chairman, carried by acclamation.

The following Object was exhibited:—

Mr. E. M. Nelson:—Polarized Podura Scale.

New Fellows:—The following gentlemen were elected *Ordinary* Fellows of the Society:

Messrs. Chas. H. Johnson and A. Quayle.

MEETING

HELD ON THE 15TH OF MAY, 1901, AT 20 HANOVER SQUARE, W., R. BRAITHWAITE, ESQ., M.D., F.L.S., &c., VICE-PRESIDENT, IN THE CHAIR.

The **Minutes** of the Meeting of the 17th of April last were read and confirmed, and were signed by the Chairman.

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
Rütimeyer, L., Kleine Schriften. Vols. i., ii. (8vo, Basel, 1898)	*Naturforschende Gesellschaft in Basel.*
29th Annual Report of the Local Government Board, 1899–1900. Supplement containing the Report of the Medical Officer for 1899–1900. (8vo, London, 1901)	*The Local Government Board.*

Dr. Hebb said that the Society had since the last Meeting received a communication from His Majesty the King, in acknowledgment of the Address which was sent to him from the Meeting of February 20th last. The text of the reply was read, as follows:—

HOME OFFICE, WHITEHALL,
3rd April, 1901.

SIR,—I am commanded by the King to convey to you hereby His Majesty's thanks for the Loyal and Dutiful Address of the President, Council, and Fellows of the Royal Microscopical Society, expressing sympathy on the occasion of the lamented death of Her late Majesty Queen Victoria, and congratulation on His Majesty's Accession to the Throne.

I am, Sir,
Your Obedient Servant,
(Signed) CHAS. T. RITCHIE.

WILLIAM CARRUTHERS, Esq., F.R.S.,
14 Vermont Road, Upper Norwood, S.E.

Dr. Hebb said they had received another paper from Mr. F. W. Millett, being Part XI. of his series "On the recent Foraminifera of the

Malay Archipelago." The paper, as in the case of those which had preceded it, would be taken as read.

Dr. Hebb then, on behalf of the Council, gave formal notice that on June 19 next, at 7.30 p.m., a Special Meeting of the Fellows of the Society would be held for the purpose of making certain alterations and additions to the By-laws. The chief alterations proposed were:—

(1) In respect to the payment of the admission fee, which, under the existing rules, was payable by instalments spread over a period of five years. It was proposed to revert to the previous system, and require the admission fee to be paid in one sum, instead of by instalments at the option of the new Fellow.

(2) In reference to the formation of hybrid Committees; power being sought to add Fellows not on the Council to Committees of Council.

(3) To make the Treasurer and Secretaries ex-officio members of all Committees.

(4) To make a new By-law dealing with the duties of the Honorary Librarian—a new office.

(5) To revise By-laws 74, 66, 89, and 65 (in future 65A). The changes in these being really emendations necessitated by obscurity of language (74), or by the alterations proposed (65, 66, 89).

The existing By-laws which would be affected, and the altered form in which it was proposed to render them, were then read seriatim to the Meeting.

Mr. Freshwater asked if the proposed alterations would be printed, and sent to each of the Fellows before the Meeting, so that they might have an opportunity of looking over them, as it seemed rather a difficult matter to remember what the alterations were after only hearing them read over once.

Mr. Vezey thought that this would hardly be necessary, seeing that the proposed alterations were, with one exception, matters of very small importance. The only important alteration was the one relating to the payment of the admission fee, which, under the existing By-law, could be paid down in one sum of two guineas, or, at the option of the person elected, payment might be spread over five years. This had been found to work unsatisfactorily, especially in cases where a Fellow wished to resign before he had completed the payment of the admission fee, when it was sometimes not easy to obtain the balance due.

Dr. Hebb said it was not proposed to print and circulate the notice as suggested, due notice having been given in conformity with the By-laws, and added that to do so would be a matter of considerable expense and of no practical utility.

Notice was given that at the next meeting of the Society there would be a demonstration and discussion on the Aperture Theory of the Microscope.

Mr. Beck said he should like to ask any Fellows of the Society who were possessors of the Abbe diffraction plate if they would kindly lend these for use in illustration of the subject to be brought before their next Meeting. Mr. J. W. Gordon would endeavour to show that the effects, as described by Professor Abbe, and relied upon by him to prove his diffraction theory, were produced, not by the object on the stage, but by the diaphragm over the object-glass; and, to make the subject more clear, they were anxious to have as many sets as possible of the diffraction apparatus for exhibition on that occasion. They did not want a very large number, but he thought that five or six sets would be required in addition to those which they already had.

The Chairman said they had that evening a large number of objects exhibited to illustrate various forms of aquatic life, which he was sure would be examined with much interest. He felt that as a Society they were very much indebted to those gentlemen who had kindly assisted in bringing so good a collection together.

The meeting was then resolved into a Conversazione, at which the following objects were exhibited:—

Mr. Ed. Bartlett:—*Vorticella.*

Mr. Alfred W. Dennis:—*Plumatella repens*, issuing from statoblast.

Mr. A. Downs:—*Fredericella sultana.*

Mr. A. Earland:—*Anuræa brevispina.*

Mr. T. D. Ersser:—*Hydra vulgaris.*

Mr. A. J. French:—*Stentor polymorphus.*

Mr. Alfred E. Hilton:—*Cristatella mucedo.*

Mr. E. E. Hill:—*Plumatella.*

Mr. E. Hinton:—*Chara fragilis.*

Mr. J. T. Holder:—Photomicrographs from life, Larva of Caddis-Fly.

Mr. G. E. Mainland:—*Corethra plumicornis*, Larva, Pupa and Imago.

Mr. K. I. Marks:—*Anuræa aculeata, A. cochlearis, Asplanchna priodonta, Brachionus angularis, Polyarthra platyptera.*

Mr. C. Muiron:—*Anuræa brevispina, Asplanchna priodonta, Brachionus pala, Triarthra longiseta.*

Mr. Julius Rheinberg:—*Cristatella mucedo*, statoblast.

Mr. G. H. J. Rogers:—*Melicerta ringens, Volvox globator.*

Mr. C. F. Rousselet:—*Cristatella mucedo, Stephanoceros eichhorni* with winter eggs, and various Rotifera.

Mr. D. J. Scourfield and Mr. C. J. H. Sidwell :—Three exhibits of *Daphnia magna*, Strauss (= *D. Schaefferi*). 1. Adult ♀, shown with polarised light in order to bring out more clearly the muscular structure and the deposits of carbonate of lime in the shell. 2. Young ♀, to show the difference in the outline of the shell as compared with the adult. 3. Adult ♂, showing the highly developed first pair of antennæ, hooks on the first pair of feet, testis, vas deferens, and penis.

Mr. Chas. D. Soar :—*Hydryphantes rubra*, showing median eye.

Mr. W. R. Traviss :—*Hæmatococcus pluvialis*, the "Blood-Rain Plant," from a tank in Camden Square.

Mr. A. Verinder :—*Melicerta ringens*.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

AUGUST 1901.

TRANSACTIONS OF THE SOCIETY.

VII.—*An Examination of the Abbe Diffraction Theory of the Microscope.*

By J. W. Gordon.

(*Read June* 19, 1901.)

Plate VII.

The Abbe theory, which I have this evening the honour to bring under discussion in your assembly, stands in the very curious position of having attained to general acceptance without having ever been proved, and of being commonly received on the authority of its author, who has in terms repudiated it. For my own part I should have preferred, had that been possible, to discuss the theory in the abstract without connecting it with any person, because of the risk which the introduction of the author's name involves of giving to the discussion itself a personal character, and so substituting barren altercation for useful debate. But the hypothesis in question has been so long and is so widely known as the Abbe theory, that it would be idle for me to avoid the use of Professor Abbe's name for the purpose of identifying it. But it will, I hope, be recognised that I make no attack upon Professor Abbe himself; I do not even attribute to him the championship of the theory which goes by his name, and which appears to me to be propagated at the present time by his disciples rather than by himself. And lest I should, by inadvertence, do him any injustice, I desire your leave to place in the forefront of my criticisms the disclaimer of the Abbe theory which Professor Abbe has himself published.

The disclaimer is to be found in the 7th edition of Carpenter's *The Microscope and its Revelations*, at p. 64, where an extract is given from a letter in which Professor Abbe says:—

"I no longer maintain in principle the distinction between the 'absorption image' (or direct dioptrical image) and the 'diffraction image,' nor do I hold that the microscopical image of an object consists of two superimposed images of *different origin* or different mode of production."*

The matter, however, is not left in the clearness of this very definite statement; for the disclaimer is accompanied by an explanation in which the reader is told that with coarse objects the whole result is the same as if the image did not depend at all upon diffracted light, whereas the representation of the fine details is apparently dependent upon the successful collection of the light which they disperse by diffraction. The explanation is too long for textual quotation, since it is with the disclaimer only that I am now concerned, and those who desire to know what was passing in Professor Abbe's mind when he wrote it should consult the text in the place that I have named. I am unable to elucidate it; for, reading the disclaimer and the explanation together, I am wholly at a loss to understand either the one or the other. The editor of Carpenter's book apparently considers that the disclaimer makes no difference to the theory, for on p. 62 he writes:—

"It has been demonstrated (by Abbe's researches) that microscopic vision is '*sui generis*.' There is and can be no comparison between microscopic and macroscopic vision. The images of minute objects are not delineated microscopically by means of the ordinary laws of refraction; they are not *dioptrical* results, but depend entirely on the laws of *diffraction*."

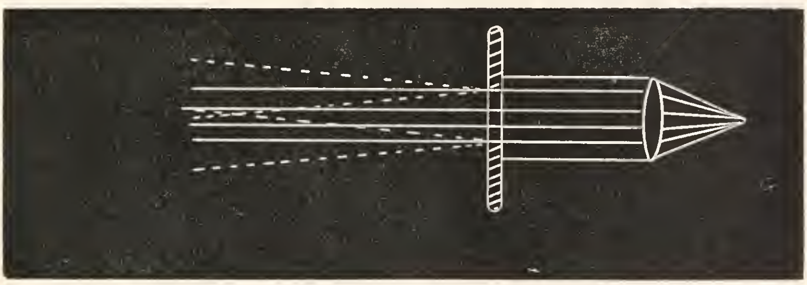
This is the original Abbe theory with which you have long been familiar, and to which the criticisms will be directed that I have this evening to submit for your consideration. I should introduce the personal element, which I am above all things desirous of shunning, were I to attempt any more curious inquiry into the measure of Professor Abbe's past responsibility for the Abbe theory or of his present adhesion to it.

If you place a diffraction grating upon the stage of a Microscope, illuminate it with a beam of parallel light obtained from a luminous line, so arranged that its axis lies in a plane passing through the axis of the instrument and parallel to the direction in which the diffraction grating is ruled, you will, upon removing the ocular and looking down the tube of the instrument, see in the principal focal plane of the objective a central image of the source of light flanked by spectra right and left, the spectra being likewise images of the source of light, true representations corresponding in shape and dimensions with the principal image with monochromatic light, and more or less impure spectra in the case of mixed light, the degree of impurity being determined by the extent to which the monochromatic images of differing colours overlap. Of the rays which meet and by interference

* The 8th edition of Carpenter's book has appeared while this paper has been passing through the press; it follows the 7th in all that relates to the present subject, and the references above given to the 7th edition apply equally to the latest.

mutually cancel and reinforce one another so as to produce the alternate light and dark spaces, which thus diversify the principal focal plane, a large proportion will be caught by the ocular and enter into new combinations in the plane of its working focus, to build up there the microscopic image of the grating on the stage. In this respect, however, they will not differ from the rays which meet to part again in the central image of the source of light. It is a general rule that all the rays given out from a luminous point which fall upon and pass through a properly corrected lens are reunited in the focussed image of that point produced by the lens. A ray of diffracted light differs for this purpose in no respect from any other ray of light. It is refracted in exactly the same way and to exactly the same point as what has been somewhat obscurely called a "direct" ray along the same axis. In fact it is a direct ray, the direct ray from its source in its own direction, and it is called diffracted, not in virtue of any distinctive property which itself possesses, but in virtue

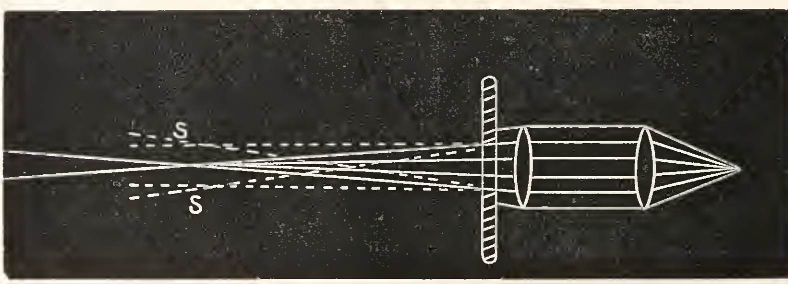
Fig. 65.



of the fact that a neighbouring ray belonging to the same pencil of rays to which it belongs has been suppressed by interference, and that, having strayed into the geometrical shadow of some opaque object, it has escaped the destructive agencies which guard the integrity of shadow margins. It is, of course, true that shadows which thus suffer invasion from straying beams of light retaliate by transgressing the boundary on their own account, and produce straying beams of shadow—if the expression may be allowed—within the illuminated area. But with such diffracted shadows we are not now concerned. It is the diffracted light only which has received attention in the discussion of the Abbe theory, and for present purposes it will be a sufficient description of this diffracted light to speak of it as light which transgresses the limit of a shadow.

Returning to our diffraction spectra in the tube of the Microscope, we may observe that they lie in what may be quite correctly described as the shadow of the diaphragm of the objective. The accompanying diagram will make this clear. In fig. 65 the diaphragm is shown without any lens, and passing a cone—sensibly a cylinder—of light, having its apex at the virtual source, its base at an infinite distance behind the opening of the diaphragm. In fig. 66, the same diaphragm is shown fitted with a lens which condenses the emergent beam into a sensible cone, having its apex at the principal focal point, so that the opening of the diaphragm becomes the base of one sheet of the emergent cone, the other sheet having its base as before at an infinite distance behind. The effect upon the shadow, as shown in the diagrams, is to vary its contour, but physically the shadow itself remains unchanged. In both cases it is produced by the destructive interference of one part of the transmitted wave-front upon the other part, and in both cases the same—i.e. essentially the same—boundary phenomena are manifested at and near the confines of the beam. Geometrical conditions which cause an intensification of the central light at the principal focal point give rise to similar intensification of

Fig. 66.

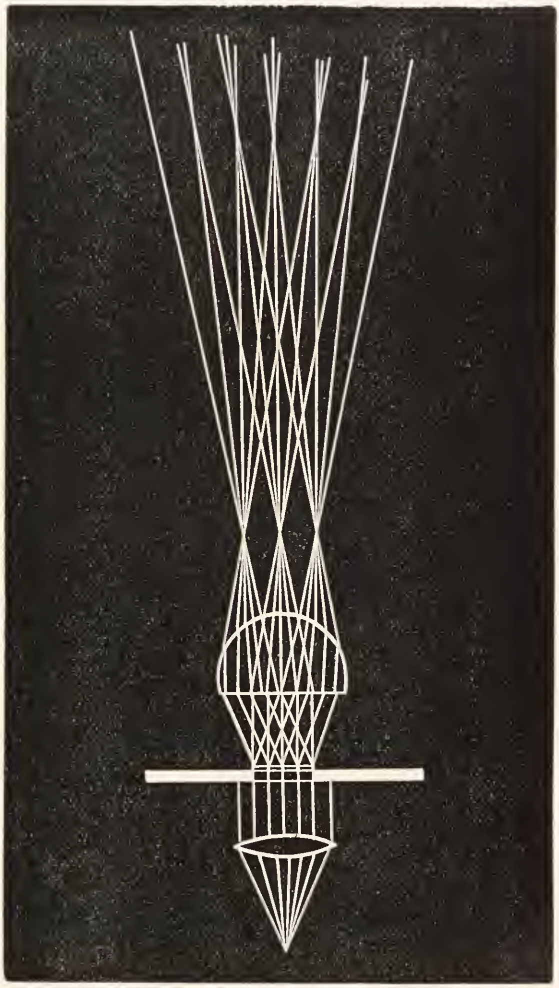


the diffracted light at the angular focal points marked S in the figure, and thus render visible and even conspicuous phenomena which the diffused light surrounding the shadow cone in fig. 65 is too weak to show.

In order to appreciate the use made of these phenomena in the Abbe theory, it will be convenient to add a diagram, fig. 67, in which the shadow cones originating on the stage are shown in comparison with the shadow cones originating at the source of light. By these means it is possible to exhibit to the eye the course of the diffracted light, and to indicate what part of it, after having contributed to the spectrum images of the source of light, goes on to contribute again to the building up of the image of the object on the stage in the visible focus of the Microscope. Thus the diffracted rays contribute to the formation of a microscopic image upon the ordinary theory of image formation. In this way, for example, they will, by common consent, when present contribute to the formation of the broad outlines of the microscopic picture.

The Abbe theory attributes to these rays of diffracted light a further function of a very mysterious kind; and lest I should mis-state it, I take the authoritative statement of this special function from the translation of Naegeli and Schwendener's *The Microscope in Theory and Practice* (p. 97). They say:—

Fig. 67.

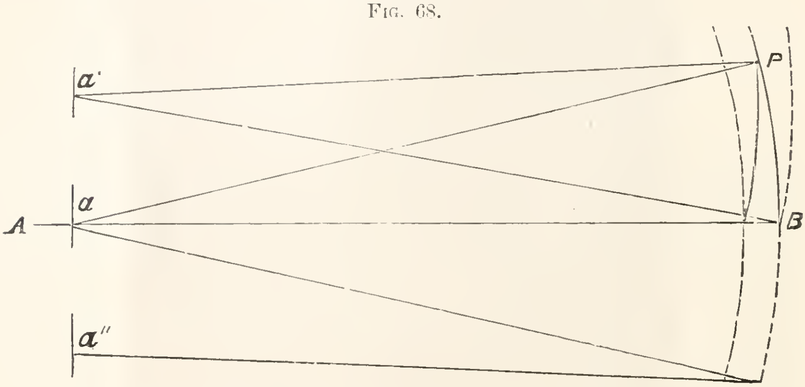


"It is the diffraction of light in the object which produces the image-forming rays of the fine structural details. These diffracted rays produce well-defined diffraction or interference images in the upper focal plane of the objective, where they interfere and remain in the microscopic image, and, therefore, take part also in the final virtual image.

"If we shut out these interference images by diaphragms, or if the angular aperture of the objective is too small to admit at least the first pencil of rays produced by diffraction, as well as the undiffracted light, the corresponding details disappear in the microscopic image—a valve of *Pleurosigma* shows neither squares nor lines, and fine rulings upon glass appear as a homogeneous surface."

The development of this theory in full detail occurs at p. 232, where they add the following diagram :—

Fig. 68.



In this diagram (fig. 68) A B is the optical axis of the Microscope; a the direct image of the source of light; a' and a'' are two diffraction images of the same object the nearest to the direct image on either side of it. B is a point in the plane of the image of the diffraction grating which is taken to be the object on the stage of the Microscope. The arc B P is drawn with a as its centre; the other arc which passes through the point P is drawn about a' as its centre. The length upon the axis A B intercepted between these two arcs is taken to be one wave-length.

I do not propose to ask you now to wade through the mathematical discussion of this diagram; it will suffice to say that by geometrical considerations Naegeli and Schwendener show that, upon certain assumptions which are duly laid down, the distance from B to P will be m times the distance of the bright lines in the object on the stage which produces the diffraction, m being the coefficient of magnifying power. It follows, as they say, that the number of interference lines in any given space in the image plane agrees with those of the striæ.

This is as far as their argument carries them; that is to say, they show that, in number and in distance from centre to centre, the diffraction images of the source of light in the upper focal plane of the instrument will correspond with the number and distance from centre to centre of the bright lines of the grating in any given portion of the field occupied by the microscopic image of the grating. It leaves much unexplained; for instance, it does not disclose any agreement between the total number of images in the interference pattern and the total number of lines in the grating; it does not show why the bright images of the supposed diffraction pattern should be superposed upon the bright lines of the real image of the grating instead of being intercalated between them; and it does not explain why these repeated images of the source of light should assume the shape as well as the position of lines in the diffraction grating.

A "theory" which rests upon such slight foundations and leaves so much to be explained can hardly be regarded as an elaborated theory; but in fact, the importance of these omissions is by no means to be measured by the mere gaps which they leave in the doctrine itself. The attempt to supply any one of them reveals at once the unsoundness of the entire hypothesis. To take them briefly in their order. First there is the question of total number. You place your *Diffractions Platte,* supplied by Zeiss of Jena for the purpose of demonstrating the Abbe theory to the eye, upon the stage of your Microscope, illuminate it by a narrow beam of parallel light, and observe it through an *a a* objective. You count the number of striæ in the image; thirty-one in the coarser ruling, sixty-one in the finer. You read in Naegeli and Schwendener's book that these are not really produced by the refraction of light from the corresponding striæ in the grating, but are images of the slit through which the light enters the Microscope placed by Abbe's law exactly where the images of the striæ, if produced by refraction, ought to fall. You inquire why they are exactly the same in number as the striæ in the grating. There is no numerical relation between the number of lines in a diffraction grating and the number of images of the source of light which it will yield. Why then should these particular interference images agree in number exactly with the markings on the object? To this there can be no answer. The number of repetitions in a diffraction pattern when the whole is in view must depend upon the brightness of the incident light. If this be increased, the old images will show with enhanced brilliancy, and new images will come into view beyond them. If, on the other hand, the light be diminished, the number of visible diffraction images will diminish also by the fading out of those that are least luminous. Hence the number of spectra which a given grating will yield is quite indeterminate, and the proposition that a definite number of line images, thirty-one in one part, sixty-one in another part of the field, may be generated in this way, will not bear stating.

The theory is equally at fault if you examine it to ascertain why the bright diffraction lines should be superposed upon the bright lines of the real image, instead of being intercalated between them. It is quite obvious that a bright line of the hypothetical diffraction pattern must occupy the middle of the field, the point marked B in Naegeli and Schwendener's diagram. Is it also plain that this spot must be occupied by a bright line in the visible image of the grating? The simple answer to this question is that, if such a bright line did chance to occupy that position, it could easily be displaced by a turn of the stage-propelling screw of the Microscope. What, then, would become of the coincidence between the "diffraction image" and the so-called dioptric image? Moving the diffraction grating across the stage of the instrument would not displace the images produced by diffraction of the source of light. Of course, if the grating be moved out of the beam, the diffraction images will disappear, just as the shadows in a room disappear when the blind is drawn. But they will be blotted out one by one where they stand; they will not shift, any more than shadows of the window-frame upon the wall of a room will shift at the drawing of the blind. Thus the extremely simple experiment of sliding the *Diffractions Platte* across the stage of the Microscope suffices to distinguish what is due to refraction from whatever is due to interference. The "dioptric image" will be displaced by the displacement of the object on the stage; the interference image—if there be one—will remain stedfast. Make this experiment with your eye upon the microscopic image of the grating, and you will see that everything, down to and including its minutest detail, is part of the "dioptric image," and obeys the law of refraction. Remove the ocular and repeat the experiment with your eye on the diffraction images in the principal focal plane at the back of the objective, and you will see that they remain unmoved by the displacement of the grating until one by one they are extinguished as it passes out of the beam, and that then they die at their posts. What is true of this primary set of diffraction images must be true also of any secondary interference images derived from them. They are all *ex hypothesi* images of the source of light, and while it retains its position they cannot be displaced.

This experiment may be reversed. Leaving the *Diffractions Platte* at rest upon the stage, you move the source of light across the field of the instrument. Its images are, of course, displaced in the opposite direction. You then replace the ocular, and observe the image of the grating while you again displace the source of light. There is no corresponding movement. The distribution of light is affected, and the centre of illumination follows the inclination of the axis of the beam, but the bright lines of the image, the minute details said to be produced not by refraction but by interference, remain. They obey, with a perversity which, however, does not surprise you, the laws of dioptrics, and exhibit no sympathy with the diffraction system.

It is indeed obvious that the position of the hypothetical bright lines of the secondary diffraction system must be quite independent of the position of the grating on the stage of the instrument, and that coincidence between them and the bright lines of the real image of the grating, if it existed in any given case, would be a matter of chance liable to be destroyed by the least displacement either of the source of light or of the object, and so unlikely to recur as a matter of probability that it may be regarded as practically an impossible contingency—in this respect like most other coincidences. Here again is a crucial test under which the theory breaks down.

There is still a third point to be considered, the simplest and most obvious of all objections to the Abbe theory. We are told that these minute striations, seen in the microscopic image of a Zeiss' *Diffractions Platte*, are really diffraction images—images, therefore, of the narrow slit which serves as the source of light. That is perhaps conceivable. The slit which lies under the sub-stage condenser is long and narrow and bright; it is arranged so that its axis is parallel to the common axis of the ruled lines in the grating; it bears, therefore, a strong resemblance to these lines; and if we suppose its image to be repeated a proper number of times and to be duly disposed in space, it is quite easy to suppose that we might mistake its repetitions for a picture of the ruled grating. But, now, suppose that this Abbe stop is removed, and a candle substituted as the source of light. On looking down the tube of the instrument at the new diffraction system, you see, of course, spectra in the shape of candle flames; but on replacing the ocular and looking once more at the image of the *Diffractions Platte*, you do not see a grating ruled with candle flames. You see exactly what you saw before, a grating ruled with straight lines—that is to say, with lines prevailingly and approximately straight. But here and there a broken line or a wavy line will betray a tremor in the ruling instrument. Now if all these are interference images of the candle flame, why are they not all exactly alike, in the first place ? why do they not all bear at least a general resemblance to a candle flame, in the second place ? and why do they not change in appearance when a broad source of light is substituted for a narrow source, in the third place ? To these questions again there can be no answer, except that the Abbe theory is wholly at variance with the facts.

These observations may suffice upon this line of criticism. It is desirable to come to closer quarters with the Abbe theory by examining the line of argument by which it is supposed to be supported. And naturally, in the first place, one turns to the argument already referred to in Naegeli and Schwendener's book. The mere mathematics of that argument may be taken to be correctly worked out; but it is necessary to examine with some care the physical basis of the exposition. It proceeds, as will be obvious from a glance at the diagram (fig. 68), to deduce from the relative positions of a, a' and a''—the three diffraction images of the source of light which enter into the calculation—the resulting positions of B and P, which are adjacent bright lines both in the real image of the grating and in the hypothetical diffraction image which is supposed to occupy the same field. In the first place, therefore, it is necessary to determine the distance separating a from a' and a'' respectively. For this purpose our authors assume that the distance is measured by the sine of the angle of diffraction, and is given by the expression $a - a' = a - a'' = sin\ \alpha . f$, where α stands for the angle of diffraction and f for the principal focal length of the objective (pp. 233, 228, and 25). The determination is quite arbitrary, for an earlier diagram by which they illustrate the course of the diffracted beam shows this distance as equal to the tangent, not to the sine, of this angle of diffraction. In explanation of this discrepancy they cite the authority of Professor Abbe, who has laid down the proposition that, "when an optical system is completely aplanatic for one of its focal points, every ray emerging from this point meets a plane drawn through the other focal point at a distance from the axis, the linear magnitude of which is equal to the product of the equivalent focal length of the system and the sine of the angle which this ray makes with the axis." But, curiously enough, the very terms of Abbe's theorem exclude the particular case to which they have applied it. It is expressly limited to a focal point for which the instrument is completely aplanatic. Now, no Microscope is made aplanatic for infinite distance. It is corrected for a focal point on the stage, and therefore cannot be completely aplanatic in the upper principal focal plane of the objective where the diffraction spectra appear. The whole calculation, therefore, is vitiated by a fundamental error ; for the one thing that Professor Abbe's proposition settles about the images a and a' and a'' is that the distance between them will not be what Naegeli and Schwendener have chosen to assume that it is.

Having thus determined the position of their luminous points, they next proceed to lay the foundation for a calculation of the interference phenomena to which they must give rise, by the following extraordinary postulate. They say (p. 232) : "We now come to our proper task, viz. to establish the effect which these diffraction phenomena produce in the plane of the real image. This may be simply done if we consider the aperture images in the upper focal plane, the direct one as well as those due to interference, as so many (secondary) sources of light whose rays interfere, as in Fresnel's experiment with the mirror. For, since these sources of light are point for point the optical images of the same primary source of light, there is no difference of phase between them." "No difference of phase between them"! Surely no more extraordinary mistake was ever made by a competent author. For why, assuming them to lie in a true plane, should there be any correspondence of phase between them? The wave-fronts passing this point are not plane wave-fronts, but spherical wave-fronts focussed on the point B. It is clear therefore that a cannot in any case be found in the same wave-front as a' and a''. If, then, they are in equal phase, they must lie in successive wave-fronts, and a circle drawn from the centre B through a' and a'' would cut the axis A B at a point lying exactly one wave-length, or an integral number of wave-lengths, behind a. But why should it? The radius a' B is quite indeterminate, and depends only on the particular focal adjustment of the instrument. It may be varied by indefinitely small degrees so as to give any desired flatness to the arc $a' a''$. But this readjustment of the upper focal plane would make no difference to the distribution of a, a' and a'' in the principal focal plane, which, as our authors have themselves shown, is quite independent of the distance of the diffraction grating from the objective. Obviously the phase relation of a, a' and a'' must be quite indeterminate, and the corner-stone of the Abbe theory crumbles into dust. The rest of the demonstration is mere mathematics, quite correctly worked out, but of course proving nothing when unsupported by physical facts.

Summarising the results of this critical examination of the Abbe theory, we arrive at this conclusion:—The calculation upon which the theory rests is itself based upon two fundamental errors, one as to the position of the real diffraction images in the principal focal plane of the Microscope, the other as to the phase relation between the direct and the diffracted rays. The theory itself, when extended to determine the number of bright lines seen in the real image of a diffraction grating, their position in the picture, and their individual appearance, breaks down entirely, and yields only conclusions which are wholly at variance with the facts. Upon theoretical ground this may suffice.

It must, however, be admitted that most of the authors who have expounded the Abbe theory have based it not upon physics, but upon observation, and certain phenomena now very familiar are pointed out as the sufficient proof of the accuracy of Professor Abbe's conclusions. It will be said: "If you reject the Abbe theory, how are you to explain these phenomena?" But here again it will not suffice to place implicit confidence in the writers of books. The eye sees what it brings the faculty of seeing; and no more striking illustration of this principle is to be found than the limitation which prepossession in favour of a theory has placed upon the vision of many able men who have observed the Abbe phenomena. That no controversy may arise as to the facts, I will not venture to put forward my own description of these phenomena; and, as among the descriptions which I have seen, the best and best illustrated by far occurs in Dr. Zimmermann's work, *Das Mikroskop*,* I avail myself for this purpose of his text.

Perhaps, however, I may be allowed to preface an account of the phenomena with a description of the apparatus which is supplied by

* 'Das Mikroskop,' von Dr. A. Zimmermann, Leipzig und Wien (Franz Deuticke), 1895.

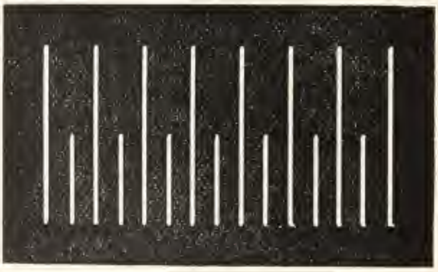
Zeiss of Jena, for the purpose of exhibiting these phenomena. The apparatus comprises four distinct appliances:—

(1) An opaque disc to be placed in the distant focus of the substage condenser to define the source of light. It takes two forms. In the one form it is provided with a narrow opening 0·4 in. long and 0·018 in. wide, as shown in fig 69. In the other form it is provided with a circular opening of 0·022 in. diameter. With this second form we shall not this evening be concerned.

Fig. 69.

(2) A test plate or diffraction grating, which is sold under the name of Abbe's *Diffractions Platte*, and serves as the object viewed in the various experiments. This slide is provided with three groups of rulings. The central one, which is the one principally used in the Abbe experiments, is ruled in one half with a coarse grating having 1750 lines to the inch, and 31 lines in all. In the other half it is ruled as a fine grating with 3500 lines to the inch, and 61 lines in all. The two flanking groups are ruled with about 2400 lines to the inch, and each of them comprises two gratings laid across one another. In one group the angle of intersection is a right angle, in the other an angle of about 62°. The two component gratings are ruled in separate films of silver, and are separated from one

Fig. 70.



another by about 0·0004 in. We shall not, however, have much occasion to refer to them in the course of this discussion. By way of completing the description of the principal group, it may be added that the ruled line has a uniform breadth of about one fourteen-thousandth part of an inch. Sufficiently for present purposes the design and proportions of this grating are shown by fig. 70.

(3) The next appliance consists of a series of diaphragms with a suitable carrier, by means of which they can easily be mounted and

dismounted at the back of the objective, for the purpose of modifying its aperture. A description in detail of the various forms of these diaphragms would serve no useful purpose. So far as they are material to the present discussion, they are figured in Dr. Zimmermann's drawings, and will be reproduced here in that connexion.

(4) Lastly, an objective, *a a* of the Zeiss series, is recommended for use with the rest of the apparatus, and is supplied for the purpose.

We are now in a position to follow Dr. Zimmermann's description. He says (p. 46, § 69) "For the purpose of making a direct observation in the Microscope of these diffraction images,* the so-called Abbe *Diffractions Platte* may be employed with advantage, upon which are traced three several groups of lines ruled in a thin film of silver. We shall here limit our attention to the midmost of these groups which contains only parallel lines spaced, in one half of the area occupied, twice as far apart as in the other half." He then gives a drawing, here reproduced as fig. 71, which he says is only simplified by diminishing the number of lines to one-fourth of the actual number. He then continues:—

Fig. 71.

"In order to observe the diffraction image yielded by this group of lines, the observer first focusses the Microscope provided with a low-power objective (about Zeiss *a a* or A), and under strong illumination upon the ruling in the usual way, then places on the stop stage of the Abbe substage condenser, or in the ordinary stop cylinder, a stop of blackened cardboard provided with a narrow slit less than ½ mm. wide; and having disposed this so that it lies parallel with the lines in the ruling, he removes the ocular and looks down the tube of the instrument. He will then see a white image of the slit flanked by a large number of diffraction spectra."

This is represented by another figure, here replaced by fig. 72,† and our author proceeds:—

"If now he moves his eye above the Microscope in a horizontal direction parallel with the lines in the ruling, he will notice that the number of the spectra is suddenly doubled. This arises from the fact

* By diffraction images he means the fine "structure" details of a microscopic image.

† As this and some other of Dr. Zimmermann's figures are elaborately designed drawings, it has been thought more proper to re-draw this and the other figures in question from Nature than to borrow the artistic features of the very beautiful plates which illustrate Dr. Zimmermann's work.

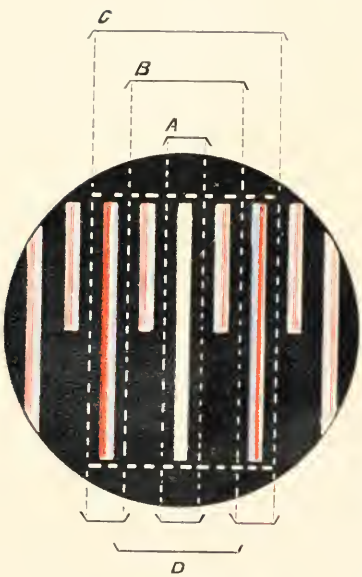
. . . that the more widely spaced ruling yields more closely packed diffraction spectra.

"If now a more powerful optical system, for example, one comprising a larger aperture angle, be employed to obtain the diffraction image, a still larger number of diffraction spectra will at once become visible, but the diffraction image will at the same time become smaller, so that it cannot be observed in the manner above described with a powerful objective. But if the Microscope be provided with a draw-tube, the diffraction image so produced can be enlarged by inserting a low-power objective in the lower end of the draw-tube, replacing the ocular in its ordinary position and focussing the diffraction image in the instrument so modified."

I pause at this point to remark that the effect here described as due to the change of objective can be produced in another way, which, in considering the bearing of these phenomena upon the Abbe theory, it is important to bear in mind, but which Professor Abbe and his disciples appear to have entirely overlooked. It will be observed that in the arrangement described in this passage—which is the lighting arrangement that runs through the whole series of experiments—the substage condenser is focussed upon the infinite distance, so that light-waves originating at the stop are re-formed as plane waves by the substage condenser, and focussed in the principal focal plane of the objective. It is as plane wave-fronts, therefore, that they pass through the diffraction plate. Suppose now that the substage stop were removed farther from or brought nearer to the condenser, so that the light waves given off from its aperture might pass the diffraction plate in the form of spherical wave-fronts, concave in the one case, convex in the other. What difference would that make to the diffraction image? The experiment is easily made, and it will be found that in either case the effect upon the diffraction image is the same as that of changing the objective. The shorter the radius of curvature of the wave-fronts when they pass the grating, the narrower and more closely packed will the diffraction spectra be; and when the image of the source of light is actually focussed in the plane of the grating so that the radius of curvature of the wave-front there is approximately = O, the diffraction spectra will be found to have disappeared entirely, having all crowded into and been absorbed by the central image. This experiment cannot easily be performed with the Abbe stop,* because the Microscope is not constructed to facilitate the varying of the distance of the stop from the condenser. But if for the Abbe stop the image of a flame focussed by the concave mirror be substituted, it may very easily be done. The condenser can then be racked up and down so as to vary its distance from the flame image—which does not for this purpose differ materially from the Abbe slit—and so to give any desired curvature to the wave-front

* This experiment was exhibited at the meeting by means of a Microscope specially fitted for the purpose.

Fig. 72.



[Face p. 366.

in the plane of the diffraction plate. When the flame image occupies the position assigned by Dr. Zimmermann to the slit in the Abbe stop, and the other arrangements correspond with the specification of his experiment, the spectra will be seen precisely as he describes them. If, by moving either the condenser or the mirror, the wave-front emerging from the upper surface of the condenser be caused to assume a curved form, the spectra will be seen to diminish in breadth and to crowd together. Proceeding thus by steps the observer may produce with any given objective the diffraction image assigned, according to the reasoning of Dr. Zimmermann's text, to any other objective of higher power than its own. A narrow-angled objective will in this way yield the diffraction image of an oil-immerson objective, and all without distinction will yield one common result. That is to say, proceeding by regular degrees to shorten the radius of curvature of the wave-front in the diffraction plate, the microscopist may marshal his spectra in an orderly procession marching inwards towards the centre until at last they all, from both sides, merge in the white central image. If when this happens he replaces the ocular and looks once more upon the stage, he will see the image of the flame coinciding with the image of the grating, and will have ocular demonstration that, under these conditions, that is to say, with critical illumination, all objectives are in this respect alike, for diffraction by the object on the stage is abolished altogether.

The process by which the diffraction pattern disappears under these conditions is worthy of special attention. It is sometimes said that under ordinary illumination the diffraction spectra are unseen because the direct light from one point of an extended source of light obscures the diffracted light from another point. In some circumstances this may be true, but it is not the explanation of the phenomena just described. They show that with critical illumination of the object on the stage, diffraction images disappear, because under these conditions there is no destructive interference by parallel rays of light; not because they are obscured by direct light. The importance of this fact upon the Abbe theory is unmistakable, and will be very obvious as we proceed. At this point it may suffice to emphasise and draw attention to the fact that we have here the means of gathering any desired number of diffracted rays into the beam received by any given objective. For the angle of diffraction is a variable angle, which depends not only upon the spacing of the striæ of an object, but also on the radius of curvature of the wave-fronts which pass through the striæ. If a particular object gives too widely divergent diffraction spectra with plane waves, we have only to give to the illuminating wave-fronts a curved form, and we can compel it to moderate its dispersive action even to the extent of abolishing its diffraction images altogether.

Stated in this way the proposition now put forward sounds, as indeed it is, very elementary. But it is by no means superfluous to call attention to it in this connexion; for, although it is one of those things which everybody knows, it is also a point which everybody appears to have forgotten in the discussion of the Abbe theory and phenomena. For example, among other extravagant inferences which have been deduced from the Abbe theory, is the conclusion that striated structure having centre distances less than half a wave-length of light can never be microscopically resolved, because it is said such a structure would produce such a wide dispersion of the diffracted rays that no objective could possibly embrace both the direct beam and even the nearest diffracted beam in its grasp, and Professor Abbe has himself published a table which purports on this principle to set the final limit upon the performance of various classes of objectives deduced from their several angles of admitted light.* All such deductions would be strangely precipitate even if the Abbe theory were correct; for, although it is quite true that you cannot extend the angular aperture of any objective to include the first diffraction image of such a structure formed by plane waves of light, it is equally true that by substituting spherical waves of short radius for plane waves in the illuminating light, you can bring not only the first but all the rest of its diffraction images into the field of your objective. On Abbe's own theory, therefore, there would be an alternative solution of the problem of augmenting the resolving power of the Microscope. It would be completely and absolutely solved for all kinds of objectives by the simple expedient of critical illumination.

But I have travelled back to the region of theory, and must return to Dr. Zimmermann and his account of the Abbe experiments. The object of the digression is to point out the great importance for judging of the bearing of these experiments upon the Abbe theory of realising and considering the conditions of illumination under which the experiments are made. Bearing this in mind, we will submit once more to Dr. Zimmermann's guidance.

"As has been already shortly stated," he writes (p. 47), "the image of the object † arises from the interference of the light-waves which originate in the diffraction spectra described in the last paragraph, and lying in the upper principal focal plane of the objective. It may in fact be shown by exact calculation for this simple case that in this way a perfectly correct picture of a structure is produced so soon as the entire diffraction image is taken up by any objective, and that on the other hand nothing whatever is visible in the microscopic picture unless, in addition to the direct (white) image of the source of light, at least *one* diffraction spectrum passes into the given objective."

Having thus explained the nature of the theoretical demonstration, he excuses himself from going into it upon the ground that the calculations involved are too intricate for his book, and proposes as

* Journal R.M.S., 1882, p. 463.

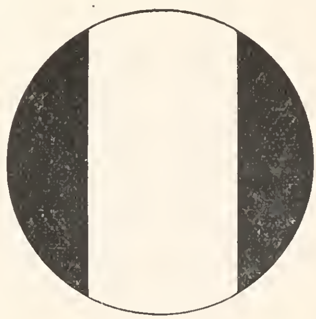
† That is, the image in the upper focal plane—in this case—of the diffraction plate.

an alternative to embark upon certain researches by which the dependence of the microscopic image upon the diffraction image of the source of light may be made the subject of ocular demonstration. We cannot, however, part from his too brief notice of the theory without remarking that there is no need to be modest in the demand for diffraction spectra. Contentment with a single spectrum strikes one as being a weak reticence, it being so easy, as we have seen, to obtain diffraction spectra in unlimited number in the most limited angular space. But perhaps this comment savours of insubordination, and for the present it is my purpose to accept without reserve all my guide's conditions.

With this exordium, then, our author comes to the first experiment, and says: "We employ again for this purpose the midmost field of the Abbe diffraction plate. We have already seen that two systems of ruled lines are traced upon this field, the one system

Fig. 73.

Fig. 74.



having the common distance of its lines apart double as great as that of the other system, and that, in consequence, in one half of the diffraction image the spectra stand double as far apart as in the other half.

"If now a diaphragm* be introduced in the plane of the diffraction images which will allow only the direct image of the source of light to pass (A of fig. 72), and the microscopic image is observed with the replaced ocular, there will in fact be seen, instead of the parallel lines, an almost uniformly bright surface (fig. 74).

"If, however, the aperture in the diaphragm be made so large that, in addition to the direct image of the source of light, the two nearest diffraction spectra corresponding to the wider system of ruled lines be allowed to pass (fig. 75),† then, in fact, the individual lines of

* The diaphragm referred to is shown in fig. 73.

† This diaphragm allows the group of spectra—including in the term spectra the central image—to pass, which is marked B in fig. 72.

the wider ruling will appear, although proportionately much thicker than in reality (fig. 76); but in place of the narrow ruling there is still

Fig. 75.

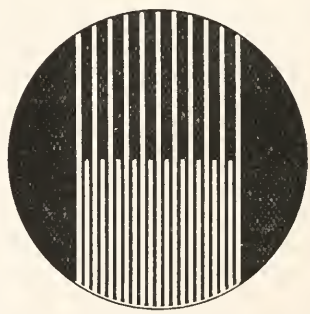
Fig. 76.

only an uniformly bright surface to be seen. Here then a line system corresponding to the actual object comes first to view only when at least one of the diffraction spectra derived from it passes into the Microscope, as is shown in figs. 77* and 78.

"Finally, the following experiment is very instructive, in which a diaphragm provided with three narrow openings is employed (fig. 79). These slits are so arranged that the midmost of them transmits the direct image, whilst the other two allow the first spectra of finer structure and the second of the coarser to pass; † the first spectra originating in the coarser structure being cut off by the interposed diaphragm.

Fig. 77.

Fig. 78.



In this case we observe in fact, entirely in accordance with the theory, that in both halves of the image the same number of lines appears.

* This diaphragm allows the group C of fig. 72 to pass.
† That is, the group marked D in fig. 72.

By rotating the diaphragm the observer may easily satisfy himself that the number corresponds to the finer ruling, and that accordingly a doubling of the lines has taken place in one half of the picture. This was, according to theory, to be expected; for in this case the diffraction image of the wider structure has been artificially made similar to that of the narrower structure. But it could not precisely have been inferred that the image produced in this way would exhibit all the features of a normal Microscope image with entire exactness, and that an incautious observer would certainly take it for the true representation of a structure actually present in the object."

This last paragraph is further illustrated by the drawing here reproduced as fig. 80, and our author then passes away from the description of experiments to the consideration of the bearing of the Abbe theory upon the examination of fine structures of irregular form, and upon the principles of Microscope construction. Into these fields we are not concerned to follow him.

Fig. 79.

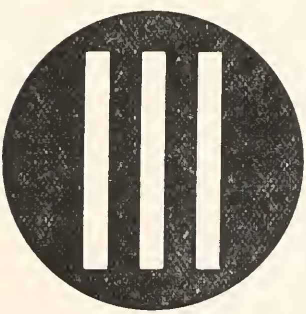
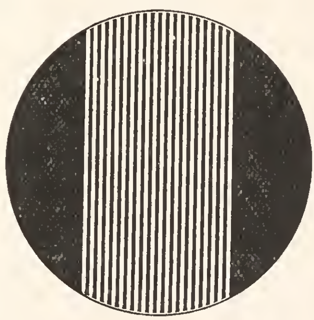


Fig. 80.



Two things are noteworthy in the foregoing description: first, the inaccuracy with which the observed appearances are recorded, and, second, the limited nature of the examination actually made. As to the first. In figs. 74 and 80 sketches are given of the appearance in the Microscope of the ruling under different conditions of observation, and both the drawings and the text convey the impression that no difference is to be detected under these conditions between the image of the coarse ruling and that of the fine. The Abbe theory itself favours this view; for if the distinctive features of the picture are derived from the distinctive diffraction spectra, it seems natural to infer that when the distinctive diffraction spectra are shut out no difference will, in fact, be discernible between the images. The fact is not so. In both these figures, if correctly drawn, the upper half—corresponding to the coarse ruling—would be only half as bright as the lower half. It may be said that the argument holds even with the necessary correction of the data, but I will not stay to discuss that question, for the second head of criticism leads to matter of much greater consequence and less debatable significance.

Suppose, then, that it had occurred to Dr. Zimmermann to change the curvature of his illuminating light-waves, and so to bring the excluded spectra into the field of view; what would he have seen? Take for example his first experiment—that illustrated by figs. 73 and 74. He passes, in fact, from this to the condition of illumination illustrated in fig. 75 by substituting a diaphragm with a wider opening for that used in the first experiment. He might equally well have passed to this second arrangement by giving to his light-waves, at the point where they pass the diffraction plate, a cylindrical form with a suitable radius of curvature.

This implies only the placing of the stop a little farther from the substage condenser, and of the substage condenser itself at a suitable distance below the stage. Then, upon withdrawing the ocular and looking down the tube of the instrument, he would have seen the group of diffraction images figured in group B of fig. 72, of course more closely packed, through the narrower opening in the diaphragm of fig. 73. Here then are all the conditions for producing the image of fig. 76; but on replacing the ocular and looking again at the object on the stage, he would have detected no change. It would still present to his view only the blank field of fig. 74. In the same way he might with either of the diaphragms figs. 73 and 75 have produced the conditions of illumination shown in group C of fig. 72. But again, he would not thereby have changed the appearance of the diffraction plate. He would have observed, on the contrary, that in every case the microscopic picture assumed the features determined by the shape and dimensions of the opening through which the image-forming beam was passed, and independent wholly of the particular grouping of diffracted rays which passed that aperture.

The line of observation so suggested might have been pursued in experimenting with the diaphragm figured in fig. 79, and with the same general result. He would have found that, however he varied the selection of diffraction spectra passed through its apertures, he made no difference in the resulting picture. But he might also have made another observation of great interest with this piece of apparatus, had he simply rotated it slowly around the axis of the instrument, and noted down the changes which occurred in the image as it revolved. He would have found that in passing from the pattern which he has depicted to the true representation of the actual form, the image developed a number of phases, some of which are, by reason of the small scale of the object, difficult to see, but among which the trebling of the coarse ruling and the doubling of the fine are clearly discernible.

Now all these phenomena are not only unexplained by the Abbe theory; they are plainly incompatible with it. They show undeniably that the pattern of the image formed in the Microscope of the diffraction plate does not in any way depend upon the particular diffraction spectra which contribute rays to its formation, and they forcibly suggest that the features of this image are profoundly affected by diffraction arising in the diaphragms themselves.

This last suggestion points to a fresh line of experiment. If the Abbe phenomena take their rise in the diffraction produced by the Abbe diaphragm behind the objective, they should be slightly modified by changes in the length of tube. For the scale of the diffraction image produced by the diaphragm will vary directly with the distance between the diaphragm and the visible image. Suppose then that we displace the diaphragm from its position in the Abbe apparatus and drop it actually upon the top of the objective. We can, as we know, by a very slight alteration of the position of the stop beneath the substage condenser, alter the angle of diffraction so that the same spectra shall pass the apertures in this position as in the original position. No difference will be made therefore in the conditions required by the Abbe theory, but the diffraction image produced by the diaphragm itself will be enlarged in the proportion of about one-twentieth. This is not a great change, but it is visible, since it disturbs the exact superposition or apposition of the outlying parts of adjacent diffraction images upon which the Abbe phenomena really depend. But this will appear more clearly at a later point in the present paper. Suffice it at this point to say that the changes are such as entirely to confirm the hypothesis on which the experiment is based.*

Enough has now been said to show that observations upon the Abbe diffraction plate, when made in a critical spirit, lend no support to the Abbe theory, but even show it to be untenable. But in order to cover, so far as I am able to cover it, all the ground of this investigation, I desire, before parting from these experiments, to draw attention to certain exhibitions of these same Abbe phenomena by objects which are incapable of producing any diffraction spectra at all.

First Experiment.—In the first place I propose to use the Abbe apparatus of diaphragms upon a self-luminous object which Professor Abbe himself places in a class apart, and which in fact is quite incapable of producing a diffraction spectrum of any sort. For this purpose I take a ruled glass plate in which are a number of lines traced at a distance of $\frac{1}{100}$ in. apart in a film of soot. The lines have the same proportional diameter—1 to 7—relatively to their dark interspaces that the lines of the coarser ruling in the Abbe Diffraction Plate have to their intervening spaces. This glass plate is arranged at a suitable distance behind the substage condenser, and its image is focussed upon the stage of the Microscope, side by side with the ruling on the Abbe *Diffractions Platte.* By a little management the aërial image of the carbon film may be made to assume the exact

* This is a difficult experiment in any case, and is simplified if the tube of the Microscope be shortened as much as possible. It is much easier to succeed with six inches than with ten inches of tube-length.

dimensions of the Abbe ruling, so that here you have in the same field two objects visibly alike, but differing, from the present point of view, in the important particular that the one can and the other cannot be made to yield a diffraction spectrum. Now we can repeat Dr. Zimmermann's experiments and the other Abbe tests upon both these objects simultaneously, and in all cases it will be found that there is no difference between the behaviour of the one and that of the other. When the one is blurred the other is blurred; when the ruling appears doubled in the one, it appears doubled in the other; when it appears trebled in the one, it appears trebled in the other; and so forth. Whatever results the diffraction plate can be made to yield, this ghostly grating, with no diffracted rays to be manipulated, contrives to yield also.

Second Experiment.—Yet another experiment of the same sort, and this time I propose to cut loose from the Microscope altogether, and ask you to observe the Abbe blurring, the Abbe doubling, and all the other Abbe phenomena, upon an object as large as the diagram which stands as fig. 70 in this paper. This time the optical instrument with which I propose to work is the eye itself, and it is, of course, necessary to modify the Abbe diaphragm if it is to be applied direct to the eye, in accordance with the reduced focal length of the instrument. In the Microscope the distance between the Abbe diaphragm and the plane of the image is about 9 in., in the eye it is effectively about $\frac{3}{4}$ in., or perhaps less. The exact distance, of course, depends on the distance at which the diaphragm is held in front of the eye, and must be measured between a corresponding point within the eye and the retina. Somewhere between fifteen and twenty will be the proper numerical ratio between the two sets of diaphragms; and as nothing turns on a very exact reproduction, I have prepared a number of diaphragms in which the apertures and their spacing have dimensions $\frac{1}{15}$ of those of the Abbe diaphragms. If now you will take one of these diaphragms, and, holding it close to the eye, look through it at fig. 70, holding the paper at a full arm's length from the eye, you will see that all Dr. Zimmermann's phenomena are reproduced.

The significance of these results is wholly unmistakable. It cannot indeed be said of fig. 70, as of the grating last described, that it cannot yield a diffraction spectrum at all. Theoretically it would no doubt give off diffracted rays at extremely small angles to the principal ray. But their angles of deviation would be insensibly small and their brightness insensibly feeble: they cannot, therefore, enter into the explanation of the strongly marked phenomena which you have just witnessed. These are due, as are the analogous phenomena of the diffraction plate, to diffraction in the diaphragm itself.

It is easy to perceive, when once this point is realised, that the Abbe phenomena may be exhibited by a modified form of the Abbe apparatus on a much larger and more easily intelligible scale than in the experiments described by Dr. Zimmermann. Those experiments are hard to follow for two reasons :—

(1) They are performed with a great deficiency of light; and

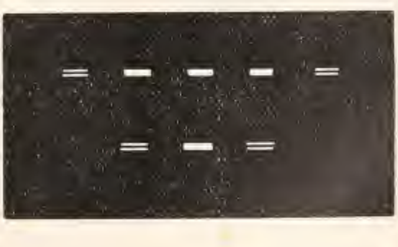
(2) They are displayed by an object of insufficiently large dimensions.

But when we realise that the Abbe phenomena depend not upon diffraction produced by the diffraction plate, but upon diffraction produced by the Abbe diaphragm, we see at once that both these defects can be cured. To take the first. The deficient lighting is due partly to the small aggregate amount of light passed by the diaphragm, but even more to the diaphanous quality of the fine silver film in which the ruling is traced. It can be improved by substituting a more opaque background for the Zeiss film.

The difficulty of the small scale of the Abbe phenomena as exhibited by Zeiss' apparatus may be overcome by another simple expedient. The dispersive power of a diffraction grating is inversely proportional to the distance from centre to centre of its constituent lines. Now the Abbe diaphragm (fig. 79) has a distance of $\frac{7}{100}$ in. from centre to centre, and its dispersive power is barely sufficient to double the coarse ruling of the diffraction plate under the magnifying power of the *a a* Zeiss objective. If now we reduce the separation of lines in the diaphragm, we shall in corresponding measure increase its dispersive power. Thus, with a diaphragm passing the same quantity of light as that shown in fig. 79, but having six apertures in the place of three, we shall obtain dispersive power enough to double a ruling on the stage so coarse that its lines will stand $\frac{1}{900}$ in. apart. If in place of the six openings in the diaphragm we introduce sixty, the dispersive power will be equal to doubling lines that stand $\frac{1}{100}$ in. apart. These are very convenient dimensions to work with, and will be assumed as data in the description of the following experiments.

Third Experiment.—The diaphragm being arranged in the Zeiss carrier, a mercury globule is placed upon the stage, and so illuminated that it forms a minute image of a distant lamp flame serving in the well known way as a point of light. The point, viewed now through the above described diaphragm, constructed as a grating with sixty spaces, shows a set of diffraction spectra as in fig. 81, where the five-image pattern results from bright, and the three-image pattern from moderate illumination. The number of visible diffraction images depends, of course, upon the brightness of the point. When the naked flame is reflected in this way the point is very bright, nad a system of five, seven or even more images may easily be visible.

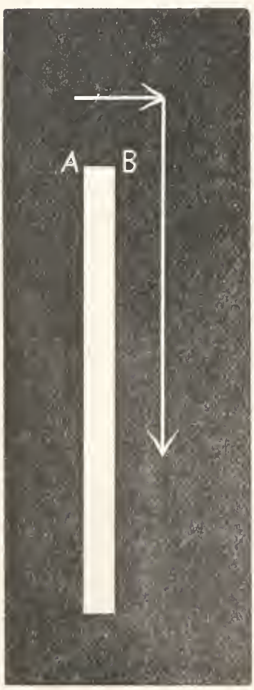
Fig. 81.



But if subdued light be substituted for the direct lamp-light, a point is easily reached which corresponds pretty much to the lighting which commonly obtains on the stage of the Microscope, in which three images are clear and conspicuous, the rest but feebly luminous and more or less invisible in consequence. These invisible images may become visible when they overlie and so reinforce one another, under which conditions they do, in fact, give rise to the familiar intercostal points and fictitious markings of very minute and regularly formed objects such as diatoms. But for the broad effect with which we are in this experiment concerned, they are of no importance.

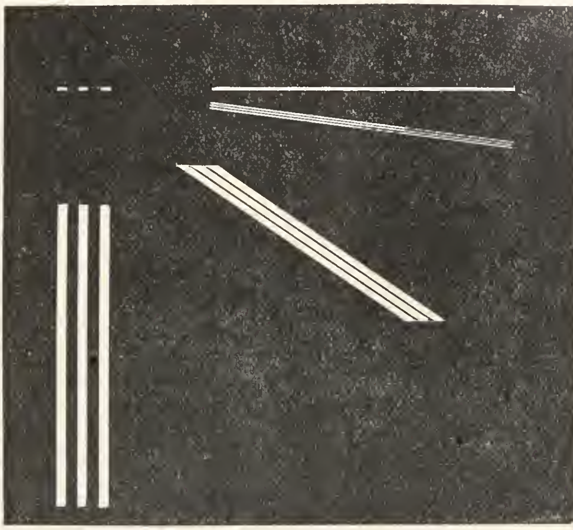
We shall have presently to consider the physical law of the formation of this image of a point of light; but for the moment I desire to draw your attention to the fact that this is the truly focussed image of a point of light seen through this particular aperture. Every aperture, however extended, has its own proper point image, and the condition assumed for the purpose of elementary dioptrics, that the image of an object produced by a lens corresponds point for point with its original, is never realised in fact. Every luminous point of an object focussed by a lens is focussed in some definite shape, which shape has nothing to do with the correction of the lens, but is determined solely by the form and curvature of the wave-front which the lens transmits; determined therefore in part by the size and dimensions of the effective surface of the lens, in part by the form of the wave-front when received by the lens, and in part by the refractive index of the lens in relation to the surrounding medium.

Fig. 82.



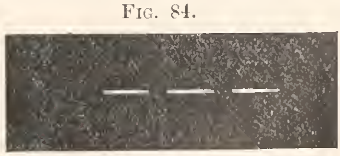
The law is not a complicated one, but for the moment it will be simpler to assume, as we may, that our point pattern is the three-image pattern of fig. 81 than to work out the theory of its formation. As it will be necessary to refer frequently in what follows to the geometrical properties of this focussed image of a point of light, it will be convenient to have a word by which to designate it. I propose to call it the antipoint of that point, or in general the antipoint simply, meaning thereby the form given by the particular segment of wave-front in question to the focussed image of the point in which it has originated. Assuming then that we have to represent a simple geometrical figure by means of antipoints such as are shown in fig. 81, let us next consider what the result must be; and for this purpose we will take as the simplest possible case a narrow parallelogram. Such an object, if we had a true point to work with, would be depicted thus:—Starting from one corner, A, fig. 82, we should carry the point along one edge A B of the parallelogram, so that its trail would trace out a line. Next we should carry the line

Fig. 83.



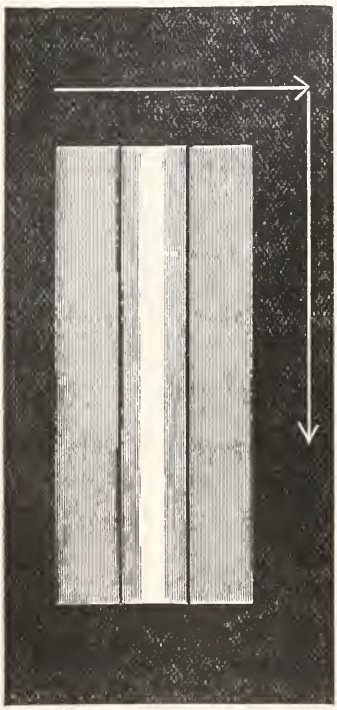
along the longitudinal axis of the parallelogram so that its travel would develop a surface, and when that was done the parallelogram would stand disclosed, the integral of the point. By a similar series of operations we may integrate a surface from the antipoint of fig. 81; but here a question of orientation arises which did not come into consideration when we were dealing with the absolutely symmetrical mathematical point. For it is obvious that an infinite number of lines can be traced by carrying the antipoint in different directions. Fig. 83 makes this plain without verbal explanation. Let it now be assumed that the short edge of the parallelogram lies in the long axis of the antipoint. Tracing it, we shall then obtain three short lines, as in fig. 84. Now it is to be observed that the flanking lines here are not pure spectra like the flanking images in the antipoint. They are built up from such spectra, which overlie one another in the resulting lines, so that the blue constituent of one combines with the red constituent of another to produce white illumi-

Fig. 84.



nation—"blue" and "red" are, of course, used in this connection vaguely and inaccurately to express complementary colours generally —hence the flanking lines are, like the principal, white lines, but with the addition of coloured extremities where the mixture of complementary colours is incomplete. Having thus obtained a graphic expression for the short edge of the parallelogram, we may proceed to develop the whole parallelogram from it as before, with the result shown in fig. 85. It is obvious that by giving a different angular position to the axis of the antipoint, we might have produced correspondingly modified images in which the flanking members would have stood at varying distances from the principal image, and both principal and flanking images would have varied slightly in breadth. This will be easily appreciated with the help of fig. 83.

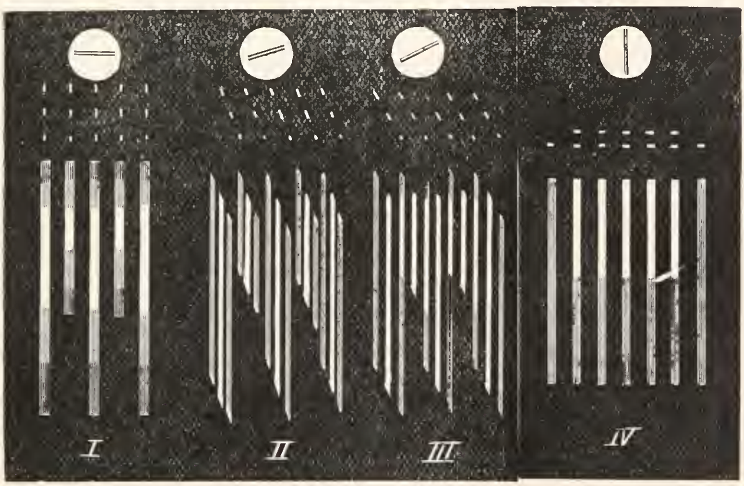
Fig. 85.



We are now in a position to understand the phenomena presented to our observation when the 0·01 in. ruled surface is viewed through the 0·0025 in. grating. As the grating is rotated over the field of the Microscope, the object takes on a series of appearances represented in some of their more marked phases by fig. 86. The drawing is self-explanatory, but a word or two may be bestowed upon some of its characteristic features Thus it is to be observed that the phase marked I. in the drawing, although representing the object with considerable precision, does not present an absolutely true picture, for the lines, although not repeated in a lateral direction, are repeated in a longitudinal direction, and hence are exaggerated in length, and terminate, not in clear-cut extremities, but in graduated ends. Again, the phase marked II. gives rise to a trebling of the number of lines, and to a serrated appearance along the upper and lower margins of the figure. The phase marked III. causes the number of lines to be doubled, the fictitious lines being feebler than their principals, but in the central portion so strengthened by reinforcement where they overlie one another, that they appear of equal, or almost equal, brightness with the real lines.

These appearances are all easily and directly explained by reference to the rotation of the axis of the antipoint produced by rotating the diaphragm as indicated in the figure, and no doubt can be entertained as to their origin. If now the modified apparatus used for this experiment be replaced by the original Zeiss apparatus, all these phenomena will be found to be exhibited by the *Diffractions Platte* when viewed through the diaphragm with three slits. The gradual disengagement of the phantom lines from the true lines as the rotation of the diaphragm proceeds, the serrated edge along the top and bottom of the figure, and the strengthening up of the phantom lines to a brightness approximately equal to that of the true lines—all these marks identify the Abbe experiment with the one last described, and show that the Abbe phenomena take their rise in the form of an antipoint, which resembles that depicted in fig. 86.

Fig. 86.



It is now apparent that for the discussion of all questions involving the resolving power of the Microscope. and indeed of any other optical instrument, the form of the antipoint is of capital importance. Until we know the form and dimensions which it takes, the degree of correspondence between an object and its optical image must remain unknown. The practical determination of this point presents no difficulty. It is only necessary to take a luminous object sufficiently small to be sensibly a luminous point, and to view it under the given conditions, when the antipoint will actually appear in the field of view. But the mathematical law connecting point and antipoint will be found to have been very fully investigated, and also to be susceptible of a very exact statement. The first investigation of this most interesting topic was, so far as I am aware, undertaken by

Sir Geo. Airy, who in 1835 published his results in the *Cambridge Philosophical Journal*, vol. 5, p. 283, and subsequently renewed the investigation in his *Undulatory Theory of Optics*, pp. 60–82, edition of 1877. The immediate subject of his inquiry was the resolving power of the telescope for fixed stars—the problem of point and antipoint pure and simple. He did not advance to the consideration of the way in which images could be built up of antipoints; and although the one follows, as we have seen, extremely simply from the other, it may be that the limitations of Sir Geo. Airy's statement have been mistaken for limits of his theory. Later, i.e. in 1896, Lord Rayleigh, writing, as it would seem, independently of Sir Geo. Airy's work, applied the same principles to the resolving power of the Microscope. His paper appears in vol. 42 of the *Philosophical Magazine*, p. 167. It has been objected to Lord Rayleigh's investigation, that he assumes the full aperture of the objective to be occupied with rays from the object on the stage, whereas it is said that in fact diffraction may cut out certain parts of the cone of incident light, and leave the effective aperture something less than the angular aperture of the lens. This objection is somewhat beside the mark, because, as we have seen, it is always quite easy to get rid of diffraction on the stage of the Microscope by the expedient of critical illumination. Even were this otherwise, the problem presented by a segmentally illuminated objective would have to be investigated by an extension of Lord Rayleigh's method. It cannot possibly be solved by Professor Abbe's method, which is vitiated by the fundamental and irremediable error that it seeks in the object for the explanation of phenomena which originate in the instrument.

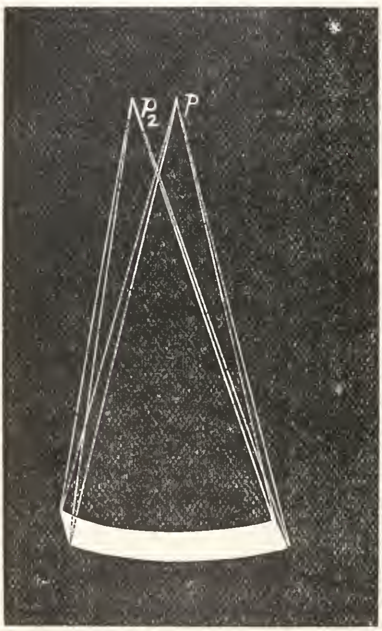
While the work of Airy and of Rayleigh has left only gleanings for other labourers in this field, the gleanings may themselves perchance prove valuable. I venture therefore to offer you the result of my own attempt to contribute towards the labour of gathering up such ears of corn as still remain ungarnered. In what follows I shall not attempt to follow closely in the steps of the two investigators just named, because their results are, from the point of view of the ordinary reader, too abstractly mathematical—as a friend of mine puts it—they are too much contaminated with differential calculus to please a middle-aged taste. I shall take the liberty therefore of striking out in a new direction, so far as the form of the explanation is concerned, and shall hope to submit it to you in a shape better suited to the exigencies of oral discussion.

When a train of wave-fronts—by which, of course, I mean a series of wave-fronts advancing in orderly and rhythmic sequence—when a train of light wave-fronts is intercepted by an opaque screen, the segments of the successive wave-fronts which escape past the edges of the screen or through apertures in its expanse pass on and become a source of light in the space behind the screen. But, as is well known, they do not illuminate the whole rearward space. The luminiferous impulse which they convey is propagated in what are sensibly rectilinear paths, and this rectilinear propagation of light gives rise to sharply defined boundaries between the lighted space and the shadow. The boundary, however, is not as simply rigorous as we commonly suppose. Careful examination shows that it is transgressed by the shadows which invade the lighted region, and by the light which in its turn makes inroads upon the shadow. These boundary phenomena, confined within limits too narrow to affect sensibly the common phenomena of vision, have a very sensible effect upon the images formed by means of shadows in various optical instruments, and pre-eminently in the Microscope, where they give rise under high magnification to fringes, intercostals, and other such-like appearances which sometimes completely obscure the true image. Their investigation, although of primary importance in the theory of the Microscope, and presenting in fact no serious difficulty, has been singularly neglected hitherto. We have already seen how, by the simple expedient of observing by an easy experiment the form of the antipoint, and then by an equally easy construction developing a geometrical figure in which antipoints replace the points of nature, it is possible to pass from an object on the stage through an entire series of the varying appearances which that object will take on when viewed through the Microscope. The most complicated illusions exhibited by diatoms and such-like objects can be investigated with equal success and no more difficulty, but I do not propose to trespass on your time this evening with digressions into that region. In bringing this long paper to a close I ask leave only to add a few observations on the general considerations which determine the shape and dimensions of the antipoint.

We have, then, to consider how a segmental wave-front illuminates a point which lies within its own geometrical shadow; for, as has been already mentioned, the reciprocal case of the imperfect lighting of the illuminated area near the shadow boundary is of no consequence for the present purpose. The light which thus passes into the zone of shadow is called diffracted light, and its propagation, like the formation of the shadow itself, is due to the interference of successive waves with one another's work. To this conception of interference of light we rise by considering all the points upon a wave-front as so many independent foci, sources of light from which the luminous impulse is transmitted in all directions. These foci, however, are co-ordinated to one another by a double law; every one shines with exactly the same brightness as every other one, and vibrates in exact synchronism with every other one in the same wave-front. We may then estimate the whole illuminating effect of the wave-front on any given point in front of it by adding together the impulses which every part of the wave-front would send to that point if it stood alone. For the case of a focal point, such as p in fig. 87 which stands equidistant from all parts of the segment, this addition is a very simple matter. All the several impulses will arrive simultaneously and in equal phase, and the aggregate effect will be the simple total of the individual effects. The whole disturbance produced by any one wave-front under these conditions falls as a single blow at a single indivisible point of time. There can be no interference by one wave-front with the work of its predecessor, but every one in turn produces its whole effect without impediment from wave-fronts that have gone before, and without diminution from those that follow. Here the intensity of the resulting light is at its maximum.

But the point p_2 is in a different case. Here the impulse received from the extended wave-front does not fall as a single blow, for the simple reason that the distance of the receiving point from one point upon the wave-front differs from its distance from another point. Hence those parts of the whole impulse which are received from nearer points upon the wave-front will arrive earlier than those other parts that have had farther to travel, and the whole effect of the wave-front will arrive in a stream of partial effects;—a pressure, so to speak, lasting for a finite time, instead of a sharp or single blow. Now this extended duration of the working of any one wave-front on the point p_2 gives occasion for the successive wave-fronts to overlap in their action. Before one has finished another must have begun, for there are no gaps in their ranks, and so arises the possibility of interference. And this is not a possibility only, it is a thing that must occur; for two wave-fronts cannot (save exceptionally) concur in time and space without more or less counter-working one another. The counteraction may be very slight when they are nearly in the same phase, and there is one, the exceptional case just referred to, in which they simply reinforce one another without any counter-working. That occurs when the successor is one exact wave-length or any integral number of wave-lengths behind the predecessor. In that case the two wave-fronts will coincide in phase, and such wave-fronts must of necessity follow one another at intervals which are integral multiples of the period of oscillation. But all the intervening wave-fronts must coalesce only imperfectly with their leader, and therefore must counter-

Fig. 87.



work it and one another more or less. The extent to which they will thus counterwork one another is evidently measured by their differences of phase. A complete oscillation comprises an excursion first in one direction and then back again in the opposite direction, like the forward and backward swing of a pendulum. If two wave-fronts overlap one another, therefore, to the extent of half a period, they will exactly neutralise one another, for the one will tend to elicit a movement the direct opposite of that which the other tends to set up. These equal and opposite forces can produce stress but no movement, and thus we see that by interference the same set of undulations which at p give rise to bright illumination, may at p_2 set up a state of strain of which our eyes can give us no account. Such, in broad outline, is the undulatory theory of shadow formation.

This explanation must, however, be pursued a step farther, for it is not yet apparent why over one region the successive wave-fronts should always harmonise so as to reinforce one another and produce light, and in another region, sharply divided from the first, should interfere destructively and produce shadow. This, however, will be very clear when we consider how small a magnitude a wave-length of light is. Something like $\frac{1}{50,000}$ inch comprises a complete set of wave-fronts of light; that is to say, within that small space, measured radially from any focal point, you may find, at any given instant of time, a set of wave-fronts exhibiting every possible phase of the light oscillation. If all these wave-fronts are brought together at any given point in time and space, they will evidently cancel one another; for the series will, of course, contain in the second half an impulse which is the opposite of every impulse in the first half. Hence, whenever we find that a given segment of a wave-front occupies a whole wave-period in delivering its consignment of energy at a given point, we may infer that the discharge is not effected without impediment, that succeeding wave-fronts will enter into competition with it for discharging facilities, and that the visible effect will be diminished accordingly. If the period of discharge be exactly one wave-period, and if the rate of discharge be uniformly maintained throughout that period, we may infer that all possible phases of the luminiferous impulse are concurring at every instant, and the result will therefore be a strained but total darkness. A case may be supposed in which the period of discharge will occupy longer than a complete wave-period, say for example $30\frac{5}{8}$ wave-periods. In that case thirty complete sets of undulation phases will at any instant concur and cancel one another. There will be $\frac{5}{8}$ of a complete set over. But this assortment of undulation phases represented by the fraction $\frac{5}{8}$ will not be all concordant. On the contrary, the phases of the 5th eighth will be opposite each to each to the phases of the 1st eighth, and these two divisions will, in like manner, cancel one another. There remain three eighths of a single set of phases uncancelled, and these, although not mutually destructive, are nevertheless only imperfectly attuned. The effect which they will produce may be determined by considering them as equal concurrent forces coinciding at a point in space and inclined at angles proportionate to their differences of phase. This method of solution leads to the construction of a polygon of forces; and if we consider the total impulse from each eighth as a single force, we shall evidently obtain the figure 88 in which the three equal sides represent the three equal impulses, and the common angle of inclination of these sides to one another is equal to $\frac{2\pi}{8}$, the proportion which their common difference of phase bears to a complete wave oscillation. The fourth side will, on this

Fig. 88.

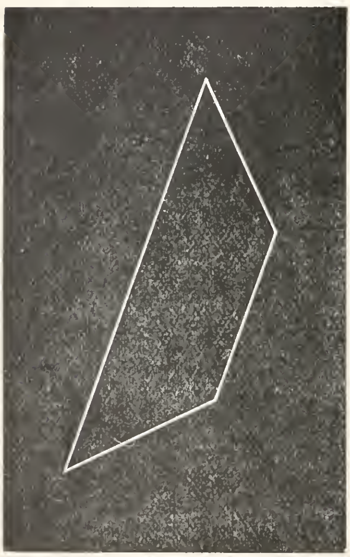
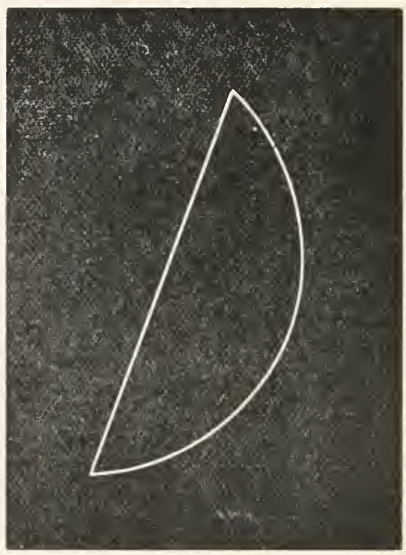


Fig. 89.



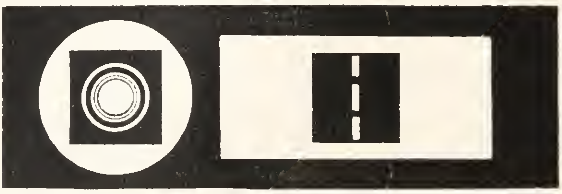
hypothesis, represent in length the amplitude of the resulting wave at the point p_2 and in direction its relative phase. This would give us an approximation to the true result; but as the impulses actually received are not sharply distinguished by marked differences of phase, but pass into one another by imperceptible gradations, the true result itself must be reached by substituting for the three sides of fig. 88 the corresponding arc of a circle of fig. 89, having the angular value $\frac{3}{8}\, 2\pi$. The chord of that arc will then represent in magnitude and direction the amount of light received by the point in question, and its phase relatively to the contemporaneous phase of the wave-front from which the illumination is derived. From this it is easy to calculate that the total effect of the impulses transmitted through the given aperture to this front is only $\frac{2 \sin \frac{3}{8} \pi}{30 \frac{5}{8}}$. This, then, affords a measure of the illuminating effect of the wave-front segment upon a point of space so situated with regard to it. Whereas it would send to the focal point p an impulse proportioned to its whole expanse, the impulse which the point now under discussion could receive would be proportioned only to that which the given wave-front could discharge in three parts of time out of $30\frac{5}{8} \times 8 = 245$ parts, these three parts of time being utilised only to the extent of a discharge at the average rate of 78 p. c. of the full discharging capacity of the segment. Thus a point of space asymmetrically situated with regard to the wave-segment, and so much over its geometrical shadow that thirty and five-eighths sets of complete undulation phases concur to reach it from the wave-front segment at every instant of time, receives only 78 p. c. of $\frac{3}{245}$, = nearly 1 p. c., of the light received by the focal point. Now, the distance over the shadow boundary which suffices to cause such an amount of retardation as is here assumed, in the discharge of the light impulse, is very small. The wave-length of $\frac{1}{50000}$ in. multiplied by $30\frac{5}{8}$ amounts only to about the sixteen-hundredth part of an inch. If we suppose that the wave-segment has a rectangular form, a diameter of half an inch and a focal length of ten inches; it is easy to see that a displacement of no more than $\frac{1}{80}$ in. away from the focal point would plunge the observer into a shadow where the amplitude of the light wave was reduced to this small fraction ($\frac{1}{100}$) of the focal amplitude. If he goes farther still away, the darkness will grow denser without sensible mitigation, for the numerator of the fraction can never increase to more than $2 \sin \frac{\pi}{2}$, and the denominator increases continually and indefinitely.

The fraction which works out at $\frac{2 \sin \frac{3}{8} \pi}{30\frac{5}{8}}$ in the above example, and represents the efficiency of a given wave-front, considered as a source of light to a given point, may with advantage receive a name. I propose in what follows to speak of it as the aperture-value from that point of that wave-front.

The case that has just been discussed is that of a point situated well within the full shadow. The case which it is necessary to consider in discussing the form of the antipoint is that of the region lying close about the focus and in the shadow boundary. The diagram already employed will serve for the investigation of this case, if we assume the difference of the paths from p_2 to the nearer and the further edge respectively to be much less than that already supposed, say, for example, to be $= \lambda$—i.e. one wave-length. Then the wave-front would of course occupy one wave-period of time in discharging its energy on the point p_2, and on the assumption of a uniform rate of discharge during this period of time, the phase value of the wave-front for the point p_2 would be $\frac{0}{1}$. In other words, the complete series of phases which would arrive at every instant of time would cancel one another, and at this point we should have a full shadow. The distance of the point p_2 from the focal point is evidently $\frac{\lambda}{a} d$, where λ is the wave-length, d the distance from p_2 to the wave-front, and a a function of the breadth of the aperture through which the wave-front passes. This is the expression found by Sir Geo. Airy, as above mentioned, for the radius of the dark ring defining the limits of the luminous disc which represents a star in the telescope. In the equivalent form of $\sin a . d$, where a is the angle of diffraction, and d, as before, the distance of the diffraction image from the aperture which limits the wave-front, it is to be found in all the text-books as the position of the first minimum in the series of diffraction spectra. It is not necessary to repeat here a demonstration so easy to be found in the text-books. The expression itself is only adduced because it very readily yields the required definition of the shape and dimensions of the antipoint. For it is to be observed that this function does not in any way depend upon the amount of energy given out by the wave-front; that is to say, it does not depend at all upon the brightness of the source of light. The counteracting forces are always accurately balanced against one another; what strengthens one must equally strengthen the other, so that increasing the brightness does not even tend to dissipate the darkness; it may increase but cannot relieve the strain. If we trace the line which forms the locus of this point, we shall have a true geometrical boundary of the central disc of the antipoint; and a very little consideration will show what, in a general sense, must be the distribution of light within that boundary. For evidently all points situated nearer to the focus than this point must confer upon the wave-front a finite aperture-value, for the fraction will be $\frac{m}{n}$, where m is the fraction representing the resultant of the series of wave-fronts that do not cancel one another, and n represents the fraction of a complete wave-period occupied by the discharge. At the focal point itself $m = 1$, for the successive wave-fronts do not overlap at all, and therefore no destructive interference can take place; and n is evanescent, because no time is occupied by the discharge. Here the expression tells us only that the illumination is a maximum, not what its value is. But at every intermediate point both m and n must have finite values, and then the series of values $\frac{m}{n}$ will indicate not only the order of gradation, but also the steps in the gradation of the light. It is also evident that m will gradually fall off from 1 to 0, and n will gradually increase from 0 to 1. Thus there will be a continuous diminution of light from the maximum at the focal point itself to the minimum at the point p_2. It does not, of course, follow that the light will be strong enough right down to this point to be perceived by the eye. On the contrary, it is clear that the visual limit will be somewhere short of this minimum point, for the value of $\frac{m}{n}$ will become extremely small before becoming $= \frac{0}{1}$, or infinitesimal. The exact boundary of the visible area cannot therefore be determined. Its position will depend upon the total light received by the antipoint, and will lie nearer to p_2 with strong illumination than with weak. For this reason definition and resolving power are impaired by excessive brightness of the image—a point as to which I propose to add an observation later on. In any case, however, the point p_2 will be a landmark beyond which the central disc of the antipoint cannot extend.

Into the question of illumination of the central disc it is not necessary to enter more fully here, but we have still to consider its form. This may of course be traced by laying down as a boundary the line which forms the locus of the limiting point p_2. The position of this point is determined, as we have seen, by the expression $\frac{\lambda}{a} d$. Now, for any given antipoint at any given time, λ will have an invariable value, and d a value subject only to such slight variations as we may ignore. But a may vary to any extent, for it is a function of the diameter of the aperture which determines the shape and dimensions of the wave-front, and not necessarily a linear function. Moreover, it may vary in the same aperture for every several diameter. Take, for instance, the cases of circular, square, and oblong apertures. The circle is perfectly symmetrical, and has only one value for all its diameters. The square is symmetrical along two axes, but has different values for its axial and diagonal diameters. The long rectangle is bilaterally symmetrical along each of its principal axes separately, but with very different values for the two sets of diameters. The central disc of the antipoint produced by these several apertures will vary correspondingly. The circle will of course produce a circle, since the inverted symmetry can still only be satisfied by the circular form. Here a is simply proportional to the diameter. The square in like manner will produce a form approaching to the circle, but having indentations opposite to the salient angles of the aperture. With strong illumination these indentations become so pronounced as to give to the antipoint a cruciform appearance. But the long rectangle will produce a very remarkable modification in the form of the antipoint. The rule that the diameter of the antipoint must vary inversely as the diameter of the aperture results in this case in a very marked deviation from the circular form of the antipoint. Clearly the elongated form of the aperture must result in a reciprocally compressed form of the antipoint—i.e. the antipoint will appear elongated along the axis which is shortened in the aperture, compressed along the axis which is the long axis of the aperture. Thus the antipoint will present a general resemblance to the aperture with its axes interchanged, and in the case of a much elongated aperture this general resemblance will be so close that it would be scarcely inaccurate to describe the antipoint as a reproduction of the aperture on a reduced scale, and with its axis turned through a right angle. The mere geometry of these relations between aperture and antipoint must not detain us now. Fig. 90 gives the figures of the antipoint produced in the two important cases of a circular and a long rectangular aperture, moderate brightness of illumination being presumed.

Fig. 90.



Small figures have been inscribed in the apertures of the diagram to show to the eye at once the forms and orientation of these antipoints, and this general reference to the theory of these figures must suffice for the present.

It has been already seen that the expression $\frac{\lambda}{a} d$ gives the position of minimum illumination, because the time occupied by the wave-front in discharging its energy upon the point so determined gives opportunity for the coincidence at that point of one complete set of wave-fronts—i.e. of one set of wave-fronts in every possible phase of vibration, and of no more than go to one complete set. It is obvious that two complete sets would cancel one another in like manner; so also three complete sets, or any number of complete sets, if they coincided both in time and space. Consequently the point $\frac{2\lambda}{a} d$, $\frac{3\lambda}{a} d$, and so on, are also points of total darkness, with maxima rising to various intensities of illumination lying between them. That is to say, the aperture-value of the given wave-front at any of these points situated in the same plane as the focus, and distant from it by $\frac{d}{a}$ (λ; 2λ; 3λ; etc.), is zero. The aperture-value at the interposed points of maximum illumination will evidently run down in a regular scale. Between $\frac{\lambda}{a} d$ and $\frac{2\lambda}{a} d$ it will have the value $\frac{A}{3\pi}$; between $\frac{2\lambda}{a} d$ and $\frac{3\lambda}{a} d$ it will have the value $\frac{A}{5\pi}$; and so on; where A is a function of the diameter the precise value of which depends upon the form of the aperture. Though slightly overstating the degree of illumination, these fractions represent with sufficient accuracy for present purposes the brightness of these several subsidiary maxima, and it is evident that they fall off rapidly, and must therefore, save with the very strongest illumination, become invisible at no great distance from the focus. In fact, with low illumination only the two nearest images, those having the maximum brightness of $\frac{A}{3\pi}$, can be seen. With strong illumination the next pair will come into view, while dazzling light, such as direct sunlight or the image of a flame, may bring a much larger number into sight. It will, however, serve our present purpose to discuss the case in which only the first pair of images are conspicuous enough to be seen when isolated in the field of the Microscope.

A very little consideration will show that the shape of the flanking image, being determined by the same factors and by almost the same co-efficients as the shape of the central disc, will closely resemble its primary; and, without pausing over the mathematical proof, I may perhaps at once premise that the parallelogram will produce secondary images scarcely distinguishable in form from the primary, and a circle will produce concentric rings.

We have now reached the point at which these results may be applied to the explanation of the phenomena of resolution in the Microscope; but in view of the Abbe experiments it will be of interest to carry the investigation of the antipoint produced by the rectangular aperture one step farther. The case so far considered is that of a single opening, but the opening may be doubled, or it may be trebled, as it is in the Abbe diaphragm of fig. 79.

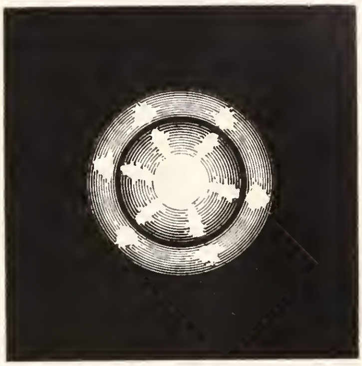
The superposition of the different patterns of antipoint produced by the several members of the series of apertures under these conditions of course gives complexity to the resulting figure; but when the spaces between apertures have the same diameter as the apertures themselves, the resulting antipoint is simple. For the group of three apertures in that case yields an antipoint having the same form and dimensions as would a rectangle having a diameter equal to three times the diameter of any one of the apertures or spaces. The distribution of light will, however, be different; for the dark spaces, which only shut off from the first flanking image as much light as would in any case be suppressed by interference, cut off from the principal image $\frac{2}{5}$ of the light which would otherwise reach it. The relative brightness of the secondary image is therefore enhanced in this proportion; but obviously the increased relative value is secured by loss of light to the focus, not by gain to the excentric image. In this case, therefore, the secondary images are of much greater importance to the appearance of the antipoint than when it is produced by an uninterrupted aperture. Their importance may be still farther increased by adding to the number of apertures, so that the limit is reached only when the first flanking images become equally bright with the principal. It is thus possible, by adding to the apertures in an Abbe diaphragm without change of spacing, to emphasise the Abbe phenomena without otherwise modifying them, or by changing the spacing to modify the phenomena as desired, an expedient to which recourse has already been had in the experiments described above, in which ruled glass diaphragms replaced those supplied by Zeiss with the Abbe apparatus.

Coming now to the practical application of these laws, no further explanation will be necessary to make plain the origin of the various phenomena described by Dr. Zimmermann and illustrated in figs. 71 to 80. They result in every case from constructing the picture of the *Diffractions Platte* from antipoints having the forms here shown to be given to them by the various apertures which Professor Abbe uses. This branch of the inquiry has been already exhausted by the discussion based on fig. 86.

Of greater interest is the solution of intercostals and such like optical illusions produced in the ordinary use of the Microscope when brought to bear on such objects as diatoms which are studded with points of light. There is, for instance, the case of *Pleurosigma angulatum*, to which my attention has been recently called by Mr. E. M. Nelson. Much discussion has taken place concerning the appearance of that diatom in the Microscope when exhibited by its own diffracted light alone; and it is interesting to see how any given theory of resolving power illustrates the problems which such a case presents. The Abbe theory has been brought to bear upon this case, and has yielded a result which was brought before your Society in a paper read by the late Mr. Stephenson (*Jour. R.M.S.*, 1878, p. 186). How far the explanation so given corresponds to the facts I do not know. I am told that the bright points of the diatom are in that explanation misplaced by an angle of 30°, but of this I have no personal knowledge. But what is more surprising than either resemblance or dissimilarity between the theoretical drawing and the actual image—for these may on any hypothesis be accidental—is the fact that any figure at all should have been put forward as *the* theoretical figure. For, in fact, the figure may be made to vary indefinitely. Everything, or almost everything, depends upon the adjustments. The angular position of the bright dots is, of course, a definite fact which no adjustment of the Microscope could alter. But the size and shape of the antipoint can be varied indefinitely between very wide limits by altering the power of the objective and the length of the draw-tube. Like all calculations of the dimensions of the antipoint, the algebraical operations involved in the solution of this problem are very tedious, but a comparatively easy graphic solution can be reached by treating the six beams of light as six equal coincident forces inclined at angles in one plane proportionate to their relative phases, and combining them by means of a polygon of forces as above described.

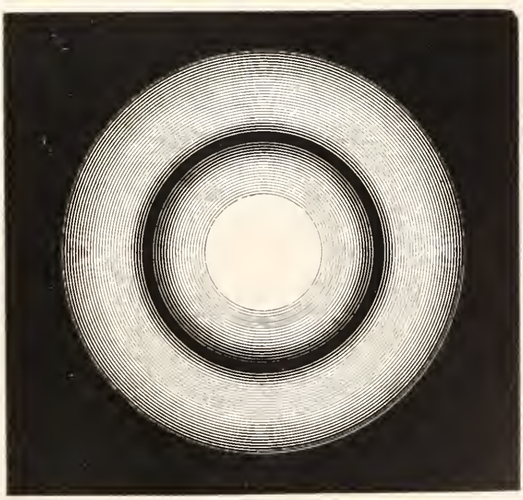
Proceeding in this way, I have deduced the two following figures for the resulting antipoint in the two contrasted cases, in which

Fig. 91.



(1) the objective has a large effective back lens and low magnifying power—(fig. 91); and (2) the objective has small effective back lens aperture and high magnifying power—(fig. 92). It is evident that

Fig. 92.



widely different geometrical figures would result from plotting down the pattern of the diatom with antipoints so very different as these in form and dimensions; and as a complete series of intermediate forms of antipoint can be obtained by properly proportioning the emergent wave-front and the focal length, it is not too much to say that any such solution as that said to have been worked out by Dr. Eichhorn can at best be only a particular case having no special bearing upon the general problem.*

There is, however, a problem of much greater practical importance than any of those presented by optical illusions, upon which the theory of the antipoint has an all-important bearing. I refer to the problem of the construction of an objective with reference to resolving power. Practical experience has established the very high resolving power of wide-angled objectives, but of this practical excellence no satisfactory explanation has yet been given. The explanation generally accepted that a wide-angled objective collects a larger number of diffraction spectra than a narrow-angled lens, has been proved by the foregoing investigation to be neither true in fact nor explanatory if true. But the theory of the antipoint suggests the true explanation, which indeed becomes perfectly obvious when the general laws governing the form of the antipoint are taken into consideration. The problem, of course, is to make the antipoint as nearly punctiform as possible. An image in which the points of nature were replaced by truly punctiform antipoints, if such an image could be produced, would be perfectly resolved. Now, the visible geometrical form of the antipoint depends upon three influences:—

(1) The focussing property of the wave-front segment by which it is formed.

(2) The brilliancy of its illumination.

(3) The overlapping of the outlying parts of adjacent antipoints.

The first of these influences has formed the subject of this inquiry, and has been shown to depend upon the contour of the wave-front, being affected both by its outline and by its curvature. Strong curvature and wide expanse tend towards the compression of the antipoint. On the other hand, a flattened form and small diameter of the wave-front tend to expand the antipoint, and so to destroy the resolution of the image.

The second of these influences has received cursory notice in connection with figs. 81 and 90; and it is obvious that the subordinate features of the antipoint—the margin of its central disc and its flanking or encompressing images—will be more conspicuous with strong than with weak illumination. This point, therefore, may pass without more detailed consideration.

* The reader will no doubt appreciate that the drawings of antipoints throughout this paper are mere diagrams, any close representation by means of woodcuts being impossible. Moreover, the salient points are of necessity exaggerated in order to exhibit them clearly. Thus, for example, the stellate appearance of fig. 91 is accentuated much beyond the reality.

The last of these influences, that is to say, the complicating effect of the reinforcement of the outlying parts of the antipoints by overlapping has been briefly considered in the notice given to intercostals; and it is not possible, in a paper of the general character of this one, to do fuller justice to it. But it is obvious that this overlapping results from the contiguity of distinct luminous details in the image. If the centres of two antipoints are juxtaposed, the overlapping of their peripheral parts does not in general give rise to patterns; but when the centres are separated by a dark field, that dark field may, and in some circumstances does, serve as the background upon which the overlapping peripheral parts of the antipoints become visible. A third case may be proposed, that, namely, in which the two centres are so widely separated that the outlying members cannot overlap. But in that case the third influence—that which we are now considering—would not come into play. The appearance of the antipoint in such a case would be determined only by the shape and dimensions of the wave-front and the amplitude of its oscillations. This last consideration shows that the scale of the image has much to do with the resolution of its details. Any feature which bulks large enough to dwarf the details of the antipoint will be clearly defined; but, on the other hand, any feature which is so small that its appearance is liable to be materially affected by the pattern of the antipoint by means of which it is portrayed, will be liable to be seriously obscured by the prominence which overlapping gives to the subordinate parts of the antipoint.

There is still another circumstance connected with the scale of the image to which it is worth while to advert, although it does not immediately grow out of the considerations so far advanced. The eye itself, like every other optical instrument, constructs its image, not of true points, but of antipoints. Any detail, however well defined in the instrumental image, will be lost in the visible image if its projection on the retina is not sufficiently large to be clearly depicted by means of the retinal antipoint. It is for this reason that a mere reduction of scale by shortening the tube-length of the Microscope will cause a loss of the finest detail. Such a shortening does not in any way impair the resolution in the instrumental image; it may even improve that resolution. But a point is reached at which the antipoint produced by the human iris is too coarse for the true delineation of the minutest detail, and then, of course, defective resolution occurs in the eye.

We are now able to lay down the instrumental conditions of good resolution in general terms :—

1.—The emitted wave-front must produce a very small antipoint.

2.—The image must be sufficiently, but only just sufficiently, illuminated for good definition.

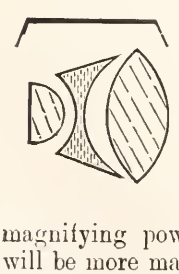
3.—The scale of the image must be sufficiently large.

The second of these conditions may be dismissed as being a mere detail of manipulation. The illumination is so completely under the operator's control, and so easily regulated, that the maker of the objective does not need to take it into account. He may assume that his lens will always be put to work under the best possible conditions so far as illumination is concerned.

The two remaining conditions are antagonistic the one to the other, and to a certain extent mutually exclusive. A small antipoint is most easily secured by giving a small radius of curvature to the wave-front at the plane of the aperture. But a small radius of curvature behind the objective implies a low magnifying power, and a low magnifying power in its turn implies an image on a small scale. In fact, the radius of curvature of the emergent wave-front as it passes out of the back lens of the objective is always about 10 ins., a little more or less. This may be taken to be a fixed quantity. There remains only the expedient of expanding the wave-front as the last resource of the Microscope maker for diminishing the antipoint, and so improving the resolving power of his lens. The wide-angled objective is one way, and a most excellent way, of accomplishing this object. The wide angle fills and requires a back lens of comparatively large diameter ; it also implies a shallow form of objective, with small axial distance between the front and back lenses ; and this again implies high magnifying power. Thus we get the two desiderata of large scale and small antipoint combined. And this is the real cause of success of wide-angled objectives. It is an accident, and a very fortunate one, that Professor Abbe's theory should have pointed to this form of construction ; for it mattered nothing to the practical result upon what theory these objectives were constructed, provided they, in fact, secured the broad wave-front and the large scale image.

But that practical result is now secure, and if the Abbe theory should continue to hold the field, it would in the future only obstruct the further course of improvement. For it is manifest that the simple wide-angled objective is not the only form which can yield this combination. In fig. 93 is shown diagrammatically what I will venture to call a compound-angled objective. The beam of light enters the front lens under a narrow angle, is expanded by the negative lens seen in the middle of the objective, and emerges as a broad wave-front from a back lens of high magnifying power. The objective will possess many excellent properties when made. As against the narrow-angled objective it will have the excellence of superior defining, resolving, and magnifying power. As compared with the wide-angled objective it will be more manageable, for it will work at a greater distance from the stage, and it will require a less oblique pencil of illuminating

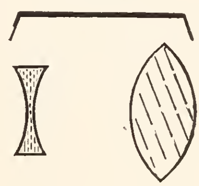
Fig. 93.



light, so that the mounting and sub-stage arrangements will be much simplified. The one thing that it will not do will be to gather in the diffracted rays scattered by minute striæ in the object; but it will be found that this deficiency will not impair its performance.

Another appliance intended to serve the same purpose is shown in fig. 94. This, perhaps, can hardly be called an objective at all; it is rather an adjunct to an objective, and is intended to be placed behind the objectives in present use for improving their definition and resolving power. It consists of a negative lens for expanding the wave-front, backed by a positive lens of counter-equivalent power for restoring the focus. In this way a back lens of much larger diameter than could be conveniently mounted in an objective of standard size can be worked up into the combination, and a proportionate improvement in the performance of existing objectives may be looked for.

Fig. 94.



At present these are only theoretical results, and it may be that many practical difficulties will have to be surmounted before they can be realised in practice. But they point out one direction in which marked improvements in objective construction may reasonably be looked for—provided, of course, that a superstitious adherence to the Abbe theory does not prevent the Microscope makers from trying experiments in these directions. It is out of my power to put these theoretical results to the rigid test of experiment; but I may say, for the encouragement of others more fortunate in this respect, that I have made some experiments with rough models improvised out of the lenses of opera-glasses, with results that appear to me, and, I believe, to some of my friends, to be highly promising.

It is perhaps unnecessary, but I should like to guard myself by adding that these suggestions for the improvement of objectives are not only theoretical—the drawings are mere diagrams and in no sense designs. I am far too sensible of my limitations to offer suggestions to the Microscope makers concerning the designing of their instruments. My task will be accomplished if I succeed in drawing attention to the possibilities of this type of combination.

There is one more word which, as a visitor, I hope I may be allowed to add—a word in acknowledgment of the very liberal way in which your Society has opened the pages of its Journal to the publication of this paper, and placed its abundant facilities of illustration at my disposal, for the purpose of exhibiting the argument which I have now the honour to submit for your consideration. I do not presume to make that acknowledgment in the form of thanks, for I am well aware that this very effective support is not conferred upon me as a boon, but is extended to me quite impersonally as the exponent of a view which you consider proper to be brought under searching discussion. But if I may not thank you, I hope that I may at least assure you that I am very sensible of the advantage which your co-operation gives me in putting these views forward. And in a more personal strain I hope that I may tender my thanks to Mr. Conrad Beck and the other Fellows of the Society whose liberal aid in the furnishing of appliances for this evening's demonstration has enabled me to put my case before you with every advantage for which an advocate can ask.

NOTE.

Resolution of Amphipleura pellucida.

Mr. A. Eliot Merlin and Mr. E. M. Nelson write that they have resolved the transverse striæ on *Amphipleura pellucida* mounted in Professor Hamilton Smith's medium, illuminated by sunlight passed through an acetate of copper screen. Powell's chromatic condenser with oblique slot was used, oil-immersed to the slide, the objective being Powell's dry apochromatic $\frac{1}{4}$, and the power only 350 diameters. They think that this is probably worth recording, as the resolution must be very strong and sharp before it can be seen with such a low magnification.

Later they found that the striæ on *A. pellucida* mounted dry on cover could be distinctly resolved into dots with the vertical illuminator and Leitz $\frac{1}{10}$ in., 1·3 N.A. The important point in this observation is that the illumination was central, by which term it is meant that the annulus beyond N.A. 1·0 at the back of the objective was evenly illuminated all round. This is remarkable, because it was formerly understood that, in order to obtain the maximum resolution, it was necessary to utilise only a small part of the annulus in a direction at right angles to the striation. When, however, this latter arrangement was tried, the structure remained unresolved even with an N.A. of 1·4.

In each instance the edge of the flame was maintained at such a distance from the vertical illuminator that its image was sharply focussed upon the object.

OBITUARY.

John Ware Stephenson.

Died 3rd May, 1901, aged 82.

Mr. J. W. Stephenson, F.I.A., F.R.A.S., actuary to the Equitable Life Assurance Society, was elected a Fellow of the Microscopical Society of London in 1861, and was Treasurer of the Royal Microscopical Society from 1872 to 1881. He contributed eighteen papers to the Society,* among which the more important are:—(1) on an Erecting Binocular[1]; (2) on Bichromatic Vision[2]; (3) on a Polarizing Prism[3]; (4) on a Homogeneous Immersion Objective[4]; (5) on a Catoptric Immersion Illuminator[5]; (6) An N.A. Table[6]; (7) two papers on mounting in dense media[7].

The first binocular Microscope was made in 1677, by Père Cherubin d'Orléans, Capucin, (François Laserré). The second binocular was proposed by Sir Charles Wheatstone in 1851; he was unsuccessful in persuading either Messrs. Ross, Powell, or Beck to construct it. The third was invented (1851), constructed (1852), and published (1853), by Professor J. L. Riddell of New-Orleans.† After this, many forms of binocular Microscopes appeared, notably Wenham's (1860), in the form as at present used. The binocular designed by Stephenson in 1870, which is still known by his name, is similar to that of Professor Riddell's, with the exception that the erecting prisms in Stephenson's are placed immediately over the dividing prisms instead of over the eye-pieces, as in Professor Riddell's. In 1872 Stephenson adapted his binocular to use with high powers, by making the divided prisms smaller, and lowering them down inside the mount close to the back lens of the objective; and, further, he made the erecting prism removable, so that a plate of black glass could be inserted in its place, to act as an analyser for polarised objects, the inclination of the body-tubes being at the proper polarising angle. The polarising and the high-power binoculars have not come into general use, but the instrument in its original form has been called by some of the most eminent microscopists of the day the best instrument for mounting and dissecting as yet devised. In 1873

* The titles of the various papers have been abridged.

[1] M.M.J., iv. (1870) p. 61, pl. 57; vii. (1872), p. 167, pl. 15; x. (1873) p. 41.

[2] Op. cit., vii. (1872) p. 215.

[3] Op. cit., p. 246, fig. 1.

[4] J.R.M.S., i. (1878) p. 51 (woodcut).

[5] Op. cit., ii. (1879) p. 36 (woodcut).

[6] Op. cit., p. 839.

[7] Op. cit., iii. (1880) p. 564; ii. ser. 2 (1882) pp. 134 and 163.

† Q.J.M.S., ii. (1854) p. 18, figs. 2 and 3.

Mr. Stephenson first heard of Professor Riddell's priority of the invention, and at once acknowledged it before the Society.*

The papers on bichromatic vision and on a secondary polarising prism have probably not received the attention they deserve.

Professor Abbe's diffraction theory of microscopic vision was first noticed in the *Journal* of this Society † in July 1874, in an editorial paragraph on 'The Capability of the Microscope.' In the next year Dr. H. E. Fripp, in the *Proceedings of the Bristol Naturalists' Society*,‡ gave a translation of the original paper. This translation was largely abstracted in the same year in the *Journal* of this Society,§ and two years later, in January 1877, Mr. Stephenson read a paper,‖ again drawing the attention of the Society to this subject. He was (and remained, so far as we know) a firm believer in the truth of this theory and its necessary deductions.

The next paper, on a Homogeneous Immersion Objective, was at the time the cause of much dispute about priority. Sir D. Brewster in 1837, and Professor Amici in 1844, experimented with water- and oil-immersion lenses, the object of Brewster's experiments being to get rid of dispersion, and the object of those of Amici to diminish the excessive refraction at the plane surface of the front lens. Dr. Royston-Pigott,[8] in 1870, suggested turpentine ¶ as an immersion fluid, with a view to increase the aperture, because its refractive index was similar to that of balsam. He also published a table of the maximum apertures of dry, water-, and turpentine-immersion objectives in terms of crown-glass or balsam angles.

In 1871 Mr. R. B. Tolles[9] of Boston contributed two letters to the *Monthly Microscopical Journal*, describing his experiments with balsam immersion objectives and condensers, and in one letter twice uses the word homogeneous in connection with this subject; he also says: "The case is totally and most obviously applicable to that of the ordinary balsam-mounted Microscope object for an aperture far above 82° of angular pencil actually traversing the object, and made available in the view to the eye of the observer. For obtainment of extremest angle, however, let one precaution be taken, viz., balsam be used above the slide and balsam below."

At this time (1871) a controversy about the aperture of objectives was going on, and letters frequently appeared in the *Journal* referring to experiments made with objectives immersed in balsam, and to the measurement of their balsam angles.

This controversy was still in progress in 1878, when Mr. Stephenson read before the Society his paper on a wide-angled immersion objective

* M.M.J., x. (1873) p. 41. † Op. cit., xii. (1874) p. 29.
‡ Proc. Bristol Nat. Soc., n.s., i. (1875) p. 200.
§ M.M.J., xiv. (1875) pp. 191 and 245. ‖ Op. cit., xvii. (1877) p. 82, pl. 173.
[8] Op. cit., iv. (1870) pp. 26 and 140.
¶ Turpentine was chosen as being homogeneous, *quâ* dispersion, with the flint concave of a doublet front, and, *quâ* refractive index, with balsam.
[9] M.M.J., vi. (1871) pp. 84 and 214.

without adjustment-collar. This paper informs us:—(*a*) that the author had suggested to Professor Abbe the desirability of constructing an object-glass corrected for use with some immersion medium optically identical with the cover-glass, for the purpose of removing all necessity for collar adjustment; (*b*) that Professor Abbe, acting on this suggestion, had measured the optical constants of nearly 100 different media, and had found that oil of cedar was the best for the purpose; (*c*) that Messrs. Zeiss had constructed a homogeneous immersion $\frac{1}{9}$ objective from Professor Abbe's formula. The lens was exhibited at the time.

Early in the next year (1879), Mr. Stephenson brought to the notice of the Society a catoptric immersion illuminator which he had designed a couple of years previously. This was an annular illuminator for wide-angled lenses, which would necessarily give a dark ground with narrower apertures; by the employment of suitable stops oblique light could be obtained in one or more azimuths. In 1885 he further amplified the idea by a catadioptric illuminator,[10] but this new form did not prove as serviceable as the older one.

The next paper was a numerical aperture table giving, in addition to the N.A., the theoretical resolving power for objectives when illuminated by oblique light; it also contained three columns with the equivalent angular apertures of dry, water, and homogeneous immersion objectives, in this respect being an enlargement of Dr. Pigott's table[11].

There are two valuable papers by Mr. Stephenson upon mounting in dense media; among the substances experimented with were bisulphide of carbon, phosphorus, sulphur, biniodide of mercury, iodide of potassium, and oil of cassia; and in 1882 there is a statement that some slides containing diatoms mounted in phosphorus[12] in 1873 were still perfectly good.

[10] J.R.M.S., v. (1885) ser. 2, pp. 207 and 523, figs. 44 and 112.
[11] M.M.J., iv. (1870) p. 26. [12] Op. cit., x. (1873) p 1.

SUMMARY OF CURRENT RESEARCHES

RELATING TO

ZOOLOGY AND BOTANY

(PRINCIPALLY INVERTEBRATA AND CRYPTOGAMIA),

MICROSCOPY ETC.*

ZOOLOGY.

VERTEBRATA.

a. Embryology.†

Teratogenic Influence of Saline and Saccharine Solutions.‡ — E. Bataillon finds that this is in relation to the plasmolysis which is set up in the developing egg, and may be measured in terms of molecular weight and isotonic co-efficient. The optimum temperature for development is not the same as that of the maximum resistance to plasmolysing solutions. This maximum is about 15° C. for the egg of *Rana temporaria*. Above and below this, blastoporic abnormalities are obtained with weaker solutions than those requisite at 15° C. The inertia of the vegetative pole is the initial trouble; the prolapse of the vitellus by a large blastopore follows as a consequence. But perhaps the most important conclusion, telling against the theory of specific chemical influence, is that at each temperature all isotonic solutions have the same effect.

Is there Parthenogenesis in Vertebrata?§ — Prof. R. Bonnet has published a careful discussion of this interesting question, and reviews 161 documents bearing on it. He comes to the conclusion that we are not as yet warranted in speaking of parthenogenetic processes in Vertebrates. The phenomena which have been described as parthenogenetic are partly degenerative and partly the results of imperfect or feeble fertilisation. So-called parthenogenetic tumours are interpreted as the results of the development of a blastomere which has got separated off, or has divided with abnormal slowness.

Division of Chromosomes.‖ — Dr. E. V. Wilcox discusses the question whether there is really that sharp distinction between longitudinal and transverse division of the chromosomes which Weismann supposes.

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

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

‡ Comptes Rendus, cxxxii. (1901) pp. 852–4.

§ Anatomische Ergebnisse (Merkel and Bonnet), ix. (for 1899) pp. 820–50. See Zool. Centralbl., viii. (1901) pp. 341–2.

‖ Anat. Anzeig., xix. (1901) pp. 332–5.

He points out that in the ovum before the first maturation division, the nuclear chromatin breaks up into minute particles, described by authors in some cases as too small for definition by the Microscope. Later, these particles condense to form chromosomes; but in view of the origin of these, the author regards it as absurd to assume that they possess such a form of bilateral symmetry as would render one form of division quantitative and another qualitative. He not only rejects the current distinction between qualitative and quantitative divisions, but doubts the possibility of as yet including the maturation phenomena of different animals in one general statement. The attempt has, he believes, already led many to do violence to the actual facts of observation.

Spermatogenesis of Batrachoseps.*—Dr. Gustav Eisen finds that the testis of this batrachian is admirably adapted for cytological study, owing to the large size of the cells. As the result of his observations, he gives the following account of the structures of the cell. The *cytosome* consists of the cytoplasm, the plasmosphere, the hyalosphere, the granosphere, the metaplasmic secretions, the cytoplasmic membrane of the various fibres and spindles, except the contractile fibres. The nucleus or *karyosome* contains the chromioles, the chromomeres, the leaders, the chromosomes, the chromoplasm, the endochromatic granules, the linin, the linoplasts, the nuclear membrane, and the chromoplast. The *archosome* consists of the centrioles, the somosphere, and the centrosphere, centrioles and somosphere constituting the centrosome of other authors. The spheres consist of plasmosphere, granosphere, and hyalosphere, and are not permanent cell-organs; their three constituents have different functions. The archosome usually lies within the granosphere. The chromioles are the most minute visible elements of the chromosomes, are constant, and are probably the bearers of the hereditary qualities. They are connected together by chromoplasm, and are nourished by the endochromatic granules. The chromoplasts are bodies having the staining reactions of chromoplasm, which, by means of the linin, direct the movements of the chromioles. The linoplasts nourish the linin network, and form the true nucleoli. The archosome directs the formation of the spindle; its contained centrosphere is an organ of locomotion, by means of which the archosome is capable of moving in the cell. The object of mitosis is to produce the division of the chromioles, which, together with the chromoplasts, the archosome, and the cell-wall, form the most permanent structures of the cell. The other structures are for the most part ephemeral, and have for their object the accomplishment of mitosis. In the mitosis the author distinguishes two processes, the radiosomic and the chromosomic. The first is controlled by the archosomes, and has for its object the formation of spindles and fibres and the reconstitution of the cytosome. The second is directed by the chromoplasts, and includes the formation and splitting of chromosomes, and the separation of the halves. The two processes are parallel but independent.

Differences in the Development of the same Ectodermic Structures.†—Dr. Karl Peter considers the development of the nerve-cord,

* Journ. Morphol., xvii. (1900) pp. 1–117 (14 pls.).
† Anat. Anzeig., xix. (1901) pp. 177–98 (8 figs.).

the olfactory sac, the lens, and the auditory vesicle, in the various Vertebrate types, and observes that two deviations from the norm are not infrequent, probably because of differences in the spatial and other conditions of development.

Instead of an invagination whose margins coalesce, there may be a solid primordium, which subsequently acquires a lumen by dehiscence. An organ may thus owe its origin entirely to the inner ectodermic layer, while the outer layer, which normally shared in the development, has no share beyond being protective. Origin by infolding and origin from a solid primordium are not rigidly separable, for intermediate modes occur, and both may occur in one type.

Development of Immature Ova of Rana fusca.* — E. Bataillon experimented with ova removed from the female towards the end of copulation, when many were still in the body cavity. These were fertilised and the segmentation was observed. Apart from a few irregularities, the development seemed at first almost normal. But some eggs, apparently undeveloped but with slightly dilated volume, were seen moving actively and regularly within their envelopes. These *monstres anides* showed a rudiment of a blastula-like nature, a complete covering of ectoderm, a large segmentation-cavity, *not a trace of invagination*, but a cylindrical prolongation towards the region of the blastopore.

In another set, two kinds of abnormality were observed—(*a*) with cleavage restricted to the animal hemisphere, with nuclear division without cell-boundaries at the lower-pole; and (*b*) with no cell-boundaries at all, but numerous nuclei.

The author thinks that all the different cases may be arranged in a series; during maturation there are oscillations in osmotic pressure, and there is a gradation in the results. There may be no true cell-division except at the upper pole, and karyokinesis only below; there may be no true cell-division at all, and abnormal karyokinesis; or there may be no physical obstacle operative until the time of gastrulation approaches, and then there result the exogastrulæ (like Lithium-larvæ of Echinoids) or *monstres anides* referred to above.

Somatopleure and Splanchnopleure.† — Prof. Charles Sedgwick Minot protests against the frequent German misuse of these terms as equivalent to somatic and splanchnic mesoderm. Sir Michael Foster, who invented the words, writes "Certainly somatopleure is body-wall, both ectoderm (epiblast) and mesoderm (mesoblast), and splanchnopleure to suit." It was to this sense that Huxley and Balfour adhered, and it is to this sense that all should adhere. There are many terminological difficulties which seem inevitable, but this new ambiguity is altogether unnecessary.

Female Urinogenital Organs of Marsupialia.‡ — J. P. Hill finds that in *Myrmecobius fasciatus* the female urinogenital organs agree with those of *Perameles* in the possession of a small median vaginal apparatus, consisting in virgin animals of two separate cul-de-sacs, and also in that the anterior parts of the lateral vaginæ, the uterine necks,

* Comptes Rendus, cxxxii. (1901) pp. 1134–6.
† Anat. Anzeig., xix. (1901) pp. 203–5.
‡ Proc. Linn. Soc. N. S. Wales, xxv. (1900) pp. 519–32 (3 pls.).

and the median vaginæ, all remain imbedded in the genital cord, and so retain the position occupied by the Müllerian ducts in the fœtus. Further in both animals there is a distinct cloaca. The organs of *Myrmecobius* differ from those of *Perameles* in that the middle parts of the lateral vaginæ are free and coiled, and in that there is a long urino-genital sinus. The author has further re-examined *Trichosurus vulpecula*, and corrects his previous statement that parturition here takes place through the lateral vaginal canals. He now finds reason to believe that a pseudo-vaginal passage is formed during birth, and as in *Perameles* rapidly disappears after birth, to be formed anew at the next parturition.

Development of Ductus Endolymphaticus.*—Dr. R. Krause has investigated a large series of Vertebrate embryos, in order to confirm or disprove Balfour's statement that the ductus endolymphaticus of higher forms is the homologue of the duct found in the Elasmobranchs, and therefore the remnant of the original invagination which forms the ear. He is able to entirely confirm Balfour's view in birds, reptiles, and mammals, and finds further that no true ductus endolymphaticus exists in fishes.

Artificial Rearing of Soles.†—Fabre-Domergue and E. Biétrix note that they have succeeded in rearing soles from the egg to the assumption of the adult form. This has been done in four other cases,—herring (Meyer), *Cottus* (Fabre-Domergue and Biétrix), plaice (Dannevig), and blenny (Garstang).

The young soles first fed on plankton-organisms; when their yolk-sac was exhausted they devoured larval fishes; when the adult form was assumed they ceased to hunt for larval fishes and turned to Copepods and small Annelids. In May some of the young soles had reached a length of 35 mm. The authors succeeded with about 50 per cent., and they suggest the practical importance of their experiments.

Development and Significance of the Ora Serrata.‡—Prof. O. Schultze finds that this characteristic structure of the human eye is merely a result of the conditions of development, and has no functional importance. At the time when the ciliary processes begin to raise themselves from the primitively smooth surface of the corpus ciliare, the retinal investment of the last-named, originally very thick, becomes gradually thinned. The thinning process spreads over the optic cup as the ciliary body becomes differentiated, and its posterior margin forms the ora serrata. The jagged nature of the ora serrata is due to the formation of projections and hollows as the ciliary processes spread backwards, and the fusion or partial disappearance of these gives rise to the variable conditions found in the adult.

b. Histology.

Blood-Circulation without Capillaries.§—Prof. Charles Sedgwick Minot brings forward evidence to show that in all Vertebrates there occur two types of blood-vessel with endothelial or endothelioid walls

* Anat. Anzeig., xix. (1901) pp. 49–59 (21 figs.).
† Comptes Rendus, cxxxii. (1901) pp. 1136–8.
‡ Verh. Phys. Med. Ges. Würzburg, xxxiv. (1901) pp. 131–43 (1 pl. and 3 figs.).
§ Proc. Boston Soc. Nat. Hist., xxix. (1900) pp. 185–215 (12 figs.).

only. Vessels of both types intervene between the ends of the arteries and the veins—the familiar capillaries and the unfamiliar "*sinusoids.*"

A sinusoid is of relatively large size, and its epithelium is fitted closely against the cells of the organ in which it is developed; it has numerous wide and free communications with neighbouring sinusoids; the sinusoid wall follows the shape of the parenchyma of the part, with no or exceedingly little (secondary) connective-tissue between it and the adjacent parenchyma; the development also seems different from that of true capillaries. Blood sinusoids have been found to afford the main channels of the circulation in pronephros, mesonephros, liver, heart, suprarenal capsules, parathyroid glands, carotid glands (probably), and coccygeal glands.

Structure of Nerve-Cells.*—Prof. L. Vincenzi has studied the cells of the ventral nucleus of the ear in kittens, and finds them to be invested by a distinct pericellular membrane. This membrane invests the whole cell, and is prolonged over the cell processes. It appears to the author to have a scale-like rather than a reticular structure, apparently consisting of polygonal scales each of which projects over the next. A number of cells with their processes are figured and described, and the course of the processes discussed.

In an additional note,† the author notes that he has now found that the pericellular membrane is neither reticular nor made of scales, but forms a continuous investment. The various appearances observed by himself and other authors he explains as follows. In treating endothelium with nitrate of silver, it has often been observed that lines of adhesion become more deeply coloured than other parts. He believes that the pericellular investment is a membrane having polygonal lines of adhesion to the underlying cell. These lines of adhesion stain more deeply, and give to the investment a reticular appearance. He finds further that, at least in some cases, the investment is connected with capillary vessels.

Elements of Connective-Tissue.‡—Josef Schaffer does not altogether agree with Waldeyer's recent paper § on this subject, especially as regards the dropping of the term cement-substance (*Kittsubstanz*). He considers that the term should be retained to designate the structureless connecting substance which unites the formed elements of the ground-substance, and is probably of the nature of mucin. This cement-substance is present, although in small quantities, in many regions of the body, as between the fibrillæ of lamellar bones, in developing connective-tissue, and so on. Further, Schaffer is of opinion that ground-substance, though it may arise from metamorphosed protoplasm, does not usually do so, but rather originates by a process of secretion from the cells.

Endings of the Olfactory Nerves in Fishes.‖—K. P. Jagodowski has studied these in the pike and some other fishes. As Max Schultze showed, the olfactory bud consists of epithelial supporting cells and olfactory cells. Of the latter the author finds three types:—(*a*) rods in

* Anat. Anzeig., xix. (1901) pp. 33–42 (20 figs.).
† Tom. cit., pp. 115–8 (4 figs.). ‡ Tom. cit., pp. 95–104.
§ Cf. this Journal, *ante*, p. 141.
‖ Anat. Anzeig., xix. (1901) pp. 257–67 (10 figs.).

which the peripheral process is throughout almost as thick as the body of the cell; (*b*) small compact cells with no peripheral process (the *Riechstäbchen* and *Riechzapfen* of Dogiel); and (*c*) the spindle-shaped or pear-shaped cells with a shorter thicker peripheral process, and a very thin varicose central process, as described by Schultze.

But the author has found, what Schultze and Dogiel saw hints of, long delicate flagellum-like processes (*Riechgeisseln*) which extend far outwards, and are probably of great importance in fishes, where the cells lie deeply within the folds and are covered by a thick layer of mucus.

Innervation of the Mammalian Kidney.*—A. E. von Smirnow finds that all the blood-vessels of the kidney are provided with nerves, and that there are other nerves associated with the urinary tubules and with the canaliculi both of the cortical and of the medullary substance. He shows generally that there is a rich abundance of renal nerves and nerve-endings of diverse physiological import, and more particularly he confirms the supposition that there are secretory and sensory nerves in the parenchyma.

Salivary Glands.† — Dr. A. Maximow describes at great length the macroscopic and microscopic changes in the salivary glands after cutting the chorda tympani, the normal conditions in the dog, and the changes induced by binding the efferent ducts.

Histology of Thyroid Gland.‡ — Dr. Motta Coco has made some observations on the connective-tissue investment of the thyroid in the dog. He finds that in the adult the branching connective-tissue makes a network throughout the whole gland, with irregular meshes whose walls are sometimes thick and sometimes thin. The network is present throughout, invests both its vessels and nerves, and finally surrounds the vesicles.

γ. General.

Relations of Arctic and Antarctic Faunas. § — Dr. G. Pfeffer argues in support of the view that the faunas of higher latitudes represent the cöeval relics of the almost uniformly developed and almost universally distributed early tertiary faunas, as they have been evolved under the influence of the cooling of the climate, by a process of separating out and selection. The similarity of the operating causes secured that the same components of the old fauna remained behind in both north and south; and thus has arisen the great and still well-marked similarity of the two faunas.

Genesis of Mid-Pacific Faunas. ‖ —Dr. H. A. Pilsbry brings forward evidence in favour of the hypothesis of a late palæozoic or early mesozoic mid-Pacific continent (upon the sunken heights of which the present island masses, volcanic or coral, have been superposed). The hypothesis is advanced to account for the constitution of Polynesian

* Anat. Anzeig., xix. (1901) pp. 347–59 (1 pl.).
† Arch. Mikr. Anat., lviii. (1901) pp. 1–134 (3 pls.).
‡ Anat. Anzeig., xix. (1901) pp. 88–95 (2 figs.).
§ Ann. and Mag. Nat. Hist., vii. (1901) pp. 301–22. Trans. from Ver. Deutsch. Zool. Ges., ix. (1899) pp. 266–87.
‖ Proc. Acad. Nat. Sci. Philadelphia, 1900 (published 1901) pp. 568–81.

land-snail faunas, which are shown to be:—(1) nearly homogeneous over vast areas; (2) composed of ancient types, with no admixture of the great series of modern families; and (3) not derivable from any tertiary or modern continental fauna or faunas in the sense Atlantic island faunas have been derived. The molluscs, land and marine, supply no evidence that this Pacific continent was ever connected with, or faunally affected by, the Americas, but emphatically contradict such connection.

Eyes of Cave Animals.* —Prof. C. H. Eigenmann sums up some of his previously recorded results in a general paper on the degeneration of the eyes which occurs in North-American cave salamanders and cave fishes (Amblyopsidæ). He discusses in detail the structure of the different parts of the eye in these forms, and in regard to the nature of the degenerative changes, comes to the following conclusion:—"The adult degenerate eye is not an arrested ontogenic stage of development, but a new adaptation, and there is an attempt in ontogeny to reach the degenerate adult condition in the most direct way possible."

Variations in Vertebral Column of Man.† — Dr. T. Dwight, at the close of his study on this subject, formulates six conclusions (1) Variations occur in two ways:—(*a*) by irregular development of the costal elements at and near the ends of the regions of the spine; (*b*) by irregular segmentation, through which there are more or fewer vertebræ than usual. (2) Variations of both kinds are variations around a mean. It is not impossible that some of them may be reversive; that any are progressive is a mere assertion. (3) Assuming the correctness of Rosenberg's studies in ontogenesis, his view (the notion of changes of position of the ilium and the consequent modification of vertebræ according to the position it finally assumes) may account for some of the variations, but even in these cases something more is needed to explain the concomitant changes. (4) Variation of the costal elements at one end of a region is often associated with variation of an opposite nature of those at the other end. Several regions may be involved, and the two sides may vary independently. (5) Variations, which separately seem either reversive or progressive, generally lose that appearance when the whole spine is considered. (6) After the occurrence of the original error in development there is a tendency for the spine to assume, as nearly as possible, its normal disposition and proportions. This implies a vital principle, as do also concomitant variations, and, indeed, all development.

Variation in Chelopus insculptus.‡ — Prof. G. H. Parker describes two abnormal specimens of this American tortoise, in which both the scutes and the bony plates showed variation. The general interest of the paper is that it tends to show that the variations in scutes and plates are correlated, and that the connection between the two is much closer than has been hitherto supposed.

Variations of the Toad.§—Prof. L. Camerano has published an important and elaborate study of the variations of over a score of characters

* Proc. Indiana Acad. Sci., 1899, pp. 31–46 (9 figs.). Cf. this Journal, 1899, p. 273.
† Anat. Anzeig., xix. (1901) pp. 337–47 (3 figs.).
‡ Amer. Nat., xxxv. (1901) pp. 17–24 (5 figs.).
§ Mem. R. Accad. Sci. Torino, l. (1901) pp. 81–153 (2 pls.).

in *Bufo vulgaris* Laur., one of those dry statistical studies with curves and formulæ which will probably form part of the foundation of a securer ætiology.

Variation in Catfish.* — C. H. Eigenmann and U. O. Cox record various examples of saltatory variation, and among them some interesting abnormalities in *Ameiurus melas*. In nine specimens taken at random from a brook in a cave, variation in regard to the barbels was found in the majority of cases, supplementary barbels being usually present. The specimens form a series, showing apparently that the left side is leading the way in the variation, but that there is a tendency towards the acquisition of bilateral symmetry. The authors believe that the specimens must have been derived from a common ancestor, and that the variation is progressive.

Otoliths of the Frog.† — M. Marage finds that the ear of the frog contains a liquid of undetermined nature containing in solution bicarbonate of calcium and traces of bicarbonate of magnesium, with crystals of insoluble carbonates. The mixture has a high density, and is well suited to conduct sound. One of the functions of the otoliths is to maintain as constant as possible the acoustic conductibility of the medium.

Do Fishes distinguish Colours? ‡ — N. Zolotnitsky has made a number of experiments with tench, carp, and other fishes, which have convinced him that they have a marked preference for red objects, e.g. little pieces of woollen thread the size of *Chironomus* larvæ. This was especially well seen in forms accustomed to feed on these larvæ and in those that were hungry. Green and white threads were ignored; yellow threads were sniffed at. He maintains that the question cannot be dismissed with a hurried negative answer.

Hygienic Habits of Animals.§—Dr. E. Trouessart discusses (1) the disposal of refuse and excrement at a distance, including the eating of the placenta and the hygienic devices of the bee-hive; (2) the removal or burial of corpses; (3) the ventilation of dwellings; and (4) the preservation of food-supplies. Most of the facts are familiar, but it is useful to have them collected, and their presentation is picturesque. Dr. Trouessart also discussed in a subsequent lecture ‖ the relations between zoology and medicine, illustrated especially by reference to Pasteur's work on pébrine, Laveran's researches on Hæmatozoa, and Metchnikoff's studies on phagocytosis.

Maternal Devices.¶—Xavier Raspail discusses some of the "*ruses maternelles*" exhibited by female animals in securing their young from enemies against which the maternal strength and care cannot directly cope.

Marks on Dolphins made by Cuttlefish. ** — Prof. D'Arcy W. Thompson refers to the figure of *Delphinus novæzelandiæ* in the 'Voyage

* Amer. Nat., xxxv. (1901) pp. 33–8 (2 figs.).
† Comptes Rendus. cxxxii. (1901) pp. 1072–4 (2 figs.).
‡ Arch. Zool. Expér., ix. (1901) Notes et Revue, pp. i.–v.
§ Bull. Soc. Zool. France, xxvi. (1901) pp. 10–20. ‖ Tom. cit., pp. 32–45.
¶ Tom. cit., pp. 53–61.
** Ann. and Mag. Nat. Hist., vii. (1901) pp. 503–5 (1 fig.).

de l'Astrolabe' (pl. xxviii. fig. 2), and to some other cases, where peculiar markings on the skin have been described. These, as Captain Chaves suggested, are almost certainly the scars left by the suckers of *Architeuthis* and other cuttlefishes.

Tracheal Bulb in Male Anatidæ.*—Frank Finn contributes some interesting notes on the structure and function of the peculiar bony, or bony and membranous, bulbs found at the base of the trachea in many males of the duck tribe. There can be no doubt, from the observations made, that the use of this peculiar structure is to modify the voice of the owner, as Yarrell suggested. Careful study of the living birds will show that in nearly every case where the tracheal enlargement exists in the male, he emits a correspondingly different note from the female—generally one of a weaker character, if not always. A table of nine instances is given, bearing out this conclusion.

Position of Dipnoi.† — Dr. R. Semon briefly summarises the various views which have been held on this subject, and gives as his own opinion that the Dipnoi are more nearly related to the extinct group of fish from which Amphibia originated than any class of fishes of which we have living representatives. As to the suggestion that the resemblances between Amphibia and Dipnoi may be due to convergence, produced by the habit in both cases of alternating between an aquatic and a terrestrial life, the author notes that the terrestrial habit is wholly exceptional in the Dipnoi, that they cannot take food on land, and have limbs not adapted for terrestrial progression. Further, under these circumstances, the suggestion of parallelism in development could only explain the structure of organs directly associated with the air-breathing habit, (lungs, posterior nares, heart, circulatory organs) or influenced by the absence of water (skin and peripheral sense-organs), but it is not only by such organs that a relationship with Amphibians is shown. Thus, although the fins are not used in terrestrial progression, they possess a stylopodium free from fin-rays (homologue of humerus and femur), and a joint corresponding to that of elbow and knee in terrestrial forms. Again, the brain shows the beginning of commissures in the hemispheres, a lobus hippocampi, ganglion-cells in the central grey matter, and two cortical layers; the ductus endolymphaticus exhibits a complicated structure; the cranial nerves show many deviations from the fish-type, deviations of a kind which reappear in Amphibia; the post-branchial body is rudimentary; the tissue elements agree with those of Amphibia; many of the details of development recall the conditions in Amphibia—all characters which cannot be explained away as due to convergence. On the other hand the Crossopterygia, which have been frequently described as the fish most nearly related to Amphibia, possess only such Amphibian characters as are shared by the Dipnoi, to whom the Crossopterygia are undoubtedly related. The author further considers that, while the Crossopterygia lack the progressive Amphibian-like characters of the Dipnoi, they are along their own lines as specialised as the latter. As to the nature of the relation between Amphibia and Dipnoi, the author inclines to the view that they are offshoots of a common stem, but he

* Journ. Asiatic Soc. Bengal., lxix. (1900) pp. 147–9.
† Zool. Anzeig., xxiv. (1901) pp. 180–8.

believes that it is as yet impossible to decide between this view and the suggestion that they arose separately but near together from a primitive Selachian stock.

Mechanism of Tongue in Frog.*—Prof. Marcus Hartog points out that the exact method in which the tongue is everted in the Anura has not hitherto been fully explained. He finds that there is an enormous lymph space between the sub-maxillary muscle and the hyoid bone.

The petrohyoids raise the hyoid and commence its protraction, an action continued by the geniohyoids. The genioglossi and hyoglossi may co-operate to some extent at first, shortening the tongue and so expanding its cavity; but it is the mylohyoid which by its contraction expels the lymph of the subhyoid space into the tongue, and is the true "protrusor linguæ" muscle. In retraction the intrinsic muscles pull the tip of the tongue backwards, and the median portion of the genioglossi especially pull its base downwards and inwards. The sternohyoids and omohyoids retract the body of the hyoid bone, with its attachments to the tongue, and the closure of the mouth by the levators of the mandible presses the tongue against the roof of the mouth, and so expels the lymph from its cavity. Clearly this sudden propulsion of the tongue of the Anura is an erection, and is thus comparable with the sluggish protrusion of the foot in Lamellibranchs, also too often miscalled a "protraction."

Tunicata.

Histology of Ascidians.†—P. Vignon finds that the ciliated cells of the branchial sac in Ascidians confirm his view that the basilar granulations of the cilia have nothing to do with the motion of the cilia. Such granulations represent the most frequent method of insertion of the cilia, but not the only possible one. He also discusses the mechanism of secretion of the "liver" cells in Ascidians.

Development of Branchial Sac in Corella.‡—Marc de Selys Longchamps finds that in *Corella parallelogramma* there are six pairs of protostigmata, but these in all probability arise from primitive slits. Each of these six divides first into two, then into four, and these later take on a crescent shape. The crescents divide, and later form spirals. The author contrasts in detail this method of origin with that found in *Ciona*, *Ascidiella*, and *Molgula*.

INVERTEBRATA.

Plankton of West Coast of Norway.§ — E. Jörgensen has studied the seasonal variations in the surface flora and fauna in the vicinity of Bergen. From January to March organisms are few both as regards individuals and species. About the end of March great numbers of Diatoms suddenly make their appearance, and persist for a few weeks, to be then as suddenly replaced by Peridinieæ and Rotatoria. These

* Comptes Rendus, cxxxii. (1901) pp. 388–9; Ann. and Mag. Nat. Hist., vii. (1901) pp. 501–3.
† Tom. cit., pp. 714–6.
‡ Arch. Biol., xvii. (1900, published 1901) pp. 673–711 (1 pl.).
§ Bergens Museums Aarbog, 1899 (published 1900) pp. 1–112 (4 pls.). See also Bot. Centralbl., lxxxv. (1901) pp. 66–8.

two groups persist throughout the remainder of the year, though there is a replacement of species and genera. Periodical incursions of Diatomaceæ take place throughout the summer, but these are of short duration until the late autumn, when the diatoms again appear in numbers, and the plankton consists of a combination of Diatomaceæ and Peridinieæ. These conditions persist until the end of December, the period constituting the time of the greatest wealth of species. The author is able to confirm the statement that the Peridinicæ are luminous, having observed this in *Ceratium fusus* and *Peridinium lenticulare* beneath the Microscope.

New Fresh-water Organisms.* — Max Voigt describes some new forms found in the vicinity of the Biological Station at Plön. Among them are a new Protozoon—*Zachariasia velifera* g. et sp. n., which occurs only on *Closterium ehrenbergi*; and two new species of Gastrotricha, *Chætonotus serraticaudus* and *Ch. nodicaudus.*

Mollusca.

Aquatic Mollusca of Switzerland.† — Dr. O. S. Imhof points out that certain lacustrine genera, especially *Anodonta*, *Unio*, and *Limnæa*, are exceedingly variable, the varieties being, as he believes, directly related to the variations in the external conditions due to storms, amount of sediment in the water, and so on. He gives very full lists of species and varieties for the different lakes, with tables showing the distribution in the Swiss area.

γ. Gastropoda.

Pleurotomaria beyrichi.‡ — E. L. Bouvier and H. Fischer have been able, on a well-preserved specimen of this interesting mollusc, to make some observations on the soft parts. They find that the gills are symmetrically arranged in the branchial chamber, but the left is larger than the right. Even this left gill, however, is small, and the two gills scarcely occupy the anterior half of the pallial chamber. In themselves they would in all probability be insufficient for the respiratory needs of the organism, were they not supplemented by an accessory breathing-organ. This consists in a richly vascular area of the pallial chamber, which is supplied by a large vessel, and is apparently truly homologous with the lung of *Helix*. This vascular area and the gills appear to take about equal parts in the respiratory process, and the authors believe that this is the primitive condition. In the aquatic Prosobranchs the gills predominate, and the vascular area becomes the mucous gland; in the terrestrial forms, on the other hand, the vascular area becomes increasingly important, and, while retaining to some extent its power of secreting mucus, forms the essential breathing-organ, while the gills degenerate.

The same authors continue their study of this interesting type,§ and describe the alimentary tract and nervous system. They discuss the hind part of the intestine, which shows a remarkable branch,

* Zool. Anzeig., xxiv. (1901) pp. 191–5.
† Biol. Centralbl., xxi. (1901) pp. 43–62.
‡ Comptes Rendus, cxxxii. (1901) pp. 583–5. § Tom. cit., pp. 845–7.

running far forward to beside the œsophagus; the peculiar twists of the œsophagus; and the hints of buccal and œsophageal pouches. The nervous system is almost identical with that of *Pl. quoyana*, but a more complete study of it has been made. The following points are emphasised:—(*a*) The absence of differentiated pallial ganglia, and the concrescence of pedal and pallial cords, as in Chitonidæ; (*b*) the origin of the visceral commissure on the cerebro-pallial connectives, and not, as in other Diotocardia, on the ganglionated pallial cords; (*c*) the development of a very large ganglion at the origin of the osphradial cord, representing in part the point of origin of the pallial nerves; (*d*) the very feeble development of the secondary pallial nerves; and (*e*) the strong development of the primary pallial nerves.

Spawning and Oviposition in Trochus.*—A. Robert points out that agglomerated spawn is formed by *Tr. granulatus* Born., *Tr. striatus* L., *Tr. conuloides* Lam., *Tr. exasperatus* Penn.; while *Tr. magus* L., *Tr. cinerarus* L., *Tr. crassus* Pult. lay their eggs singly. In the former series there is in the females an ampulla-like swelling on the excretory canal of the right kidney, and this secretes the mucus of the spawn-masses.

Arthropoda.

α. Insecta.

Constancy of Insects in their Visits to Flowers. †—Prof. F. Plateau has made some experiments bearing on this, following in so doing the work of Prof. A. W. Bennett, R. Miller Christy, G. W. Bulman, and G. W. Ord, whose results are duly acknowledged.

(1) None of the Apidæ observed—*Bombus*, *Apis*, *Megachile*, *Anthidium*, *Cœlioxys*—exhibit absolute constancy. Even those which are habitually most constant may turn from the kind of plant they have been visiting, and tackle a quite different species.

(2) The species of *Bombus* are very fickle, rarely remaining constant to one species except for a short time.

(3) In *Anthidium manicatum* and *Apis mellifica* the constancy is remarkable, but with distinct exceptions.

(4) Like his predecessors, Plateau found that the inconstant bees pass from one flower to another quite different in colour and form; they seem indifferent except to nectar and pollen.

(5) The difference in habit between the constant and inconstant forms does not seem to imply great intelligence; it is perhaps an expression of the fact that the constant forms are less strong and save their energy by uniformity of action.

(6) The constancy results in greater adeptness in collecting the nectar and pollen, and saves time, but it is not adhered to in order to secure these ends.

Periodic Pœcilandry. ‡—P. Lesne calls attention to variational peculiarities among the males of beetles belonging to the xylophagous family Bostrychidæ. In *Bostrychopsis*, *Schistocercos*, and *Heterobostrychus*,

* Comptes Rendus, cxxxii. (1901) pp. 850–1.
† Ann. Soc. Entomol. Belg., xlv. (1901) pp. 56–83.
‡ Comptes Rendus, cxxxii. (1901) pp. 847–50.

there is marked sex dimorphism, but the males are very polymorphic, and some have come to be very like females. The female characters may be assumed on the head (*gynæcocephalous*), afterwards on the thorax (*hemigynous*), and finally on the elytra (*homœomorphic*). There is in the males in successive stages a variation towards characteristics of the female, "periodic pœcilandry" in short.

Ocelli.*—Dr. O. E. Imhof gives a summary account of the number, size, and arrangement of the ocelli in Diptera, and proposes to do the same for all insects. The precise object in view is not explained. In his introductory notes he observes that 3 is the commonest number; the occurrence of 6–12 is rare; only in Collembola is the presence of more than 3 (up to 18) of general occurrence. The predominant arrangement is a frontal triangle, but there are occasionally lateral groups, and very rarely the ocelli are on the under side of the head.

Phagocytosis in Postembryonic Development of Diptera.†—Prof. V. L. Kellogg contrasts the larva of *Holorusia rubiginosa*—a giant Tipulid whose immature stages are now for the first time described—and the larva of *Blepharocera capitata.*

In the latter there is a great breaking down of the larval organs; the musculature, the alimentary canal, and the respiratory system are largely broken down and re-formed; and in all of this histolysis (18 days) phagocytes are abundant and conspicuous. In *Holorusia*, however, with its 12 days of pupal condition, histolysis is unaccompanied by phagocytosis. The condition in which the histolytic phenomena occupy the longer time is the one in which the histolysis is accompanied by plagocytosis.

Prof. Kellogg suggests that the explanation may be as follows:—In *Blepharocera*, with its highly specialised larval form, its peculiar and specially developed organs, the change to imago is radical; the histolysis of larval tissues is extensive. In *Holorusia*, with its generalised larval form and its less modified organs, the change to imago is accomplished with much less breaking down of larval organs and re-formation of imaginal ones; the histolysis is less radical and considerable. The phagocytes are the agents or the assisting agents in the more extended and radical histolysis.

Cephalic Glands of Collembola.‡ — Victor Villem has studied these structures in *Sminthurus* and *Orchesella*, and has reached conclusions differing from those of Folsom § on *Orchesella*, especially as regards the course of the salivary duct, the structure of the labium, and some other points. He is of opinion that *Sminthurus* is eminently well adapted for the study of these structures, and that certain primitive characters possessed by it shed light upon the condition of parts in *Orchesella*, which is more difficult to study, and whose more specialised nature has, as he believes, led Folsom astray.

Formation of Eggs in Apterygota.‖ — A. Lécaillon has made out some interesting points in this connection. He finds that four different

* Biol. Centralbl., xxi. (1901) pp. 189–92.
† Amer. Nat., xxxv. (1901) pp. 363–8 (2 figs.).
‡ Arch. Biol., xvii. (1900, published 1901) pp. 653–71 (2 pls. and 4 figs.).
§ Cf. this Journal, 1899, p. 595.
‖ Comptes Rendus, cxxxii. (1901) pp. 586–8.

conditions occur in the group. Thus, in the Aphoruridæ, the Poduridæ, and the Entomobryidæ, the egg remains passive during the formation of yolk, and it is the vitellogenous cells which take an active part in its elaboration. There are no ovarian follicles, and the mesodermic cells of the ovary wall remain small. In the Sminthuridæ somewhat similar conditions obtain, but the mesodermic cells of the ovary wall take an active part in yolk-formation, and are of more importance than the vitellogenous cells. In *Campodea* the mesodermic cells form follicles, but the follicular cells are small, and the vitellogenous cells are of the greatest importance in yolk-formation. In *Machillis*, also, follicles are present, but vitellogenous cells are absent, and the ova themselves are the active agents in the elaboration of deutoplasm. The absence, or slight importance, of the follicle cells, and the size and functional importance of the vitellogenous cells, are interesting points of contrast with the higher insects.

Sexual Dimorphism in the Sound-producing Apparatus of Orthoptera.*—A. Petrunkewitsch and G. von Guaita have studied 130 species (101 genera) in reference to their sound-producing organs. Most Saltatoria have these organs, but they occur at diverse parts of the body. Those of the females are usually different in structure from those of the males. The structural dimorphism is very notable in some Acridiidæ and Locustidæ, and the sounds are likewise very different. There is nothing to support the theory that the instruments of the female have been inherited from the male side. There has been independent evolution in the two sexes.

Like Hæcker (in regard to the song of birds), the authors argue that the sound-producing apparatus may be interpreted as an adaptation securing a wider range of pairing, and obviating close in-breeding.

Stridulating Organs of Corixidæ.† — G. W. Kirkaldy discusses the question as to the exact organs concerned in the production of the chirping noise made by the males of this family of water-bugs, and concludes that they are the following. The active agent (stridulator) is a comb of chitinous teeth, placed on the inner surface of the thickened tarsus (pala) in the male, and absent in the female. The passive agent, or stridulatory area, consists of a patch of chitinous pegs placed on the inner surface of the femur of the male; it is absent, or feebly developed, in the female. The sound is probably produced by drawing the left tarsus across the right femur, and *vice versa*. A point of interest is that the stridulating organ, in its minute details, is a characteristic structure in the different species, and a means of distinguishing species in, at least, the male. It is possible that other parts of the body are also capable of producing sounds.

Viviparous Beetles.‡ — G. C. Champion and T. A. Chapman confirm the fact that viviparity occurs in the genus *Orina*. In *O. cacaliæ*, *O. vittigera*, and *O. gloriosa*, the eggs develop into larvæ in the ovarian tubules; in *O. tristis* an egg is laid, but at an advanced stage, containing, in fact, a larva with conspicuous jaws, spiracles, and eye-spots. The

* Zool. Jahrb., xiv. (1901) pp. 291–310 (4 pls.).
† Journ. Quek. Micr. Club, 1901, pp. 33–46 (2 pls.).
‡ Trans. Entom. Soc. London, 1901, pp. 1–18 (2 pls.).

larvæ of *O. tristis* and *O. vittigera* are described for the first time, and compared with those of the other species.

Sexual Forms of Texan Ecitons.* — W. M. Wheeler and W. H. Long describe the males of *Eciton opacithorax* and *E. schmitti*, and the female of the latter species, and have some interesting notes on habits, &c. They find that the sexual forms of these species resemble one another more closely than the workers. Though numerous specimens of males were found, they noticed no traces of male dimorphism, and were able to confirm Emery's view, that the so-called dimorphic males are merely other ants hatched from larvæ and pupæ stored by the Ecitons as a reserve of food. This storing of living pupæ is a common habit, the pupæ being those of many different kinds of insect. Observations on captive nests lead the authors to the conclusion that the large mandibles of the male *Ecitons* are secondary sexual characters, analogous to those of the male stag-beetles, and not weapons or clasping organs. An interesting point is the pleasant smell of the sexual forms as compared with the rank odour of the workers; the authors believe that this, in part, explains the extraordinary attractive power exerted by both females and males on the workers.

Metathoracic Pterygoda.† — L. B. Walton calls attention to the general presence of a sclerite on the metathorax which seems homodynamous with the so-called tegula of the mesothorax. It appears necessary, he says, to consider that the typical thoracic segment possesses the components of both pterygodum and wing, the former joined to the dorsal margin of the episternum, the latter articulated with the dorsal margin of the epimeron. Furthermore, the morphological position of the pterygodum in respect to the wing indicates that it may have an important bearing in elucidating the metamerism of the antennate arthropods.

Antennæ of Odonata.‡—Dr. O. E. Imhof thinks that these structures have been very inadequately studied. This may be due to their minuteness and needle-like character. The author has studied them in three genera—*Gomphus*, *Calopteryx*, and *Lestes*—and shows that there is considerable variety in structure.

New Marine Hemiptera.§ — H. Coutière and J. Martin propose a new sub-family — Hermatobatinæ — for *Hermatobatodes marchei* g. et sp. n. from the Philippines, *H. haddoni* Carpenter, and *H. djiboutensis* sp. n. Their affinities with Veliidæ are especially emphasised.

Are Drone Eggs Fertilised?‖ — Ferd. Dickel is of opinion that normal drone eggs are certainly fertilised. Unfertilised eggs give rise only to drones, but normal eggs from bee-cells are capable of giving rise to drones, workers, or queens, according to their treatment. The author believes that the determination of sex takes place in the following way. In the queen there are two glands in the posterior region, virtually

* Amer. Nat., xxxv. (1901) pp. 157–73 (3 figs.).
† Tom. cit., pp. 357–62 (5 figs.).
‡ Biol. Centralbl., xxi. (1901) pp. 255–6.
§ Comptes Rendus, cxxxii. (1901) pp. 1066–8.
‖ Anat. Anzeig., xix. (1901) pp. 104–8.

functionless in her, but functional in allied forms, e.g. wasp, of less specialised nature. These glands are the homologues of the sex-determining glands of the workers, which open at the mouth, and can be divided into male and female glands and merely nutritive glands. By the introduction of the secretion of male, or of female, or of both glands into the cells, the workers determine the sex.

Prof. August Weismann,* in a reply to Dickel, reaffirms the older view, laying special emphasis on the absence of proof of fertilisation in drone eggs. He contests Dickel's statement that drone eggs can be made to give rise to workers or even queens, and doubts the statement that drones, the offspring of an Italian queen mated with a German drone, display the characters of the German race.

In a further note,† Dickel gives some details concerning crossing experiments which were conducted with all possible care, and showed the appearance of paternal characters in the male offspring. He also describes some experiments which, as he believes, prove that (fertilised) drone eggs, if artificially placed in queen or worker cells, will develop into queens or workers.

δ. Arachnida.

Habits of Water Spider.‡—W. Wagner gives a detailed account (in Russian) of the habits of *Argyroneta aquatica* Cl., and a French *resumé* on which the following notes are based.

There is marked sexual dimorphism, and the males have a different way of entangling the air, and a specific gravity brought thereby nearer to that of water than is the case with the females.

During resting periods much care is given to the arrangement of the fine threads attached round the body. Reciprocal relations are placid; there is no quarrelling except in cramped captivity. The females chase the males if they importune too much, and yield to them if they are strong enough. One large male was seen to devour a female, the reverse was never observed.

The making of the diving-bell nest seems wholly instinctive, but the summer nest is different from the winter one. The repair of the nest is a continuation of the original constructive activity, and not a novel work. There is considerable diversity in the choice of a site—among algæ, in a hole, in a piece of floating wood, in an empty gasteropod shell, and so on. The visual organs are poor, and there is little evidence of mutual recognition. A comparative study of webs shows that the architecture of *Argyroneta* has a close resemblance to that of the Drassidæ.

The maternal care increases towards the time of hatching, but it seems rather for the cocoon than for its contents. After hatching, the care rapidly wanes and disappears.

Parental Care in a Spider.§—Dr. L. Kathariner has made some interesting observations on an Algerian spider, *Stegodyphus lineatus* Latr., which he brought to Freiberg. An egg-clump found in his collecting box was placed on a twig near the drinking-horn-like nest which was

* Anat. Anzeig., xix. (1901) pp. 108–10. † Tom. cit., pp. 110–1.
‡ Bull. Soc. Imp. Nat. Moscou, 1900, pp. 61–174 (1 pl. and 37 figs.).
§ Biol. Centralbl., xxi. (1901) pp. 72–4.

placed in a large glass. Next morning it was found inside the nest, and there it was treated by the spider with great care. In the sunshine she brought out the clump and exposed it to the rays; in the evening she took it back. This went on for about three weeks. Thereafter the mouth of the nest was closed by a delicate web, which was gradually strengthened. But the spinner left a hole for dragging in food. At a certain date even the hole was closed up, but when the observer made an opening a fortnight afterwards, he found that the young had hatched. The details of the protective device are carefully given; its efficacy is even more thorough than our summary suggests.

Stigmatic Organ of Nymph of Ornithodoros megnini.* — E. G. Wheler describes a remarkable organ found in a tick, identified as this species, which was removed from the ear of an American visitor at Cambridge. The organ in question consisted of two protuberances, placed in the position of stigmata, one at each side of the body. Each was truncate, perforated by a hole at the tip, and from this hole a pointed organ could be protruded and withdrawn.

Larval Hydrachnida.†—Chas. D. Soar has a note on the parasitic young of the common water-mites, and the hosts on which they occur. He is of opinion that the larvæ remain attached to the same host for a whole season, from the summer of one year until the spring of the next.

ε. Crustacea.

Paranuclei in Cells of Digestive Gland of Crayfish.‡ — P. Vigier discusses the body described by Nussbaum in 1881 under the name of *Nebenkern*, and by others as paranucleus, *noyau accessoire*, and "parasome" (Henneguy). In an actively secreting cell it lies near the nucleus, or between the latter and the free surface; it is due to the nucleolus, which migrates into the cytoplasm to contribute to the elaboration of the secretory product. The best name for it, according to the author, would be *pyrenosome*. Rhumbler has regarded the nucleolus as a mass of reserve-material for nuclear consumption; Hæcker has called it excretory; the author considers it as "a body formed from a differentiation of the chromatin, and capable of migrating as a whole, or of giving off a portion of its substance into the cytoplasm, to furnish to the latter the materials necessary for the elaboration of the characteristic products."

Spermatogenesis in Sacculina.§—O. Duboscq describes the lineage of spermatic cells, — spermatogonia, spermatocytes, spermatides, and spermatozoa. The cells arise indifferently from the peripheral cells or from those of the vas deferens. These cells form, as far as may be, a lining to the cavities produced by the disappearance of other cells of the same origin which have undergone degenerative hypertrophy (hyaline degeneration with karyorhexis). A hypertrophied cell does not divide unless amitotically; after death it forms nourishment for the spermatic cells.

* Journ. Quek. Micr. Club, 1901, pp. 61–2 (2 figs.).
† Tom. cit., pp. 65–6 (1 fig.).
‡ Comptes Rendus, cxxxii. (1901) pp. 855–7.
§ Arch. Zool. Expér., ix. (1901) Notes et Revue, pp. xvii.-xxiv. (9 figs.).

Deep-sea Isopods.*—E. L. Bouvier has examined *Bathynomus giganteus* and *B. döderleini*, the two known species of this remarkable genus of gigantic abyssal Isopods. He finds that the tufts (*houppes*) described by Milne-Edwards as accessory breathing-organs, are placed on the endopodites of the pleopods, and are larger and more elaborate in *B. giganteus* than in the smaller species. Their appearance entirely confirms Milne-Edwards' view of their function. The eyes in both cases show adaptation to the abyssal life. Their ocelli in *B. giganteus* number 3000 in place of the usual 30–40, and are almost double the usual size. Owing to the large size of the animals, it is possible to make out that the sympodite of the pleopods consists of three joints, as does also the peduncle of the antennules. The antennules display a rudiment of an accessory flagellum, a primitive character suggesting affinity with the Anisopoda. The discovery of three segments in the basal piece of pleopods and antennules confirms Hansen's views as to the structure of the Crustacean appendage. The proximal segment of the three, which Hansen believes to be always represented in Crustacea, may fuse with the side of the body, where in Decapods it carries the pleurobranch. In other cases this proximal segment atrophies.

Ephippium of Bosmina.† — D. J. Scourfield finds that the winter or resting egg in this genus is surrounded by an investment, analogous to the ephippium of the Daphnidæ, and formed of a portion of the carapace of the mother. It consists of the valves of the shell, less a considerable portion of their ventral margins, which here, as in many Cladocera, break away at a line of weakness when the ephippium is formed. The use of this is, no doubt, that if the very convex ventral region remained, the shell could not form a closed protective investment. A special peculiarity of the ephippium of *Bosmina* is the occurrence of 3 (1 median and 2 lateral) bands of thickened chitin on its surface. These possibly help to keep the valves firmly closed.

Giant Ostracods.‡ — Rev. T. R. R. Stebbing refers to previous descriptions of large Ostracoda, and reports the discovery of *Crossophorus africanus* sp. n., dredged by Dr. Gilchrist in 90–100 fathoms off Cape St. Blaize. "The specimen has a length of 15·5 mm., with a height of 12·5 mm., so that the noble *Crossophorus imperator* and the truly gigantic *Megalocypris princeps* are positively dwarfed by the comparison." A parasitic isopod (*Cyproniscus crossophori* sp. n.) was found inside the Ostracods.

Marine Crustacea of German Lakes. § — Dr. Max Samter has continued his investigation of the distribution of *Mysis relicta* and *Pallasiella quadrispinosa* in the lakes of Germany. He has found the former in the Dratzig-See, the latter in the Dratzig, and in the following, from which *Mysis* is absent:—the Enzig-See, the large Lübbe-See, and the Pielburger-See. Both are absent from the shallow Vilm-See. In no case was *Pontoporeia affinis*, which occurs in the Madü, found to be present, but the negative result may be due only to the technical

* Comptes Rendus, cxxxii. (1901) pp. 643–5.
† Journ. Quek. Micr. Club, 1901, pp. 51–6 (1 pl.).
‡ Knowledge, xxiv. (1901) p. 100.
§ Zool. Anzeig., xxiv. (1901) pp. 242–5. Cf. this Journal, *ante*, p. 155.

difficulties found in investigating the depths at which it lives (20–25 metres), in spring and autumn—the only suitable seasons for these crustacea. The absence of *Pallasiella* from the Vilm-See is explained by the fact that it is too shallow to allow of a summer migration to colder water, which always takes place in the other lakes.

Annulata.

Histology of Oligochætes.*—Dr. M. de Bock finds that the "muscular columns" which constitute the musculature of the body-wall in Oligochætes are bundles of fibres enveloped in a fine membrane. The fibres are made up of muscular elements, not further divisible, and formed of contractile substance. These elements originate from myogenic cells, each of which produces several elements. In the Lumbricidæ, the muscular columns tend, especially in the longitudinal layer, to arrange themselves in compartments, bounded by a distinct membrane originating from the connective-tissue. This connective-tissue contains nuclei, but the cell-boundaries have disappeared. The lateral line of the Limicoline forms is due to the fact that the muscle cells tend to have their nuclei aggregated in special regions, where they are raised on peduncles. The lateral line has no nerve, but contains a vessel, apparently of lymphatic nature.

Malayan Oligochætes.†—Prof. D. Rosa describes a small collection from Sumatra and Amboina, including one species of *Pontoscolex* and six of *Pheretima*, one of the species of the latter genus being new. The new species, *P. picteti*, though well defined, is nearly related to *P. houlleti* and *P. tobaënsis.*

Hypodermic Impregnation of Hæmenteria costata.‡—Prof. H. Bolsius figures some sections of this leech which throw light upon the manner in which the spermatozoa, set free from the hypodermic spermatophore, penetrate the uterus. One of the sections shows the free spermatozoa aggregated in masses about the nerve-end and the uterus, and another shows that the periphery of the uterus is traversed by numerous canaliculi with funnel-shaped openings, into which the sperms pass. The section does not show canaliculi throughout the thickness of the uterine wall, nor openings into its central lumen, but the author believes that this can be explained as due to the sinuous course of the canaliculi. His general conclusion is that the spermatozoa reach the uterine lumen by predetermined paths, and not by perforating the wall, as Kowalevsky supposed.

Leeches of Illinois.§—J. Percy Moore gives a descriptive catalogue of the Hirudinea of this State, with notes on the habits, the food of the different forms being treated in especial detail.

Nematohelminthes.

Segmentation in Nematode Embryos.‖—Prof. Ludwig Rhumbler has studied living young of *Rhabdonema nigrovenosum* removed from the

* Rev. Suisse Zool., ix. (1901) pp. 1–41 (2 pls.). † Tom. cit., pp. 131–6.
‡ Zool. Anzeig., xxiv. (1901) pp. 195–8 (2 figs.).
§ Bull. Illinois State Lab. Nat. Hist., v. (1901) pp. 479–547 (6 pls.).
‖ Anat. Anzeig., xix. (1901) pp. 60–88 (21 figs.).

lungs of frogs, and finds that the nuclei of the blastomeres show a remarkable periodic movement, at times rising to the periphery of the cell, and then sinking again within the cytoplasm. A series of time observations on segmenting eggs showed that the movements are not a matter of chance, but take place according to definite rules, formulated by the author as follows:—The nucleus begins to approach the cell-periphery as a division is finishing, it remains at the point of contact for several minutes, then begins to travel inwards to begin the new division; the place of contact always lies in the plane which forms the next division-plane, and the segmentation furrow appears at the point of contact. Similar conditions were found by the author to obtain in several other Nematodes (species of *Strongylus*, *Sclerostomum*, &c.), but the phenomenon apparently does not occur in all. As to the significance of the movement, the author associates it with the accelerated growth of the cell-periphery, which makes segmentation possible, and finds in it a confirmation of his view that the nucleus is a store of food-material (*Stoffmagazin*), not a centre of force.

Germinal Layers in Nematodes.* —A. Conte has studied these in *Cucullanus elegans* Zed. and in the *Filaria* of the green frog. As previously, for *Sclerostomum equinum*, he finds a more or less considerable disappearance of the ectoderm and a *total* disappearance of the endoderm. The alimentary canal of the adult is formed in part by ectodermic elements constituting the œsophagus, and in part by mesodermic elements constituting the intestine. In all these three viviparous forms the general cavity is lined by two layers of mesodermic origin.

Oxyuris curvula and O. mastigodes.†—Max Jerke has investigated the characters of these two nematodes from the horse, together with their life-history, effect on the host, and so on. He finds the two to be good species, though they are very nearly related; the differences between the males exclude the possibility of there being only one dimorphic species. As regards the life-history, the ripe females lay their eggs in the vicinity of the anus, and then die. The eggs remain here within a sticky mass for a few days, then fall to the ground, to be again ingested with food. Within the stomach of the host the investment dissolves, and the young worms find their way usually to the cæcum, where they live upon the ingested food. They are not parasites in the strict sense, and cause only symptoms of local irritation about the anus. The eggs will not develop without access of oxygen, wherefore development does not occur within the gut of the host.

Platyhelminthes.

Poison of Parasites.‡ — Dr. P. Mingazzini prepared with careful precautions extracts of *Tænia cucumerina* (*Dipylidium caninum*), *Moniezia*, *Ascaris lumbricoides* (from the pig), and *Echinorhynchus gigas*, and tried the effect of the fluids on Protozoa and as injections into rabbit, cat, dog, guinea-pig, and pigeon. It always had a poisonous effect. The

* Comptes Rendus, cxxxii. (1901) pp. 1064–6.

† Jenaische Zeitschr. Naturwiss., xxxv. (1901) pp. 347–408 (1 pl. and 4 figs.).

‡ Rass. Medicina Moderna, Ann. ii. No. 8 (1901) 20 pp. See Zool. Centralbl., viii. (1901) p. 226.

extract of tape-worms from carnivores seemed more virulent than that of tape-worms from herbivores; that of *Echinorhynchus* was almost as effective as that of tape-worms from herbivores; that of *Ascaris lumbricoides* was less potent. In some cases paralysis and even death followed the injection.

Histolysis and Histogenesis in Cercariæ.*—C. Vaney and A. Conte describe these processes in the development of two tailed cercariæ from *Helix pomatia* and other species, and in the cercaria of *Distomum leptostomum* Olsson from *H. aspersa*. The destruction of cells and nuclei and the formation of a ventral plate (which gives rise to all the organs) recall the histolysis and imaginal discs in the pupation of insects, but there is no trace of any phagocytosis.

Structure of Dicranotænia coronula.† — Mr. T. B. Rosseter has found this parasite in the alimentary canal of the domesticated duck, where it occurs in the intestine near the rectum, and not in the duodenum, as is the case with most tape-worms. He describes the male and female genital organs, and finds that the cirrus is smooth, not spinous, as Dujardin stated, but has a spinous sheath. In regard to the female organs, he amplifies considerably Dujardin's brief description.

Trematodes from Bursa Fabricii, Oviduct, and Eggs of Birds.‡— Prof. M. Braun discusses five species of *Prosthogonimus* which have this habitat. The genus, as revised, includes *Distomum ovatum* Rud., *Dist. pellucidum* v. Linst., and *Prymnoprion anceps* Looss. The new species noted are *Prosthogonimus japonicus* from a hen's egg, and *Pr. rarus* from the bursa of coot and duck.

Monostomum orbiculare. § — M. Lühe discusses this species, which Rudolphi found in the gut of *Box salpa*. Its name, it seems, must be changed to *Mesometra orbicularis*, and beside it must be placed *M. brachycœlia* sp. n., which Parona found, but did not distinguish from its ally. Closely allied is *Monostomum spinosissimum-Stossichianum*, also from *Box salpa*.

New Species of Temnocephaleæ. ‖ — Prof. W. A. Haswell describes three new species of *Temnocephala*, and discusses some points at issue between himself and Monticelli ¶ in regard to the structure of the genus.

Gyrator reticulatus Sekera. ** — O. Fuhrmann believes that the specimen upon which Sekera's description of this new form was founded, was merely a specimen of his *Macrorhynchus cœruleus*. The structure described by Sekera as the unpaired testis is the vesicula seminalis, which is completely separated from the vesicula granulorum—a character which at once places the animal in the genus *Macrorhynchus*. Sekera apparently missed the two laterally placed testes and the two minute ovaries.

* Comptes Rendus, cxxxii. (1901) pp. 1062–4.
† Journ. Quek. Micr. Club, vii. (1900) pp. 355–70 (2 pls.).
‡ Centralbl. Bakt., xxix. (1901) pp. 12–19 (4 figs.).
§ Tom. cit., pp. 49–60 (5 figs.).
‖ Proc. Linn. Soc. N. S. Wales, xxv. (1900) pp. 430–5 (1 pl.).
¶ Boll. Soc. Nat. Napoli. xii. (1898).
** Zool. Anzeig., xxiv. (1901) pp. 177–8. Cf. this Journal, *ante*, p. 280.

New Rhabdocœle Turbellarian.* — Prof. W. A. Haswell describes, as *Didymorchis paranephropis* g. et sp. n., a Turbellarian found in the branchial chambers of the New Zealand crayfish (*Paranephrops neozelanicus*). Its most striking characters are the following:—The pharynx is of the type called by Von Graff a pharynx doliiformis; there are two excretory apertures near the mouth, and a single reproductive aperture; the ovary is single and compact, and there are two elongated vitelline glands; there is no bursa copulatrix, and the paired testes are compact; the penis is complex and chitinous. The animal appears to spend its whole life in the crayfish's gill-chambers, the eggs being attached singly to the epipodites. There is no metamorphosis in development, the young being like the adult when hatched. The animal appears to be nearest the Vorticida, but is not related to *Anoplodium* and *Graffilla*, the already known parasitic forms of that family.

Incertæ Sedis.

Life-History of Orthonectids.† — M. Caullery and F. Mesnil distinguish the sexual plasmodial stages—which move by pseudopodia, multiply by division, and propagate the parasitic infection—from the sexual ciliated stages, to which the former give origin endogenously. Metchnikoff found that some plasmodial forms of *Rhopalura intoshi* were hermaphrodite; this is general in *Rh. metchnikovi*, and probably also in *Rh. julini*. The authors confirm Koehler in finding rare hermaphrodite forms of *Rh. ophiocomæ*. The development of the ciliated sexual forms does not seem to proceed directly within the parasitic plasmodial forms in their original hosts; it is probable that the ripe forms escape into the sea, that fertilisation occurs there, that a fresh infection occurs, and that then the ciliated forms begin to appear within their plasmodial parents. The dimorphism of females indicated by Julin seems to have been somewhat exaggerated, and the authors find intermediate forms. They find no reason to believe that the one type of female gives origin to males and the other type to females.

Development of Phoronis.‡ — Dr. A. T. Masterman discusses some points at issue between himself and Prof. Roule. He reaffirms his conclusions as to the origin of the mesoderm from paired hypoblastic ingrowths, and is of opinion that Roule furnishes no valid evidence for the theory of a mesenchymatous origin. He further rebuts the imputation of error in regard to his descriptions of such larval organs as mesenteries, dorsal vessel, &c., and suggests that there may be considerable differences between the two larvæ studied respectively by himself and Roule. Masterman further entirely rejects Roule's hypothesis of the relation of the Actinotrocha to the trochophore, and of the latter to the Vertebrate embryo.

Rotatoria.

Specific Characters of Asplanchna intermedia.§—C. F. Rousselet has published an account of this hitherto insufficiently characterised

* Proc. Linn. Soc. N. S. Wales, xxv. (1900) pp. 424–9 (2 pls.).
† Comptes Rendus, cxxxii. (1901) pp. 1232–4.
‡ Zool. Anzeig., xxiv. (1901) pp. 228–33. Cf. this Journal, *ante*, p. 158.
§ Journ. Quek. Micr. Club, viii. (1901) pp. 7–12 (1 pl.).

species, giving all the characters—shape of jaws, number of flame-cells, and shape of male—by which it can be distinguished from closely allied species, and comparing these characters with those of *A. brightwelli* and *A. amphora*. A plate with figures of the jaws of these various forms and of the males accompanies the paper.

New Rotifers. — F. R. Dixon-Nuttall * describes a new species, *Diaschiza ventripes*, which is characterised principally by the ventral position of the foot and toes. Two very good figures accompany the paper, as well as a very useful key for the identification of the other species of this difficult genus.

M. F. Dunlop † has a short account of *Cathypna ligona* sp. n., which he discovered in Scotland, and which is distinguished by a broad spade-shaped appendage to the ventral plate. By means of the good figures accompanying the description this new form can always be readily identified.

Echinoderma.

Polarity in Egg of Sea-urchin.‡ — Prof. Th. Boveri finds that the mature egg of *Strongylocentrotus lividus* shows a division into three regions, each of which gives rise to a special part of the future embryo. The animal and vegetative halves of the egg are separated by a pigmented zone; this pigmented zone gives rise to the gut and its derivatives; the vegetative pole to the primary mesenchyme and the larval skeleton; the animal pole to the ectoblast and its derivatives. The author does not regard the morphological difference as the cause of this difference in development, but as merely the expression of a pre-existing physiological distinction. As to the exact nature of this intrinsic polarity, the author is inclined to lay stress upon the differences between the animal and vegetative regions of the egg, as determining the developmental processes. He explains the production of normal plutei from (*a*) separated blastomeres, or (*b*) two united eggs, as due to the fact that the segmented egg is not a unity, but a collection of individuals, which later lose their individuality in building up a unity of a higher order. Normal development consists in this loss of individuality by the units in order to constitute a new complex individuality.

Cœlentera.

Origin of Reproductive Organs in Ctenophora.§ — A. Garbe has studied this in *Pleurobrachia rhodopis* and *Pl. pileus*. The formation of the meridional vessels occurs by progressive splitting from the aboral end towards the sensory pole, and not by a series of independent buddings from the funnel. All the eight ribs are present in the youngest larvæ, which have only two main meridional vessels. The germ-cells arise in the oral ends of the meridional vessels by proliferation of the walls of the vessels, and increase in size towards the sensory pole. They do not protrude into the lumen of the vessels, but occur in the

* Journ. Quek. Micr. Club, viii. (1901) pp. 25–8 (1 pl.).
† Tom. cit., pp. 29–32 (1 pl.).
‡ Verh. Phys. Med. Ges. Würzburg, xxxiv. (1901) pp. 145–76 (4 figs.).
§ Zeitschr. wiss. Zool., lxix. (1901) pp. 472–91 (2 pls.).

wall of the vessel which faces the ectoderm, and surround the lumen in sickle-like fashion. The "genital sinus" is merely a cleft, formed by the elevation of the fine epithelium, and has no important morphological significance. In *Pl. pileus* the primordia of the reproductive organs occur not only in the eight meridional vessels, but also in the tentacular and stomachic vessels.

Halcampella in the Black Sea.* — Th. A. Wryagévitch has found, on the surface of mussel shells in the Bay of Balaclava, a minute Actinarian which is a (possibly new) species of *Halcampella*. The Actinarian is placed within a membranous investment, which attaches it to the surface of the mussel. This is the first record of a *Halcampella* in the Black Sea. Further details are promised.

North American Hydromedusæ.† — Charles W. Hargitt has completed two parts of a synopsis of North American Hydromedusæ. It gives a key to the families, genera, and species of Tubulariæ and Campanulariæ.

Porifera.

Studies on the Hexactinellida.‡ — Prof. Isao Ijima has published an instalment of the results of seven years' study of the Hexactinellida. It deals with the Euplectellidæ—and describes in detail *Euplectella imperialis* Ij., *E. marshalli* Ij., *E. oweni* Herkl. and Marsh, *E. curvistellata* sp. n., *Regadrella okinoseana* Ij., *R. komeyamai* Ij., *R. phœnix* O. Schm., and *Walteria leuckarti* Ij. The illustrations are superb.

Protozoa.

Protozoa and Bacteria.§—S. Prowazek, among other observations, records a fatal infection with bacteria in *Vorticella microstoma*. The specimens appeared in a culture, and showed within their macronuclei numerous bacteria, which produced liquefaction of the nuclear substance. As this progressed, various pathological symptoms appeared, including a vacuolation of the protoplasm. An interesting point was the fact that, as the disease progressed, the normal digestive processes became entirely suspended, so that bacteria within the food-vacuoles not only remained undigested, but actually multiplied and swam freely in the fluid contents of the vacuole. At this stage the irritability of the stalk seemed unimpaired, which suggests that the nucleus has more to do with nutrition than with the muscular contractions.

Systematic Work on Flagellata.‖—Dr. G. Senn gives an account of the structure and functions, distribution and systematic relationships of the Flagellata. The characters of chief systematic importance are the following:—(*a*) The anterior apex and the insertion of the flagellum and the mode of nutrition; (*b*) the form of the contractile vacuoles and the nuclear structure; (*c*) the general organisation of the plasma. Seven

* Zool. Anzeig., xxiv. (1901) pp. 246–50 (9 figs.).
† Amer. Nat., xxxv. (1901) pp. 301–15, 379–95 (32 figs.).
‡ Journ. Coll. Sci. Univ. Tokyo, xv. (1901) pp. 1–299 (14 pls.).
§ Zool. Anzeig., xxiv. (1901) pp. 250–2 (2 figs.).
‖ Engler and Prantl, 'Die natürl. Pflanzenfam.,' Lief. 202–3, i. Teil, Abteilung *a*, Bogen 7–13, Leipzig, 1900, 4to. See La Nuova Notarisia, xii. (1901) pp. 38–40.

families are recognised:—Pantostomatineæ, Protomastigineæ, Distomatineæ, Chrysomonadineæ, Cryptomonadineæ, Chloromonadineæ, and Eugleninææ.

New Genus of Peridinieæ.*—Achille Forti describes as *Heteroceras schroeteri* g. et sp. n., a new form collected by Prof. Schroeter in the Pacific Ocean, characterised by the fact that the body is bifurcated from the middle of the cell, and is elongated. In its other characters the new form comes midway between the two genera *Phalacroma* and *Amphisolenia*. Like the members of the former genus, it has the margins of the longitudinal furrows prolonged into wing-like structures supported by spines; while, as in *Amphisolenia*, it has the body elongated and branched and the coat only slightly developed.

Life-history of Gregarines.†—Prof. L. Cuénot has investigated the Gregarines found in earthworms, in the domestic cricket, and in *Periplaneta orientalis*, which belong to the genera *Monocystis* (*Lumbricus* and *Allolobophora*), *Gregarina* (*Gryllus* and *Periplaneta*), and *Diplocystis* (*Gryllus*). In all these genera the life-cycle shows the following stages:—(1) A growth-period, resulting in the conversion of the sporozoite into the adult; (2) a process of union, in which the two individuals become surrounded by a common envelope; (3) the appearance in each individual of a micronucleus or segmentation nucleus, and the mitotic division of this into many nuclei; (4) the formation of sporoblasts by the accumulation of cytoplasm round these nuclei; (5) the conjugation in twos of the sporoblasts which fuse to form zygotes; (6) the transformation of the zygotes into sporocysts and the formation of eight sporozoites within the sporocysts. At least in *Gregarina* and *Diplocystis* the sporozoites do not divide when they enter the host, and give rise each to only a single adult. The remarkable fusion of the sporoblasts was observed most clearly in *Monocystis*, less certainly in *Diplocystis*. In these two genera further, the absence of a true process of copulation during the (permanent) union of individuals prior to sporulation was clearly proved. In each of the united forms a segmentation nucleus appears, but there is no interchange of nuclear fragments, nor any trace of polar body. The segmentation nucleus is extra-nuclear in *Diplocystis*, but is formed within the old nucleus in *Monocystis*. The nucleolus of the Gregarine nucleus resembles in all respects the germinal spot of the egg in Metazoa; it corresponds to the macronucleus of Infusoria. In the cricket, *Gregarina* is an intestinal and *Diplocystis* a cœlomic parasite, the two being perfectly distinct and reproducing the type.

Trypanosoma sanguinis in Batrachians.‡—Karl Koniński finds that this blood-parasite occurs in the Bufonidæ as well as in species of *Rana* and in *Hyla arborea*, but he has failed to find it in Pelobatidæ. In frogs and toads the probability of its occurrence increases with the age of the animals; it is commoner in males than in females, and is to be found at all seasons of the year. Infected and sound animals may be kept together for many months without the latter acquiring the parasite, and the infected animals apparently retain their normal health. There is no

* Ber. Deutsch. Bot. Ges., xix. (1901) pp. 6–7 (2 figs.).
† Arch. Biol., xvii. (1900, published 1901) pp. 381–652 (4 pls.).
‡ Biol. Centralbl., xxi. (1901) pp. 40–3.

indication that the parasite produces malarial or febrile symptoms, and the author is disposed to regard *Trypanosoma* as a commensal rather than a parasite. Dead parasites, in addition to living ones, occur in the blood, and the author regards the *Amœba rotatoria* of Mayer as a moribund form of *Trypanosoma*, though its position in the life-history has yet to be determined.

La Tristeza.* — Under this name is known in the Argentine and Uruguay the disease called elsewhere Texas and Tick fever. In reference thereto, J. Lignières confirms the observations of Smith and Kilborne on *Piroplasma bigeminum*, and adds some further information on the evolution of the parasite, its artificial cultivation, and on vaccination against La Tristeza.

The transformations of the parasite were followed out in the stomach of the tick, and also in cultures made in defibrinated blood and incubated at laboratory temperature.

* Ann. Inst. Pasteur, xv. (1901) pp. 121–8 (1 pl.).

BOTANY.

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

a. Anatomy.

(2) Cell-Contents (including Secretions).

Formation of Anthocyan.*—Dr. L. Linsbauer calls attention to the fact that mechanical injury causes in many plants the production in the cell-sap of a red pigment identical with the anthocyan of flowers. It is most common in woody plants, and usually begins to be formed in the palisade-tissue. The author attributes the phenomenon to a decrease, resulting from the injury, in the power of the tissue in question to transport certain special cell-contents, or to the destruction of a harmonious relationship between assimilation and conduction.

Latex and Mucilage-Sap.† — Prof. H. Molisch gives an exhaustive treatise on this subject. Laticiferous tubes are multinucleated living cells, the membrane being lined with a layer of protoplasm which contains nuclei, leucoplasts, vacuoles, and other bodies; the nuclei differ greatly in size and form in different plants; they are especially distinguished by their distinct membrane. Under leucoplasts the author includes not only those bodies which form starch, but also those which excrete oil or albumen. Starch was observed only in the laticiferous tubes of the Euphorbiaceæ, *Nerium Oleander*, and *Allamanda Schottii*. Proteinoplasts containing protein-grains occur abundantly in the latex of *Cecropia peltata* and other plants. Related to them are the remarkable albuminoid bodies of Aroideæ, the albuminoid-crystalloids of the Apocynaceæ, and the crystalloids in the vacuoles of *Jatropha*, *Musa*, &c.

The latex is usually acid, very rarely neutral, and never alkaline; hence it must be regarded as a cell-sap rather than as a form of protoplasm. It sometimes contains great quantities of lime (*Euphorbia Lathyris*) or magnesia (*Ficus elastica*). In some cases (*Carica Papaya*) it contains a ferment. The latex of the Musaceæ and Aroideæ is rich in tannin.

Mucilage-sap (*Schleimsaft*) is not nearly so widely distributed as latex, at all events in special tubes. It is described in the case of the Liliaceæ, Amaryllideæ, and Commelynaceæ. The mucilage-tubes result from the coalescence of cells; each chamber contains one or more nuclei, and often a bundle of raphids. The contents have usually an acid reaction. A new substance, *luteotilin*, is described occurring as sphaero-crystalls in the mucilage of many Amaryllideæ, Liliaceæ, Commelynaceæ, Gramineæ, and Lobeliaceæ.

* Oesterr. Bot. Zeitschr., li. (1901) pp. 1–10.

† 'Studien üb. d. Milchsaft u. Schleimsaft d. Pflanzen,' Jena, 1901, 111 pp. and 33 figs. See Bot. Centralbl., lxxxvi. (1901) p. 17.

Nature of the Vegetable Alkaloids.* — From experiments made chiefly on *Coffea arabica* and *liberica*, the seeds of which contain a large quantity of caffeine, the late G. Clautriau concludes that no diminution in the amount of the alkaloid takes place during germination, whether grown in the dark or in the light; the young plant contained more caffeine than was present in the endosperm. The author regards the alkaloids generally as excretory products of metastasis, which may, under certain circumstances, be used up again in further constructive metastasis.

Starch in Evergreen Leaves.†—According to K. Miyake, the amount of starch in evergreen leaves at any one period of the year differs greatly in different plants. As a general rule, those of Monocotyledons contain less than those of Dicotyledons, Gymnosperms, and Pteridophytes. The minimum is about the end of January (in Japan); after the end of February the amount again increases. In Central and Southern Japan many evergreen plants contain some starch in the chlorophyll-bodies during the coldest period of winter, while in Northern Japan it usually disappears at that time from the mesophyll and the guard-cells of the stomates. Although the process is comparatively feeble, assimilation and the transport of starch do take place during the winter.

Protopine-bearing Plant.‡—In *Adlumia cirrhosa*, a climbing plant belonging to the Fumariaceæ, J. O. Schlotterbeck finds the roots to contain a small quantity of this alkaloid, which is probably identical with fumarine; this latter, being the earlier name, should be retained. The author states that this alkaloid occurs in a larger number of species of plants than any other alkaloid, all belonging to the Papaveraceæ or Fumariaceæ.

Glucoside present during Germination in the Beech.§—In the young beech seedling P. Tailleur finds a glucoside and a diastase which in the presence of water, give rise to methyl-salicylic acid, with its characteristic odour of winter-green, and to glucose which is assimilated by the plant. This reaction is localised in the hypocotyl; it does not occur in the seed nor in the mature plant.

Reserve Carbohydrate producing Mannose.‖—J. Parkin finds, in the bulbs of *Lilium candidum*, and other species of the genus, a carbohydrate which on hydrolysis yields mannose and not glucose. The author believes it to be widely distributed in the vegetable kingdom.

(3) Structure of Tissues.

Peculiarities in the Cambium of Trees.¶—L. Jost finds that, in pine-trees, the cambium undergoes a change at the point of departure of a branch from the main stem, the cells becoming shorter and thicker; this can be especially observed in the medullary rays. The same is the

* Ann. Soc. r. d. Sci. Nat. Bruxelles, ix. (1900) 113 pp. See Bot. Ztg., lix. (1901) 2te Abt., p. 70.
† Bot. Mag. Tokyo, xiv. (1900) p. 44. See Bot. Centralbl., lxxxv. (1901) p. 385.
‡ Amer. Chem. Journ., xxiv. (1900) pp. 249–53.
§ Comptes Rendus, cxxxii. (1901) pp. 1235–7.
‖ Proc. Cambridge Phil. Soc., xi. (1901) pp. 139–42.
¶ Bot. Ztg., lix. (1901) 1te Abt., pp. 1–24 (1 pl. and 6 figs.).

case in the lower angle made by the branch with the main stem in the beech. He notes also that, in many trees, geotropic curvatures may be established after the growth in length is fully completed.

Anatomy of the Primulaceæ.* — E. Decrock has studied in detail the structure of the Primulaceæ, and of its sub-orders, with relation both to the anatomy and to the histology of the different organs. This is followed by a monograph of the genera and species (the four species of *Soldanella* are reduced to one), and some general considerations on the classification and biology of the order. The following are given as the more important points of structure.

The central cylinder of the root must be regarded as a conducting fibro-vascular bundle, and not as a series of xylem-bundles and phloem-vessels. This bundle exhibits n centres of xylem-differentiation, and n centres of phloem-differentiation. The morphological value of the stem as an axial organ is not the same as the morphological value of the root. Sections made at the summit of the stem never show a sharply defined central cylinder. At this zone the conducting system of the stem is always a direct continuation of the foliar traces. There is no distinction between primary and secondary xylem in the stem; the primary vessels are differentiated at the expense of a cambium with tangential septa, and not at the expense of procambial cells.

(4) Structure of Organs.

Relationship between the Length of the Stem and of the Leaves in Coniferæ.†—R. Meissner discusses the peculiarity displayed by many conifers that there is no positive relationship between the length of the branch and that of the leaves which it bears, longer shoots often bearing shorter leaves, and *vice versa*. He explains this by the observation that the period of strongest growth in the leaves does not coincide with the period of strongest growth in the stem; hence the climatal conditions may be more favourable during the most active period in the growth of the leaves than during the most active period in the growth of the stem, and *vice versa*.

Forms of Leaves.‡ — Prof. E. Warming illustrates the statement that there are three factors which give to leaves their various forms,—their physiological work, the conditions of their environment, and their parentage. He takes a number of examples, mostly from climbing plants, and those which grow in the deep shade of other plants. With a few exceptions (*Vicia*, &c.), the leaves of climbing plants are broad, cordate, and acuminate, and are so placed that the position of the lamina is vertical.

Theory of Phyllotaxis. § — H. Winkler discusses the different theories—the contact (*Anschluss*) theory, the theory of pressure, and the teleological theories—which have been proposed to account for the phenomena of phyllotaxis, and decides that no one of them is adequate to explain the observed facts. He does not propose any alternative

* Ann. Sci. Nat. (Bot.), xiii. (1901) pp. 1–199 (40 figs.).
† Bot. Ztg., lix. (1901) 1te Abt., pp. 25–60 (1 pl.).
‡ Overs. k. Dansk. Vidensk. Selsk. Forhandl., 1901, pp. 5–49 (11 figs.) (French *resumé*). § Pringsheim's Jahrb. f. wiss. Bot., xxxvi. (1901) pp. 1–79 (4 pls.).

theory, but concludes that the formation of organs at the apex of a shoot is an extraordinarily complicated process, depending on a whole series of factors, as to whose mode of operation we know next to nothing. No theory of phyllotaxis can be of value which does not take into account the processes which go on within the apex of the growing shoot.

Variegated Leaves.* — Mdlle. Rodrigue has studied the structure of variegated leaves in 33 species. The white effect is due, in most cases, to the absence of chlorophyll, although a similar appearance is given by certain dissolved pigments, and by the reflection of light. Where chlorophyll is absent, the leaf may be regarded as diseased, and the tissues are different from those of normal leaves, being much thinner, and without any palisade-parenchyme.

Organs of Exudation.† — J. Goffart calls attention to a prevalent confusion in botanical treatises between the process of secretion and that of exudation (*sudation*). The former process involves the elimination of viscous, resinous, or other matters not required further for the nutrition of the plant. The latter consists simply in the expulsion of water containing in solution a very small amount of organic and inorganic substances, from 0·007 to 0·12 p.c., chiefly calcium carbonate. The apparatus for the two processes is also entirely different. In his account of the structure of the exudation apparatus, which occurs mostly in the leaves, the author adopts in the main the description of Spanjer.‡ While secretion requires the aid of a protoplasmic body for elaborating the secreted products, exudation consists simply in filtration through intercellular cavities, the cells which bound these cavities taking only a passive part in the process. The exudating apparatus is in all cases situated at the extremity of a vein, and consists, in its most perfect condition, of vascular bundles, an epithema, the epithemial sheath, and the epithemial epiderm. Exudation takes place in many aquatic plants; then through pores at the apex of the leaves.

Roots of Herbaceous Plants. § —T. Freidenfelt classifies the roots of herbaceous annuals under the following heads:—(1) Ruderal type (*Galeopsis*, *Lamium*, *Myosotis*, *Veronica*, *Viola*, &c.); the primary root soon branches; adapted for energetic absorption; (2) Tap-root type; adapted for fixing the plant firmly in a dry or sandy soil; (3) Central type, intermediate between these two (*Lapsana*, *Atriplex*, *Draba*). In saprophytes and in annuals provided with haustoria (root-type of hemi-parasites), the root-system is greatly reduced, and the development of lateral roots but feeble.

Tuberous Rootlets of Cycas. ‖ — A. C. Life has studied the coral-like outgrowths from the ascending rootlets of roots of *Cycas revoluta*. The tubercles contain a central vascular cylinder and a very thick cortex, about midway in which is a zone coloured green by an endophytic alga. They are abundantly supplied with lenticels, and their primary func-

* Mém. Herb. Boissier, xvii. (1900). See Bot. Gazette, xxxi. (1901) p. 209. Cf. this Journal, *ante*, p. 296.
† Bull. Soc. R. Bot. Belgique, 1900, pp. 54–80.
‡ Cf. this Journal, 1898, p. 554.
§ Bot. Not., 1900, Heft 5, 15 pp. See Bot. Centralbl., lxxxvi. (1901) p. 156.
‖ Bot. Gazette, xxxi. (1901) pp. 265–71 (10 figs.).

tion appears to be one of aëration. In addition to an *Anabæna*-like alga, at least three bacterial forms and the hyphæ of a *Rhizobium*-like fungus were obtained from the cells of the tubercles, but none of these organisms were identified. They suggest a symbiosis connected with the supply of nitrogen to the host.

Morphology of Gymnosperms.*—In the present volume Prof. J. M. Coulter and Prof. C. J. Chamberlain supply us with a much needed account of the present state of our knowledge respecting the external morphology and the process of fertilisation in this class of vascular plants, the interest of which has been so greatly increased since the discovery of the ciliated spermatozoids, which are, however, as the authors point out, not strictly homologous with the spermatozoids of the pteridophyte, being morphologically sperm mother-cells rather than sperms. The gymnosperms are classified under the four heads of Cycadales, Gingkoales, Coniferales, and Gnetales, to which are added chapters on Fossil Gymnosperms, Comparative Morphology, Phylogeny, and Geographical Distribution. No attempt is made to describe the internal anatomy. Although the outside title "Seed-plants," and the inside title "Morphology of Spermatophytes," would imply a wider scope, the present volume is confined to the treatment of Gymnosperms. There is no index, a decided defect in the work. On the whole it is admirable.

β. Physiology.

(1) Reproduction and Embryology.

Basigamy, Acrogamy, and Mesogamy.†—Profs. R. Pirotta and B. Longo propose a somewhat more definite use of the terms basigamy and acrogamy than has hitherto been practised. By *basigamy* they understand the process that has been observed in the Casuarineæ, Betulaceæ, *Corylus*, &c., where the course of the pollen-tube is *endotropic*, i.e. it makes its way through the tissue to the morphological base of the ovule. *Acrogamy* is the ordinary process, where the course of the pollen-tube is *ectotropic*, i.e. it creeps along the conducting tissue of the ovary till it reaches the morphological apex of the ovule, and penetrates the embryo-sac through the micropyle. In *Ulmus*, *Cynomorium coccineum*, and the Cannabineæ, an intermediate process has been observed, to which they apply the term *mesogamy*.

Parthenogenesis in Antennaria alpina.‡—Dr. H. O. Juel gives further details of this phenomenon which he has already described, and contrasts it with the perfectly normal process in *A. dioica*. In *A. dioica*, besides the male and female forms, there are three other forms, one of which is bisexual. In the production of the embryo-sac the first division of the mother-cell is heterotypic (reduction in the number of chromosomes), while the second is homotypic. The development of the oosphere into an embryo, and of the central nucleus to an endosperm, take place only after impregnation.

* 'Morphology of Spermatophytes,' New York, 1901, vii. and 189 pp. and 106 figs.

† Atti r. Accad. Lincei, ix. (1900) pp. 296–8. See Bot. Centralbl., lxxxvi. (1901) p. 93.

‡ Handl. K. Svensk. Vetensk. Akad., xxxiii. (1900) 59 pp., 6 pls. and 5 figs. See Bot. Ztg., lix. (1901) p. 131. Cf. this Journal, 1895, p. 557.

In *A. alpina* the male plant is exceedingly scarce. In the development of the embryo-sac there is no tetrad-formation; the mother-cell gives birth to the embryo-sac without division; the oosphere develops into the embryo parthenogenetically, and the endosperm arises from the two polar nuclei without any fusion. The cycle of development of the plant is completed without either increase or reduction in the number of chromosomes.

The paper concludes with some theoretical considerations respecting the relationship to one another of the various modes in which the embryo is produced in spermatophytes.

Parthenogenesis and Chalazogamy in Alchemilla.* — In all the species examined of this genus belonging the section Eualchemilla, Sv. Murbeck † states that true parthenogenesis is more or less constant. In *A. alpina* the ovum-cell begins to divide in the unopened flower-bud, the anthers being still closed and destitute of pollen. The mature ovule has the appearance of a naked nucellus, owing to the coalescence with it of the single integument at the micropyle. In the young nucellus, when the integument first begins to be formed, there is a hypodermal group of archesporial cells. Each of these archesporial cells breaks up by transverse septation into a covering cell and an embryo-sac mother-cell; from any of these latter an embryo-sac may be formed. One or more (usually from two to six) of these embryo-sacs penetrate through the epidermal cap composed of the covering cells, as far as the tissue of the integument. The divisions of the nucleus which lead to the formation of the two polar groups take place quite normally. The oosphere, synergids, and antipodals, have the normal position and structure; from the former the embryo is formed without any process of impregnation; there is nothing unusual in its later development. The fusion of the polar nuclei frequently takes place at a late period; the central nucleus thus formed divides immediately, and produces two endosperm-nuclei. In the development of the embryo-sac, in fact during the whole of the life of the plant, the number of chromosomes appears to remain unchanged.

In *Alchemilla arvensis*,† belonging to the section Aphanes, the process of parthenogenesis is replaced by one of chalazogamy. As in other species of *Alchemilla*, the micropyle of the single integument is closed at an early period. The pollen-tube descends through the style, and works its way through the short funicle to the base of the nearly orthotropous ovule; it then ascends within the integument until it reaches the level of the germinal vesicles. The actual act of impregnation of the oosphere was not observed, but the process appears to take place in the normal way.

Development of the Endosperm and Testa of Corydalis.‡ — In *Corydalis cava*, according to G. Tischler, the resting nuclei of the parietal layer of the embryo-sac exhibit a peculiar arrangement of the

* Lund's Univ. Arsskr., Bd. xxxvi. No. 7 (1901) 46 pp. and 6 pls. See Bot. Ztg., lix. (1901) 2te Abt., p. 129.

† Tom. cit., No. 9, 20 pp. and 2 pls. See Bot. Ztg., lix. (1901) 2te Abt., p. 135.

‡ Verhandl. naturhist.-med. Ver. Heidelberg, vi. (1900) pp. 351–80 (2 pls.). See Bot. Centralbl., lxxxv. (1901) p. 365.

chromatin shortly before division. The regular reticulate arrangement disappears, and lumps of chromatin are formed, often with pseudopode-like protuberances, connected by delicate threads of linin. The same is the case with the endosperm tissue, which subsequently fills up the embryo-sac. Irregular divisions of the nucleus are very common in the endosperm; and the number of chromosomes in each nucleus is very variable. In the formation of septa the kinoplastic thickening-plate in the equatorial region divides, the new membrane arising in its middle. Many nuclei are always enclosed in each cell, which subsequently coalesce; the combined nuclei ultimately become spherical, and are distinguished from the uncombined ones by their greater size. Some of the nucleoles coalesce, while others remain separate; when quite mature most of the nuclei contain only a single nucleole. In the further division of the endosperm, after the coalescence of the nuclei, peculiar processes take place, which may be pathological. The cells which travel into the interior of the embryo-sac are at first naked, and are separated by a granular protoplasm.

The formation of the "beams" in the epiderm of the testa is effected by outgrowths from the walls into the cell-cavity; the cellulose-beams are formed within them, and increase by apposition. The nucleus in these cells is used up in the formation of the beams. Multinucleate cells occur in the integument; the increased number of nuclei being probably connected with the thickening of the wall.

Corydalis lutea and *C. ochroleuca* agree with *C. cava* in the mode of formation of the testa, but present considerable differences in the formation of the endosperm.

Impregnation in Cucurbita Pepo.*—Prof. B. Longo describes impregnation in the gourd as "mesogamic" (*vide ante*, p. 431), i.e. intermediate between the basigamic and the ordinary acrogamic modes. The pollen-tube, traversing the conducting tissue, which is here the suture of the ovary, reaches the peripheral tissues of the funicle, which present the same characters as the conducting tissue. When it has traversed in a tortuous manner that part of the outer integument of the ovule which covers the apex of the nucellus, with which the conducting tissue is in connection, the pollen-tube penetrates the neck of the nucellus, either by the apex or more often a little below it, and passes in a straight line through the prolongation of the nucellus. Here it swells up, forming a kind of bulb larger than the embryo-sac itself, which it finally reaches. No similar mode of impregnation was observed in other species of Cucurbitaceæ. The peculiar mode of impregnation appears to be connected with a difference in the structure of the ovule, and in its relation to the internal wall of the ovary.

Embryo-sac of Orchideæ.†—P. Dumée has examined the embryo-sac of a number of species (and genera) of Orchideæ, at a very early period in its development, in order to settle the question as to its origin. At a very early period the nucellus is composed of three rows of cells, all resembling one another, and of nearly the same size; later, one of the cells of the axial row exceeds the rest in size, and is the mother-cell of

* Atti. r. Accad. Lincei, x. (1901) pp. 168–72 (2 figs.).

† Bull. Soc. Bot. France, xlvi. (1899) Sess. Extraord., pp xxx.–xxxii. (2 pls.).

the embryo-sac. Although this cell has the appearance of being situated beneath the epidermal cell, it is in reality the upper cell of the axial row. At a later period this median cell has two nuclei, preliminary to a complete septation and the separation of the epidermal cell, which then divides by a septum perpendicular to the free surface.

Oogenesis in Abies pectinata.*—Dr. F. Cavara gives the following account of his researches on this subject. There are generally formed in the endosperm two or three corpuscles, rarely only one, still less often more than three. In each corpuscle is an archegonial neck, composed of a few layers of quadratic cells, between which is a narrow canal. At the base of the neck is the ventral cell, funnel-shaped, and separated from the corpuscle by a somewhat oblique and sinuous wall. The corpuscle or archegone is large and variable in form, and is separated from the surrounding endosperm by a well-defined layer of investing cells. In the primordial stage of the archegone a cytoplasm is distinguishable and a central areole corresponding to the nucleus. The cytoplasm is distinguished by quite peculiar characters found in all the Abietineæ and probably in all the Coniferæ. It is coarsely granular, and usually contains a number of the formations called by Hofmeister "germinal vesicles," and which Arnoldi considers to be of nuclear origin. In the species under consideration they vary in size and in structure. The central areole does not possess the morphological characters of a nucleus. It remains for a long time in the archegone, and has no nuclear membrane, linin network, or nucleoles.

When the pollen-tube, with one of the generative nuclei, enters the ventral cell, a differentiation is apparent in the oosphere, consisting apparently in the expulsion or quantitative reduction of a portion of the chromatic substance, with the formation of a true nuclear substance. The anterior generative nucleus then passes through the thin membrane of the canal, and enters the oosphere; the posterior nucleus either remains outside the ventral cell or also passes into the archegone. The union of the two sexual nuclei takes place, therefore, in *Abies pectinata*, in the prophase or in the commencement of the spireme stage. No structures were observed which could rightly be called centrospheres or centrosomes.

Gametophyte and Embryo of Taxodium.†—W. C. Coker finds the process of formation of these structures in *Taxodium distichum* to agree closely with those in Cupressineæ, and to differ widely from those in *Sequoia*.‡ The archespore lies at the very bottom of the nucellus, and resembles, in form and position, that of *Juniperus*, *Callitris*, and other Cupressineæ. One of the cells at or near the centre of the group begins to enlarge, and later on the megaspore extends nearly the whole length of the much-enlarged nucellus. A cellular endosperm soon begins to form, its growth being most rapid at the micropylar end. After the endosperm has become a compact tissue, the nuclei begin to divide, apparently amitotically. After the neck-cells are cut off from the mother-cells of the archegones, they divide into four, as in *Juniperus*.

* Bull. Soc. Bot. Ital., 1900, pp. 317–22.
† Johns Hopkins Univ. Circulars, xix. (1900) pp. 45–6.
‡ Cf. this Journal, 1896, p. 647.

When the pollen-tube has reached the embryo-sac, three nuclei—probably the pollen-tube nucleus, the stalk nucleus, and the "body-cell nucleus"—are seen in a group, and all of them pass into the archegone, but the tube and stalk nuclei are at that time undergoing disintegration; both male nuclei may enter the same archegone. The male and female nuclei come into contact near the upper end of the archegone, and fuse completely near the base of the oosphere. The first division of the fertilised oosphere does not seem to be constant in direction. In the next stage the pro-embryo consists of three tiers of four cells each. In the upper tier no cell-walls are found, the nuclei lying free in the cavity of the archegone. The pro-embryo is in this stage very like that of *Juniperus*; by the elongation of the second tier from the top the embryo is forced out into the endosperm.

Visits of Birds to Flowers. — E. Werth * discusses the question whether the Nectarinieæ (honey-birds) of tropical Africa visit flowers for the sake of the honey, or of the insects which feed on the honey, and concludes, from the structure both of the birds and of the flowers, that the former is generally the case, although the capture of insects may also sometimes be the object; but the sucking organ is not so much the long tongue, as has been stated, but the beak.

Prof. F. Dahl † has investigated the same problem in the Bismarck Archipelago. He finds there 3 species of Papageieæ, 2 of Meliphagideæ, and 2 of Nectarinieæ, which visit flowers. From an examination of the contents of the stomach, he determined conclusively that the Papageieæ (sp. of *Charmosyna*) are pollen-eaters, while the Meliphagideæ and Nectarinieæ are entomophagous. No evidence was found that the entomophagous birds feed also on honey, and the flowers which they were observed to visit had no nectaries.

Werth, ‡ in reply, while admitting that an examination of the contents of the stomach must be conclusive as to the nature of the food, still maintains that the Nectarinieæ feed on honey as well as insects; otherwise it would be impossible to account for their sucking apparatus.

Protection against the Germination of Foreign Pollen.§—W. Burck has observed that different substances have very different effects on the germination of pollen-grains belonging to different species. Thus with *Mussendæa* [*Mussænda* ?], even a very small quantity of levulose greatly promotes the emission of pollen-tubes, while saccharose, dextrose, mannite, dextrin, and asparagin have no such influence. With *Pavetta*, on the contrary, a very small quantity of levulose caused the pollen-grains to burst. Pollen-grains of *Canna* and *Justicia* burst in water, but not in a 20 p.c. solution of cane-sugar when a mere trace of levulose was added. He suggests that on the stigma there may be produced, not only substances which promote the production of the pollen-tubes of the particular species, but others also which act injuriously on the pollen of foreign species.

* S.B. Ges. Naturf. Freunde Berlin, 1900, pp. 73–7; and Verhandl. Bot. Ver. Prov. Brandenburg, xlii. (1901) pp. 257–60. See Bot. Centralbl., lxxxvi. (1901) p. 297. † Tom. cit., pp. 106–13 (3 figs.). ‡ Tom. cit., pp. 113–7.

§ S.B. kon. Akad. Wetensch. Amsterdam, Sept. 20, 1900 (English). See Bot. Ztg., lix. (1901) 2te Abt., p. 134.

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

Chlorophyll-Assimilation through the Bark.*—Mdlle. M. Goldflus has carried out a series of experiments—for which a special apparatus was made—on a great variety of woody plants, tending to show that these do not depend so largely as has hitherto been supposed on their leaves for their chlorophyll-assimilation. Chlorophyll always occurs, in larger or smaller quantities, in the branches. It is always formed in the trunk, but is limited to the bottom of the crevices when the outer bark splits. The authoress concludes that chlorophyll may be formed in every living tissue without distinction of position; and that its formation and localisation depend entirely on physiological conditions. Trees assimilate through their whole surface, in winter as in summer; hence the phrase "winter-rest" is only a comparative one.

Chlorophyll-Assimilation outside the Living Plant.†—By mixing together an extract of the soluble constituents of leaves in glycerated water and a green powder obtained from leaves at a temperature above 100° C., J. Friedel has succeeded in obtaining the chlorophyll reaction on exposure to light, independently of the living plant. It is apparently due to the action of a diastase present in the powder.

Cytisus Adami.—W. Beijerinck ‡ stimulated into development the dormant buds in the branches of this graft-hybrid between *Cytisus Laburnum* and *C. purpureus*, by severe cutting-back. The branches from these buds exhibited generally a more or less complete reversion to one or the other parent-type; in a few cases they exhibited the characters of one parent in one (longitudinal) half, of the other parent in the other half.

Dr. R. Laubert § obtained somewhat similar results; the reversions to the *C. purpureus* type reproduced the characters of the parent-form in every particular. In no case did any branch exhibit transitional characters between those of one and those of the other parent-form.

Growth in Length of Petals and Fruits.‖—A. Kraetzer records the observation of a "great period" in the growth in length of petals and fruits similar to that established by Sachs in the case of stems and roots. In the case of flowers the great period is either immediately before or immediately after the opening of the flower and the shedding of the pollen. In *Mirabilis longiflora* the rate of growth of the petals increases during the four days before opening from 3 to 34 mm. *per diem*, completely ceasing on the following day. In fruits (Cucurbitaceæ) the zone of most active growth is usually towards the base of the fruit.

Grafting the Potato on the Potato.¶—Further experiments by E. Laurent confirm his previous conclusion that, in grafting one variety

* Rev. Gén. de Bot. (Bonnier), xi. (1901) pp. 49–62 (2 pls. and 2 figs.).

† Comptes Rendus, cxxxii. (1901) pp. 1138–40.

‡ S.B. k. Akad. Wetensch. Amsterdam, 1900, pp. 365–71. See Bot. Centralbl., lxxxv. (1901) p. 333; also Bot. Ztg., lix. (1901) 2te Abt., pp. 113–8 (2 figs.).

§ Beih. z. Bot. Centralbl., x. (1901) pp. 144–65 (9 figs.).

‖ 'Ueb. d. Längenwachsthum d. Blumenblätter u. Früchte,' Würzburg, 1900, 50 pp. and 1 pl. See Bot. Centralbl. lxxxvi. (1901) p. 20.

¶ Bull. Soc. r. Bot. Belgique, 1900, pp. 85–90. Cf. this Journal, 1900, p. 607.

of potato on another, the stock exercises no visible influence on the form or coloration of the tubers produced by the graft.

Non-sexual Propagation of Opuntia.*—In *Opuntia arbuscula* Carleton E. Preston finds a method of non-sexual propagation analogous to layering, decumbent branches being borne down to the ground, where they root, by the weight of the fruit. The same species also displays another mode of non-sexual propagation by the formation of adventitious shoots on the roots.

(3) Irritability.

Perception of Gravitation by Plants.†—B. Němec gives the result in detail of observations on the effect produced by gravitation on the position in the cell of the nucleus and of other bodies of less and of greater specific gravity. He regards these observations as proving incontestably the presence in plants of a "sense-organ" which has for its function the perception of the irritation of gravitation (geotropism). The unicellular geotropic organs of multicellular plants often contain in their apex a dense protoplasm in which are a variety of solid bodies, the position of which is not directly determined by gravitation, but which, nevertheless, enable the protoplasm in which they are imbedded to exercise pressure in a definite direction. Gravitation may be regarded as the pressure exerted by bodies of a higher (or of a lower) specific gravity on sensitive protoplasm.

Geotropic Function of the Root-tip.‡—Prof. F. Darwin describes a "root-lever," which has for its object the support of the weight of the cotyledons during germination, while they are free to move in any direction in obedience to the curvature of the root. Experiments made with this instrument confirm the author's previous conclusion that in certain geotropic parts of plants the apex is a percipient organ, while the more basal motor region is set in action by an influence transmitted from the sensitive region.

Motile Cushions of Robinia and Psorliera.§ — E. Pantanelli confirms, in the case of *Robinia pseudacacia*, the statement of Pfeffer that, in the movements of the motile cushions, the two halves of the cushion display similar properties; while in *Mimosa*, *Oxalis*, *Phaseolus*, and *Desmodium*, the two halves of the cushion react differently. In *Psorliera hygrometrica*, great moisture of the air affects the nyctitropic movements by promoting the closing movement in the evening and the opening movement in the morning. The leaves close during rain.

Horizontal Nutation of the Stem of Pisum sativum, &c.‖—Experiments made by D. Neljubow on *Pisum sativum* and some other Leguminosæ (*Vicia sativa*, *Ervum lens*) led to the same results as those obtained by other observers, viz. a tendency, when grown in the dark in the open air, for the shoots to assume a horizontal position. From control experiments made under cover (in the laboratory or orangery)

* Bot. Gaz., xxxi. (1901) pp. 127–8.

† Pringsheim's Jahrb. f. wiss. Bot., xxxvi. (1901) pp. 80–178 (36 figs.). Cf. this Journal, *ante*, p. 179.

‡ Proc. Cambridge Phil. Soc., xi. (1901) pp. 134–6. Cf. this Journal, *ante*, p. 179.

§ Atti soc. nat. e mat. Modena, ii. See Bot. Ztg., lix. (1901) 2te Abt., p. 122.

‖ Beih. z. Bot. Centralbl., x. (1901) pp. 128–39 (2 figs.).

the author comes to the conclusion that the horizontal position is due neither to heliotropism nor to geotropism, but to unfavourable vital conditions, especially to the contamination of the air by small quantities of poisonous gases.

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

Formation of Asparagin and Proteids in Plants.*—According to E. Schulze, asparagin is not produced only during germination, but also at subsequent periods, as for instance, during the development of the leaf-buds. It occurs also in the roots of plants, sometimes in considerable quantities, accompanied by amido-acids and other soluble crystallisable nitrogenous compounds.

Experiments by the same author † on the cultivation of *Lupinus luteus* show that in germination a considerable decomposition of proteids takes place. Most of the products are subsequently converted into asparagin, which accumulates to a large amount, owing to the small quantity of glucose present being insufficient to enable the asparagin to be completely transformed into proteids. An increase takes place both in the asparagin and in the proteids.

The same author ‡ adduces further evidence that asparagin can be produced from other products of the decomposition of proteids. But in the absence of light a considerable production of proteids can take place only when all the other conditions are exceptionally favourable,—when proteids are present only in small amounts, and when amides and reducing sugar are abundant.

From experiments on *Brassica Napus* and *Daucus Carota*, M. Iwanoff § concludes that the formation of proteids goes on in the dark in plants. The process can, however, proceed energetically only when there is present an abundance of amides and a considerable amount of readily available carbohydrates, as in the case of the onion. A considerable amount of proteids was found in the leaves of *Brassica Napus*, which must have been newly formed, unless it had migrated from the roots in the form of albumin or pepton.

Influence of Nutrition by various organic substances on the Respiration of Plants.‖ — A series of experiments carried on by W. Palladine led to the following general conclusions. The energy of respiration depends on the quality of the combustible substance. The substances employed are thus arranged in the order of their combustibility :—fructose, glucose, saccharose, maltose, raffinose, glycerin, mannite. Cut etiolated leaves respire but feebly, but the energy of respiration increases sensibly after treatment with saccharose. Cut ends of branches, on the other hand, respire energetically, but the energy decreases after treatment with saccharose. In the absence of carbo-

* Landwirth. Jahrb., xxvii. pp. 503–16. See Journ. Chem. Soc., 1901, Abstr. ii. p. 332.

† Tom. cit., pp. 516–20. See Journ. Chem. Soc., 1901, Abstr. ii. p. 333.

‡ Landwirth. Vers.-Stat., lv. (1901) pp. 33–44. See Journ. Chem. Soc., 1901, Abstr. ii. p. 184. Cf. this Journal, 1900, p. 608.

§ Tom. cit., pp. 78–94. See Journ. Chem. Soc., 1901, Abstr. ii. p. 184.

‖ Rev. Gén. de Bot. (Bonnier), xi. (1901) pp. 18–32, 93–6, 127–36.

hydrates the quantity of proteinaceous substances which are not digestible not only does not diminish, but actually increases.

Migration of Ternary Substances in Annual Plants.*—G. André finds that in *Sinapis alba* and *Lupinus albus*, at a period of twenty-four days after germination, the saccharafiable carbohydrates amount to 7·43 p.c. in the seed, and 13·15 p.c. in the whole plant; while but very little increase has taken place in the insoluble cellulose. At the period of flowering this has increased to an average of about 25 p.c. Vasculose is not properly a carbohydrate, but is more of the nature of humic substances; it is a kind of residue of vegetable life.

Halophytes and their Chlorine-contents.†—W. Benecke disputes Diels' statement ‡ that in plants which grow in a soil saturated with sodium chloride (halophytes) the sodium chloride is being continuously decomposed within the plant, accompanied by the formation of malic acid. Experiments made with the same plants as those observed by Diels—*Salicornia herbacea* and *Cakile maritima*—exhibited a slight increase, rather than a diminution, in the amount of chloride contained at successive periods.

Physics of Fermentation.§—E. Prior and H. Schulze describe qualitative experiments on the fermentation of mixtures of dextrose and levulose and of maltose and dextrose, by yeast-cells. These support the views that fermentation takes place inside the yeast-cell; that it is dependent on the diffusion of the sugar solution through the cell-wall; that the rate of diffusion through the cell-wall varies for different species of yeast-cells; and that in a mixture of sugars the amount of each which is fermented by yeast-cells varies with the osmotic pressure of each sugar.

c. General.

Mutation Theory.‖—Dr. J. W. Moll reviews a work by H. de Vries,¶ which he regards as making an important step in advance of—though not antagonistic to—Darwin's theory of the origin of species. After a review of the various theories which have attempted to account for specific variations, he refers to the existence of what Jordan has called "elementary species," i.e. forms derived from a common ancestor, distinguished from one another by characters which, although very minute, are still hereditary and constant. Of these elementary species, 200 have been described within the bounds of a single species proper in the case of *Draba verna*. Quite distinct from these are those abrupt (*stossweise*) variations ("single variations" of Darwin), which sometimes occur, and of which de Vries records a remarkable instance in the genus *Œnothera*.** For such variations de Vries proposes the term *mutations*.

* Comptes Rendus, cxxxii. (1901) pp. 1058–60, 1131–4.

† Pringsheim's Jahrb. f. wiss. Bot., xxxvi. (1901) pp. 179–196.

‡ Cf. this Journal, 1899, p. 178.

§ Zeitschr. angew. Chem., xiv. (1901) pp. 208–15. See Journ. Chem. Soc., lxxx. (1901) p. 262.

‖ Biol. Centralbl., xxi. (1901) pp. 257–69, 289–305 (1 fig.); also Rev. Gén. de Bot. (Bonnier), xiii. (1901) pp. 5–17 (10 figs.).

¶ 'Die Mutations-theorie u.s.w. Bd. 1, Die Enstehung d. Arten durch Mutation,' Leipzig, 1901.

** Cf. this Journal, 1900, p. 609.

The theory now proposed by de Vries, and supported by Moll, is that the production of new species is not due to the gradual accentuation during hundreds or thousands of years, of differences which have sprung up in the form of continuous variations, but is due to the operation of the law of mutation, i.e. to the fixing by heredity of differences which have sprung suddenly into existence. These differ from the continuous variations, not only in their specific characters (*sie sind da oder sie sind nicht da*), but also in their not disappearing by reversion to the parent type. The new species are distinguished from their parent-forms, not by one character only but by several, and are usually represented by a large number of individuals appearing at the same time. The theoretical conclusion is suggested that this is the history of the formation not only of new species, but of all the higher groups also.

Development of Heat by Plants.*—A series of experiments on different plants, carried out by Sig. N. Passerini, showed that the organs of plants exposed to the sun attain a temperature considerably higher than that of the atmosphere; while those not exposed to the direct rays exhibit usually during the warmer part of the day, a temperature sensibly lower than that of the surrounding air; the greatest difference observed in the former case was 17°·2 C. The side of fruits exposed to the sun absorbs the greatest amount of heat, hence assumes the deepest colour, and forms the largest amount of sugar. Fruits situated low down nearest the ground absorb most heat, since they receive that reflected from the soil as well as the direct rays. A portion of the heat absorbed directly from the rays of the sun is dispersed by radiation when the calorific rays cease to impinge on the plant; but the increase of potential energy does not proceed exclusively from the purely luminous rays.

Influence of the Electric Current on the Resistance of Vegetable Tissues to Conduction.†—T. Wjasemsky has followed out the observations of Burdon Sanderson on the electromotive properties of the leaves of *Dionæa*. He is led to believe that the diminution in the resistance offered by the tissues of the leaf caused by the current is due to the conveyance into the tissues of water from the moist electrodes.

Effect of Hydrocyanic Acid Gas on Seeds.‡—From experiments made chiefly on the grains of cereals, C. O. Townsend has ascertained that dry seeds may be fumigated with the usual strength of hydrocyanic acid gas for the length of time required for the destruction of animal life without in any degree interfering with the germinating power of the seeds, and without rendering them injurious as food. Moist seeds are, on the other hand, much more sensitive to the influence of hydrocyanic acid gas than dry seeds.

B. CRYPTOGAMIA.

Relation of the Zoospore to the Spermatozoid. § — Prof. P. A. Dangeard compares the modes of reproduction in the lower forms of vegetable life with those in *Polytoma uvella*, the lowest animal organism which

* Nuov. Giorn. Bot. Ital., viii. (1901) pp. 64–74.
† Physiol. Russe, ii. (1900) pp. 81–106 (3 figs.) (German).
‡ Bot. Gazette, xxxi. (1901) pp. 241–64 (6 figs.).
§ Comptes Rendus, cxxxii. (1901) pp. 859–61.

exhibits ordinary sexual reproduction. The zoospores and the gametes in this organism possess a locomotor apparatus much more complicated than has hitherto been described. It consists of two flagella situated anteriorly; a blepharoplast or insertion-nodule of the flagella, resulting from a thickening of the ectoplasm; a thread which starts from the blepharoplast and is placed by the side of the nucleus, the *rhizoplast*; and a small nodule at the point of contact of the rhizoplast with the nuclear membrane, the *condyle*. The spermatozoid exactly reproduces during its formation these various processes in the zoospore, from which it is unquestionably derived. The centrosome does not play the part that has been attributed to it in spermatogenesis. It is only in the process of karyokinesis that it can be regarded as the dynamic centre.

Muscineæ.

Cave Mosses.*—L. Géneau de Lamarlière and J. Mareu have investigated the specialities of structure of the mosses found in caves in certain districts of France. They agree in general with those of species which grow in dense shade and in cold or damp places, having in some instances a distinct boreal character. No special species is described. The Hepaticæ appear, on the whole, to be less affected by the absence of light than the Musci.

Fossil Moss.†—In a locality in Saxony (geological formation not stated) A. Geheeb finds the remains of a moss indistinguishable from *Hypnum fluitans*, which he names *H. fluitans* forma *fossilis.*

Rhizoid-rudiments on the Ventral Scales of Marchantiaceæ.‡—C. Warnstorf describes, in the case of several species of Marchantiaceæ, a peculiarity resembling that found by Correns § in some Musci, viz. the capacity of certain cells to form rhizoids or protonema. In the Marchantiaceæ (*Marchantia polymorpha*, *Fegatella conica*, *Targionia hypophylla*, &c.), these conical rhizoids occur on the ventral scales, as they do also in *Corsinia marchantioides*; in *Calypogeia trichomanis* they are found on the scales of the male branches.

Algæ.

Galls on Algæ.‖—Dr. A. Trotter enumerates the recorded cases of galls found on seaweeds and freshwater algæ. Of zoocecidia, in addition to the well-known parasitism of *Notommata Wernecki* on *Vaucheria*, he mentions galls produced by *Tylenchus fucicola* on *Ascophyllum nodosum*, and by *Harpacticus chelifer* on *Rhodymenia palmata*. Among phytocecidia;—bacteria produce galls in a number of algæ, both marine and freshwater. The fungi which produce galls in algæ appear to be confined to the Chytridiaceæ. Of algæ producing galls on algæ several instances are mentioned:—*Streblonemopsis irritans* on *Cystoseira opuntioides*; *Ectocarpus valiantei* on *Cystoseira ericoides*. A list is further given of the species of algæ which produce galls on Phanerogamia and on

* Comptes Rendus, cxxxii. (1901) pp. 921-3.
† Beih. z. Bot. Centralbl., x. (1901) pp. 125-7.
‡ Hedwigia, xl. (1901) pp. 132-5 (5 figs.).
§ Cf. this Journal, 1899, p. 564.
‖ La Nuova Notarisia, xii. (1901) pp. 7-24.

Hepaticæ:—*Phytophysa Treubii* on a species of *Pilea*; *Anabæna Cycadearum* on the roots of various Cycadeæ; *Nostoc lichenoides* on species of *Anthoceros* and *Blasia*, &c.

Carbohydrate of Carrageen-moss.* — J. Sebor has determined the nourishing constituent of *Chondrus crispus* to be a complicated carbohydrate composed of galactose, glucose, and fructose, together with a small quantity of pentoses.

Swarmspore Formation in Hydrodictyon.† — According to H. G. Timberlake, the best medium for cultivating *Hydrodictyon reticulatum* and inducing the formation of swarmspores is a mixture of 100 cc. 1 p.c. aqueous solution of iridium chloride and 3 cc. glacial acetic acid. There is no differentiated chromatophore in the cell. The pyrenoids and nuclei are scattered irregularly throughout the cytoplasm, and the chlorophyll is contained in the whole cytoplasmic body. The nuclei in both the resting and dividing stages show the structure typical of higher plants. Cleavage takes place by means of surface constriction of the protoplasmic membrane on the outside and the vacuole membrane on the inside of the protoplasmic layer. The process is a progressive one, the cleavage furrows cutting out first large irregular multinucleated masses of protoplasm, which are in turn broken up into smaller masses, until each contains a single nucleus, the entire protoplast being thus broken up into spores. The swarmspores are uninucleated biciliated cells. At the base of each pair of cilia is a clearly defined basal body.

Fungi.

Germination of Fungus-Spores.‡—A series of experiments made by B. M. Duggar on about twenty species of Fungi—especially *Aspergillus flavus* and *Sterigmatocystis niger*—furnish fresh evidence of the extent to which the germination of spores is affected by chemical and physical agents. Salts of potassium and magnesium are not, as has been stated, absolutely indispensable for the germination of all the lower Fungi. On the other hand, germination is often favourably influenced by substances which yield no nutriment. Changes in the form of the hanging drop and in the rapidity of evaporation may accelerate or retard germination. Small differences in the temperature and in the supply of oxygen produced but little result. The length of time during which spores retained their power of germination varies greatly with different species,—only 24 hours with *Botrytis vulgaris*, 65 days with *Aspergillus flavus*.

Sources of Nitrogen for Fungi.§—Mary H. Smith finds pepton to be a favourable source of nitrogen for saprophytic fungi (*Aspergillus flavus*, *Botrytis vulgaris*). In potassium nitrate and potassium nitrite both fungi grew luxuriantly, the *Aspergillus* developing well-formed fructification.

New Genera of Fungi.—Parasitic on the leaves of a *Loranthus* in Brazil, P. Hennings ‖ finds a fungus which he makes the type of a new genus *Pilgeriella*, allied to *Trichosphæria*:—Perithecia membranacea, in

* Oesterr. Chem. Ztg., iii. (1900) p. 441. See Bot. Centralbl., lxxxvi. (1901) p. 70.
† Bot. Gazette, xxxi. (1901) p. 203. ‡ Tom. cit., pp. 38–66.
§ Tom. cit., pp. 126–7. ‖ Hedwigia, xxxix. (1900) Beibl., p. 134.

mycelio crustaceo maculiformi superficiali fusco incidentia, ovoidea v. oblonga, papillato-osteolata; asci clavati, 8-spori, aparaphysati; sporæ oblongæ, continuæ, hyalinæ v. subflavescentes.

In an instalment of his description of the fungi gathered in Brazil by Ule, Dr. H. Rehm * describes, under the Sphæriaceæ, a new genus *Vestergrenia* g. n., with the following diagnosis:—Perithecia sessilia, globosa, glabra, haud papillata, poro minutissimo pertusa, membranacea, atra, basi hyphis fuscis conjuncta; asci ovales, crasse tunicati, longe tenerrime stipitati, 8-spori; sporidia elliptica, 1-cellularia, hyalina, 3-sticha; paraphyses nullæ.

F. Bucholtz † describes, as the type of a new genus *Pseudogonea*, belonging to the Tuberaceæ, an underground fungus found in Italy. The receptacle is irregularly spherical and hollow, with one or more roundish or fissure-like openings; its wall is clothed within and without by a spiny pseudo-parenchymatous rind; there are no true labyrinthine passages; the asci are cylindrico-club-shaped and 8-spored; the spores spherical, very finely verrucose; the paraphyses septate.

In a collection of Fungi from Java made by M. Fleischer, P. Hennings ‡ finds two species of a new genus of Gasteromycetes, *Pirogaster* g. n., which he thus defines:—Peridium coriaceum, simplex, pisiforme, stipitatum, extus pallidum; gleba carnosa, violacea v. brunnea, venoso-reticulata; sporæ globosæ, aculeato-asperatæ, coloratæ.

Peronosporaceæ. § — Prof. A. N. Berlese follows up his general account of the structure of this family of Fungi with a monograph of the known genera and species. The family is first of all divided into two subfamilies, the Planoblastæ and the Siphoblastæ. The former are characterised by the non-sexual propagation taking place by means of zoospores which are formed either in zoosporanges which remain adherent to the mycele, or more often in deciduous conids; they comprise the genera *Pythium*, *Cystopus*, *Phytophthora*, *Plasmopara*, *Sclerospora*, and *Basidiophora*. In the second subfamily non-sexual propagation is effected by conids which germinate by means of a mycelial filament, and which are homologous to the deciduous zoosporanges of the Planoblastæ; it comprises the genera *Bremia* and *Peronospora*. The present paper treats of genera 2–5.

Pilobolus.‖—E. Palla gives a useful monograph of this genus of Fungi, of which he makes eight species, one, *P. heterosporus*, being new. But in some cases the "species" includes a number (in the case of *P. Kleinii* as many as 20) of "small species" or subspecies, differing from one another only in the form or appearance of the spores, a difference which can be detected only by prolonged culture.

Chytridiaceæ.¶—R. Lüdi describes a new species of *Synchytrium*, *S. Drabæ*, parasitic on *Draba aizoides*, and, in a general review of the genus, gives his opinion that, in the Synchytrieæ, as in the Uredineæ and Schizomycetes, there may be biological species which do not differ from one another morphologically. A long series of experiments on

* Op. cit., xl. (1901) p. 100 (1 fig.). † Tom. cit., pp. 129–31 (5 figs.).
‡ Op. cit., xl. (1901) Beibl., pp. 26–7 (2 figs.).
§ Riv. Pat. Veg., ix. (1901) pp. 1–126 (21 figs.). Cf. this Journal, 1899, p. 189.
‖ Oesterr. Bot. Zeitschr., l. (1900) pp. 349–70, 397–401 (1 pl.).
¶ Hedwigia, xl. (1901) pp. 1–44 (2 pls. and 5 figs.).

S. Taraxaci led to the conclusion that it is nearly or quite confined to species belonging to the genus *Taraxacum* as host-plants. It appears to be a sharply differentiated species, both physiologically and morphologically. The last portion of the paper treats of *Cladochytrium Menyanthis*, and the mode of formation of its resting-spores.

Parasitic Fungi. — A. von Jaczewski * finds, on the branches of species of *Casuarina*, a parasitic fungus which he identifies with *Botryosporium diffusum*.

G. Delacroix † describes a conidial form of *Guignardia Bidwellii*, the fungus which produces the black-rot in grapes, found both on the sclerotes and on the pycnids or spermogones; it may be regarded as a *Verticillium*, or rather as an *Acrocylindrium* form.

Dr. L. Montemartini ‡ gives an account of the injury inflicted on fruit-trees by *Monilia fructigena*, and prescribes the best remedies.

Dr. C. v. Tubeuf § makes an important contribution to our knowledge of the parasitic fungi which attack trees, in the following points:— The so-called "*Schütte-krankheit*," which is very destructive to many species of conifers, is due to fungi belonging to the family Hysteriaceæ, especially to species of *Lophodermium*, *Hypoderma*, and *Hypodermella*. The injuries inflicted by *Lophodermum pinastri* are especially described in detail. A species of *Fusoma* (*F. blasticola = parasitica*) is destructive to conifer seedlings. *Tuberculina maxima*, belonging to the Ustilagineæ, is parasitic on the Uredineæ parasites of conifers. *Peridermium Strobi*, a parasite of the Weymouth pine, was successfully cultivated on various species of *Ribes*. *Æcidium strobilinum* was determined to be the æcidioform of *Pucciniastrum Padi*. *Gymnosporangium juniperinum* belongs to the cycle of *Roestelia cornuta* on *Sorbus Aucuparia* and *Amelanchier rotundifolia*; *G. tremelloides* to that of *R. penicillata* on *Pyrus Malus*, *Sorbus Aria*, and *S. chamæmespilus*. The author believes that the wind has much more to do with the dissemination of the spores of parasitic fungi than has generally been supposed.

A disease of apricots in Italy and the South of France, known as *eczema empetiginoso*, is attributed by R. Farneti ‖ to a fungus belonging to the Hyphomycetes, which he describes as a new species under the name *Stigmina Briosiana* sp. n.

On a new species of *Melampsora*, *M. paradoxa*, parasitic on a willow, P. Dietel ¶ finds a peculiar kind of teleutospore, hitherto undescribed, usually 1-, but occasionally 3–4-celled, characterised by the peculiarity of being formed singly, instead of, as is usually the case, in groups or layers.

Parasitic on the lucerne, and on *Medicago falcata* in N. Italy, G. Pollacci ** finds a destructive parasitic fungus, *Pleosphærulina Briosiana* sp. n.

* Zeitschr. f. Pflanzenkrankheiten, x. (1900) p. 146. See Bot. Centralbl., lxxxv. (1901) p. 52. † Comptes Rendus, cxxxii. (1901) pp. 863–4.

‡ Rev. Pat. Veg., viii. (1901) pp. 210–8.

§ Land- u. Forstwirthsch. k. Gesundheitsamte, ii. (1901) pp. 1–178 (7 pls. and numerous figs.). See Hedwigia, xl. (1901) Beibl., pp. 9–11.

‖ Atti Ist. Bot. Univ. Pavia, vii. (1900) p. 9 (1 pl.). See Bot. Centralbl., lxxxv. (1901) p. 405. ¶ Hedwigia, xl. (1901) Beibl., pp. 32–5 (10 figs.).

** Atti Ist. Bot. Univ. Pavia, 1901, 5 pp. and 1 pl. See Hedwigia, xl. (1901) Beibl., p. 47.

Dr. V. Peglion * describes the injuries inflicted on cereal crops in Italy by the attacks of *Sclerospora graminicola*, which attacks also other kinds of grass, and with which he identifies *S. Kriegeriana* parasitic on *Phalaris arundinacea*, and *S. macrospora* parasitic on an *Alopecurus*.

H. von Schrenk † describes fully a disease of *Robinia Pseudacacia*, produced by *Polyporus rimosus*.

The chrysanthemum-rust, *Puccinia Chrysanthemi*, is identified by E. Jacky ‡ with *P. Tanaceti* and *P. Balsamitæ*. It attacks only *Chrysanthemum indicum*, and is characterised by its two-celled uredospores.

Histological Researches on the Sporulation of Yeasts. § — A. Guilliermond, from an examination of numerous yeasts, and particularly of *S. Ludwigii*, states that at the commencement of spore-formation the red granules become, as it were, dissolved, and appear to behave like reserve bodies. He confirms the observations of previous writers who attributed to these granules a large share in the formation of the spores of yeasts and bacteria, and of others who considered them to be reserve substances.

Intracellular Nutrition of Yeast.‖—E. Kayser finds that the acidity produced on fermentation by yeast and caused by volatile and fixed acids, is dependent on the nature of the medium and the conditions of the fermentation. The presence of acetic acid or pepton decreases the amount of fixed acids, but both fixed and volatile acids are increased in quantity by the presence of phosphates. The amount of aëration also has an effect on the relative quantity of fixed and volatile acids formed with fermentation.

Adaptation of the Uredineæ to their Substratum.¶—P. Hennings calls attention to several instances in which two so-called species of Uredineæ growing on different host-plants are apparently morphologically identical with one another. He draws the conclusion that the structure of the leaf has much more to do with the parasitic fungi found upon it, than the genetic relationship of the host-plant. The structure of the leaf as to thickness, firmness, and degree or nature of hairiness, must necessarily largely determine the species of parasitic fungi which can develop upon it.

Fulminaria mucophila g. n.**—C. Gobi finds this parasite, which he identifies with Lagerheim's *Harpochytrium Hyalothecæ*, on all algæ which have a broad gelatinous sheath, especially on desmids. It consists of a very slender capilliform but solid stalk, which attaches itself to the membrane of the host, and a usually sickle-shaped body which becomes afterwards transformed into a zoosporange. The individual is derived from a pear-shaped swarmspore which has a single flagellum at its narrower end, and which has the power of exceedingly rapid

* Atti r. Accad. Lincei, x. (1901) pp. 262–5.

† Twelfth Ann. Rep. Mo. Bot. Gard., 1901, pp. 21–3 (3 pls.). See Bot. Gazette, xxxi. (1901) p. 206.

‡ Zeitschr. f. Pflanzenkrank., x. (1900) p. 132. See Bot. Centralbl., lxxxvi. (1901) p. 34.

§ Comptes Rendus, cxxxii. (1901) pp. 1194–6.

‖ Ann. Inst. Pasteur, xiv. (1900) pp. 605–31. See Journ. Chem. Soc., lxxx. (1901) p. 263.

¶ Hedwigia, xl. (1901) pp. 125–8.

** Script. Bot. Hort. Univ. Imp. Petrop., fasc. xv. pp. 283–92 (1 pl.). See Bot. Centralbl., lxxxvi. (1901) p. 149.

motion. When it comes into contact with the gelatinous sheath of an alga, it bores through the jelly by means of the flagellum, and becomes the stalk of the sporange. The systematic position of the genus is doubtful.

Cytology of the Hymenomycetes.* — Pursuing his researches on the cytology of the Hymenomycetes, R. Maire states that in *Hygrocybe conica* we have the only example at present known of the development of basids without any fusion of nuclei. The cells of the lamellæ are plurinucleate; while those of the sub-hymenium contain only a single nucleus with two chromosomes, dividing by mitoses resembling those of the basids.

M. Maire explains the diversity in the results obtained by different observers as to the number of chromosomes, by the statement that, after the appearance of the centrosomes and of the spindle, and the partial or entire disappearance of the nuclear membrane, the chromatic filaments are in the first place transformed, not into chromosomes, but into a variable number of strongly chromatophile granulations, the *protochromosomes*, which reunite, at the end of the prophase, into two definite chromosomes, placed side by side in the middle of the spindle, and which then usually divide longitudinally.

Merulius lacrymans.†—G. Marpmann gives a detailed account of the appearance presented by this destructive fungus, and of the injury inflicted by it on wood. The microchemical reactions by which its presence can be recognised are given, especially those with Nessler's reagent.

"Bleeding" of Stereum sanguinolentum.‡ — According to V. Kindermann, the seat of the blood-red pigment of the juice which exudes from this fungus when wounded is special hyphæ which he terms tannin-hyphæ, occurring mostly in the sub-hymenial layer; in the hymenium they run parallel with the basids. They are somewhat wider than the other hyphæ of the receptacle, their diameter being from 29 to 52 μ. Here and there is an irregular transverse septation. Towards the somewhat club-shaped projecting apices the membrane is much thinner. The fresh tannin-hyphæ contain a reddish-brown homogeneous fluid, with numerous oil-drops, which becomes blood-red on exposure by oxidation. Its function appears to be to hinder decay.

Spore-formation of Acrospeira.§ — Experiments made by R. H. Biffen with various culture-media support the view that an alteration in the food-supply and other external conditions may induce a change in the external characters of the spores rather than in their nature. In *Acrospeira mirabilis*, in addition to the ordinary chlamydospores, groups of chlamydospores were produced on chestnut-agar surrounded by a thick envelope of several layers of cells. The submerged hyphæ also produced flask-shaped structures from which endoconids arose.

* Comptes Rendus, cxxxii. (1901) pp. 861–3. Cf. this Journal, 1900, p. 620.
† Zeitschr. f. angew. Mikros., vii. (1901) pp. 1–12.
‡ Oesterr. Bot. Zeitschr., li. (1901) pp. 32–5 (1 fig.).
§ Proc. Cambridge Phil. Soc., xi. (1901) pp. 136–8.

Sporothrix Schenckii.*—A. Foulerton remarks that *Sporothrix Schenckii* is a recent addition to the list of pathogenic mould-fungi. It produces lymphangitis, abscesses, and ulceration. In the pus are found ovoid bodies, and cultivations yield a mould-fungus. When animals are inoculated with cultures, only spore-forms are reproduced ; hence it would appear that the spore-forms are capable of reproduction as such. These spores have some resemblance to the "yeast-form" of *Oidium albicans*, which in some media can be cultivated as such, but when transferred to different substrata, a development of mycele occurs.

Mycetozoa.

Affinities of the Mycetozoa.†—E. W. Olive argues against the theory of the location of the Mycetozoa in the animal kingdom advocated by De Bary. If we assume that the pseudoplasmode of the Myxobacteriaceæ indicates a genetic connection with that of the Acrasieæ, then the Mycetozoa have affinities with higher plants through the Bacteria, which are evidently derived forms of fission-algæ.

Culture of Myxomycetes.‡—N. Ensch calls attention to several interesting points of structure and development observed in the cultivation of Myxomycetes on artificial media. If *Chondrioderma difforme* is grown on sterilised stems and leaves of *Vicia faba*, the plasmodes are formed only on the plant, never on the glass ; the myxamœbæ appear, therefore, to result from the influence of a chemotatic irritation exercised by the plant. The myxamœbæ can be cultivated for a considerable period without becoming converted into plasmodes. The spores of *Chondrioderma* germinate also on gelatin ; but the swarmspores have no flagella, and are converted into microcysts after creeping about for a time. The author succeeded in preserving a plasmode of *Fuligo septica* five weeks without fructifying.

Like other fungi, the Myxomycetes require air for the formation of sclerotes or sporanges ; this very rarely occurs with submerged plasmodes. If a plant which is beginning to form plasmodes in the air is suddenly immersed in water, peculiar phenomena of disorganisation are manifested.

Glycogen was found in all the species examined, but not in the swarmspores or amœbæ ; it makes its appearance only after the formation of plasmodes ; it is most abundant before the breaking-up of the plasmode into spores, and especially in the dense peripheral layer.

Feeding Plasmodes of Fuligo.§ — Professor J. W. Harshberger placed under observation an actively streaming plasmode of *Fuligo septica* found on *Pleurotus sapidus*. The application of pieces of several fungi—*Coprinus cornatus*, *C. atramentarius*, *Hypholoma perplexum*, *Phallus impudicus*—was followed by their rapid environment and digestion ; and the same was the case, after a time, with raw beef-steak and white of egg ; the yoke of egg and butter were left untouched. It was not till the original food-substance had been destroyed as food that saprophytic organisms, such as mould-fungi, had any chance of development.

* Brit. Med. Journ., 1901, i. pp. 957–8.
† Proc. Indiana Acad. Sci., 1898, pp. 209–12.
‡ Misc. Biol. déd. au prof. A. Giard, Paris, 1899. See Bot. Centralbl., lxxxvi. (1901) p. 8.
§ Bot. Gazette, xxxi. (1901) pp. 198–203 (1 fig.).

Protophyta.

α. Schizophyceæ.

New Genera of Protococcoideæ.*—From the plankton of a well in Denmark, Prof. R. Chodat describes the following three new genera of Protococcoideæ:—*Lemmermannia*, founded on *Tetrapedia emarginata* Schroed.; *Hofmannia*, cells united into cœnobes of four individuals, each containing a pyrenoid, springing from a membranaceous hyaline tube; *Cateria*, cells cylindrical, narrower in the middle, membrane attached to both parts by a ring.

Phormidium.†—Dr. L. Macchiati gives full descriptions of the two species of this genus of Oscillatoriaceæ, *P. uncinatum* and *P. autumnale*, one found in a mineral spring, the other on rocks and stones.

β. Schizomycetes.

Hereditary Variation of Microbes.‡—Prof. M. W. Beijerinck remarks that it has been frequently noticed that bacteria cultivated in the laboratory exhibit in the course of successive cultures marked variations which are so different from the original that, had their developmental history been unknown, they might have been considered with some certainty to be different species. These changes may be classified under three heads, viz.:—Degeneration, Transformation, and ordinary Variation.

Degeneration may be regarded as the gradual impairment of growth affecting an organism by repeated cultivation. In transformation a change affects all the members of a culture, some definite characteristic being lost, and, possibly though not necessarily, being replaced by another. The most common change is ordinary variation. With this the majority of the culture remains unaltered, while a few individuals acquire new characters and are distinguished as variants. These correspond to the "races" of cultivated plants, and retain their newly-acquired characters permanently, though subject to occasional reversion. Variants may originate suddenly, possibly from unequal fission of the dividing cell, but in most instances it is a gradual process, the stages or subvariants being connected with the original form by transitional phases. Subvariants occur only in small numbers, and either show a disposition to revert to the original form or to continue to produce variants. Yet by careful selection of colonies these variants may be retained. Numerous examples are quoted by the author, but for these the original should be consulted.

Chemistry of Bacteria.§—E. Bendix obtained a pentose from tubercle bacilli by boiling the dried organisms with a 5 p.c. solution of hydrochloric acid. The solution reduced alkaline copper solutions, gave the

* Bull. Herb. Boiss. See La Nuova Notarisia, xii. (1900) p. 41.

† Bull. Soc. Bot. Ital., 1901, pp. 13–20.

‡ Kon. Akad. v. Wetenschappen, Amsterdam, 1900. See Centralbl. Bakt., 2te Abt., vii. (1901) pp. 363–4; also Archiv. Néerland. Sci. exact. et nat., iv. (1901) pp. 213–30 (5 figs.).

§ Chem. Centralbl., 1901, i. 406–7. See Journ. Chem. Soc., lxxx. (1901), Abstr. ii. p. 206.

characteristic orcinol hydrochloric acid reaction, and with phenylhydrazin formed an osazone which melted at 153°–155°.

The pentose was found to be contained in the nucleo-proteids of the bacilli. A mixture of fæcal bacteria cultivated in urine, and the bacilli of diphtheria, both showed the pentose reactions, but the bacillus of typhoid gave negative results.

Influence of Temperature and Nutriment on the Motility of Bacteria.*—Dr. T. Matzuschita states that incubation temperature is unsuitable for the motility of bacteria, as he found that these microbes immediately, or after a few days, lost their power of moving, but retained it much longer at room temperature. In bouillon movements were preserved longer than on agar and much longer than on potato. *Bacillus pyocyaneus* and *Vibrio choleræ asiaticæ* retained the power longer and more strongly than other bacteria. *Bacillus fluorescens liquefaciens* on potato at 20° did not move after the first day, while *B. pyocyaneus* was moving up to the eleventh. For examining the motility of bacteria the author found it advisable to use bouillon cultures at room temperature 1–3 days old.

Reduction of Sulphates in Brackish Water by Bacteria.†—Prof. R. H. Saltet discusses the results obtained by Mulder, Beijerinck, and Stokvis on investigations on the reduction of sulphates by bacteria. His own observations lead him to believe that the reduction of sulphates to sulphides takes place in two or perhaps more stages; at any rate, there is first reduction to sulphites by *Bacillus desulfuricans*, and then other bacteria effect the reduction to hydrogen sulphide.

Aerobic Spore-bearing Bacilli.‡—Dr. W. W. Ford, in a short communication, gives details relative to some sporogenous bacilli, eight of which are new. They are divided into two groups, pathogenic and non-pathogenic, of five each. Both groups grew well on the ordinary culture media, and spore-formation was rapid. They do not form gas in carbohydrate media. They coagulate milk, and liquefy casein, gelatin, and blood. On potato and on gelatin the growth was characteristic.

All were potential anaerobes, but some failed to grow in the closed arm of the fermentation tube. Their source of origin was liver of rabbit, guinea-pig, and cat, kidney of rabbit, the human stomach, and pleural exudate.

Branching of Spirilla.§—Dr. H. Reichenbach records some interesting observations on certain appearances closely resembling branching which were found on microscopical examination of the sediment of a bouillon culture. This culture had been kept for six days at 33°·5. Extremely long spirals, some with as many as 70 turns, were noted. The branched, or T-shaped forms to which attention is drawn usually presented a swelling at the point of junction of the arms, and, as is well shown in the illustrations, exhibited the appearance of ganglion cells. The arms of the T were often devoid of waviness, and a development of

* Centralbl. Bakt., 2te Abt., vii. (1901) pp. 209–14.
† Op. cit., vi. (1900) pp. 648–51, 695–703.
‡ Bull. Johns Hopkins Hosp., xii. (1901) pp. 13–5.
§ Centralbl. Bakt., 1te Abt., xxix. (1901) pp. 553–7 (1 pl.).

spirilla from them was not observed. This, notwithstanding the resemblance, shows that the appearances are not to be regarded as true branching.

Organisms of Nitrification.*—A. Stutzer has recently gone over by himself experiments with the organisms of nitrification, and his present views are almost identical with those of Winogradsky. A few years ago he published certain researches,† the results of which were at variance with those of the Russian observer, who expressed the opinion ‡ that Stutzer's results were due to errors of manipulation.

Bacteriology of Normal Organs.§—Dr. W. W. Ford maintains that at least 70 p.c. of the organs of our ordinary domesticated animals contain bacteria which are capable of development provided a sufficient time be allowed to elapse between the removal of the organs and their final examination. Rabbits, guinea-pigs, dogs, and cats were killed in conditions of fasting and of full digestion. Cultivations were made in various media with pieces of kidney and liver. Each organ, each animal, and each species, was found to exhibit its own peculiar bacteriological features regardless of the methods of sterilisation and preservation. In rabbits and guinea-pigs the most prominent were *Staphylococcus albus*, *S. aureus*, *B. mesentericus*, *B. proteus*; while in dogs and cats *B. mycoides*, *B. megaterium*, and *B. Zopfii* were present.

The difference between the author's results and those of former observers is accounted for by the length of time allowed between the excision of the organs and the bacteriological decision, the author's interim being much longer, and varying from 6–17 days. The records of previous observers were taken at the end of 2–3 days. Their results were negative, and these observations were confirmed by the author, who also obtained sterile cultures for the first few days.

New Urea-Bacteria.‖—In the course of investigations on the decomposition of urea by urease, and by the process of katabolism, Prof. M. W. Beijerinck met with three microbes which are engaged in the preparatory stages of the decomposition. These are *Urobacillus Miquelii*, *Urobacillus Leubii*, and *Planosarcina ureæ*.

Urobacillus Miquelii is a motile rodlet with a few peritrichous flagella. It does not form spores. It liquefies gelatin and decomposes urea. It is phylogenetically connected with *B. Zopfii* and *B. asteroides*.

Urobacillus Leubii is a rodlet 3–5 μ long and about $1 \cdot 5$ μ broad. It forms oval spores from $0 \cdot 8$–1 μ in length, which are extremely resistant to heat and chloroform. It is motile, and possesses peritrichous flagella, which are stained with some difficulty. *U. Leubii* produces two kinds of colony, one yellowish, cloudy, and containing spores, the other more transparent and spore-free. It decomposes urea and does not liquefy gelatin.

Planosarcina ureæ produces yellowish non-liquefying colonies in gelatin. The colonies in solid and fluid media consist of packets of 4–8 or more cells, which are covered with flagella, and are extremely

* Centralbl. Bakt., 2te Abt., vii. (1901) pp. 168–78.

† Cf. this Journal, 1896, p. 105. ‡ Cf. this Journal, 1896, p. 664.

§ Journ. Hygiene, i. (1901) pp. 277–84.

‖ Centralbl. Bakt., 2te Abt., vii. (1901) pp. 47–54 (3 figs.).

motile. The cells measure from 0·7 to 1·2 μ, and produce very resistant spherical spores with a diameter of 0·6 μ. It decomposes urea readily but not rapidly, converting only 3 p.c. while another organism, *Urococcus ureæ*, has disposed of 5 p.c. of urea.

Parasites on the Seats of "Cabinets d'aisance." * —F. F. Santschi contributes an elaborate report of bacteriological examinations made on the seats of water-closets, latrines, privies, and other forms of *cabinets d'aisance*. The seats are divided into two classes, the English and the Turkish. The examination appears to have been carried out with great thoroughness, and according to the most approved methods of bacteriological research. Thirty-seven species of microbe were detected, many of them being pathogenic bacteria, but among the latter it is satisfactory to note that *B. tuberculosis* was not discovered.

Behaviour of certain Pathogenic Microbes in Milk, Cream, and Cheese. † — Dr. E. Klein, after an investigation of the behaviour of *Bacillus tuberculosis*, *B. diphtheriæ*, *B. typhosus*, and *Streptococcus*, when cultivated in sterilised milk, cream, and cheese, reports that milk incubated at 37° forms a suitable medium for the propagation of the tubercle bacillus. When fresh tuberculous deposits were used, milk cultures were rendered highly virulent. Milk was found to rejuvenate cultures, e.g. glycerin-agar, which from lapse of time had lost their power to produce tuberculosis on inoculation. The regained virulence was, however, easily lost again. On sterilised cheese, and in sterilised cream at 37°, tubercle bacilli were found to thrive.

While the ability of *B. typhosus* to thrive in milk is confirmed, cream proved a suitable medium only at about 20°; for at 37° the microbe disappeared in two weeks. From cheese this bacterium had disappeared within a like period.

The diphtheria bacillus grew well at 20°, but at 37° was not recovered after a fortnight. Cream and cheese were unsuitable at both temperatures. *Streptococcus scarlatinæ* grew at both temperatures in milk. It could be recovered after two weeks from cream and cheese at 20°, but not at 37°.

Ætiology of Plague. ‡—Dr. J. A. Thompson, in a contribution to the ætiology of plague, expresses the opinion, formed from observations made during the epidemic at Sydney, N.S.W., that the communication from rats to man is effected very commonly, and indeed usually, by fleas. The direct evidence adduced, though small, is positive.

Bacteriological Researches on the Roots and Seeds of Hedysarum coronarium. § — K. H. Nicolai found in the roots of *Hedysarum coronarium* spherical and rod-like bacteria. As there were no nodules on the roots, it was probable that the bacteria gained entrance through the root-hairs. No trace of albumen was detected in the bacteria by the ordinary tests. The bacteria grew on all the usual media. The addition of asparagin (0·01) and of cane sugar (0·05) to 10 ccm. of gelatin

* Bull. Soc. Vaudoise Sci. Nat., xxxvii. (1901) pp. 41–90.
† Local Gov. Board Rep. 1899–1900 (1901) pp. 577–87.
‡ Journ. Hygiene, i. (1901) pp. 153–67.
§ Inaug. Diss., Erlangen, 1900, 34 pp. See Centralbl. Bakt., 2te Abt., vii. (1901) p. 301.

did not hasten growth. Gelatin was always liquefied, and pigment always apparent. The presence or absence of light seemed to exert no influence on colony formation. The reaction of nutrient media, neutralised with normal caustic soda, was always slightly acid. In hanging drops movements were observed, but flagella were not made out. Spore formation was not observed. In the seeds bacteria were not discovered, hence the bacteria in the roots must have found their way in from the soil.

Bacteriosis of Walnut.*—Under the name *Pseudomonas Juglandis* sp. n., Prof. Newton B. Pierce describes a micro-organism very destructive to the fruit, leaves, and young branches of the walnut and allied species.

Mosaic Disease of the Tobacco Plant.†—Dr. Ivanowski states that on the diseased parts of the plants the cells of the yellow leaves are filled with thin short rodlets. These are easily demonstrable by proper fixation and staining, and there is no necessity to assume, as Beijerinck did, that the cause of the mosaic disease is a contagium fluidum vivum.

Bacteriology of Ozæna.‡—Dr. F. Perez, who has already described the bacteriological characters of *Coccobacillus fœtidus Ozænæ,* § in a second memoir dealing with the ætiology and prophylaxis of the disease, refers the contagion to a canine as well as a human origin.

Parasitic Theories of Cancer. || — Dr. A. Borrel discusses the numerous views and observations relative to the ætiology of cancer. His remarks refer to the coccidian and blastomycetic theories, and are illustrated by numerous excellent coloured drawings. The result of his summing up is that the parasitic theory is not proven. In connection with the illustrations depicting the appearances observed in cancer cells, reference may be made to the drawings illustrating H. O. Juel's paper on tetrad division.¶ The appearances herein depicted have certainly superficial resemblance to those seen in cancers.

Enterococcus of Dysentery.** —X. Lewkowicz believes that he has discovered the cause of dysentery in a microbe whose nearest ally is *Pneumococcus.* In the stools it is found in pairs or short chains. On solid media it occurs singly, in pairs, chains, and tetrads. In fluid media it forms very long chains. It has a well-marked capsule. It is easily stained and also by Gram's method. The growth condition and the appearance of the cultures are much like those of *Pneumococcus*, but on blood-agar *Enterococcus* forms large colonies, which in addition are transparent, mucoid, and at times viscid and ropy. It coagulates milk, and is pathogenic to animals.

* Bot. Gazette, xxxi. (1901) pp. 272–3.
† Centralbl. Bakt., 2te Abt., vii. (1901) p. 148. Cf. this Journal, 1900, p. 225.
‡ Ann. Inst. Pasteur, xv. (1901) pp. 409–16.
§ Cf. this Journal, 1900, p. 244.
|| Ann. Inst. Pasteur, xv. (1901) pp. 49–67 (3 pls.).
¶ Pringsheim's Jahrb. f. wiss. Bot., xxxv. (1900) p. 626 (1 pl. and 8 figs.). Cf. this Journal, *ante*, p. 299.
** Przeglad lekarski, 1901, Nos. 5–7. See Centralbl. Bakt., 2te Abt., vii. (1901) pp. 635–9 (4 figs.).

Pseudo-tuberculosis.*—Dr. E. Klein makes an important communication on the pathology and ætiology of pseudo-tuberculosis, the disease caused by a microbe first isolated by Pfeiffer in 1889, though the term was applied by Eberth, in 1885, in reference to necrotic caseous nodules found in the viscera of the rabbit and guinea-pig. The microbe has been found by the author in water, in sewage, and in milk. It is pathogenic to guinea-pigs, both by inoculation and by feeding. It gives rise to necrotic caseous foci much resembling the nodules of true tuberculosis, but differing from them in the absence of giant-cells. The bacillus is always present in large numbers in the pseudo-tubercules, and a striking feature is its intracellular distribution. It is cultivable on the usual media, and the growth presents some resemblance to that of *B. coli*. It differs from the latter in forming alkali, in rendering broth turbid, and in not forming indol. The microbe is a cylindrical rodlet with rounded ends. In some examples one or two flagella were detected by Van Ermengem's method. In gelatin cultures its length varies from $1 \cdot 2$–$2\ \mu$, in agar from $0 \cdot 8$–$1\ \mu$. Owing to its resemblance to *B. coli*, doubtful samples from water, sewage, or milk should be tested by experiments on animals. The paper concludes with accounts of experiments on protection in pseudo-tuberculosis, and on the relation of tuberculosis to pseudo-tuberculosis.

Negative Acid-fast Phase of Tubercle Bacilli.† — Dr. E. Klein remarks that he has several times come across in milk acid-fast bacilli which were not tubercle bacilli ; and as there are several known bacteria having this acid-fast property, it is unsafe to rely too much on the specific colour reaction. In the incipient stages of growth numbers of tubercle bacilli are anything but acid-fast, for when stained they lose the red and pick up the blue. It is only on young cultures that acid-weak bacilli are found, for after a fortnight few will be met with. The generally accepted view is that the acid-fastness is due to the presence of fat in some part of their anatomy ; but the author suggests that it is more probable that the chemical constitution of the bacillary sheath and the protoplasm is not the same in the several phases of growth on certain artificial media, and that in the earlier stages the bacilli are deficient of that particular ingredient by which they obtain the acid-fast character.

Production of Casease by a Parasitic Streptothrix.‡ — Prof. E. Bodin and Prof. C. Lenormand have found that the streptothrix previously described as the *Oospora* form of the *Microsporum* of the horse produces in cultures a diastase which, like rennet, coagulates casein, and another diastase which dissolves the clot-like casease. The quantity of casease existing in the culture fluid varies with the nutritive medium and the physiological condition of the fungus. It is greatest in neutral peptonised and glucosed media at the moment when the whole of the glucose is used up, and when the fungus is in the condition of inanition and of dissimilation. It is then that the fungus may be regarded as an active producer of casease. The fluid containing the casease liquefies

* Local. Govt. Board Rep. 1899–1900 (1901) pp. 355–84 (17 pls.).
† Tom. cit., pp. 587–92 (2 pls.).
‡ Ann. Inst. Pasteur, xv. (1901) pp. 279–88.

the gelatin in such a way that it is impossible to solidify it by cooling, and the liquefaction proceeds *pari passu* with the amount of casease.

New Pathogenic Anaerobic Bacillus.* — N. Harris makes a preliminary report on a hitherto undescribed bacillus which was isolated from a liver abscess. In anaerobic cultures in hydrocele fluid there developed colonies which, on microscopical examination, showed organisms, chiefly bacilli, but also cocci and filament forms. The bacillus, for which the name *B. mortiferus* is proposed, is non-motile, is decolorised by Gram's method, does not liquefy gelatin or form spores. It is killed in ten minutes at 50° C. It exhales a strongly fæcal odour, and forms gas. In rabbits and guinea-pigs it reproduces lesions similar to those found in the human subject.

Secondary Infection by Bacillus mesentericus.† — E. Sacquépée records some observations on typhoid fever patients which indicate the invasion of *B. mesentericus*. The symptoms somewhat resembled those of malaria, but no hæmatozoa were found. *B. mesentericus* was cultivated from the blood. The cultures were made in bouillon, on agar, and on potato. At first the organism was somewhat modified, but after several transfers exhibited its classical cultural and morphological features. It is presumed that the microbe gained entrance through the ulcerated surface of the intestine.

Chemical Action of Bacillus coli communis and Similar Organisms on Carbohydrates and Allied Compounds.‡—A. Harden finds that *B. coli com.* ferments glucose with production of a quantity of lactic acid corresponding to rather less than half the sugar, and of alcohol and acetic acid in approximately equivalent amounts, each representing about one-sixth of the carbon of the sugar. Small amounts of succinic and formic acids are also produced, and carbon dioxide and hydrogen evolved. *B. typhosus* produces the same products from glucose, but yields a large amount of formic acid and no gas. Some of the abnormal forms of *B. coli com.* act in a similar manner on glucose; others produce the same substances but in entirely different proportions. *d*-Fructose yields the same products of fermentation by *B. coli* as glucose, and *l*-arabinose and *d*-galactose also yield *l*-lactic acid. Mannitol yields a much larger proportion of alcohol (26–29 p.c.), and a much smaller amount of lactic and acetic acids. The production of alcohol by this organism therefore appears to depend on the presence of the group $CH_2(OH).CH.OH$, in the compound to be fermented. Glycerol, which also contains this group, yields nearly half its weight of alcohol when fermented by the same organisms. Formic acid is decomposed into carbon dioxide and hydrogen, but lactic acid is not attacked, and hence the active lactic acid is probably not produced by the selective decomposition of previously formed inactive acid. When asparagin is the sole nitrogenous nourishment, glucose and mannitol are fermented as usual by this organism, but a large proportion of the hydrogen is absorbed, and reduces the asparaginic acid to ammonium succinate.

* Proc. Soc. Amer. Bacteriol., 1900. See Centralbl. Bakt., 1te Abt., xxix. (1901) p. 447.
† Ann. Inst. Pasteur, xv. (1901) pp. 261–5.
‡ Proc. Chem. Soc., xvii. (1901) pp. 57–9; also Journ. Chem. Soc., lxxix. (1901) Abstr. ii. pp. 610–28.

The foregoing results were obtained under anaerobic conditions; when the conditions are altered different decompositions take place.

Life-History of Bacillus coli communis.* — Dr. W. C. C. Pakes concludes, from a large number of observations of varieties of *B. coli*, that they fall under distinct types. Of those studied, fifty-two were typical, morphologically and physiologically; all of these were motile. In doubtful cases, motility was best tested in cultures in dextro-glucose broth. The typical *B. coli* does not stain by Gram's method, and does not sporulate; it produces indol and gas. It coagulates milk, but not at 20°, and in extreme cases curdling may be delayed for twelve days. Dextro-glucose is fermented when *B. coli* is grown in sodium formate broth, the formate being decomposed into carbon dioxide and hydrogen. The gas evolved causes frothing of the medium, while no such result occurs with *B. typhosus*. Not only the typical members, but all of the *coli* group, including the typhoid bacillus, reduce nitrates to nitrites. None decompose urea. All the varieties produce hydric sulphide, and this was shown by inoculating pepton water to which a lead salt had been added. The colon bacillus reduces a 5 p.c. solution of neutral red, converting it into a fluorescent yellow; the typhoid bacillus has no such action. *Proteus vulgaris* and *B. prodigiosus* have the same reducing action as *B. coli*. Some of the typical colon bacilli ferment glucose, some glycerin, some both, and some neither.

Modification of the Functions of Bacillus coli.†—L. Grimbert and G. Legros, by cultivating five different types of *B. coli* under various abnormal conditions, deprived two of the varieties of their power to produce indol, but the power to ferment lactose was unaffected.

Varieties of Bacillus coli isolated from Typhoid and Normal Dejecta.‡—Dr. W. H. Horrocks examined normal and typhoid dejecta in the hope of discovering cultural characteristics or reactions to specific sera, by which varieties of *B. coli* occurring on typhoid stools might be distinguished from those in normal dejecta; so that, even if *B. typhosus* were not detected, some criteria would be obtained for indicating that a water had been fouled by typhoid organisms.

The conclusions arrived at were that, as far as cultural characters are concerned, there appear to be no types of *B. coli* in typhoid stools which display sufficiently constant characters to enable them to be distinguished from the varieties of *B. coli* found in normal stools.

As regards reaction to antityphoid horse serum, the varieties of *B. coli* isolated from typhoid stools show much greater sensibility to agglutination than the varieties of *B. coli* isolated from healthy stools. Consequently, if varieties of *B. coli* isolated from a water supply are found to be agglutinated with antityphoid horse serum diluted 1–500, it would seem that there are reasonable grounds for the assumption that the water supply in question has been fouled with the specific dejecta from cases of enteric fever.

Pathogenic Bacilli intermediate between the Typhoid and Colon Groups.§—Dr. H. Cushing made a comparative study of some members

* Brit. Med. Journ., 1901, i. p. 958.

† Journ. Pharm., xiii. (1901) pp. 107–9. See Journ. Chem. Soc., lxxx. (1901) Abstr., ii. p. 265.

‡ Journ. Hygiene, i. (1901) pp. 202–13.

§ Bull. Johns Hopkins Hosp., xi. (1900) pp. 156–70 (10 figs.).

of a pathogenic group of bacilli of the Hog Cholera or *Bacillus enteritidis* Gaertner type, intermediate between the typhoid and colon groups. The members of this intermediate group possess the morphological and motile properties of Eberth's bacillus, but differ therefrom chiefly in the fermentation reactions, since they produce gas in the presence of glucose and other more easily fermentable carbohydrates. Their chief distinguishing feature from the bacillus of Escherich, on the other hand, rests upon the fact that fermentation in various media made from milk does not produce sufficient acidity to precipitate the casein, but on the contrary, the acid production is but a transient process, and is followed, in the presence of air, by a prompt (2–3 days) and distinguishing alkalinisation of the media, which furnishes a ready means of differentiation from both the typhoid and the colon types. Though the subdivision into these three closely-allied groups was made by Durham in 1898, the author's paper is extremely valuable, as it not only summarises fully what is already known, but adds further information and also particulars relative to a new organism, *Bacillus O.* The paper is well illustrated.

Growth of the Typhoid Bacillus in Soil.*—Dr. S. Martin's recent investigations on this subject show that certain cultivated soils, especially garden soils, when sterilised, are favourable to the vitality and growth of the typhoid bacillus. Virgin or uncultivated soils are unfavourable. When the typhoid bacillus is added to unsterilised soils, kept very moist, and at a temperature of about 19°–37°, it cannot be recovered. If, however, the soil be less moist or dry, and at a temperature of 2°–12°, the bacillus may be recovered up to twelve days. The reason of the disappearance of the bacillus from unsterilised soils appears to be the antagonism of some of the soil microbes to its growth; and there is some evidence to show that the disappearance has been *pari passu* with an increase in the number of putrefactive bacteria. As far as is known, the typhoid bacillus has no resting stage. It has no spores; so that if it once die it cannot be expected to reappear unless a fresh inoculation occur.

Variability of the Agglutinative Aptitude of the Typhoid Bacillus.†—E. Sacquépée finds that the agglutinative aptitude of *B. typhosus* is variable; being sometimes more, sometimes less agglutinable than the typical bacillus. The variations in excess are slight and transitory, those in defect are more important and are of frequent occurrence under natural conditions. The latter, while answering in other respects exactly to the classical type, are little or not at all agglutinated by typhoid serum, but when preserved in closed tubes spontaneously assume the typical function. On the other hand, the typical typhoid bacillus, if long in contact with an immunised organism, becomes less and less agglutinated by the serum. From this the author concludes that the typhoid-like forms are variants of *B. typhosus* modified by a long sojourn in an infected or immunised organism. They have become modified by getting accustomed to their environment.

Accumulation Experiments with Bacteria Decomposing Carbamide.‡—Prof. M. W. Beijerinck describes investigations the object of

* Local Gov. Board Rep. 1899–1900 (1901) pp. 525–48.

† Ann. Inst. Pasteur, xv. (1901) pp. 249–60.

‡ Centralbl. Bakt., 2te Abt., vii. (1901) pp. 33–61 (1 pl. and 4 figs.). See Journ. Chem. Soc., lxxx. (1901) Abstr. ii. p. 264.

which was to accumulate that variety of bacteria in a mixture which was best adapted to the conditions of the experiment. In some cases the experiments resulted only in the relative increase of one variety, whilst in others one variety accumulated and the rest completely disappeared.

Bacteria which decompose carbamide are of two kinds, one effecting decomposition by means of urease, an enzyme insoluble in water, and the other (a phosphorescent species) by direct contact with the living protoplasm (katabolism). These two methods of decomposing carbamide are distinguished by the temperature at which the maximum decomposition takes place, the katabolic decomposition being at its maximum at the most favourable temperature for the growth of the micro-organisms, whilst the decomposition produced by urease is at its maximum at a much higher temperature.

Bactericidal Properties of Blood Serum.* — Dr. Ostrianine made experiments on the bactericidal effect of rabbit serum on anthrax and cholera under normal conditions and during the infection from these organisms. The conclusions arrived at were that the bactericidal property of the serum of rabbits infected with anthrax and cholera is not exhausted during the disease, and that it is related to the leucocytosis.

* Ann. Inst. Pasteur, xv. (1901) pp. 266–78

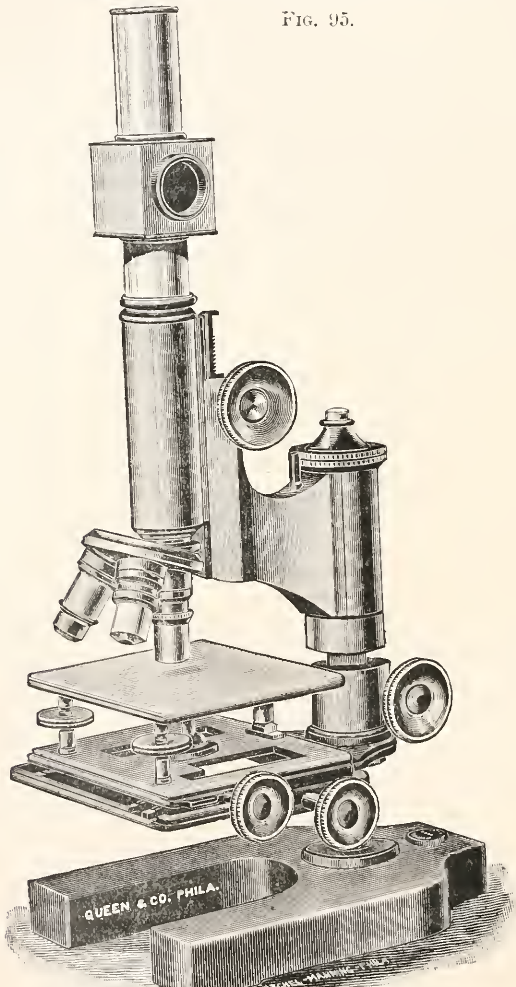
MICROSCOPY.

A. Instruments, Accessories, &c.*

(1) Stands.

Queen Microscope for Physical Laboratory Metal Examinations.—This instrument is made entirely of brass, highly finished. The coarse

Fig. 95.



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

adjustment is by diagonal rack-and-pinion; the fine by a delicate micrometer screw with graduated head. The draw-tube is nickelled and graduated, and the body-tube into which it fits is felt-lined.

Three methods of illumination are used:—(1) A large thin glass vertical illuminator, fitting into the top of the draw-tube, as shown in fig. 95. (2) The thin glass vertical illuminator of English form, used just above the objective; and (3) a Zeiss vertical illuminating prism used in same position as (2). Each of these has its special advantages, and all are generally supplied with the instrument.

The stage is double. A large mechanical stage, with ample movements in both directions, has attached to it, by means of levelling screws, an upper plate without central opening. On this is placed the metal to be examined.

The compound stage, as thus constructed, is attached to the main post of the Microscope by a strong sleeve with separate rack movement. This permits the object to be brought into focus without disturbing either the optical part of the instrument or the position of the light. This is a very important feature. The entire stand revolves upon the base, and the stage may also be swung out separately if desired.

The outfit includes two eye-pieces, three objectives with revolving triple dust-proof nose-piece, and stand complete; in a polished mahogany case, with lock.

Günther's New Loup Stand.*—C. Benda describes this stand, consisting of a metal pillar of 32 cm. in length, standing on a solid fairly heavy metal plate (20×13 cm.). On this moves a rotatory sleeve, pushable up and down, and clamped by screws. The sleeve is firmly connected with a horizontal arm of about 40 cm. in length, so that this is movable in all directions about the vertical pillar. The arm consists of two limbs, approximately equal in length, and connected by a hinge-joint, movable in the horizontal plane. The distal limb is hollow, and receives the loup-stalk 20 cm. long. This stalk can be drawn out, reversed, and clamped by screws. The loup can thus be set and secured in any position. The loup supplied has a diameter of 9 cm., and a focus of 10 cm.

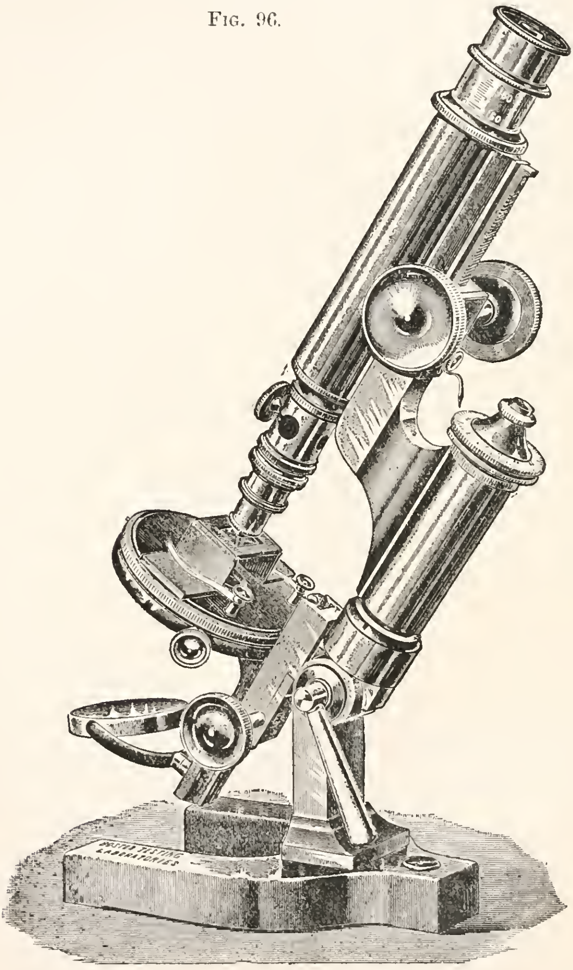
Special Stand and Specimen-holder for the Microscopical Examination of Metals.—For the microscopical examination of metals vertically reflected light must be used,—that is, light reflected downward by means of a vertical illuminator placed between the nose-piece of the Microscope and the objective. The source of light, condensing lenses, &c., must be so arranged that the beam of light will enter the vertical illuminator. With the ordinary stand any change of objective, or a change in the thickness of the piece under examination, necessitates a corresponding lowering or raising of the tube and, therefore, of the vertical illuminator attached to it. The beam of light then no longer enters the illuminator as it should, and the source of light and other illuminating appliances must be raised or lowered. To obviate this troublesome manipulation, the stand (fig. 96) used in the Boston Testing Laboratory, Boston, U.S.A., is provided with a stage capable of up and down motion by rack-

* Arch. f. Anat. u. Phys., 1900, pp. 179–80; and Zeitschr. f. wiss. Mikr., 1900, pp. 199–200.

and-pinion, by means of which the coarse adjustment is regulated. The position of the vertical illuminator, once fixed, need never be disturbed. The motion due to the fine adjustment may be neglected.

The above motion of the stage, moreover, greatly increases the working distance of the stand; this is very important, as it permits the examination of very thick pieces of metal.

Fig. 96.



By means of the special holder it is possible to place immediately on the stage, in the proper position to be examined, any sample of metal, no matter how irregular its shape, thus doing away with all tedious mounting of irregular specimens, or with the cutting of two parallel surfaces.

(2) Eye-pieces and Objectives.

HARTWIG, H.—Zur Berechnung dreitheiliger Fernrohr- und Mikroskopobjective. (On the Calculation of Three-lensed Telescope and Microscope Objectives.)
Zeitschr. f. Instrumentenk., XX. (1900) p. 230.

STREHL, K.—Studien an Mikroskopobjectiven. (Studies on Microscope Objectives.)
[The author makes a series of comparisons on the combinations of objectives and oculars from two firms whom he calls X and Y. Elaborate tables of results are given.] *Zeitschr. f. wiss. Mikr.*, XVII. (1900) pp. 425–32.

(4) Photomicrography.

A First Book of the Lens.—C. Welborne Piper's book * with the above title is intended to be an elementary treatise on the action and use of the photographic lens. Its title accurately expresses the scope of the work, and the various diagrams are very clear and instructive. The subject of lens combination is very fully illustrated. The topics of the ten chapters are :—Light and optics ; action of lenses ; focal points and distances ; combining lenses ; aberration ; scale ; intensity and illumination ; depth ; focussing scales ; measuring lenses ; types of lenses. There is also an appendix of tables.

Lantern-Slide Making.†—Number 22 of the "Amateur Photographer" library consists of a handy little volume, by the Rev. F. C. Lambert, M.A., under the above title. The book, which seems very clearly and concisely written, is expressly intended to be a guide to those who are as yet quite ignorant of the subject. At the same time it is hoped that the experienced worker may here and there pick up a useful stray hint. The work is divided into twenty chapters, with an appendix.

CHEYNEY, J. S.—Photomicrography. *Micr. Bull.*, 1900, p. 17.

(5) Microscopical Optics and Manipulation.

STREHL, K.—Theorie der allgemeinen Mikroskopischen Abbildung. (Theory of the Microscopical Image.) Erlangen (Blaesing), 1900, 8vo, 38 pp.

(6) Miscellaneous.

LAUNOIS, P. E.—Les Origines du Microscope. Leeuwenhoek, sa vie, son œuvre.
Comptes Rendus de l'Assoc. Française, Sess. 28, pt. 1, p. 82.

B. Technique.‡

(1) Collecting Objects, including Culture Processes.

New Incubator.§—Dr. N. Gertler has patented an ingenious form of thermostat which is specially suited for medical men (fig. 97). The case is double, and is made of wood, the interspace being filled with felt or with infusorial earth. The heater or thermophore is brick-shaped, and is placed on the floor of the apparatus. It is made of metal, is

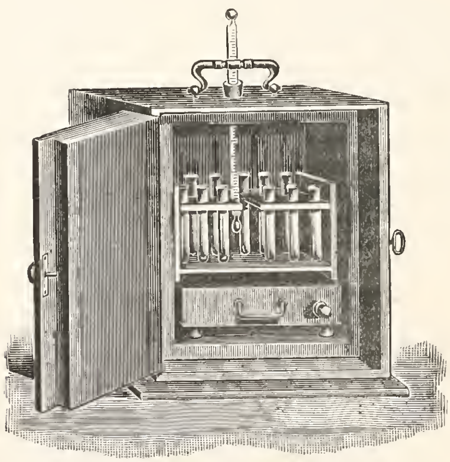
* Hazell, Watson, and Viney, 170 pp. and 67 figs.
† Hazell, Watson, and Viney, 144 pp. and 27 figs.
‡ This subdivision contains (1) Collecting Objects, including Culture Processes ; (2) Preparing Objects ; (3) Cutting, including Imbedding and Microtomes ; (4) Staining and Injecting ; (5) Mounting, including slides, preservative fluids, &c. ; (6) Miscellaneous.
§ Centralbl. Bakt., 1te Abt., xxix. (1901) pp. 668–72 (1 fig.).

provided with two handles, and an opening which is closed hermetically by means of a screw. This heater is filled with acetate of soda. Besides the door there is only one aperture, that for the thermometer. The apparatus is easily put into working order. The heater is put into boiling water for 30, 45 or 60 minutes, according as it is desired to keep up the temperature for 24, 36 or 48 hours. After the boiling is finished the heater is wiped and put into the incubator.

The apparatus will accommodate about twenty-four test-tubes placed in a suitable stand. If the stand be not used it is advisable to put some cardboard on the heater.

The apparatus may also be used as a heat reservoir, by boiling the heater for an hour, and afterwards further heating it over a spirit-lamp until the temperature is above 100° C. The heater is then placed in the incubator, care being taken not to shake it. When required for use

Fig. 97.



the heater is shaken, and if this do not suffice, an iron wire is inserted through the screw-hole and the contents stirred up. The heater instantly becomes warm. In this way the apparatus can be got ready some time before it is required for use. A list of the commoner pathogenic organisms which have been cultivated successfully by means of this apparatus is given.

Electrically Heated Incubator.*—F. Hanfland has devised an incubator which is heated and regulated by the electric current. In the water-jacket are inserted a number of copper tubes in which the heaters connected by wires from the battery are placed. The regulating apparatus consists of an electromagnet which actuates a mercury break by means of a lever when the temperature rises higher than that for which the regulator is set.

* Zeitschr. f. wiss. Mikr., xvii. (1900) pp. 440–2 (1 fig.).

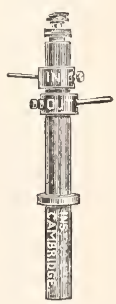
Improved Culture Media.*—Prof. Deycke and Dr. Voigtländer, as the result of studies on the preparation of culture media, recommend the following.

(1) An albuminate nutrient medium. 200 grm. of fat-free horse-flesh are finely minced and rubbed up with 250 ccm. of 3 p.c. caustic soda, and then incubated in an Erlenmeyer's flask for 24–30 hours. The filtrate is neutralised with hydrochloric acid and diluted to 3 litres. Next, 7·5 grm. salt and 150 grm. glycerin are added to the solution, which, after having been alkalinised with soda solution, is worked up with agar or gelatin. For some microbes the addition of 1·5–2 p.c. grape-sugar is necessary.

(2) A pancreatised medium. A pig's pancreas was chopped up and placed on ice for 24 hours, and then treated for several days with a mixture of 40 grm. glycerin and 160 ccm. water. The expressed juice was used in the preparation. 200 grm. of meat were treated as above, and then with 0·25 p.c. dry carbonate of soda. After sterilisation the mixture was digested, 50 grm. of pancreatic juice for 7–10 hours at 37°. The solution was neutralised with hydrochloric acid, diluted with water to 3 litres, and worked up with glycerin and agar into a substratum.

Steel Gas Regulator.†—The Cambridge Scientific Instrument Company now supply a steel gas regulator of new design for maintaining incubators, baths, and sterilisers at a constant temperature (fig. 98). Its advantages are:—(1) the ease with which it is adjusted; (2) the risk of breakage is reduced to a minimum; (3) the facility for making direct metallic communication with the gas supply, thus avoiding the use of rubber tubing and consequent risk of fire. The instructions for use are as follows. Unscrew and remove the top milled head, then remove the small screw half-way down the steel barrel. Fill the regulator with mercury until it runs out of the screw-hole. Replace the screw firmly and also the top milled head, and see that the gland nut is screwed down tightly to ensure a gas-tight fit. The adjustment for temperature is made by the top milled head. To lower the temperature at which the regulator is to work, slightly turn the milled head in the direction of the hands of a watch; to raise the temperature the head is turned in the opposite direction. The top pipe is the inlet and the lower one the outlet for the gas. A small by-pass prevents the gas flame from being extinguished when the main gas supply is cut off.

Fig. 98.



Simple Device for Distributing Equal Quantities of Culture Media.‡—A. Robin contrived the ingenious apparatus shown in fig. 99, which is self-explanatory. The end of the rubber tubing *a* is connected with a funnel into which the culture medium is poured.

Modification of Kabrhel's Method of Anaerobic Cultivation.§—The modification suggested by Dr. St. Růžička consists in filling the

* Centralbl. Bakt., 1te Abt., xxix. (1901) pp. 617–27.

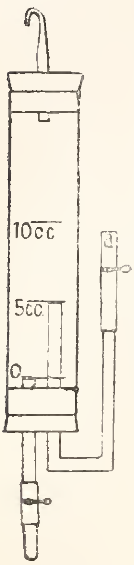
† List, 1901, pp. 13–14 (1 fig.).

‡ Proc. Soc. Amer. Bacteriol., 1900. See Centralbl. Bakt., 1te Abt., xxix. (1901) p. 492 (1 fig.).

§ Centralbl. Bakt., 1te Abt., xxix. (1901) p. 672.

pyrogallol dishes with distilled water instead of with potassium hydrate solution. Pieces of potassium hydrate are dropped in the water only just before the bell-jar is put over the rest of the apparatus. By this procedure the pyrogallol solution does not turn black or turbid. It remains clear and becomes brown only. This serves also as an indication of the complete removal of the oxygen.

Fig. 99.



Method of rapidly Filtering Nutrient Agar.*—Dr. S. Růžička describes the method initiated by A. Hoza for rapidly filtering agar. ½ kilogramme of finely chopped meat and 1 litre of distilled water are allowed to stand for 24 hours in a cool place. The fluid is then squeezed through linen, and 10 grm. pepton and 5 grm. salt are added. The mixture, placed in a glass flask plugged with cotton-wool, is steam-sterilised for ½ hour, and then boiled on the open fire for 1½ hours. The next steps are to neutralise and warm for 20 minutes over a small flame. Thereupon it is filtered again, and to the filtrate 15 grm. of finely divided agar are added, and the contents of the flask boiled for 1½ hours over an open flame. The flask is then placed for 2 hours on a Koch's steamer, after which the contents are hot-filtered, care being taken not to disturb the sediment.

Cultivation of Gonococcus on Agar.†—Dr. L. Nicolaysen mentions two cases of gonorrhœal joint affection from which the *Gonococcus* was cultivated on agar. The joints were punctured, and the exudation, sown in ascites bouillon and on ordinary agar, was incubated at 37°. The resulting growth presented the cultural characters and microscopical appearances of *Gonococcus*. From this the author argues that the received opinion that *Gonococcus* never grows on agar, or that if a coccus do grow on agar it is not *Gonococcus*, can no longer be maintained.

(2) Preparing Objects.

Preparing Bacterial Cultures for Museum Specimens.‡ — Prof. H. W. Conn puts 2 p.c. agar in large test-tubes which are tilted so as to make slants. The tubes are left undisturbed for from 6 to 8 weeks, in order to allow the surplus moisture to evaporate. They are then inoculated in long streaks, and immediately sealed up with plaster of Paris and paraffin. The cultures grow for a few days, then cease growing and remain unaltered indefinitely. No disinfectant is needed. The method is satisfactory, except for the fact that the moisture in the tube condenses with changes of temperature, rendering the tube cloudy.

Preparation of Radulæ.§ — K. Diederichs remarks that snails are best killed in boiling water. When large, the foot, liver, and stomach should be removed. The head and rest of tho body are then boiled in

* Centralbl. Bakt., 1te Abt., xxix. (1901) p. 673.
† Nord. Med. Arkiv., xxxiv. (1901) Afd. ii. Häft i. No. 5.
‡ Proc. Soc. Amer. Bacteriol., 1900. See Centralbl. Bakt., 1te Abt., xxix. (1901) p. 497.
§ Zeitschr. f. angew. Mikr., vii. (1901) pp. 29–30.

caustic potash until the whole mass is softened. When the mass is washed in water the radula is easily removed. If any dirt be found adhering to it, the radula should be re-boiled in dilute caustic potash. In dealing with small snails care should be taken, as the organ is very fragile. The preparation may be mounted unstained in glycerin jelly or in isinglass. If it is to be mounted in balsam it must be stained, and picro-carmin is best suited for these objects. Ranvier's and Weigert's formulæ are recommended. For the larger kinds of snail the radula should be immersed in the solution undiluted for 2 or 3 hours. For the smaller kinds the solution should be diluted one-half with distilled water, and allowed to act for 3–6 hours. Should the preparation be over-stained, the excess of colour may be removed by means of dilute warm caustic potash. The stained preparations are then treated in the usual way with alcohol, and mounted in xylol-balsam.

(3) Cutting, including Imbedding and Microtomes.

Method of making Sections of Nervous Tissue.*—Dr. S. Tschernischeff recommends the following method † for making sections of nervous tissue. A piece of spinal cord about 1 cm. thick, fixed by any method, is dehydrated in absolute alcohol for 24 hours, and for another 24 hours in anilin. The anilin is removed by immersion in a mixture of alcohol (1) and ether (2). After 24 hours the preparation is transferred to the clove-oil-ether-celloidin solution diluted with an equal bulk of ether. The medium is inspissated to the consistence of sour cream by removing the cover of the vessel. After a few hours the preparation is placed in benzol, and finally in 80 to 86 p.c. alcohol, until it has attained the required consistence.

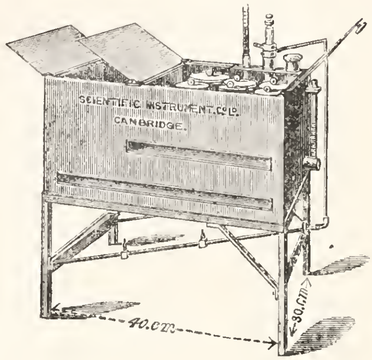
Instead of celloidin the author tried colloxylin, and found it possessed several advantages over the former. The solution is made as follows:—10 grm. of dry colloxylin are placed in a mixture of 10 ccm. of oil of cloves, and 50 to 60 ccm. of ethyl-ether. Absolute alcohol is also added drop by drop (but not more than 1 ccm.) to make the colloxylin dissolve quickly. A piece of spinal cord which has been dehydrated in alcohol and anilin is placed in the colloxylin solution freely diluted with ethyl-ether for 24 hours. The cover of the vessel is then removed to allow the solution to thicken. After a few hours the piece is transferred to 85 p.c. alcohol. Colloxylin sections are quite as good as those made by celloidin imbedding.

Imbedding Bath. ‡—The Cambridge Scientific Instrument Company make an imbedding bath of new design (fig. 100). It consists of two upper compartments with copper lids, one for specimen jars, small bottles, etc., the other for four large and three small porcelain crucibles with lids, and space for two or three watch-glasses. It has two drying shelves for slides, thermometer, gas regulator, and glass gauge to show the height of water in the bath. The bath is supported on a strongly made iron stand with two gas burners beneath, and is fitted with rubber tubing and Page's glass regulator. It can also be fitted with metal

* Zeitschr. f. wiss. Mikr., xvii. (1900) pp. 449–51.
† A modification of Stefanow's. Cf. this Journal, 1900, p. 728.
‡ List, 1901, p. 12 (1 fig.).

tubing and steel regulator, thus reducing the risk of fire to a minimum, and also with electric heater and regulator.

FIG. 100.



(4) Staining and Injecting.

New Blood Stain.*—R. C. Rosenberger finds that phloxin stains the granules of leucocytes, and recommends the following mixture. Saturated aqueous solution of methylen-blue 5 parts, saturated aqueous solution of phloxin 2 parts, alcohol (95 p.c.) 3 parts, distilled water 6 parts. The stain should be shaken before using. It works well after fixation by heat, alcohol, or ether and alcohol. Stain 1 to 4 minutes, wash, dry, mount in balsam.

Staining Blood-films.†—Dr. A. E. von Willebrand has devised the following method for the simultaneous staining of blood-films with eosin and methylen-blue. The solution is composed of equal bulks of 0·5 p.c. eosin dissolved in 70 p.c. alcohol and saturated aqueous solution of methylen-blue. To this 1 p.c. acetic acid is added drop by drop until the eosin staining appears; as a rule, 10 to 15 drops of the acetic acid are sufficient to effect the development. Before use the solution must be filtered. The films should be fixed by dry heat, by absolute alcohol, or by 1 p.c. formol-alcohol. The staining takes from 5 to 10 minutes, during which time it is advisable to heat the staining fluid until it vaporises. The erythrocytes are red; nuclei dark blue; neutrophile granules violet; acidophiles red; and plasma granules deep blue.

Staining Diphtheria Bacilli. ‡ — Dr. H. van de Rovaart finds that Loeffler's alkaline-methylen-blue solution heated for 1–1½ minutes gives better results than the acetic acid solution recommended by Neisser. He regards the after treatment with 3 p.c. hydrochloric acid alcohol as an unnecessary complication, and advises instead contrast-staining with

* Philadelphia Med. Journ., vii. (1901) p. 448. See Journ. Applied Microscopy, iv. (1901) p. 1305. † Deutsche Med. Wochenschr., xxvii. (1901) pp. 57–8.
‡ Centralbl. Bakt., 1te Abt., xxix. (1901) pp. 574–5.

vesuvin solution heated for 1–1½ minutes. By this method the granules and the bacterial body are more deeply stained than by the Neisser method.

(6) Miscellaneous.

New Fermentation Tube.*—A. Robin devised the apparatus which is shown in the accompanying illustration (fig. 101). The side tube *c* is packed with non-absorbent cotton; the arm A of the U tube is filled with mercury; the tube B is filled with the culture, and then the rubber stopper holding the side tube *c* and the straight tube *d* is tightly inserted. When this is done, the end of *d* which serves for the escape of air displaced by the stopper is sealed in the flame. The gas generated in B escapes into A, displacing the mercury. To determine the CO_2 ratio,

Fig. 101.

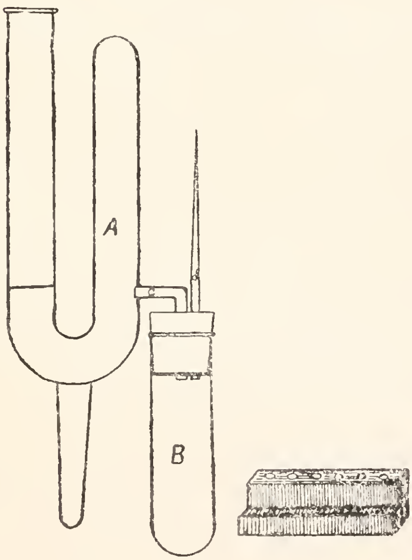
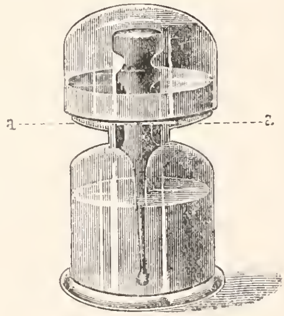


Fig. 102.



the tube B is filled up to the rubber stopper. Two fermentation tubes are used. In one the arm A is filled with mercury, and the other with a saturated solution of sodium or potassium hydrate, this being readily accomplished by inclining the U tube. The CO_2 passing through the caustic solution is absorbed, and the unabsorbed gas (H) is left; from this the ratio is easily determined.

Bottle for Cedar Oil.†—In Schuberg's bottle for keeping cedar oil the stopper has two grooves (*a a* in fig. 102), so that any excess may drain downwards. This prevents the oil from running over the neck and making the outside greasy. A glass cap fits over the neck. When travelling, the stopper should be replaced by a cork.

* Proc. Soc. Amer. Bacteriol., 1900. See Centralbl. Bakt., 1te Abt., xxix. (1901) pp. 491–2 (1 fig.).

† Zeitschr. f. angew. Mikr. vii. (1901) pp. 45–6 (1 fig.).

Isolating Bacillus typhosus from Soil.*—Dr. S. Martin now uses ordinary peptone broth in test-tubes, adds a small portion of the soil, and then incubates for 4–6 hours at 37°. At the end of this time the medium is usually slightly turbid. It is then brushed, without recharging the brush, over the surface of six agar plates. Each plate is examined under a low power after 24 hours incubation, and those colonies which have any resemblance to typhoid are studied further. The examinations of one testing extend over a period of three weeks. Each colony is examined microscopically, and a broth culture made. This culture is tested for indol after a lapse of 3 or 4 days, and from it are also made sub-cultures on agar slopes, shake-glucose-gelatin, milk, and potato. If the sub-cultures show typical typhoid bacilli, the micro-organisms are further tested by determining the number of flagella, and by the serum reaction.

Value of Plating as a means of Determining the Number of Bacteria in Drinking Water.†—W. C. C. Pakes finds that plating upon ordinary gelatin, whether made with distilled or ordinary tap-water, gives no necessary criterion of the number of bacteria present. As far as possible the gelatin should be made without meat extractives, with the water to be examined, or with a sample of water similar in mineral constitution. As a corollary to the foregoing, the only satisfactory method of determining the contamination of water by sewage is to ascertain the number of sewage organisms present in the water.

New Hæmoglobinometer.‡—Dr. A. Dare describes a new instrument for estimating the quantity of hæmoglobin. Unmixed blood is used, and the stratum is of constant thickness. The essential parts of the instrument are an automatic pipette and a graduated colour-screen to calculate directly the percentage of hæmoglobin. The blood and the comparison screen are placed side by side and inspected through a lens fitted into a telescoping camera-tube. By means of a screw the colour scale is rotated until the two tints correspond.

Method for Increasing the Number of Tubercle Bacilli in Sputum and Urine.§—Jochneann, after mentioning some artificial media intended for the cultivation of the tubercle bacillus, points out that Heyden-agar, by preventing the growth of other microbes, acts electively towards tubercle. It seems to act best when slightly acidulated with lactic acid, an orange-red pigment being formed. So, too, with acid Heyden-broth, the growth was more copious than when the reaction was alkaline. For increasing the number of bacilli in a sample of sputum he used the following medium:—Heyden nutrient 5 grm., salt 5 grm., glycerin 30 grm., normal soda solution 5 ccm., distilled water 1000 ccm.; 20 ccm. of this bouillon were mixed with 10 ccm. of sputum, and incubated for 24 hours at 37°. Then 3 ccm. of carbolic acid were added and the sediment examined in the usual way. In the case of urine the sediment obtained by centrifuging is treated in a similar manner.

* Local Gov. Board Rep. 1899–1900 (1901) pp. 531–4.

† Centralbl. Bakt., 2te Abt., vii. (1901) pp. 386–91.

‡ Bull. Johns Hopkins Hosp., xii. (1901) pp. 24–5.

§ Hygienische Rundschau, x. (1900) pp. 969–81. See Bot. Centralbl., lxxxv. (1901) pp. 343–4.

Orienting Small Opaque Objects.*—Dr. R. W. Hoffmann, after mentioning his method of orienting very small objects,† states that opaque objects imbedded in collodion-clove-oil mixture can be oriented easily if the procedure be carried out in 90 p.c. alcohol. When objects are difficult to cut as well as opaque—such as embryos of worms, insects' eggs, eggs and embryos of certain mollusca—he advises that the specimen should first be saturated with thick celloidin and afterwards the mass treated with oil of cloves. The objects are then placed on a slip of glass and oriented under 90 p.c. alcohol.

Employment of Projection Apparatus for Demonstrating Vital Processes.‡—Prof. W. Pfeffer advocates the use of a projection apparatus for demonstrating vital processes of living organisms to large classes. The apparatus employed is constructed by several firms, to whose catalogues reference should be made for particulars as to the details.

The most interesting feature in the author's arrangement is for cooling the light. This is in the first place passed through a tank of water 200 mm. thick, kept cool by means of ice. In order to decrease the heat still further the light is also filtered through a nearly saturated solution of iron sulphate, by which most of the heat rays are removed.

Although some of the light rays are extinguished in the process, there is ample illumination even for high magnifications. The distance required varies from 3–4½ metres both for micro- and macro-projection. Suitable carriers are provided for adapting the different preparations to the apparatus, and an erecting arrangement converts the reversed position of the specimen into the natural.

The apparatus is adapted for demonstrating swarming movements, galvanotaxis, the streaming of protoplasm, plasmolysis, growth, and various movements in plants.

Bacteriological Examination for Diphtheria.§ — Dr. L. Cobbett states that, as the result of a very large number of bacteriological examinations (950), when one has become well acquainted with the range of the morphological variation of the diphtheria bacillus, it is fairly easy to distinguish it from all others (that is, if the acid-producing but non-virulent bacillus which resembles the Loeffler bacillus in all other ways, be admitted as an attenuated diphtheria bacillus). The bacillus of Hoffmann is the only one which presents any difficulty, and this could, as a rule, be excluded on morphological grounds alone. In cases of difficulty the formation of acid in glucose media appears to be the final test to distinguish between the true diphtheria bacillus, whether virulent or non-virulent, and the pseudo-bacilli. The medium used was alkalised serum to which 1 p.c. of glucose was added. Both horse and ox serum were used. The earliest visible growth of diphtheria bacilli was observed in six hours, and the latest in three days. For staining, Loeffler's methylen-blue was used, diluted with two or three volumes of water, the cover-glass preparations being mounted in the staining fluid. The groups of bacilli decolorised the fluid around them,

* Zeitsch. f. wiss. Mikr., xvii. (1900) pp. 443–9.
† See this Journal, 1899, p. 238.
‡ Pringsheim's Jahrb. f. wiss. Bot., xxxv. (1900) pp. 711–45 (7 figs.).
§ Journ. of Hygiene, i. (1901) pp. 235–59 (3 pls.).

so that they appeared as if mounted on a colourless fluid. Cover-glass preparations, from broth cultures, before being stained, were dipped in 5 p.c. acetic acid for ten seconds and washed in water, to which a few drops of ammonia had been added to more rapidly remove the acid.

Resolution of Amphipleura pellucida.* — Mr. A. A. Merlin states that, by increasing the solid axial illuminating cone from $\frac{3}{4}$ to $\frac{5}{6}$ of the total aperture of a dry apochromatic, 4 mm., with a 27 eye-piece, he was able to hold for short intervals, with slightly averted vision, the transverse striæ on *Amphipleura pellucida*, first when it was mounted in realgar, then dry, and finally in balsam. The following difficult valves in Moller's balsam-mounted type slide were in the same manner also resolved, viz. the dots on the hoop of *Navicula major ; Navicula crassinervis ; Grammatophora oceanica = G. subtilissima ;* and *Nitzschia sigmatella*. The author has not seen the most difficult structural features with a lesser cone, and says that the closing down of the cone, while greatly strengthening the contrast of the coarser, causes the finer detail to disappear altogether, and materially reduces the separating power of the objective. An acetate of copper screen was used throughout these investigations.

Origin of certain Colour Phenomena typically shown by Actinocyclus Ralfsii.†—J. Rheinberg gives a very satisfactory explanation of the colour effects seen when certain diatoms, notably *A. Ralfsii*, are viewed by transmitted light, and by an objective aperture not greater than 0·45 N.A. Experiments showed that the phenomena were not connected either with polarising or with diffraction effects. The thickness of the diatom placed the possibility of film colours out of the question. Ultimately "interference" suggested itself as the cause. Mr. Rheinberg's diagrams show how the light rays, in passing through the inequalities on the surface of the diatom, or through its apertures, or through the mounting medium, are sufficiently retarded in various parts to produce "interference" fringes. Other diatoms of suitable thickness will show similar phenomena, and for a mount of any specific medium a minimum and a maximum limit can be assigned. A great many diatom valves are of a thickness below the necessary limit, or only slightly exceed it, and assume a pale yellow-brown tint (that being the first colour in the series) e.g. *Pleurosigma angulatum*, mounted dry. The limits vary with the difference in refractive index of the diatom silex and its medium. The greater the differences, the smaller is the minimum limit for the occurrence of colour. The technical name for the whole phenomenon is "the colours of mixed plates." ‡

Progress in Metallography.§—Henri le Chatelier proposes an improved method of preparing polishing powders. The best material, as far as speed of polishing is concerned, he finds is alumina, prepared by calcining ammonium alum ; but oxide of chromium, obtained from the combustion of bichromate of ammonium, answers fairly well in the treatment of iron and steel, and is better than alumina for soft metals

* Journ. Quek. Micr. Club, viii. (1901) pp. 1–6. See also *ante*, p. 397.
† Tom. cit., pp. 13–24 (11 figs.). ‡ Preston, Theory of Light, p. 205.
§ Bull. Soc. d'Encouragement, Sept. 1900; and Nature, lxiii. (1901) pp. 232–3 (3 figs.).

such as copper. The powder is mixed with soap into a paste, and can now be bought in tubes such as are used for oil colours. The powders obtained by calcination of the above materials are treated with nitric acid, washed thoroughly, and allowed to settle in distilled water containing 0·2 p.c. of ammonia. When treating 10 grm. of powder in a litre flask, $\frac{9}{10}$ths of the liquid are siphoned off at the following intervals of time: $\frac{1}{4}$-hour, 1 hour, 4 hours, 24 hours, and 8 days. The third deposit is useful in polishing hard metals, such as iron, but the fifth and last deposit affords the best polishing powder. The soap preparations are applied in the ordinary way to discs of wood or metal covered with skin or cloth and capable of being revolved at high velocity, the whole operation of polishing proper being carried through by their aid in 5 minutes.

For examining and photographing the polished and etched specimens under the Microscope, M. le Chatelier proposes the use of monochromatic light, such as that derived from an electric arc in mercury vapour, with suitable screens between the source of light and the object to be illuminated; but it appears doubtful whether enough light can be obtained in this way for high magnification.

M. le Chatelier proposes to shorten the search for typical alloys by melting together two superposed layers, each consisting of a pure metal, the lighter one being on the top. If no alloys are formed of greater density than the heavier metal, and the crucible is allowed to cool undisturbed, a culot can be obtained which, on being sawn through vertically, shows a complete gradation from one pure metal to the other, passing through the whole series of alloys, which can then be studied in one specimen.

New Reagents for the Micrographic Study of Carburised Iron.* —MM. Osmond and Cartaud have, after numerous trials, discovered a reagent of more constant strength than liquorice juice for etching iron. They recommend a dilute solution of nitrate of ammonium (2 parts in weight of the crystallised salt to 100 parts of water). A piece of parchment spread tightly over a smooth board is soaked with this solution, and the polished surface of the specimen is rubbed upon it until sufficiently etched. It is not necessary to add any sulphate of calcium. When the parchment becomes dry a little water is poured over it. The results are exactly those produced by the extract of liquorice, and the various constituents are identified as follows:—

(1) Pearlite by the unequal depth of etching of its two components, and sorbite by its coloration, varying from light yellow to dark brown.

(2) Troostite by its yellow, brown, or blue bands merging into one another.

(3) Martensite by its characteristic needles, which are the better defined the less the carbon in the metal.

(4) Ferrite by its division into grains, and the heterogeneous appearance of these grains.

(5) Austenite, and especially cementite, remain unacted upon.

There are difficulties in the application which can be overcome by perseverance and experience. Concentration of the solution, pressure, speed, and quality of the parchment, all affect the result.

* Metallographist, 1900, pp. 1–3.

Austenite may be distinguished from martensite by immersing the metal in a solution of ammonium chloride (a 10 p.c. solution for instance), while it is connected with the positive pole of a bichromate cell, the negative pole consisting of a piece of platinum foil, or of lead, or of iron foil. The specimen is examined every ten seconds until the etching is sufficiently deep. A very dilute solution of hydrochloric acid may also be used, but the use of a battery is always desirable, as it increases the regularity of the chemical action. In both cases martensite is first coloured, successively yellow, brown, and black.

Micro-structure of Steel Quenched from the Melting-Point.* — Mr. F. C. Lan has obtained two excellent photographs very clearly illustrative of steel structure; the martensite is in large masses and visible by low magnification. A third photograph shows the remarkable change in structure due to presence of tungsten.

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[J. E. Stead considers that this may be studied under the following sections:— (1) Preliminary preparations of the specimens. (2) Methods of polishing. (3) Etching the specimens. (4) Mounting the specimens. (5) Necessary Microscope accessories. (6) Photographing the developed structures. (7) Lists of apparatus. The treatment of the subject under these heads is expressly intended to help investigators; and the author's advice, on account of his eminence, is naturally of the greatest value to microscopists who are interested in metallography.]
Proc. Cleveland Institution of Engineers, Feb. 26, 1900; and *Metallographist*, 1900, pp. 220–44 (8 figs.).

* Metallographist, 1900, pp. 244–6 (3 figs.).

PROCEEDINGS OF THE SOCIETY.

SPECIAL GENERAL MEETING,

HELD ON THE 19TH OF JUNE, 1901, AT 20 HANOVER SQUARE, W. WILLIAM CARRUTHERS, ESQ., F.R.S., PRESIDENT, IN THE CHAIR.

The President said that this was a Special Meeting of the Fellows of the Society for the purpose of making some alterations in the By-laws—pursuant to a notice duly given at the meeting held on the 15th of May last. He then called upon the Secretary to explain the nature of the alterations proposed, printed copies of which were in the hands of the Fellows present.

The Secretary then read the proposed alterations *seriatim* as given in the statement following—their adoption being severally moved from the Chair, and each being declared by the President to be unanimously carried.

10. Omit "or the first instalment thereof as provided by By-law 20" **(lines 2 and 3)** "or composition" **(line 4). The By-law as amended to read as follows:**

10. Every person elected an Ordinary Fellow shall sign the following form of declaration, and shall pay the admission fee and first annual subscription within two months from the date of election or within such further time as the Council may allow. In default of such signature and payment the election of such Fellow shall be void.

I, the undersigned, having been elected a Fellow of the ROYAL MICROSCOPICAL SOCIETY, *hereby agree that I will be governed by the Charter and By-Laws of the Society for the time being; and that I will advance the objects of the Society as far as shall be in my power. Provided that when I shall signify in writing to one of the Secretaries that I am desirous of ceasing to be a Fellow thereof, I shall (after payment of all annual subscriptions that may be due from me, and returning any books, or other property belonging to the Society in my possession) be free from this obligation.*

Witness my hand the   *day of*   19 .

20. Omit (at line 2) "or, at his option, the sum of two pounds ten shillings, payable in five equal consecutive annual instalments." **The By-law as amended to read as follows:**

20. Every Ordinary Fellow shall pay an admission fee of two guineas, and a further sum of two guineas as an annual subscription.

50. Cancel existing By-law, and substitute the following:

50. The Council may, from time to time, appoint any Fellows of the Society, whether Members of the Council or not, to be a Committee to deal with any matter referred to it. Every such Committee shall conform to any regulations that may be imposed on it by the Council.

58. To read as follows:

58. The Treasurer shall be a Member of all Committees appointed by the Council, or by any General Meeting. He shall receive all moneys due to the Society, and shall pay therefrom only such amounts as may be ordered by the Council.

64. To read as follows:

C. Secretaries, Librarian, and Curator.

64. The Secretaries shall be Members of all Committees appointed by the Council, or by any General Meeting. They shall take, or cause to be taken, minutes of the proceedings of all Meetings, and produce and read them at the ensuing Meetings; they shall conduct the business and correspondence of the Society; and shall discharge all such other duties as are usually discharged by Secretaries of Scientific Societies.

65. To be cancelled, and the following substituted:

65. The Council shall, at the Annual Meeting, propose a Fellow of the Society to act as Librarian. He shall be elected by the Society. He shall have the care of all the books, MSS. and journals of the Society, and the management thereof, subject to the control of the Library Committee and of the Council. He shall make and keep up a Catalogue of the documents under his charge, and shall make an annual report to the Council as to their condition.

65A. The Council shall, at the Annual Meeting, propose a Fellow of the Society to act as Curator of the instruments, and tools, and such other objects belonging to the Society as may from time to time be confided by the Council to his care. He shall be elected by the Society. He shall make and keep up a catalogue of all the objects under his charge, and shall make an annual report to the Council as to their condition.

66. Omit the Words "and Librarian." **Read as follows:**

66. The Council may appoint an Assistant Secretary, and assign to him such duties as it may think desirable, at such remuneration as it may deem proper.

74. To be cancelled, and the following substituted:

74. Minutes shall be made in a book provided for that purpose of all resolutions and proceedings of General Meetings, and any such minutes, if purporting to be signed by the Chairman of the Meeting at which such resolutions were passed or proceedings had, or by the Chairman of the next succeeding Meeting, shall be received as evidence of the facts therein stated.

89. To be cancelled, and the following substituted:

89. The Assistant Secretary shall make and keep up a Catalogue of all the property of the Society, other than that included in the Catalogues of the Librarian and Curator respectively; and shall make an annual report to the Council as to the condition thereof. He shall also keep a list of all donations to the Society, and of all property borrowed by the Fellows.

MEETING

HELD ON THE 19TH OF JUNE, 1901, AT 20 HANOVER SQUARE, W.
W. CARRUTHERS, ESQ., F.R.S., PRESIDENT, IN THE CHAIR.

The Minutes of the Meeting of 15th May last 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, and the thanks of the Meeting were voted to the donors.

	From
Cunningham, J. T., Sexual Dimorphism. (8vo, London, 1901)	*The Publishers.*
Zircon Sand	*Prof. Hy. G. Hanks.*

The Secretary said they had received a small quantity of Zircon sand for distribution amongst those Fellows of the Society who wished to have samples. Applications for this were to be made in writing to the Assistant Secretary.

Attention was called to a new $\frac{1}{40}$ in. objective which was being exhibited in the room by Mr. T. Powell.

Mr. J. W. Gordon then read his paper entitled " An Examination of the Abbe Diffraction Theory of the Microscope." The diagrams in illustration of the subject were shown upon the screen, and the following experiments were exhibited under a number of Microscopes on the table:—

Experiments Nos. 1, 2, 3, and 4 exhibited the phenomena described by Prof. Abbe, as illustrated by the well-known apparatus supplied by Carl Zeiss, of Jena, including the use of Abbe diaphragms with single apertures of varying sizes and a triple aperture.

Experiment No. 5.—In this experiment a diaphragm with two slots was substituted for the Abbe diaphragm with three slots. The spacing of the slots was the same as in the Abbe triple-slotted diaphragm, and the diffraction pattern produced by the diaphragm itself was therefore similar, except as to brightness. This diaphragm, which transmitted those diffraction images that the triple Abbe diaphragm excluded, yielded typically the same image, the appearances differing only in brightness of illumination from those produced by the Abbe triple-slotted diaphragm.

Experiment No. 6.—The Abbe arrangement was modified by the substitution of a broad uncovered flame as the source of light for the Abbe substage-stop, in order to show that the diffraction images in the principal focal plane take the shape of the source of light, but that the details in the image are not sensibly modified, except in respect of illumination.

Experiment No. 7.—An Abbe *Diffractions Platte* and an aërial image of a coarsely-ruled surface were shown in the same field; the dimensions of the image being adjusted so as to be visibly equal to those of the *Diffractions Platte*, in order to show that, viewed through the Abbe diaphragm, these two objects exhibit identical phenomena.

Experiment No. 8.—A diaphragm with 1000 openings to the inch was substituted for the Abbe diaphragm, and a ruled surface, having lines varying in spacing from 0·0065 to 0·026 was substituted for the *Diffractions Platte*, to show that, with this arrangement, the Abbe phenomena can be observed upon a very coarse ruling.

Experiment No. 9.—The Abbe substage-stop was mounted so far behind the condenser that its focussed image formed the source of light. By working the condenser up and down, the distance from the *Diffractions Platte* of this source of light was varied, and the curvature of the wave-fronts passing the grating was correspondingly altered. The result in altering the angles of divergence of the diffracted rays was observed by focussing the instrument upon the source of light, and it was thus shown that, whatever the combination of diffracted rays received by the Microscope, the appearance of the image is always the same.

Experiment No. 10.—The object on the stage was ruled with lines crossing one another at right angles, thus forming inclosed interspaces for showing the production of intercostal points, as well as of colour fringes, by the overlapping of the spectra.

Experiment No. 11.—A spot of light was viewed through various apertures, circle, square, long oblong, to show the form of the anti-point images produced by apertures of those different shapes.

The President said the Fellows of the Society were to be greatly congratulated upon having had the opportunity of hearing the extremely interesting explanation of this theory which Mr. Gordon had given them. It was not only of much theoretical interest, but, if it were firmly established, it would lead to a very material modification in the manufacture of objectives.

Prof. Silvanus Thompson, F.R.S., being called upon by the President, said he had not come there with the slightest intention of saying anything upon the subject of the paper; for although he had been favoured with an advance copy, he regretted that he had not had time to read it, and he also further regretted that he had been unable to be present in time to hear the reading of the first portion of it. But though not prepared for this reason to discuss it, he might say that on one point at least he entirely concurred with Mr. Gordon, and that was in rejecting the presentation of the Abbe theory as given by Naegeli and Schwendener; but on almost every other point he found himself at variance with Mr. Gordon, and, so far as he could judge, the central facts of the theory remained absolutely untouched by the arguments which had been put before them. He did not quite see why it was necessary to draw a distinction between a refraction and a diffraction image, because they could not have a refraction image without the light, and they could not have either without having interference. It seemed to him to be rather a question of terms and what was understood by them. If by diffraction was meant those effects on the image which took place where a wave-front just grazed along the edge of an object, he could only say that he did not regard this only as diffraction, because he considered that diffraction might happen at any part of a wave-front, and was not confined to anything which happened at the edge. On page 2 (of the printed slip) (p. 355) he read, "It is a general rule that all the rays given out by a luminous point which fall upon and pass through a properly corrected lens are re-united in the focussed image of that point produced by the lens. A ray of diffracted light differs for this purpose in no respect from any other ray of light." He did not agree with this statement as a complete description. He had in his possession a small diffraction object—one of those curious sets which showed rings produced in celluloid films made by Prof. Wood, of Wisconsin—this object merely acted by diffraction, and it had no edges whatever. If this was put in front of a point of light, it had the effect of retarding by certain definite amounts the wave-lengths of the light in passing through, and it consequently produced a real image of the luminous point, and in fact acted exactly like a lens. It could not be said that the light here was refracted in some way, because in one sense there was no refraction at all; and the fact that a diffraction image could be formed in that way by an object of this kind did not surely prevent them from applying the same principle to the Microscope. He did not think that the fact of the beam being broken up by a grating prevented them from regarding it as possessing the same properties as before, but it certainly would not be refracted to the same focal positions as if there were no grating. Then upon page 361 there was a passage concerning the images seen in the Microscope of a *Diffractions Platte*—which concluded with the words, "To these questions again there can be no answer except that the Abbe theory was wholly at variance with the facts." He thought on this point all depended upon what they meant by the Abbe theory, and that if they took out some of the statements which had been made with reference to it, there was not much in the effects themselves which were at variance with it. Indeed, taking those beautiful experiments which had been described, as to turning round the grating, they did not seem to him to contradict the theory, but were rather just what should take place if it were correct. Then again he did not agree with what was said as to self-luminous objects, because he thought the term was not correctly applied. For instance, if they had a number of fine platinum wires stretched parallel, like the lines of a grating, and made them white-hot by an electric current, they would properly be called self-luminous, but they would give rise to no diffraction image, because the light from them would not be all in the same phase; but if they were to be illuminated by a single light, it would be possible for them to produce diffraction effects, because they would then be in phase with one another. He also noticed that the effects described were referred to a particular part of the wave-front, but he held that every point of a given wave-front could give out the same kind of effects, because they were in the limited sense of the term self-luminous, inasmuch as every element of a wave-front was, in accordance with the well-known principle of Huyghens, capable of acting as an independent source of light. He did not think they would get much further by discussing the matter on these lines. Taking the case suggested by the diagram last shown, as to the construction of the front lens of an objective, he thought that if there was really any advantage such as stated by making the front slightly concave, it must surely have been tried by some one and most probably rejected.

Mr. Julius Rheinberg said the subject was one in which he had been specially interested, and he should like to make a few remarks upon it. As, however, he would be better able to express himself in writing, he asked to be allowed to read his comments on Mr. Gordon's paper:—

As one of those for whom the problems of microscopic vision have a peculiar fascination—problems which I have been studying and experimenting upon a good deal myself during a number of years—I should like to avail myself of the privilege of passing a few remarks on the exceedingly interesting paper to which we have just been listening.

It is always refreshing to hear a subject treated in a new way, and though, since the Abbe theory came out, there has been no lack of valuable contributions to the subject of microscopic vision in this country, as also in Germany and America, Mr. Gordon has, I think, approached the subject from a new standpoint.

The felicitous expression "antipoint," to denote the image of a point, emphasises in itself the fact that the image of a point is not another simple point, but a disc with rings, and that the image of a line is not another simple line, but a line flanked with appendage lines;

and by then showing how the antipoints vary according to the form and size of the lens aperture or diaphragms above it, the way is led to showing how the whole image of an object is built up of these antipoints. This seems both a sound and a simple way of looking at the matter, and has the advantage of a general theory, that it includes images by other optical instruments, e.g. the telescope, where the star discs and rings are the antipoints of the stars.

Though, until I had read Mr. Gordon's paper (of which, by courtesy, I have had the advantage of seeing an advance proof), I should certainly not have known how to express the matter in so simple a way, it is one of the general results I have independently arrived at, that all false diffraction lines, intercostal markings, etc., no matter whether produced in viewing a diatom, a grating, a slide of bacteria, or any other object, are but a portion of the "antipoints" of points in the object, and, in part at least, my conclusion has been drawn from the self-same observation of the appearances produced by rotating the three-slit diaphragm of the Abbe diffraction apparatus above the objective (fig. 86), which Mr. Gordon has so ably described. The disengagement of the phantom lines, the trebling of the lines at a particular moment, and the characteristic serrated appearance formed by the tops of the lines, cannot fail to strike anyone who has made this experiment.

It may seem strange that, whilst being able to so fully concur with Mr. Gordon's views with regard to the synthesis of the microscopic image being a collection of antipoints, I do not hesitate to offer the opinion that the deduction which he draws as to the possibility of improving Microscope objectives as described is an erroneous one, and that he has partially misunderstood the Abbe diffraction theory, which theory is quite compatible with his own views. Two factors seem to have been overlooked which fundamentally affect the whole question.

In company with Lord Rayleigh,* Dr. Clifford Mercer,† and Mr. Lewis Wright,‡ Mr. Gordon has apparently not sufficiently appreciated the fact that light proceeding from an illuminated point does not spread equally in all directions. This, in the case of the Microscope, is important.§

To fix our ideas:—think of a single pin-hole pricked in a piece of tinfoil in the focus of an objective of wide-angled aperture, and let the slit be illuminated by a light source some distance behind. Then the light reaching the central portion of the objective will be intense compared to that reaching other zones of the objective, and the marginal zones will probably receive practically no light whatsoever. The exact distribution of the light will depend on the size of the pin-hole.

Obviously the antipoint becomes different in this case from what it would be if light of equal intensity reached all parts of the objective, as is practically the case with telescopes, the angular aperture of which

* 'The Theory of Optical Instruments, with Special Reference to the Microscope,' by Lord Rayleigh. Published in the 'Philosophical Magazine,' August 1896.

† 'An Experimental Study of Aperture as a Factor in Microscopic Vision,' by Dr. Clifford Mercer.

‡ 'Microscopic Images and Vision,' by Mr. Lewis Wright. Published in the 'Philosophical Magazine,' June 1898.

§ Special attention has been drawn to this matter by Dr. G. J. Stoney in his masterly monograph on 'Microscopic Vision,' published in the 'Philosophical Magazine,' October, November, and December 1896.

must needs be very small. And in the case of a grating or complex object, we can readily see how it throws up strong beams or pencils of light in certain directions, weaker ones in other directions, and no light at all in some directions. Is it not evident therefore that the diaphragm above the objective is only one factor in the formation of the antipoint; the nature of the light as it reaches the objective from the object being a factor of at least equal importance? It is the latter point on which the Abbe theory lays emphasis.

It has been argued that in practical microscopy we do not deal with plane waves of light but with cones; this argument, however, does not affect the theory, since Dr. G. J. Stoney, in his memoir mentioned above, has shown how the action of a cone of light may be traced by considering it as made up of plane waves of varying obliquities; and, as regards the light emitted from the object, he tells us: "However complex the contents of the objective field, and whether it or parts of it be self-luminous or illuminated in any way, however special, the light which emanates from it may be resolved into undulations, each of which consists of uniform plane waves."

The second matter which Mr. Gordon seems at times not to have taken into account is that the Abbe theory postulates that the regular interference effects can be produced or calculated only from the combined action of spectra which proceed from a single point of the light source, or from secondary points derived from this which are known to be in the same phase.

If now we take into consideration these two points, we shall find that the proofs which Mr. Gordon brings against the Abbe diffraction theory break down, and that none of his experiments are out of consonance with it.

But before dealing with some of his remarks and of his experiments, I take leave to state what I understand to be the fundamentals of the Abbe diffraction theory. They are:

(1) The recognition that every object illuminated by plane waves emits diffracted as well as direct light, the latter being as essential to the formation of a correct image as the former.

(2) That the more nearly the whole of this light is grasped by the objective, the more nearly will the image conform to the object.

(3) That when an appreciable portion of the direct or diffracted light is not grasped by the objective, the image may be obscured by false effects, such as doubling of lines, intercostal markings, &c.

(4) That when light proceeds from an object in maxima and minima, at least two maxima (either a dioptric and a diffraction beam, or two diffraction beams) must be grasped by the objective for the formation of any effect which could be called an image.

(5) The recognition that the resolving power of the Microscope is dependent on this last clause; because, seeing that the further the maxima are apart, the closer together are the lines or points resolved, it follows that the limit of resolving power must be reached when matters are so arranged that a dioptric beam and the first diffraction maximum are just and only just grasped by the opposite sides of the marginal zone of an objective.

It is these *fundamental* assertions of the Abbe theory, some of which have been challenged and brought in question by Mr. Gordon, which I am concerned to uphold; but at the same time, to prevent misunderstanding, I wish distinctly to dissociate myself from many of the chief deductions that have been drawn from this theory, notably, that narrow cones of light are preferable to wide ones, and that there are no reasons why a wide cone should yield a more correct projection of the object. On the contrary, I hold that the Abbe school have not correctly applied their own fundamental principles, and that the elimination or rather the contraction of diffraction fringes, etc., can be readily shown to occur by the destructive interference of the elementary rays of varying obliquity into which the cone of light can be analysed.

This, however, is a digression, and I now revert to Mr. Gordon's paper.

In the first place we find certain arguments based upon the fact, that the diffraction lines in the image are supposed to be images of the light source, and that therefore these diffraction lines ought not to shift so long as the light source is kept in its place, although we may shift the object across the stage. Now this seems to be based on an entire misconception. I think Mr. Gordon will find he has misinterpreted a passage in Naegeli and Schwendener (p. 231), which, taken by itself, might possibly suggest the above, but does not do so if read in connection with the context and the diagram to which it refers. This is the only place in Naegeli and Schwendener which I can find as at all lending itself to the assumption made; and in Dr. Zimmermann's book or other works dealing with the Abbe theory, I have never seen it suggested that the diffraction lines in the image plane of the Microscope are images of the light source. The images of the light source in the experiments referred to are near the upper focal plane of the objective, and these images, as is well known, do not shift, which is in accordance with theory. The rays forming the lines in the image plane may each and every one have *passed through* the points in the upper focal plane of the objective which constitute the images of the light source, and may, *in that particular sense*, have been derived from these as secondary interference effects; but that is quite a different matter. Suppose we project the image of the object on a screen *without using an eye-piece*. Then we should have images of the light source near the back focal plane of the objective; and if it were supposed that we again had images of the light source on the screen, we should have two sets of images of the light source, without so much as a lens of any sort between them to form the one image from the other.

The argument that we do not see candle-flame images in the image plane, though we do in the focal plane of the objective, and all other arguments based on the idea that the assumption above stated has been held, do not therefore touch the Abbe diffraction theory.*

We next come to Mr. Gordon's contention that the Abbe theory is

* To avoid any possible misunderstanding, I wish to point out that I do not contend that images of the light source can never be formed in the image plane of the object, but only that under the conditions of the experiments under discussion this is not the case.

We can and do get diffraction images of the light source in the plane of the image of the object, if the light is actually focussed on the grating or object; but unless the light source is confined to *exceedingly* small limits, its dioptric and diffraction images overlie to such an extent that they cannot be separately distinguished.

wrong because Naegeli and Schwendener write as if the images of the source of light (dioptric beam and spectra) were in a true plane, and yet all in the same phase. He points out that, in order to interfere according to theory at a point in the image plane, they must lie on a concave surface directed towards that point; but that the concave surface on which they actually lie can be varied at will to give any desired small alteration of flatness to the surface without affecting the result. Now it is perfectly true that the dioptric image and spectra lie on a concave surface (attention to the same matter has been drawn by Dr. R. Strehl in his *Theorie der allgemeinen Mikroskopischen Abbildung*, 1900); but it is a mistake to suppose that an alteration of flatness of the surface can be attained in the region of the upper focal plane of the objective without the image plane being affected. If the image plane is readjusted by lengthening the tube, then, indeed, the degree of flatness of the curve is altered, and for the reason that in that case the objective would have been slightly racked down, thereby altering its distance from the actual light source, the condenser, and the diaphragm, the position of which relatively to the objective has an important bearing on the position of the spectra. It will be observed that I use the expression "*in the region of*" the upper focal plane of the objective. This is done advisedly, since the expression "upper focal plane" has been used in such a loose fashion by Naegeli and Schwendener and other writers, and they have assumed that visual spectra when present are always formed just there. But though under the special conditions of the experiments which they discuss they are formed in that region, we shall shortly see that the visual spectra are by no means always found there.

This brings us to Mr. Gordon's remarks that any number of diffraction spectra can be crowded into an objective by the expedient of racking the condenser up and down, and altering the curve of the wave-front as it passes the grating, and that, therefore, a narrow-angled objective can be made to yield the diffraction image of a wide-angled immersion one. This I think I can also show to be based on a misconception of the position of the spectra.

If the wave-front passes the grating as a curved surface, then the whole basis of the experiment is altered. For one thing, rays emanating from any point of the light source must be passing a great number of lines in the diffraction plate in different phases; but apart from this we no longer get the diffracted rays of light focussed and in the same phase in the upper focal plane * of the objective, for *the conjugate focal surface of the light source will, by the very nature of the conditions named, be somewhere else*, higher or lower, in the tube. That this is actually the case, and that the spectra apparently emanating from the upper focal plane are really formed elsewhere, can be proved by catching them on a screen of ground glass or celluloid fixed at the end of a tube, which can be inserted and pushed down into the ordinary Microscope tube.

The crowding together of the spectra, which Mr. Gordon speaks of, is merely the overlapping of the spectra, which are *seen* altogether out of focus as diffused surfaces. It is by no means a *closing together* of

* As it is customary to speak of "planes," this word is used here and elsewhere to denote the more or less curved surface on which the spectra are formed.

the sharply defined spectral images of the light source. But we can cause a fresh set of sharply defined visual spectra to appear under these conditions by contracting the iris diaphragm or stop under the condenser, and these will be formed in the region of the upper focal plane of the objective.

I must not stop now to discuss further how this can be brought into harmony with the principles of the Abbe theory; the only point I wish to draw attention to for the moment, is that we cannot apply the method of *visual demonstration* devised by Prof. Abbe, if we set up entirely different conditions; and this no doubt accounts for Dr. Zimmermann and other followers of the Abbe school not having set up their experiments that way.

I will now proceed shortly to discuss one of Mr. Gordon's own very instructive and interesting experiments.

He shows that, under suitable conditions, the image of a Zeiss diffraction plate and that of an aërial image projected by the condenser on the object plane of the Microscope, will behave in precisely the same fashion. This is an experiment with which I am familiar, having myself made a great number in similar fashion. This experiment certainly does prove that, given suitable diaphragms above the objective, the same effects can be produced with self-luminous objects as with gratings. It proves that, so far as self-luminous objects are concerned, the diaphragm above the objective *must* produce false effects. But so far as the grating is concerned, it only proves that the diaphragms *may* produce false effects. The grating, according to the way in which it is illuminated, may cause the light to be unevenly distributed in the upper focal plane of the objective, and if the diaphragm happens to be so placed that its openings just coincide with the positions of the maxima, the presence or absence of the diaphragm makes no difference, for it has not then stopped out any light.

With the self-luminous source the whole upper focal plane of the objective is necessarily filled with light, and the diaphragm must therefore necessarily stop out some of it. The remainder which is passed through may, under suitable conditions, correspond to the whole of that which was emitted from the grating. Therefore the effect would be the same. In fact, it is like using a stencil which equalises the pattern of light in both cases, though the opaque parts of the stencil may cover things in the one case which they do not in the other.

Of course, so soon as parts of the co-operating spectra * emitted by the grating are stopped out, then the diaphragm is responsible for the altered image effect, and this accounts for the duplication, triplication, serrated edge, and all the other effects. But that is in accordance, not in discordance, with the Abbe theory.

I do not propose to discuss in detail the remainder of Mr. Gordon's paper. With much of it, and particularly his admirable constructive treatment of the image as a collection of antipoints, I thoroughly agree, only I think this theory must be widened out by admitting the factor of the diffraction by the object as well as that produced by the diaphragm, and I think I have shown that the arguments do not touch this important fundamental principle of the Abbe theory.

* By co-operating spectra, such spectra are meant as have originated from one point of the light source.

I hold no brief for the Abbe theory. That too, to my mind, wants further simplification and extension, so as to undeniably include, or at least show, its bearings to the results arising from cones of light, from self-luminous objects and isolated objects, as well as gratings. Work has been already done in this direction by Dr. G. J. Stoney, in his monograph on Microscopic Vision already referred to.*

That a number of deductions harmful to the progress of Microscopy have been drawn from the Abbe diffraction theory, particularly the uncertainty as to the correctness of the image and the desirability of using narrow cones of light, seems undeniable in the face of the practical experience of to-day. But, whilst parting with the deductions which are erroneous, we must be very careful not to throw away the valuable fundamental principles.

After all, the Abbe theory, on the basis of plane waves, like the other theories on the spurious disc method, such as Lord Rayleigh's, *is but a mode of treating the subject.* A subject can be treated in various ways, and the one need not be rejected because we may use the other also. We have an example of this in the deductions as to the resolving power of the Microscope. Both the modes above named give *approximately* like results, because both are dependent on the same essential factor for resolving power, viz. the angular aperture of the objective.

It so happens, that with most problems as to microscopic vision the Abbe theory lends itself to them far better than other theories, because it is the only one at present which takes into account what happens to the light between the object and the objective, and this alone is a sufficient reason why we are bound to retain it.

May I say, in conclusion, that if, in this discussion, the remarks made have been directed more to the points of difference between Mr. Gordon's opinions and mine than to the points of agreement, I hope it will not be held that I wish in the slightest to detract from the merits of a paper which every one interested in microscopic vision must admit to be one of the most valuable contributions to the literature on the subject.

Mr. C. Beck said that before the discussion was closed he should like to say that he did not think it possible for any one discussing the paper in opposition to Mr. Gordon, and following the experiments which he had described, to dispute his contention that the effects observed were produced by the diaphragm behind the objective. The proof that these effects were entirely due to this was abundantly shown by the fact that the moment any of the conditions were altered the experiments did not succeed, and there was no reason why they should not succeed if the Abbe theory were correct.

Mr. Gordon contended that he was entitled to claim the support of Prof. Thompson, notwithstanding the impression probably left on the minds of those present by Prof. Thompson's speech, that he disagreed with the reader of the paper almost entirely. It was true Prof. Thompson had said he agreed with him in throwing over Naegeli and Schwendener's explanations, but he also said that it was extremely wicked to throw over the Abbe theory ; whereas it was clear from the quotation given at the beginning of the paper that Prof. Abbe had himself thrown it over ; but in doing so he had promised to elaborate it further ; and as he had

* Philosophical Magazine, October, November, and December, 1896.

not yet done this, what else could one do than pick it up from wherever one might be able to find it? and so he was obliged to go to Naegeli and Schwendener's book for it. Concerning the proposed use of a concave lens, Prof. Thompson had said that he did not see that any good would come of it. The speaker could not himself say whether or not this was a practicable way of making an objective; but at least an opportunity had been given of ventilating the subject. He regretted that Prof. Thompson had not been present to hear the beginning of the paper, and hoped he might have the pleasure of showing him the experiments which were arranged upon the table, by which he thought his points had been demonstrated.

As to Mr. Rheinberg's part in the discussion, he could only say that the paper which he had launched upon them dealt with so many matters that it would involve too long a time to go over them even if it were possible to pick them up. There was, however, one point fundamental to Mr. Rheinberg's remarks—he said the error had been made of ignoring the fact that with a plane wave-front they must always have diffraction. In the first place he, the speaker, had not ignored it; on the contrary, he had pointed out that this was so, but he had also shown that the crowding together of the diffraction spectra of which he had spoken was due to the fact that curved wave-fronts were substituted for plane wave-fronts in the plane of the grating, and Mr. Rheinberg had only added the perfectly correct explanation that this was due to the different phases of the light in different parts of the grating when the wave-fronts passing it were curved. The same explanation afforded an answer to Prof. Thompson's criticism of the experiment with the aërial image of a ruled screen which in the paper was described as a self-luminous object. It was self-luminous in the sense that the wave-front in that object had a radius of curvature practically $= 0$.

The President said he was sure they would give a very cordial vote of thanks to Mr. Gordon for his very able and instructive paper. It was no doubt somewhat difficult for them to follow throughout a critical and expository paper full of details, and therefore difficult to intelligently discuss it, but they would all have the opportunity of a more leisurely study of it when they could read it in the *Journal*.

A hearty vote of thanks to Mr. Gordon was then put from the Chair, and carried by acclamation.

The President announced that the meetings of the Society would now be suspended for the summer vacation—the date of the next meeting being October 16. He further intimated that the rooms of the Society would be closed from August 16 to September 16.

New Fellow.—Mr. E. G. Wheler was balloted for and duly elected a Fellow of the Society.

The following Object was exhibited:—

Mr. Thos. H. Powell:—*Coscinodiscus asteromphalus* under $\frac{1}{40}$ in. Apochromatic Oil-immersion Objective.

F. W. [illegible] West, Newman lith.

FORAMINIFERA OF MALAY ARCHIPELAGO.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

OCTOBER 1901.

TRANSACTIONS OF THE SOCIETY.

VIII.—*Report on the Recent Foraminifera of the Malay Archipelago collected by Mr. A. Durrand, F.R.M.S.—Part XI.*

By Fortescue William Millett, F.R.M.S.

(*Read* 15*th May*, 1901.)

Plate VIII.

Lagena crenata Parker and Jones, plate VIII. fig. 1.

L. crenata Parker and Jones, 1865, Phil. Trans., vol. clv. p. 420, pl. xviii. fig. 4. *L. crenata* (P. and J.) Balkwill and Wright, 1885, Trans. R. Irish Acad., vol. xxviii. p. 339, pl. xiv. figs. 17, 18.

This interesting, and, according to Brady, somewhat rare form, is abundant in the Malay Archipelago, and occurs at most of the Stations. Its relations with *L. semistriata* are well marked, and many of the passage-forms possess the characters of each species in

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EXPLANATION OF PLATE VIII.

Fig. 1.—*Lagena crenata* Parker and Jones. × 100. *a*, Lateral aspect; *b*, aboral aspect.
" 2, 3. " *semistriata* Williamson. × 100.
" 4. " *striata* var. *tortilis* Egger. × 90. *a*, Lateral aspect; *b*, oral aspect.
" 5. " *curvilineata* Balkwill and Wright. × 135.
" 6. " *striatopunctata* Parker and Jones. × 100.
" 7. " " var. *spiralis* Brady. × 150. *a*, Lateral aspect; *b*, oral aspect.
" 8. " *plumigera* Brady. × 100. *a*, Lateral aspect; *b*, oral aspect.
" 9. " *clavata* d'Orbigny var. *setigera* var. n. × 90. *a*, Lateral aspect; *b*, aboral aspect.
" 10. " *elongata* Ehrenberg sp. × 75.
" 11. " *quinquelatera* Brady. × 100. *a*, Lateral aspect; *b*, oral aspect.
" 12–14. " *gracilis* Williamson. × 100.
" 15. " *botelliformis* Brady. × 100. [Fig. 16.

about equal proportions. Although the coiled neck cannot in any way be regarded as a specific distinction, it may be remarked that the typical *L. crenata* always possesses this feature, and that it becomes less marked the nearer the individuals approach *L. semistriata.*

Of passage-forms towards *L. semistriata* may be enumerated the following :—

Lagenulina semistriata (Will.) Terquem, 1876, Anim. Plage de Dunkerque, Part 2, p. 68, pl. vii. fig. 8. *Lagena florida* Terquem, 1882, Mém. Soc. Géol. France, ser. 3, vol. ii. p. 26, pl. ix. fig. 9. *Oolina striaticollis* d'Orbigny, 1843, Foram. Amér. Mérid., p. 21, pl. v. fig. 14. *Lagena semistriata* (Will.) Brady, 1884, Chall. Rept., p. 465, pl. lvii. figs. 16, 17, 20. *L. semistriata* (Will.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 327, pl. x. fig. 39.

Lagena semistriata Williamson, plate VIII. figs. 2, 3.

Lagena striata var. *β semistriata* Williamson, 1848, Ann. and Mag. Nat. Hist., ser. 2, vol. i. p. 14, pl. i. figs. 9, 10. *L. semistriata* (Will.) Wright, 1886, Proc. Belfast Nat. Field Club, 1884–85, App. ix. p. 324, pl. xxvi. fig. 6, and *L. semilineata*, p. 320, pl. xxvi. fig. 7. *L. semiornata* Terquem, 1886, Bull. Soc. Zool. France, vol. xi. p. 320, pl. xi. fig. 2. *L. semistriata* (Will.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 327, pl. x. fig. 34. *L. semistriata* (Will.) Goës, 1894, K. Svenska Vet.-Akad. Handl., vol. xxv. p. 76, pl. xiii. fig. 737. *L. semistriata* (Will.) Morton, 1897, Proc. Portland Nat. Hist. Soc., vol. ii. p. 117, pl. i. fig. 3.

This form is very well represented, and most of the figured varieties occur.

There is nothing particularly wonderful in the variations of beings existing under different circumstances half-a-world apart, or geological systems distant in point of time. These might be expected; but more interesting, because less accountable, are the variations of creatures living generation after generation side by side in the same locality, under the same conditions, and subject to precisely the same

Explanation of Plate VIII.—*continued.*

Fig. 16.—*Lagena lævigata* Reuss sp. var. *acuta* Reuss. × 100. *a*, Lateral aspect; *b*, oral aspect.
„ 17. „ *multicosta* Karrer sp. × 100. *a*, Lateral aspect; *b*, peripheral aspect; *c*, oral aspect.
„ 18. „ *quadrata* Williamson sp. var. × 100. *a*, Lateral aspect; *b*, oral aspect.
„ 19. „ *fasciata* Egger sp. × 100. *a*, Lateral aspect; *b*, oral aspect.
„ 20. „ *marginata* Walker and Boys var. × 100. *a*, Lateral aspect; *b*, oral aspect.
„ 21. „ *marginata* Walker and Boys var. × 100. *a*, Lateral aspect; *b*, peripheral aspect.

external influences. In these varieties Mr. Durrand's gatherings are very rich, and it has been deemed more interesting to figure some of these, rather than to give a hackneyed illustration of the typical form.

Fig. 2 with the flat base is closely allied to *L. crenata*, whilst fig. 3 is flask-shaped and apiculate, with the delicate striæ characteristic of *L. striata*. This form has been figured by Reuss under the name of *L. strumosa*,* by Joseph Wright as *L. semilineata*, and by Terquem as *L. semiornata*.

Lagena striata d'Orbigny, sp.

Oolina striata d'Orbigny, 1843, Foram. Amér. Mérid, p. 21, pl. v. fig. 12. *Lagena substriata* Williamson, 1848, Ann. and Mag. Nat. Hist., ser. 2, vol. i. p. 15, pl. i. fig. 12. *L. striata* (d'Orb.) Reuss, 1862, Sitzber. k. Akad. Wiss. Wien, vol. xlvi. p. 327, pl. iii. fig. 44, and pl. iv. figs. 46, 47. *L. striata* (d'Orb.) Brady, Parker, and Jones, 1888, Trans. Zool. Soc., vol. xii. p. 222, pl. xliv. fig. 28. *L. striata* (d'Orb.) Fornasini, 1893, Mem. R. Accad. Sci. Ist. Bologna, ser. 5, vol. iii. p. 431, pl. ii. fig. 2. *L. striata* (d'Orb.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 327, pl. x. figs. 21–23. *L. striata* (d'Orb.) Goës, 1894, K. Svenska Vet.-Akad. Handl., vol. xxv. p. 75, pl. xiii. figs. 732–736. *L. striata* (d'Orb.) Jones, 1895, Palæont. Soc., p. 184, pl. vii. fig. 8.

This species is well represented, being found in considerable abundance at nearly all the Stations.

Besides the typical oval form, specimens are frequent in which the body is elongate and cylindrical, as in *Phialina cylindracea* Seguenza,† or club-shaped as in *L. grinzingensis* Karrer.‡ Others are apiculate; whilst many have the striæ produced at the aboral end, forming a brush of projecting spines. The striæ are sometimes continuous, in other examples interrupted or branching, and are of various degrees of fineness, passing insensibly into *L. sulcata*.

Lagena striata d'Orbigny sp. var. *tortilis* Egger, plate VIII. fig. 4.

Lagena tortilis Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 329, pl. x. figs. 61–63.

This pretty little variety, as represented by the Malay Archipelago specimens, is a form of *L. striata* in which the striæ are arranged spirally in place of longitudinally. It bears the same relation to *L. striata* as *L. spiralis* bears to *L. striatopunctata*.

It is abundant at Station 25 and occurs sparingly at a few other Stations in both Areas. There is little or no variation in the speci-

* Sitzber. k. Akad. Wiss. Wien, vol. xlvi. 1862, p. 328, pl. iv. fig. 49.

† Foram. monotal. Mioc. Messina, 1862, p. 47, pl. i. fig. 24.

‡ Abhandl. k. k. Geol. Reichsanstalt, vol. ix. 1877, p. 378, pl. xvi. *b*, fig. 17.

mens. On the body the direction of the spiral is always that of a left-handed screw, whilst on the neck it takes the opposite direction. In the solitary 'Gazelle' specimen figured by Dr. Egger the spiral on the body of the shell is represented as being right-handed.

The tendency of *L. striata* to have its striæ arranged obliquely has long been noticed, but hitherto no one has considered it necessary to give the variety a distinctive name. In this matter there is no general rule laid down, each author being guided by his own judgment. It would probably be wiser not to create new names for these trifling variations, bnt where the names exist there cannot be any great harm in making use of them.

The 'Gazelle' Station is West Australia.

Lagena curvilineata Balkwill and Wright, plate VIII. fig. 5.

Lagena curvilineata Balkwill and Millett, 1884, Journ. Micr., vol. iii. p. 27, pl. ii. fig. 3. *L. curvilineata* Balkwill and Wright, 1894, Trans. R. Irish Acad., vol. xxviii. p. 328, pl. xiv. figs. 21–24. *L. curvilineata* (B. and W.) Halkyard, 1889, Trans. and Ann. Rept. Manchester Micr. Soc., p. 67, pl. ii. fig. 3.

There is here figured a rather unsatisfactory example of a not very satisfactory species. It is from Station 14 in Area 1, and is a solitary specimen.

Lagena sulcata Walker and Jacob sp.

Serpula (Lagena) striata sulcata rotundata Walker and Boys, 1784, Test. Min., p. 2, pl. i. fig. 6. *Lagena striata* Williamson, 1848, Ann. and Mag. Nat. Hist., ser. 2, vol. i. p. 13, pl. i. figs. 6, 8. *L. sulcata* (W. and J.) Parker and Jones, 1865, Phil. Trans., vol. clv. p. 351, pl. xiii. figs. 28, 29. *L. striata* (d'Orb.) Sherborn and Chapman, 1886, Journ. R. Micr. Soc., p. 745, pl. xiv. figs. 16, 17; and *L. sulcata* (W. and J.) p. 745, pl. xiv. fig. 18. *L. sulcata* (W. and J.) Brady, 1888, Geol. Mag., dec. 3, vol. v. p. 481, pl. xiii. fig. 11. *L. sulcata* (W. and J.) Brady, Parker, and Jones, 1888, Trans. Zool. Soc., vol. xii. p. 222, pl. xliv. fig. 22. *L. sulcata* (Walker and Boys) Goës, 1894, K. Svenska Vet.-Akad. Handl., vol. xxv. p. 78, pl. xiii. fig. 744. *L. sulcata* (W. and J.) Jones, 1895, Palæont. Soc., p. 186, pl. i. figs. 40, 41 (1866). *L. sulcata* (W. and J.) Flint, 1899, Rep. U.S. Nat. Mus. for 1897 (1899) p. 307, pl. liii. fig. 7. *L. sulcata* var. Kiær, 1899, Norske Nordhaus Exp. (Zool.) vol. xxv. p. 5, pl. i. fig. 10. *L. sulcata* (W. and J.) Wright, 1900, Geol. Mag., dec. 4, vol. vii. p. 100, pl. v. fig. 14.

Lagena sulcata var. *interrupta* Williamson.

Lagena striata var. *interrupta* Williamson, 1848, Ann. and Mag. Nat. Hist., ser. 2, vol. i. p. 14, pl. i. fig. 7. *L. sulcata* (W.

and J.) Balkwill and Wright, 1885, Trans. R. Irish Acad., vol. xxviii. p. 338, pl. xiv. figs. 1, 2. *L. sulcata* (W. and J.) Haeusler, 1890, Abhandl. schweiz. Pal. Gesell., vol. xvii. p. 87, pl. xiii. fig. 27. *L.* (*sulcata*) *interrupta* (Will.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 328, pl. x. fig. 32.

The remarks made on *L. striata* apply equally to this form. The variety *interrupta* is less abundant and less widely distributed.

Lagena striatopunctata Parker and Jones, plate VIII. fig. 6.

Lagena sulcata var. *striatopunctata* Parker and Jones, 1865, Phil. Trans., vol. clv. p. 350, pl. xiii. figs. 25–27. *L. striatopunctata* (P. and J.) Balkwill and Wright, 1885, Trans. R. Irish Acad., vol. xxviii. p. 339, pl. xiv. fig. 20. *L. striatopunctata* (P. and J.) Chapman, 1893, Journ. R. Micr. Soc., p. 584, pl. viii. fig. 15. *L. striatopunctata* (P. and J.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 327, pl. x. figs. 35, 36, 44–46. *L. striatopunctata* (P. and J.) Goës, 1894, K. Svenska Vet.-Akad. Handl., vol. xxv. p. 83, pl. xiii. fig. 753.

This form, which elsewhere is somewhat rare, in the Malay Archipelago is very abundant at some Stations in Area 2, especially at No. 30; it is also found sparingly in Area 1.

The great majority of the specimens are of the cylindrical variety figured by Dr. Egger. In this form the ribs are broader than in the flask-shaped variety, and are flattened or even hollowed on the upper face. There is a rare variety in which the perforated alternate with solid ribs, as in the specimens of *L. desmophora* from the 'Challenger' Expedition figured by Brady.* Both the cylindrical and the flask-shaped forms are subject to an obliquity of the ribs, which connects them with *L. spiralis*. Frequently the neck is inclined to one side, as shown in the figured specimen.

The sole 'Gazelle' Station is Mauritius.

Lagena striatopunctata var. *spiralis* Brady, plate VIII. fig. 7.

Lagena spiralis Brady, 1884, Chall. Rept., p. 468, pl. cxiv. fig. 9. *L. spiralis* (Brady) Chaster, 1892, First Rept. of the Southport Soc. of Nat. Sci., 1890–1891 (1892) p. 60, pl. i. fig. 8.

The first notice of this beautiful little form appears to be that of Parker and Jones in 1865, when, in treating of *L. striatopunctata*, † they write "The ribs are comparatively strong; they range in number from four to twelve, and in one recent specimen we have seen them spiral." In 1871 it was figured by M. Ponton,‡ but was not described by him. Brady's diagnosis of the species was made from an imperfect

* Chall. Rept., 1884, p. 468, pl. lviii. fig. 42.
† Phil. Trans., clv. (1865) p. 350.
‡ 'The Beginning,' 1871, p. 562, pl. A, fig. 4.

specimen procured from 'Challenger' Station 185, Raine Island, Torres Strait, 155 fathoms.

The shell, when perfect, has an elongated neck, with a rim at the oral end. The neck is quite smooth, and where it joins on to the body there is usually a conical mass of opaque shelly matter; these features are not shown in the hitherto published drawings of the variety. In some examples the punctation of the ribs is obscure, but none of them have been observed in which it is entirely wanting, as in the specimen described by Dr. Chaster.

In the Malay Archipelago and the 'Challenger' specimens the direction of the spiral is invariably that of a right-handed screw, directly opposite to that of the spiral variety of *L. striata*; but in the figures given by Ponton and Dr. Chaster the spiral is left-handed.

In the Malay Archipelago the species is very abundant, and its distribution is precisely the same as that of *L. striatopunctata*. In addition to 'Challenger' Station 185, I have a specimen from Station 172, off Nukualofa, Tongatabu, Friendly Islands, depth 18 fathoms. Dr. Chaster's examples are from mud under Southport Pier.

Lagena plumigera Brady, plate VIII. fig. 8.

Lagena plumigera Brady, 1881, Quart Journ. Micr. Sci., n.s., vol. xxi. p. 62. *L. plumigera* Brady, 1884, Chall. Rept., p. 465, pl. lviii. figs. 25, 27. *L. plumigera* (Brady) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 329, pl. x. figs. 37, 38.

This is essentially a deep-water species, and according to Brady has been obtained from the tropical regions of the South Pacific at depths of 2350 and 2425 fathoms, and from near the Cape de Verde islands at a depth of 1070 fathoms. Dr. Egger records it from New Guinea 455 fathoms, and from West Australia 645 fathoms.

In the Malay Archipelago it is extremely rare, and has been found only at Station 30, in Area 2.

This species seems to have its isomorph in the compressed *L. lagenoides*, from which it differs only in having the transverse section circular and in possessing a greater number of ribs.

Group of *Lagena clavata*.

Lagena clavata d'Orbigny sp.

Oolina clavata d'Orbigny, 1846, For. Foss. Vienne, p. 24, pl. i. fig. 2. *Lagena lævis* var. *amphora* Williamson, 1848, Ann. and Mag. Nat. Hist., ser. 2, vol. i. p. 12, pl. i. figs. 3, 4. *L. lævis* (Mont.) Haeusler, 1887, Neues Jahrb. für Min., p. 181, pl. iv. figs. 39–48. *L. clavata* (d'Orb.) Brady, 1888, Geol. Mag., dec. 3, vol. v. p. 482, pl. xiii. figs. 4, 5. *L. lævis* (Mont.) Haeusler, 1890, Abhandl. schweiz. Pal. Gesell., vol. xvii. p. 86, pl. xiii. figs. 17, 18. *L.* (*Oolina*) *clavata* (d'Orb.) Egger, 1893, Abhandl. k. bayer, Akad. Wiss.. Cl. II.

vol. xviii. p. 324, pl. x. fig. 68. *L. clavata* (d'Orb.) Haeusler, 1893, Abhandl. schweiz. Pal. Gesell., vol. xx. p. 14, pl. i. figs. 17–22. *L. clavata* (d'Orb.) Goës, 1894, K. Svenska Vet.-Akad. Handl., vol. xxv. p. 75. pl. xiii. figs. 725–727. *L. clavata* (d'Orb.) Jones, 1895, Palæont. Soc., p. 182, pl. vii. fig. 5. *L. clavata* (d'Orb.) Morton, 1897, Proc. Portland Soc. Nat. Hist., vol. ii. p. 116, pl. i. fig. 2. *L. clavata* (d'Orb.) Fornasini, 1898, Mem. R. Accad. Sci. Ist. Bologna, ser. 5, vol. vii. p. 206, pl. 18. *L. clavata* (d'Orb.) Wright, 1900, Geol. Mag., dec. 4, vol. vii. p. 100, pl. v. fig. 13.

There is little to be said about this common species. In the Malay Archipelago it is nowhere abundant, but is scattered all over the region.

Lagena clavata d'Orbigny sp. var. *setigera* var. n., plate VIII. fig. 9.

Lagena lævis Montagu sp. (var.) Brady, 1884, Chall. Rept., pl. lvi. fig. 30.

Differs from the type in having at the aboral end a cup-shaped indentation surrounded by a circle of setæ.

In *Oolina striaticollis* d'Orbigny, and some of the figures of *Lagena tenuis* Bornemann, as interpreted by Reuss, the free ends of the ribs extend beyond the base of the shell and have a similar appearance; but in the variety under consideration the ribs are entirely wanting. Still the form is interesting, and worthy of notice as forming a connecting link between the smooth and the striated *Lagenæ*.

In the Malay Archipelago it is widely distributed, and is far more abundant than the type.

Lagena gracillima Seguenza sp.

Amphorina gracilis Costa, 1856, Atti Accad. Pontiniana, vol. vii. p. 121, pl. xi. fig. 11. *Amphorina gracillima* Seguenza, 1862, Foram. monotal. Mioc. Messina, p. 51, pl. i. fig. 37. *Lagena gracillima* (Seg.) Brady, 1870, Ann. and Mag. Nat. Hist., ser. 4, vol. vi. p. 292, pl. xi. fig. 6. *L. gracillima* (Seg.) Chapman, 1893, Journ. R. Micr. Soc., p. 582, pl. viii. fig. 6. *L. gracillima* (Seg.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 330, pl. x. fig. 11. *L. gracillima* (Seg.) Goës, 1894, K. Svenska Vet.-Akad. Handl., vol. xxv. p. 75, pl. xiii. fig. 729. *L. gracillima* (Seg.) Flint, 1899, Rep. U.S. Nat. Mus. for 1897 (1899) p. 306, pl. liii. fig. 3. *L. gracillima* (Seg.) A. Silvestri, 1900, Mem. Pontif. Accad. Nuovi Lincei, vol. xvii. p. 245, pl. vi. fig. 42.

This form is very well represented in both Areas, and the specimens form an unbroken chain from *L. clavata* to the distomatous *L. elongata*.

Lagena elongata Ehrenberg sp., plate VIII. fig. 10.

Miliola elongata Ehrenberg, 1854, Mikrogeologie, pl. xxv. i. A, fig. 1. *Lagena gracillima* (Seg.) Fornasini, 1883, Boll. Soc. Geol. Ital., vol. ii. p. 185, pl. ii. fig. 5. *L. elongata* (Ehr.) Tate and Blake, 1876, Yorkshire Lias, p. 454, pl. xviii. fig. 9. *L. elongata* (Ehr.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 330, pl. x. fig. 14. *L. elongata* (Ehr.) Goës, 1894, K. Svenska Vet.-Akad. Handl., vol. xxv. p. 75, pl. xiii. fig. 731; and *L. gracillima* (Seg.) p. 75, pl. xiii. figs. 728, 730. *L. elongata* (Ehr.) Fornasini, 1895, Lagena elongata Ehr. sp.? p. two figures in text. *L. elongata* (Ehr.) Flint, 1899, Rep. U.S. Nat. Mus. for 1897 (1899) p. 306, pl. liii. fig. 1.

This cylindrical variety of *L. gracillima* is abundant, and occurs at many of the Stations in both Areas. The striated form (*L. distoma*) is not represented.

Lagena botelliformis Brady, plate VIII. fig. 15.

Lagena botelliformis Brady, 1881, Quart. Journ. Micr. Sci., n.s., vol. xxi. p. 60. *L. botelliformis* Brady, 1884, Chall. Rept., p. 454, pl. lvi. fig. 6. *L. botelliformis* (Brady) Chaster, 1892, First Rept. of the Southport Soc. of Nat. Sci., 1890–1891 (1892), p. 60, pl. i. fig. 11.

It is difficult to make out the affinities of this peculiar form; it may be an elongated and curved *L. globosa*; but on the whole it seems more nearly allied to *L. elongata*, with which consequently it is here associated.

In the Malay Archipelago it is very rare, and has been found only at Station 5 in Area 1, and Station 25 in Area 2.

The 'Challenger' specimens were obtained from shallow water off the Cape de Verde Islands; in material from mid-ocean in the South Atlantic, 2350 fathoms; and from Station 302, south of Juan Fernandez, 1450 fathoms. Dr. Chaster obtained it from mud under Southport Pier.

Lagena gracilis Williamson, plate VIII. figs. 12–14.

Lagena gracilis Williamson, 1848, Ann. and Mag. Nat. Hist., ser. 2, vol. i. p. 13, pl. i. fig. 5. *L. williamsoni* var. near *striato-punctata* Balkwill and Millett, 1884, Journ. Micr., vol. iii. p. 78, pl. iv. fig. 4. *L. gracilis* (Will.) Chapman, 1893, Journ. R. Micr. Soc., p. 583, pl. viii. fig. 13. *L. gracilis* (Will.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 328, pl. x. figs. 25, 49; and *L. sulcata* (P. and J.), p. 328, pl. x. fig. 73. *L. gracilis* (Will.) Goës, 1894, K. Svenska Vet.-Akad. Handl., vol. xxv.

p. 77, pl. xvii. fig. 738. *L. gracilis* (Will.) Jones, 1895, Palæont. Soc., p. 189, pl. vii. fig. 6.

This is usually a striated variety of *L. clavata*, but it assumes many forms, as well illustrated by Brady in the 'Challenger' Report. In the Malay Archipelago the majority of the specimens have an affinity with the apiculata form of *L. striata* named by Seguenza *Amphorina Lyellii*,* and passage-forms exist in an unbroken series from the one to the other.

The examples figured show variations in the form of the test as well as in the character of the sculpture, which ranges from that of *L. striata* to that of *L. sulcata*.

It is abundant at Station 30, and occurs at a few other Stations in both Areas.

Lagena quinquelatera Brady, plate VIII. fig. 11.

Lagena quinquelatera Brady, 1881, Quart. Journ. Micr. Sci., n.s. vol. xxi. p. 60. *L. quinquelatera* Brady, 1884, Chall. Rept., p. 484, pl. lxi. figs. 15, 16. *L. quinquelatera* (Brady) var. *inflata* Chapman, 1893, Journ. R. Micr. Soc., p. 584, pl. vii. fig. 17.

This is a rare form in the Malay Archipelago, although it occurs at several Stations. The margins are subcarinate, and usually exhibit small cavities placed at regular intervals; some of the 'Challenger' specimens are faintly striate, and Chapman says of the gault variety "aboral extremity minutely denticulate."

Brady describes the species as being "compressed equally on five sides," and classes it with the compressed *Lagenæ*, although he also speaks of it as a modification of *L. lævis*.

The Malay Archipelago examples find their nearest affinities in *L. gracilis*, and might almost be described as a variety of that species.

The 'Challenger' localities are, South Pacific, north of the Society Islands, 2350 fathoms; and Southern Ocean, off Prince Edward's Island, 50–150 fathoms.

Compressed **Lagenæ**.

Group of *Lagena lævigata*.

Lagena lævigata Reuss sp.

Fissurina lævigata Reuss, 1850, Denkschr. k. Akad. Wiss. Wien, vol. i. p. 366, pl. xlvi. fig. 1. *Lagena lævigata* (Reuss) Balkwill and Millett, 1884, Journ. Micr., vol. iii. p. 80, pl. ii. fig. 6; and trigonal form p. 81, pl. iii. fig. 6. *L. marginata* (Montagu) Haeusler, 1887, Neues Jahrb. für Min., p. 186, pl. iv. figs. 51, 52.

* Foram. monotal. Mioc. Messina, 1862, p. 52, pl. i. fig. 40.

L. lucida (Will.) Fornasini, 1888, Boll. Soc. Geol. Ital., p. 47, pl. iii. fig. 5. *L.* (*Fissurina*) *lævigata* (Reuss) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 330, pl. x. figs. 64, 65. *L. marginata* (Montagu) Haeusler, 1893, Abhandl. schweiz. Pal. Gesell., vol. xx. p. 18, pl. i. figs. 65, 66. *L. lævigata* (Reuss) Jones, 1895, Palæont. Soc., p. 197, pl. vii. fig. 14. *L. lævigata* (Reuss) Madsen, 1895, Meddelelser fra Dansk Geol. Forening, No. 2, pp. 74 and 195, pl. fig. 3. *L. lævigata* (Reuss) var. *calostoma* Fornasini. 1901, Mem. R. Accad. Sci. Ist. Bologna, ser. 5, vol. ix. p. 48, fig. 2 A B.

This widely distributed form is found in more or less abundance at nearly all of the Malay Archipelago Stations. It varies in the usual manner from globular to elongate, and is of various degrees of compression, but in all cases the margin is marked by a narrow band of clear shell-substance.

Lagena lævigata Reuss sp. var. *acuta* Reuss sp.,
plate VIII. fig. 16.

Entosolenia marginata var. *lucida* Williamson, 1858, Rec. Foram. Gt. Britain, p. 10, pl. i. fig. 23. *Fissurina acuta* Reuss, 1862, Sitzber. k. Akad. Wiss. Wien, vol. xlvi. p. 340, pl. vii. fig. 90, and *F. apiculata*, p. 339, pl. vi. fig. 85. *Lagena acuta* (Reuss) Fornasini, 1888, Boll. Soc. Geol. Ital., vol. vii. p. 47, pl. iii. fig. 6. *L. acuta* (Reuss) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 332, pl. x. figs. 74, 75. *L. acuta* (Reuss) var. *sacculus* Fornasini, 1901, Mem. R. Accad. Sci. Ist. Bologna, ser. 5, vol. ix. p. 49. pl. fig. 3.

This occurs in two forms. In one of these, as in *L. lævigata*, the margin is rounded and marked by a band of clear shell-substance. The other is the variety described by Brady in the 'Challenger' Report,* and stated by him to be "not quite typical, and might with equal propriety be treated as a mucronate example of *Lagena marginata*."

In the Malay Archipelago the variety more nearly corresponding with *L. lævigata* is the more common and more generally distributed; the carinate variety is more restricted in its range, and is found most abundantly in Area 2.

Lagena lucida Williamson sp.

Entosolenia marginata var. *lucida* Williamson, 1848, Ann. and Mag. Nat. Hist., ser. 2, vol. i. p. 17, pl. ii. fig. 17. *Lagena lucida* (Will.) Balkwill and Millett, 1884, Journ. Micr., vol. iii. p. 80, pl. ii. fig. 7, and pl. iii. figs. 4, 5.

* Chall. Rept., 1884, p. 474, pl. lix. fig. 6.

In this variety the clear shell-substance surrounding the aperture, besides forming the marginal band as in *L. lævigata*, is produced on the centre of each side into an oval or pear-shaped mass. Compared with *L. lævigata* the test is usually broader at the base and more angular, tapering towards the oral end. Many of the examples are, however, elongate, and some apiculate.

This form is by no means so common nor so widely distributed as *L. lævigata*, and has received but little notice from writers on the Foraminifera. It is very abundant in the Tertiary beds of St. Erth, and the difference in the shell-structure is there as well marked as in the recent specimens.

Lagena fasciata Egger sp. plate VIII. fig. 19.

Oolina fasciata Egger, 1857, Neues Jahrb. für Min., p. 270, pl. v. figs. 12–15. *Lagena fasciata* (Egger) Reuss, 1862, Sitzber. K. Akad. Wiss. Wien, vol. xlvi. p. 323, pl. ii. fig. 24. *Fissurina* Nos. 66 and 67 von Schlicht, 1870, Foram. Septar. Pietzpuhl, p. 12, pl. iv. figs. 25–30. *L. quadricostulata* Reuss, 1870, Sitzber. K. Akad. Wiss. Wien, vol. lxii. p. 469. *L. quadricostulata* (Reuss) Brady, 1884, Chall. Rept., p. 486, pl. lix. fig. 15.

Having traced the changes of form in the disposition of the clear and the opaque shell-substance in *L. lævigata* and *L. lucida*, it is now necessary to follow them through their further stages. Taking *L. annectens* Burrows and Holland,* two narrow curved bands appear on each side of the shell. In *L. faba* Balkwill and Millett† these bands are slightly raised, whilst they become costæ in *L. quadricostulata* Reuss, *L. fasciata* Egger, and *L. Meyeriana* Chapman.‡

These bands may or may not unite at the base of the shell; Dr. Egger's examples of *L. fasciata* show both conditions, whilst in the only known specimen of *L. Meyeriana* the costæ, although continuous, are recurved, and form a sinus at the aboral extremity.

In the Malay Archipelago *L. fasciata* is abundant and widely dispersed, and there is great variety not only in the form of the test, but in the strength and disposition of the costæ.

It is a common form in the Tertiary beds of St. Erth.

Lagena multicosta Karrer sp., plate VIII. fig. 17.

Fissurina multicosta Karrer, 1877, Abhandl. K. K. Geol. Reichsanstalt, vol. ix. p. 379, pl. xvi. *b* fig. 20, and *Fissurina Bouei* p. 378, pl. xvi. *b* fig. 19. *Lagena multicosta* (Karrer) Brady, 1884, Chall. Rept., p. 466, pl. lxi. fig. 4. *Lingulina costata* (d'Orb.) Fornasini, 1889, Mioc. di San Rufillo, pl. i. fig. 17.

* Palæont. Soc., 1895, p. 203, pl. vii. fig. 11.
† Journ. Micr., vol. iii. 1884, p. 81, pl. ii. fig. 10.
‡ Quart. Journ. Geol. Soc., vol. i. 1894, p. 706, pl. xxxiv. fig. 7.

This is another member of the group possessing the two different characters of shell-substance; and, as in *L. lævigata,* the clear shell-substance surrounding the aperture extends in a thin band round what may be called the margin of the test.

In the Malay Archipelago examples there is very little branching or other irregularity of the costæ, and they usually cover the entire surface of the test from the base to the prominence in which is situated the aperture.

The form is extremely abundant at several stations in Area 2, but is very rare in Area 1.

The only 'Challenger' station reported is No. 346, South Atlantic, a little south of the Equator, 2350 fathoms, but I have found it in the material from Station 185, Raine Island, Torres Strait, 155 fathoms.

Lagena quadrata Williamson sp., plate VIII. fig. 18.

Entosolenia marginata var. *quadrata* Williamson, 1858, Rec. Foram. Gt. Britain, p. 11, pl. i. fig. 27. *Lagena lucida* var. *quadrata* (Will.) Reuss, 1862, Sitzber. K. Akad. Wiss. Wien, vol. xlvi. p. 324, pl. ii. fig. 26. *L. quadrata* (Will.) Balkwill and Millett, 1884, Journ. Micr., vol. iii. p. 81, pl. ii. fig. 8. *L. lævigata* var. *quadrata* (Will.) Wright, 1886, Proc. Belfast Nat. Field Club, 1884–5, App. ix. p. 324, pl. xxvi. fig. 9. *L. quadrata* (Will.) Egger, 1893, Abhandl. K. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 331, pl. x. figs. 78, 79; and *L. compressa*, p. 331, pl. x. figs. 1, 2. *L. quadrata* (Will.) var. Jones, 1895, Palæont. Soc., p. 198, pl. vii. fig. 9.

Here, as elsewhere, this species occurs in two forms; one of them with the margin rounded, and allied to *L. lævigata*; the other with a carinate margin, and differing but little from *L. marginata.*

It occurs at several Stations in the Malay Archipelago, but only in small numbers.

Group of *Lagena marginata.*

Lagena marginata Walker and Boys.

"Serpula (*Lagena*) marginata" Walker and Boys, 1784, Test. Min., p. 2, pl. i. fig. 7. *Lagena marginata* (W. and B.) Brown, 1827, Illustr. Conch. Gt. Brit., fly-leaf, pl. i. figs. 30, 31. *L. marginata* (W. and J.) Balkwill and Millett, 1884, Journ. Micr., vol. iii. p. 81, pl. iii. fig. 2. *L. marginata* (Montagu) Haeusler, 1887, Neues Jahrb. für Min., vol. i. p. 186, pl. iv. fig. 53. *L. marginata* (W. and B.) Brady, Parker, and Jones, 1888, Trans. Zool. Soc., vol. xii. p. 222, pl. xliv. figs. 27, 29, 30, 32. *Fissurina alata* (Reuss) Franzenau, 1889, Math. termész. értesito, vol. vii. p. 249, pl. iii. fig. 4. *L. marginata* (Montagu) Haeusler, 1890, Abhandl. schweizer. Pal. Gesell., vol. xvii. p. 86, pl. xiii. fig. 112. *L. marginata* (W. and B.), Chapman, 1893, Journ. R. Micr. Soc., p. 584, pl. viii. fig. 16. *L. marginata* (W. and B.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 332, pl. x. figs. 20, 66, 67, 96, 97. *L. marginata* (W. and B.) Goës, 1894, K. Svenska Vet. Akad. Handl., vol. xxv. p. 81, pl. xiii. fig. 748. *L. marginata* (W. and J.) Jones, 1895, Palæont. Soc., p. 199, fig. 22. *L. marginata* (W. and B.) Silvestri, 1896, Mem. Pontif. Accad. Nuovi Lincei, vol. xii. p. 119, pl. iii. figs. 7–9. *L. marginata* (W. and B.) Perner, 1897, Česká Akad. Cisare Frantiska Josefa (Palæont. Bohemica) No. 4, p. 18, pl. vii. figs. 3, 5, 7. *L. marginata* (Walker) Egger, 1899, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xxi. p. 104, pl. v. fig. 5. *L. marginata* (W. and B.) Flint, 1899, Rep. U.S. Nat. Mus. for 1897, (1899) p. 307, pl. liv. fig. 2. *L. marginata* (W. and B.) Silvestri, 1900, Mem. Pontif. Accad. Nuovi Lincei, vol. xvii. p. 243, pl. vi. figs. 51, 52. *L. marginata* (W. and B.) Fornasini, 1900, Mem. R. Accad. Sci. Ist. Bologna, ser. 5, vol. viii. p. 376, fig. 25. *L. marginata* (W. and B.) Wright, 1900, Geol. Mag., dec. 4, vol. vii. p. 100, pl. v. fig. 17.

This usually common form is not very abundant in the Malay Archipelago, and although it is plentiful at a few Stations, at the others it occurs but sparingly.

It is best represented by its varieties, which are numerous and diversified.

Lagena marginata Walker and Boys var. plate VIII. fig. 20.

This variety is distinguished by its truncated contour, the test being almost semicircular, with the aperture situated in a depression at the apex of the shell. In form it closely resembles the *Fissurina aperta* of Seguenza* and the *Lagena faba* of Balkwill and Millett.†

It is very rare, and occurs only at a few Stations.

Lagena marginata Walker and Boys var. plate VIII. fig. 21.

This variety is also very rare. The recurved spines at the oral extremity of the elongated neck appear to have but little value as a criterion of species, as they have been found by F. W. O. Rymer Jones in *L. lævis*,‡ and by Dr. Chaster in a compressed form resembling *L. lævigata*.§

* Foram. monotal. Mioc. Messina, 1862, p. 60, pl. i. fig. 60.

† Journ. Micr., vol. iii. 1884, p. 81, pl. ii. fig. 10.

‡ *Lagena vulgaris* typica, Trans. Linn. Soc., vol. xxx. 1872, p. 51, pl. xix. fig. 13.

§ *Lagena falcata*, First Rept. of the Southport Soc. of Nat. Sci., 1892, p. 6, pl. i. fig. 7.

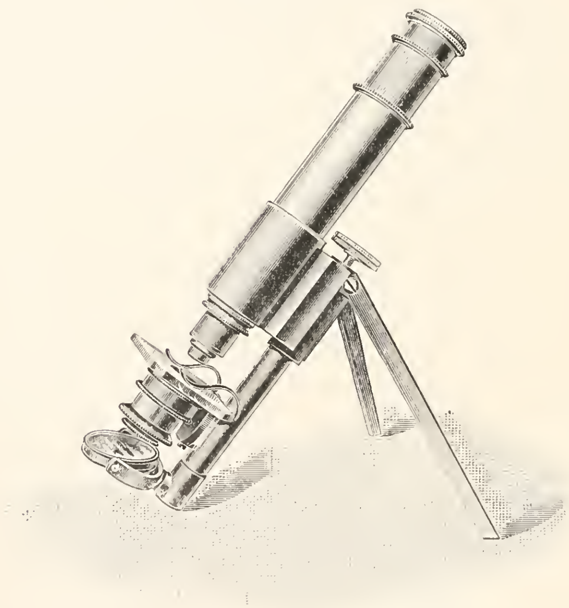
NOTE.

Note on a Travelling and Sea-side Microscope.

By Mr. A. A. C. Eliot Merlin.

As will be seen from the annexed figure (fig. 103), this form of travelling Microscope is by no means new. It having, however, fallen into disuse and been superseded by more elaborate although less portable and less steady instruments, the object of this present

Fig. 103.



communication is to draw attention to some of its advantages, in the hope that a demand for this class of portable Microscope may again arise.

The original design was worked out by Mr. Moginie, of Mr. Charles Baker's establishment, and is first described in a paper * read before the Royal Microscopical Society on January 9th, 1867, by Mr. J. Newton Tomkins, F.R.C.S., F.Z.S.. F.R.M.S. As made by

* See Microscopical Journal, 1867, vol. xv. p. 20.

Baker, the instrument had tubular legs constructed to hold pipettes, and the body was of sufficient diameter to take large-sized eye-pieces.

The modified form figured was constructed by Messrs. J. Swift and Son, and was catalogued by that firm until recently. The body and draw-tube, together with an eye-piece adapter, extend to $8\frac{1}{2}$ in. and close to $4\frac{1}{4}$ in. The spread of the folding tripod foot is $5\frac{1}{2}$ in. The stage turns on a well-made pivot for convenience in packing; plane and concave mirrors are furnished; while the whole instrument, which is remarkably well finished, and weighs only 1 lb. 2 oz., packs into a leather-covered box measuring $6\frac{1}{2}$ by $2\frac{3}{4}$ by $2\frac{1}{4}$ in. A really good micrometer screw fine adjustment is provided, working on a triangular bar; this moves the body steadily and smoothly without lateral shake even when high-power objectives are employed.

The writer has had a small achromatic condenser added of N.A. $1 \cdot 0$, furnished with an iris diaphragm and a fitting to carry either central stops, slots, or a green-glass light-modifier. The top lens of the condenser system is removable for low-power work. Thus fitted the instrument is admirably adapted for all purposes to which the more elaborate descriptions of travelling Microscopes are usually put, and will allow of the employment of even oil-immersion objectives.

An additional tripod foot is sometimes provided, in order that the Microscope may be used in an upright position when necessary.

SUMMARY OF CURRENT RESEARCHES

RELATING TO

ZOOLOGY AND BOTANY

(PRINCIPALLY INVERTEBRATA AND CRYPTOGAMIA),

MICROSCOPY ETC.*

ZOOLOGY.

VERTEBRATA.

a. Embryology.†

Artificial Parthenogenesis.‡—Prof. Jacques Loeb showed, in 1899 and 1900, that, by an increase in the osmotic pressure of the sea-water, the unfertilised eggs of a number of Echinoderms can be caused to develop parthenogenetically. He has since found that the unfertilised eggs of *Chætopterus* behave similarly, and may be developed to the stage of trochophore larvæ. In no case did he see a single egg of the control material develop into a larva, though some showed a beginning of segmentation. The greatest precautions were taken to exclude the possibility of spermatozoa getting among the eggs.

The *Chætopterus* eggs are able to develop parthenogenetically if they are put for about one hour into one of the following solutions, and then into normal sea-water:—

15–20	$2\frac{1}{2}$ *n* NaCl	+ 85	sea-water.
40	2 *n* cane-sugar	+ 60	„
30	$2\frac{1}{2}$ *n* $MgCl_2$	+ 70	„
10	5 *n* $CaCl_2$	+ 90	„

All these solutions have one element in common, the approximately equal increase of the osmotic pressure. It seems, therefore, justifiable to assume that the increase in the osmotic pressure, or the loss of water on the part of the egg, is the cause of the parthenogenetic development of these eggs. KCl (or perhaps the K-ions) seems to possess a specific effect. There is no warrant for supposing that the eggs of *Chætopterus* are normally parthenogenetic, or that the animals experimented with were dichogamous hermaphrodites.

The unfertilised eggs cannot develop into trochophores if left in normal sea-water, but a small number of K-ions is sufficient to cause

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

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

‡ Amer. Journ. Physiol., iv. (1901) pp. 423–59. Cf. this Journal, 1900, p. 64.

them to develop parthenogenetically. If the sea-water contained only a slightly greater proportion of K, we should find that *Chætopterus* was "normally" parthenogenetic.

A very striking fact is that the addition of a small amount of HCl to the sea-water also induced the parthenogenetic development of the *Chætopterus* eggs.

Although the trochophore larvæ which developed parthenogenetically died in a day or two (as those originating from fertilised ova also did), they were vigorous and normal; but during the artificial parthenogenetic development there is a strong tendency to amœboid conditions and to great indistinctness of cleavage.

As in *Arbacia*, but more readily, giant embryos may arise by fusion of two eggs, and dwarf embryos also occurred rarely in the experiments with hydrochloric acid.

Some strange facts are adduced which lead the experimenter to surmise that the possibility of a successful hybridisation between Echinoderm spermatozoa and Annelid ova is not to be dismissed as ridiculous. But it will be time enough to consider such a crossing when it is effected.

A number of preliminary experiments were made on *Phascolosoma*, *Fundulus*, *Gonionemus*, and *Podarke*.

In general, Prof. Loeb believes that the spermatozoon can no longer be considered as the cause or the stimulus of the process of development, but merely as an agency which accelerates a process that is able to start without it, only much more slowly. We may assume that the spermatozoon carries a catalytic substance into the egg. Similarly, the K-ions merely act as catalysers, accelerating a process which would otherwise proceed too slowly.

Parthenogenesis or Chemical Fertilisation.*—Camille Viguier has given a detailed account of his observations, in a paper which is in great part devoted to a criticism of Loeb and to a response to his criticisms. Viguier claims priority for the discovery that parthenogenesis naturally occurs in *Sphærechinus granularis*, *Arbacia pustulosa*, and *Toxopneustes lividus*, and he also records that he has been quite unable to confirm Loeb's results. He furnishes an excellent bibliography.

In another paper † Viguier reiterates his discovery of casual hermaphroditism in *Sphærechinus granularis*, and of casual but more frequent parthenogenesis in the same species, in *Toxopneustes lividus*, and in *Arbacia pustulosa*.

Attending in particular to two risks—(1) of intra-ovarian fertilisation, and (2) of the entrance of spermatozoa in insufficiently filtered water, Viguier made a fresh set of experiments. He convinced himself of the occurrence of genuine parthenogenesis, in a few instances, in *Toxopneustes* and *Arbacia*. But none got beyond the gastrula stage. The author thinks that the relatively low temperature at the time of experimentation had to do with this; the development of fertilised ova was much slower than usual. He suggests that the temperature may

* Ann. Sci. Nat. (Zool.), xii (1900) pp. 87–138.
† Comptes Rendus, cxxxii. (1901) pp. 1436–8.

have something to do with determining a tendency to parthenogenesis during the period before liberation.

Chemical Composition of Germ-Cells and that of Solutions inducing Parthenogenesis.* — Yves and Marcel Delage, referring to Loeb's experiments on the parthenogenetic effect on sea-urchin ova of solutions of magnesium chloride in sea-water, have inquired into the chemical composition of the germ-cells of the sea-urchin (*Strongylocentrotus lividus*), to see how the sperm stands as regards magnesium. The analysis shows that the proportions of this metal in the sperms and in the ova are not sensibly different. If there is a difference, it is rather in favour of the ova. The authors note that Loeb has meanwhile suggested that the solution acts not by any specific chemical influence, but solely by an alteration in the osmotic pressure.

Heredity and Disease.†—Prof. J. G. Adami discusses, from a pathologist's point of view, Weismann's theory of inheritance, with special reference to the transmission of acquired conditions in man. Medical men, he says, all admit that "inheritance plays a part in the development of morbid conditions," but are "unwilling to discuss or write about the exact part played by it." Perhaps the reason is that man is not a good subject for investigation; he breeds very slowly; and, as with other placentals, there are complications introduced by maternal influence during the uterine life. Thus medical men have had to depend upon biologists, whose theories "have assumed shapes which would not disgrace the schoolmen of the Middle Ages."

Prof. Adami states Weismann's theory of heredity and part of his theory of development. "So far as regards the ids, the brilliant observations of Driesch, abundantly confirmed by others, show that the conception is untenable. . . . . The existence of these hypothetical ids is absolutely disproved." [It should have been noted, however, that reconciliations between Driesch's facts and the hypothesis have been at least attempted by Weismann, Roux, and others.] Prof. Adami states Weismann's theory even by quotation, yet he writes in exposition, "However much a man abuses his soma or body is of little moment, the effect upon the offspring is minimal." [This seems an extreme statement, seeing that Weismann admits the possibility of infection of the germ, e.g. by the specific bacteria of syphilis, the possibilty of climatic and other influences affecting both soma and germ-cells, and the possibility that nutritrive changes in the soma may prompt variations in the germ-plasm.]

Adami has thought out an independent theory of heredity, which may be summed up as follows. Distinguishing the essential and directive living matter of an organism as its idioplasm in contrast to the less vital cytoplasm, recognising also that the idioplasm has come to have in the course of evolution an increasing complexity of constitution, and that in spite of its relative constancy it is capable of being changed by environmental influence, the author asks, "Can we imagine a chemical substance so constituted as to be capable of modification in its molecular constitution—and so in sundry of its properties—without undergoing complete change, without other properties being lost?" He finds an analogy in the different forms of various organic substances, such

* Comptes Rendus, cxxxi. (1900) pp. 1227–9.
† Brit. Med. Journ., June 1st, 1901, pp. 1317–23.

as malic acid, which has four forms. "*A fortiori*, idioplasm may be capable of an enormous number of modifications. The mode of the atomic arrangement in the idioplasmic molecule may, therefore, in part, explain the variation in the properties of that idioplasm seen throughout the animal and vegetable kingdoms." But it seems too much to assume for each species, or even individual, a different atomic structure of the idioplasm. Therefore the author pictures the primitive idioplasm as composed of a mass of material, each molecule of which is formed of a central ring, to which there can be attached side chains, from which sundry side chains can be detached without the central ring being destroyed.

"It is not necessary to regard the molecules of idioplasm as at all times presenting their completed structure, with every side chain attached. On the contrary, we are free to conceive the molecules being laid down and being transmitted in a relatively simple form, some of the side chains only becoming attached when the molecules are brought into certain particular relationships with their surroundings. It is not necessary, for example, to hold that already in the ovum there is idioplasm identical in structure with that eventually present in the muscle-fibres or nerve-cells developed from that ovum. Rather we must hold that in the ovum there is one common idioplasm of simple type, to which, when distributed in the various cells derived from that ovum, different side chains become attached, according to the relationships assumed by those cells; so that the cells of different orders are controlled and formed around protoplasmic or idioplasmic molecules composed of these central rings *plus* varying series of side rings. . . . . Indeed, idioplasm possessing its full complement of side chains must be regarded as *ipso facto* incapable of initiating cell-multiplication." [This suggestive theory seems in some respects a chemical re-statement of the position of Driesch and Hertwig. The reader will recognise that the idioplasmic molecule is quite as hypothetical as Weismann's "ids."]

Prof. Adami first illustrates his side-chain theory of inheritance by reference to unicellular forms, where he finds "the simplest example of the inheritance of acquired characters." [The difficulty of applying the conception of an "acquired character" or "direct somatic modification" to forms like bacteria has often been pointed out.] From the importance of environmental influence in bacteriological work the author works upwards to its importance, both in the development of the body and in the slow alteration of the idioplasm in the germ-cells. "Variation, whether slight and individual or extensive, and leading to the production of species, is ultimately the expression of modification in the constitution of the idioplasm brought about by environment." [But Weismann has also said, "The primary cause of *variation* is always the effect of external influences," and much more to the same effect.]

Passing to special medical problems, Adami admits the non-transmission of acquired mutilations. "At most we can conceive the possibility of indirect effect where the mutilation is extensive or affects organs playing an important part in general nutrition."

He next argues in support of "the indirect inheritance of acquired diathesis." Constitutional disease may have an effect upon the germ-cells and thus upon the offspring. "Conditions affecting the parents are capable of influencing and modifying the descendants." "It is changes of this order which are almost inevitably neglected by biologists—for they are not within their ken." [But their relation to the precise question of the transmission or non-transmission of "acquired characters" or "direct somatic modifications" has often been discussed.]

Finally, Prof. Adami advances further, and finds evidence of "the direct inheritance of acquired constitutional states." Immunity and its converse of special susceptibility are discussed in illustration. Weismann's theory that toxins, &c., may act directly on the germ-cells as well as on the body-cells is dismissed as "a sorry and almost Jesuitic play upon words." "The individual consists of body-plasm and germ-plasm, and whether the defect tells primarily or secondarily upon the germ-plasm of the individual, we have here examples of conditions acquired by the individual being transmitted to the offspring." But apart from exogenous and bacterial intoxications, there are endogenous or auto-intoxications such as gout, and Prof. Adami regards "the gouty diathesis as an example of truly somatogenic acquirement of an inherited and inheritable constitutional state." "Defect in bodily metabolism has led to intoxication of the germ-cells, and the offspring show a peculiar liability to be the subjects of intoxications of the same order. Here what is transmitted is a constitutional state, and that constitutional state may manifest itself in more than one way; but no one will deny that this is truly inheritance of an acquired condition." [It may be, however, that the gouty diathesis is the expression of a germinal variation.]

Morphological Continuity of Germ-Cells in Skate.*—Dr. J. Beard, in an important paper, traces the history of the germ-cells of *Raja batis*. He interprets the large yolk-laden cells of early embryos (Rückert's "megaspheres") as germ-cells, or the forerunners of such. There is an unbroken transition, and the megaspheres do not form any portion of an embryonic organ. They may occur in the most diverse places and regions (except the tail), but they have a very definite main *germ-path*—from the yolk-sac upwards between splanchnopleure and gut in the hinder portion of the blastoderm. They are vagrant, however, and often go quite astray—forming the "*verirrte Keime*" of pathologists.

The germ-cells do not arise from any part of the embryo, they arise before there is any embryo at all, or are "*Geschwister*" with it; there is no germinal epithelium!

Each germ-cell is the sister-cell of the cell destined to give rise to the embryo. If one of them were to begin development alongside of the developing embryo, the result would be the production of a more or less perfect twin. This is practically what happens in the growth of a dermoid in the ovary, testis, or elsewhere.

"The germ-cells may be regarded as unicellular organisms, which pass one part of their life-history within a multicellular sterilised stock, the embryo, or metazoon, formed by one of them at a definite

* Anat. Anzeig., xviii. (1900) pp. 465–85.

period in the life-cycle. . . . The continuity of a hypothetic germ-plasm resolves itself into an actual morphological continuity of germ-cells."

Œstrous Cycle in Sheep and the Formation of the Corpus luteum.*—F. H. A. Marshall makes a preliminary communication on this subject. The anœstrum or resting period is from March to October; in July and August, for instance, the ovaries showed no protruding follicles, nor corpora lutea, nor follicles beginning to undergo atresia. Procœstrum and œstrus are hardly separable, and the two combined are short, probably not more than two days.

At the close of the anœstrum the vulva becomes swollen and congested; there is a slight flow of mucus; in some cases there is extremely slight bleeding of the uterine wall. The characteristics of all Heape's stages from I. to VI. were more or less clearly recognised in the uterus.

It was definitely shown that ewes need not be served in order to induce ovulation, which indicates the possibility of successful artificial insemination. When ovulation takes place, one follicle may rupture, or one in each ovary, or two in the same ovary.

The author has some notes on the period of "heat," the succeeding metœstrum, and the period of rest (diœstrum). After not many days, the diœstrum is followed by another procœstrum, and so on, until the sheep becomes pregnant or the breeding season is over. The complete diœstrous cycle observed was 15 days, but other observations suggest variation from about 13 to 18 days.

Marshall gives an account of the development of the corpus luteum which agrees substantially with that given by Sobotta for the mouse and the rabbit, and by Stratz for *Tupaia* and *Tarsius*. It differs from Sobotta in the description of the part played by the theca externa, and in recording the not infrequently observed multiplication of the epithelial cells by mitotic division in the earlier stages. It is entirely opposed to the views of His, Kölliker, Nagel, Clark, Rabl, and Dœring, who all more or less clearly describe the corpus luteum as an entirely connective-tissue structure.

Cleavage of Frog's Ovum.†—Fr. Kopsch finds (1) that in the egg of *Rana fusca* there is no strict, but only approximate, correspondence between the plane of the first cleavage and the median plane of the embryo; and (2) that in *R. fusca*, *R. esculenta*, and *Siredon pisciformis*, the second cleavage does *not* separate cranial and caudal areas, nor the third cleavage dorsal and ventral areas; for the dorso-ventral and cranio-caudal axes of the embryo are not fixed until the end of the gastrulation. These results are obviously not in agreement with those of most other observers.

Division of Spermatocytes in Mammals.‡—Prof. V. von Ebner finds that in the rat the first division is heterotypical and the second homotypical, the divisions occurring much as described by Meves for the salamander. There is no evidence that a reducing division in Weismann's sense occurs, especially in view of the fact that a period of rest

* Proc. Roy. Soc., lxviii. (1901) pp. 135–40.
† Internat. Monatschr. Anat. Physiol., xvii. (1900) pp. 1–26 (1 pl. and 5 figs.).
‡ SB. Akad. Wiss. Wien, cviii. (1899) pp. 429–48 (1 pl.).

intervenes between the first and second divisions, during which individualised chromosomes are no longer to be distinguished. The only marked differences from the salamander are the completeness of the rest-stage in the rat, and the occurrence of ring-chromosomes in the second as well as in the first division. The author considers that all the evidence is against the view that the germ-cells contain individualised *chromosomes* which are the bearers of the hereditary qualities, and persist unaltered throughout the generations of the sex-cells; but this does not shake the main generalisation that the *chromatin* is the bearer of the hereditary qualities.

Spermatogenesis in the Domestic Sparrow.*—Gustave Loisel sums up his observations on the early stages of this process. He finds that the germinal epithelium of Waldeyer does not disappear in the early stages of the development of the testis; it persists in the young bird, or even in the adult, in the form of cells which may be called the germinal cells. These cells constitute the source of all the sex-cells, but diminish in number and activity as the period of spermatogenesis approaches. The spermatogonia are derived from these germinal cells, and are capable of multiplying by both direct and indirect division. These divisions are fewest in the early stages when the germinal cells are most active, and most in the later stages when the germinal cells divide little if at all. The result is that at the end of the period of pre-spermatogenesis, the generative zone of the seminiferous epithelium consists only of spermatogonia. From the time when, in the embryo, the spermatogonia of the second order appear until the formation of perfect spermatozoa in the adult, the testis does not remain in a condition of rest, but shows a periodic production of cells of an advanced type, followed by a period of regression during which these cells degenerate and are absorbed. Certain of the elements produced during each progressive period persist through the following regressive period, so that each period constitutes a step forward. When the periods succeed one another rapidly, then the functional activity of the testis begins.

Uniformity of the Embryos of Primates.†—Prof. E. Selenka compares various stages in the development of man, gibbon, *Cercocebus cynomolgus*, *Semnopithecus*, &c., and shows the very close resemblances between them, both in the early and later stages. To take a single example;—he observed in the embryo of *Cercocebusc ynomolgus* a sharp dorso-ventral indentation towards the posterior end of the trunk, which afterwards disappears; it is a striking feature never seen except in Primates; it has been described in man about the 15th or 16th day.

Retrogressive Changes in Embryonic Primordia.‡—Prof. M. Nussbaum describes the structure, the rise, and the retrogression of the papillæ of the conjunctiva scleræ which appear in the chick embryo towards the end of the sixth day of incubation, and compares the primordia of these structures with the first primordia of the feathers, showing that, as regards the *rôle* of the connective-tissue for instance, there is very little in common between them. Are the transitory papillæ

* Journ. Anat. Physiol., xxxvi. (1901) pp. 193–216 (2 pls.).
† Biol. Centralbl., xxi. (1901) pp. 484–90 (19 figs.).
‡ Arch. Mikr. Anat., lvii. (1901) pp. 676–705 (3 pls.).

hints of ancient structures now phyletically lost, or has the early incidence of degenerative processes induced a form of structure which never existed at all in adult life?

Development of the Hypophysis in Birds.*—Constantin J. Economo finds that the endoderm has nothing to do with the formation of the hypophysis in birds. The processus infundibuli arises as an outgrowth of the floor of the tweenbrain, and is the equivalent of the saccus vasculosus of fish. The processus forms a distinctly tubular infundibular gland with a duct opening into the ventricle, just as the saccus vasculosus does in fish. From the upper wall of Rathke's pocket, the hypophysial outgrowth arises, and gives off a right and left process much as it does in reptiles. The middle process becomes extensively branched, and constitutes the median and largest part of the hypophysis. The branches are at first solid, but later their club-shaped ends become hollow. The lower part of the process together with the upper region of Rathke's pocket forms the hypophysial duct, by means of which the cavity of the hypophysis comes into communication with the mouth-cavity. At this stage the hypophysis begins to secrete, but the duct is gradually narrowed, and is obliterated in the chick at the 7–10th day. The lateral hypophysial outgrowths do not disappear as in reptiles, but persist until the time of hatching.

Development of Crocodilus madagascariensis.†—Dr. A. Voeltzkow has been able to make some observations on the little-known early development of this form, and on the yolk-sac and the development of the blood and blood-vessels. As regards the development of the germ-layers, there is much general resemblance to the conditions found in *Podocnemis*. In connection with the development of the yolk-sac, the author gives an interesting comparative account of the conditions under which yolk exists in vertebrates, and the organs by means of which it is absorbed. In the crocodile in the earlier stages the yolk-sac epithelium is of great importance in yolk-absorption. It takes up the particles of yolk and conveys them to the blood-system. Later, when yolk-absorption becomes more rapid, a peculiar system of blood-vessels is developed, whose capillaries come into contact with almost every yolk-spherule. In regard to the blood and blood-vessels, the author finds that in its first origin the blood is endodermal, and precedes the formation of blood-vessels. The endothelium of the blood-vessels is mesodermic in origin, and arises without the participation of the blood-cells. The blood at this time increases by the division of its component cells, and not by budding from the walls of the vessels.

Visceral Clefts of Lacerta.‡—Dr. K. Peter describes fifteen stages in the development of the lizard's visceral clefts, and maintains that their origin is wholly endodermic. Neither an aortic arch nor an external groove is necessary for their definition. Every definitely circumscribed lateral diverticulum of the gut, down to the cardiac groove or the sinus cervicalis, which arises by proliferation, may be regarded as the primordium of an œsophageal pouch. On this view the lizard has six, and five of these always come into contact with the epidermis.

* SB. Akad. Wiss. Wien, cviii. (1899) pp. 281–97 (4 pls.).
† Abh. Senckenberg. Nat. Ges., xxvi. (1901) pp. 339–418 (7 pls. and 5 figs.).
‡ Arch. Mikr. Anat., lvii. (1901) pp. 705–65 (3 pls. and 2 figs.).

The first shares only a little in the formation of the thymus, but comes afterwards into connection with the ear, forming the tympanic cavity and auditory tube. From II. and III. arises the main part of the thymus. From IV. there also arises an epithelial body, which subsequently atrophies. The sixth forms on the left side the suprapericardial corpuscle of van Bemmelen.

Development of Spleen in Tropidonotus natrix.*—Emil Glas finds that in this form the spleen originates from the endoderm. It arises, together with the dorsal pancreas, from an evagination on the dorsal surface of the duodenum. Originally it is structurally similar to the pancreas, consisting like it of tubular glands, so that it is legitimate to speak of a hepatopancreas and a lieno-pancreas. The duct of the lieno-pancreas unites with that of the dorsal pancreas to form a common duct, which opens into the gut close to the common opening of bile-duct, cystic duct, and ventral pancreatic duct, and may be called the ductus pancreatico-lienalis. In the youngest stages this duct is entirely dorsal, and its opening is opposite to that of the ventral pancreatic duct. Later it approaches more and more closely to the bile-duct, until it finally unites with it, and opens with it on the ventral surface of the gut.

Development of Egg in Mabuia multifasciata.†—Dr. J. H. F. Kohlbrugge has been able to trace the development of the egg in this viviparous skink from the first stage until fertilisation. The primordial eggs show a reticular cytoplasm and a vesicular nucleus, whose margin consists of chromatin radiating out into the cytoplasm. As the cells increase in size, karyosomata appear in the nucleus, and smaller microsomata in the cytoplasm. Meanwhile, the future follicular cells have arranged themselves around the egg to form an investment, and individual cells become free and pass into the egg-substance. While this is going on, nucleoli, often vacuolated, appear within the egg-nucleus, and the nucleus itself becomes separated by a clear space from the cytoplasm. The egg unites with the surrounding inner follicular cells to form a syncytium, and yolk-formation begins. This occurs in two regions of the egg—at the margin under the influence of the follicular cells, and centrally under the influence of the nucleus, both karyosomata and microsomata forming yolk-spherules. The yolk-nuclei of other investigators the author believes to be the nuclei of dissolved follicle cells or nucleoli discharged from the egg-nucleus.

Germ-layers of Podocnemis madagascariensis.‡—Dr. A. Voeltzkow has studied the germinal discs in a number of eggs of this fresh-water tortoise, in order to settle the disputed questions connected with the very early stages of development. He finds that an outer and an inner crescentic groove can be distinguished. The outer or primitive crescent is the beginning of the primitive plate, and is the homologue of Koller's crescent in the chick, and Will's primitive crescent in *Platydactylus* and *Testudo*. The inner crescentic groove is identical with the mesodermic crescent, and with Kupffer's crescent. There are no intermediate plates, no diverticula of the cœlom, no formation of folds; but the common endoderm splits into enteroderm and mesoderm; the median

* SB. Akad. Wiss. Wien, cix. (1900) pp. 265–99 (3 pls.).
† Arch. Mikr. Anat., lviii. (1901) pp. 376–410 (3 pls.).
‡ Abh. Senckenberg. Nat. Ges., xxvi. (1901) pp. 275–310 (4 pls. and 8 figs.).

cell-mass, which constitutes the rudiment of the notochord, taking no part in the splitting. After the splitting has become marked, the notochord becomes separated off from the lower germ-layer; in its cranial region it is a derivative of the endoderm, and in its caudal region of the upper wall of the neurenteric canal.

Abdominal Ribs in Reptiles.* — Dr. A. Voeltzkow and Prof. L. Döderlein discuss, the former the ontogenetic development of these structures in crocodiles and *Hatteria*, and the latter their phylogenetic significance. Voeltzkow finds that in *Crocodilus* the ribs arise in the subcutaneous connective-tissue outside the ventral muscles at the same time as the covering-bones of the head, and are bony from the first. There is no direct relation between them and the ventral muscles. In their relation to the muscles, the abdominal ribs of *Hatteria* and *Crocodilus* appear to be completely homologous. Prof. Döderlein argues that this result entirely confirms the conclusion, which has long been probable on palæontological grounds, that the abdominal ribs (ventral skeleton) are the remnants of a dermal skeleton, and are entirely homologous with the membrane bones of the skull and shoulder-girdle.

Development of the Permanent Kidney in Amniota.† — Dr. U. Gerhardt has studied this much-discussed problem in embryos of white mouse, pig, dog, and fowl. He comes to the following conclusions:— (1) In Amniota the permanent kidney is a new organ, which takes its origin from the archinephric duct, but not from the primitive tubules. (2) The Malpighian bodies of the permanent kidney are spatially and developmentally quite distinct from those of the primitive kidney; they arise through the invagination of the peripheral blind end of a renal canaliculus by a vascular coil. (3) The peripheral portions of the renal canaliculi arise by the continuous growth of the collecting tubes. It was not demonstrable that the canals formed in the cortex enter secondarily into connection with those of the medulla. (4) Permanent kidney and primitive kidney are not homologous; they do not develop in the same way.

Regeneration of Bone in Urodela.‡ — Dr. H. Wendelstadt has experimented with axolotls and newts. Bone and cartilage in Urodela are regenerated only from bone and cartilage, and in the direction of embryonic growth. In a much injured arm, regeneration in a centrifugal direction may form a fresh set of bones, even when the old set, displaced by the injury, is still present. The ulna does not regenerate the radius, nor the radius the ulna; in fact there never is regeneration of a laterally adjacent separate piece of skeleton. In the centripetal direction, there may be mending (*Ausbesserung*), but no distinct replacement was demonstrated. As to the amount of regeneration, it may be noted that from the humerus there may be a regeneration of the fore-arm and of the hand.

Tympano-Eustachian Passage in the Toad.§ — H. Fox has investigated the development of the tympano-eustachian passage and associated

* Abh. Senckenberg. Nat. Ges., xxvi. (1901) pp. 315–36 (3 pls. and 1 fig.).
† Arch. Mikr. Anat., lvii. (1901) pp. 822–42.
‡ Tom. cit., pp. 799–822 (3 pls.).
§ Proc. Acad. Sci. Philadelphia, 1901, pp. 223–60 (4 pls.).

structures in the toad (*Bufo lentiginosus*). The passage is in the main derived from the dorsalmost portion of the hyomandibular fold (cleft); but its history, up to the time when it acquires a lumen and unites with an outgrowth from the pharynx, is very complex. Its final position between the mandibular and hyoid bars is produced by the separation of the latter from the quadrate and its attachment to the auditory capsule posterior to the tube. The annular cartilage arises at a stage immediately preceding the protrusion of the fore-limbs. Its primordium forms a dense cellular strand derived from the perichondrium of the quadrate and surrounding the tympanic portion of the tubal primordium. The stapes arises within the membrane closing the fenestra ovalis, and has no connection with any of the visceral arches. The columella auris is first met with in the early stages of the metamorphosis, as a compact cellular strand extending forward from the stapes and terminating imperceptibly in the connective-tissue. It continues to grow forward, and acquires connection with the quadrate. Continued growth brings it into contact with the tympanic cavity. Chondrification begins in the posterior portion of the rod. But we are not able to indicate more than a moiety of the author's results.

Symmetrical Double Monstrosities in the Trout.*—Dr. J. F. Gemmill has studied a series of four-month old monstrosities, and distinguishes four types:—(1) United in head region, (*a*) the twin brains united at the mesencephalon, (*b*) at the medulla oblongata; (2) united in pectoral region, (*a*) with pectoral fins absent on adjacent side, (*b*) present but united; (3) united behind the pectoral region, (*a*) at a considerable distance in front of the vent, (*b*) close to the vent; (4) united by the yolk-sac only.

At the region of transition in laterally symmetrical double monstrosities, the notochords are the last structures to unite; the equally primitive neural axis and gut lose their duplicity earlier; those parts of the neural axis and gut which are most closely apposed to the notochord retain evidence of original duplicity longer than parts that are more remote. Duplicity of the dorsal aorta, of the pronephric glomerulus, of the vertebral cartilages, of the body muscles, and of various other structures, is correlated with duplicity of the notochord. In paired organs the transition from the double to the single condition takes place at the expense of the inner or adjacent elements, which unite and are reduced. It is inferred that fusion has played a not unimportant part in moulding the form of the neural axis and the alimentary tract in the transition region. The law that union takes place between homologous structures always holds good. With the rarest exceptions, double monstrosities in the trout are examples either of anterior duplicity or of union by the yolk-sac only, in marked contrast to what occurs in birds and mammals. An explanation is suggested which depends on the mode of origin of the primitive streak and the overgrowth of the blastoderm on the yolk mass.

Development of Ceratodus.†—Dr. Gregg Wilson finds that the lung of *Ceratodus* arises as a pit or depression on the floor of the pharynx just

* Proc. Roy. Soc., lxviii. (1901) pp. 129–34.

† Proc. Roy. Phys. Soc. Edin., xiv. (1901) pp. 319–23 (3 figs.).

posterior to the heart in the middle line. The pronephros is distinctly of Amphibian type; it consists of two tubules which open internally into the cœlom by nephrostomes, and externally into the segmental duct. Each is furnished with a glomerulus. Later, pronephric chambers of cœlomic origin are formed into which the nephrostomes open. These preliminary notes confirm the view of the closeness of the connection between Dipnoi and Amphibia.

b. Histology.

Absorption of Anilin Stains by Living Cells.* — E. Overton shows that there is a far-reaching parallelism between the rapidity with which living animal and vegetable cells take up anilin stains, and the readiness with which these are dissolved in solutions of cholesterin, lecithin, protagon, and cerebrin, or are absorbed from aqueous solution by lecithin, protagon, &c., in suspension. Since lecithin and cholesterin seem to be present in all living cells, he argues that it is very probable that the osmotic qualities of the cell depend upon their occurrence.

Basilar Granulations of Cilia.† — P. Vignon brings forward fresh facts supporting his conclusions that the basilar granulations of cilia do not form true organs of the cell, like the centrosomes, and that they have not any motor *rôle* in the ciliary movement, which can only be called protoplasmic.

Ganglion Vestibulare of Mammals.‡—Dr. G. Alexander has studied the portion of the ganglion acusticum to which this name is given in various mammals, and finds that it consists of two parts connected by an isthmus containing small ganglion cells and nerves. Both parts of the ganglion contain bipolar nerve cells, whose central processes constitute the upper and middle roots of the auditory nerve. The peripheral processes form the utricular and ampullar nerves. The ganglion vestibulare is connected by nerve-fibres with the ganglion geniculi.

Structure of Retina.§ —H. M. Bernard has continued his researches on the histology of the amphibian retina, the present instalment being devoted to the minute structure of the rods. He finds that they are specialised protrusions of the retina, consisting of extremely delicate protoplasmic vesicles, each divided by a transverse membrane into an inner and an outer compartment. These vesicles, especially the outer, are traversed by a staining reticulum, whose threads find their way down the walls, and give off at the nodes other threads which penetrate the interior of the vesicles. The vesicles further become filled with refractive matter, largely obtained from the granules of the pigment epithelium, which condenses the mass of the reticulum into the axes of the rods. A portion of this refractive matter exudes through the transverse membrane, where it mixes with the staining matter of the inner limb, and forms the so-called ellipsoid body.

Cellular Differentiations. ‖ — Prof. M. Heidenhain has taken a critical survey of the differentiations within the cell, discussing

* Pringsheim's Jahrb. wiss. Bot., xxxiv. (1900) pp. 669–701. Cf. this Journal, 1899, p. 476.
† Comptes Rendus, cxxxi. (1900) pp. 1232–4.
‡ SB. Akad. Wiss. Wien, cviii. (1899) pp. 449–69 (7 pls. and 1 fig.).
§ Quart. Journ. Micr. Sci., xliv. (1901) pp. 443–68 (2 pls.).
‖ Anat. Anzeig., xviii. (1900) pp. 513–50 (8 figs.).

Physiological Dignity of the Structure.	Stage of Differentiation.	Differentiations of the First Degree. In the Cell-protoplasm.	Differentiations of the First Degree. In the Nucleus.	Differentiations of the Second Degree. Based on those of First Degree.	
Differentiations by active adaptation to known or unknown functions.	Primary differentiations.	1. Primary alveolar system of Bütschli, e.g. in mobile protoplasm of plant-hairs.	Chromosomes.	*a.* Reticular differentiations.	*b.* Membranous differentiations.
		2. Myofibrils, e.g. in smooth and striped muscle.		1. Strands, bands, threads, &c., in intestinal epithelial cells (M. Heidenhain).	1. *Faserkörbe* of Ballowitz, and central capsules.
		3. Neurofibrils in axis-cylinders and nerve-cells.		2. Chrondromites of Benda, and pseudo-chromosomes.	2. Krause's basal membranes in striped muscle.
		4. Tonofibrils or resistance fibrils, e.g. in intestinal epithelial cells, epidermis cells. = Cytomitom of Flemming.		3. Prenant's differentiations of ergastoplasm (?).	3. Membranous limiting layers of the cell, in so far as these are due to the transverse microsome-stratum transversal to the fibres of the central spindle.
		5. Rod-structures of gland-cells (R. Heidenhain).			4. Concentric limiting membranes of giant-cells (M. Heidenhain).
	Secondary differentiations.	Secondary alveolar system, due to involved vacuoles, fat drops, secreted granules; as in fat-cells, sebaceous cells, &c.	Waldeyer-Reinke's form of nuclear structure.		
Differentiations by passive "*Prägung*."	Tertiary differentiations.	Pseudofilar system due to coalescence of vacuoles and secretory drops, whereby a coarse or fine reticular meshwork results, as in old cartilage cells, and liver cells in certain states.	Nuclear framework of various investigators.		

chromosomes and pseudochromosomes, central capsules and idiozomes, chrondromites and archoplasmic loops, and much more besides. One thing we can attempt, namely to reproduce his schema of the "*wabigen, fädigen, membranösen*" differentiations of the cell-body (p. 512).

Minute Structure of the Gizzard in Birds.* — M. Bauer has studied this (especially in the duck and the pigeon), and indicates that in the formation of the horn-like or keratinoid lining from the secretory processes of the glandular layer, there is an inseparable combination of secretion and cuticularisation.

Skin of Hippocampus.†—H. Hoyer finds that the epidermis of this fish has a very remarkable structure. It contains numerous unicellular glands, which pour out a probably protective secretion, and also certain remarkable cells, called by F. E. Schulze the flame-cells. These cells are somewhat mushroom-shaped, have a striated border, and are furnished with a large cuticular cap, protruding from the surface of the skin. The other cells of the epidermis are covering-cells, each with a striated border.

Nerve-endings in the Pike.‡ — K. P. Jagodowski has studied the olfactory pits of *Esox lucius* by means of Golgi's method. He has obtained preparations showing the nerve-fibrils which pass from the olfactory cells to the olfactory nerve, and also showing that certain nerve-fibrils end freely at the outer margin of the olfactory epithelium, without coming into contact with the cells. Further, he finds that the olfactory cells are furnished with long whip-like threads, which project from their surface, and end freely in the slime of the nasal capsule. To these threads, which have not hitherto been described, he gives the name of olfactory flagella.

c. General.

Hair Slope in Man.§—Dr. W. Kidd notes that on all parts of the body where it exists, the hair slopes at an acute angle with the plane of the adjoining surface, and always in a definite direction which is constant for each region, the only exception to this being the eyelashes. Most, if not all, of the directions of slope in the fœtus are also found to continue throughout life, with very little modification here and there from secondary causes. Voigt's theory that the arrangement of the hair is conditioned by the structure and development of the related parts would lead one to expect similarity of slope in man and apes, but the difference in many respects is startling.

The author describes the peculiarities of hair slope in man, and uses his results to substantiate the conclusion that the direction of hair slope is, in many regions of the body, determined largely by external forces and by habits peculiar to man, and that these, repeated through numerous generations of ancestors in whom the growth of hair was more abundant, have led to the arrangements found in man as he now exists. Certain of these forces and habits can be observed in action at

* Arch. Mikr. Anat., lvii. (1901) pp. 653–76 (2 pls. and 2 figs.).
† Bull. Acad. Sci. Cracovie, 1901, pp. 143–6 (1 fig.).
‡ Anat. Anzeig., xix. (1901) pp. 257–67 (10 figs.).
§ Journ. Anat. Physiol., xv. (1901) pp. 305–22 (6 figs.).

the present time, and, as far as they go, they point to a modifying influence upon a plastic growth such as that of hair. Broadly speaking, one may say that the hair-streams pass in the lines of the least resistance on the body of man. The only interpretation which seems even approximately adequate is therefore a Lamarckian one.

Hairs of South American Edentates.* — Dr. W. G. Ridewood has examined the hairs of the newly discovered skins of *Mylodon*, for the purpose of comparing them with the existing sloths, anteaters, and armadillos. His results tend to disprove Lönnberg's theory that the hairs of *Mylodon* were furnished with an extra-cortex like that of *Bradypus* and *Cholœpus*, represented, in the specimens found, by mere traces owing to the condition of the hair. In the absence of the extra-cortex, and in their general structure, the *Mylodon* hairs resemble more closely those of *Tatusia* than those of the living sloths. This is not, however, to be regarded as indicating that *Mylodon* is related to the armadillos rather than to the sloths, but merely shows that, like the anteaters and armadillos, *Mylodon* has a generalised type of hair structure, a type still represented in the living sloths in the basal part of the hair.

Body Temperature and Respiratory Exchange in Monotremes and Marsupials.† — Dr. C. J. Martin finds that *Echidna* is lowest in the scale of warm-blooded animals; its attempts at homothermism fail to an extent of 10° when the environment varies from 5° to 35° C. During cold weather it hibernates for 4 months, with a temperature only a few tenths of a degree above that of its surroundings. The production of heat is proportional to the difference in temperature between the *Echidna* and its environment. At high temperatures it does not increase the number and depth of its respirations; it has no sweat-glands; it exhibits no evidence of varying loss of heat by vaso-motor adjustments of superficial vessels in response to external temperature.

In *Ornithorhynchus* there is a distinct advance. The body temperature, though low, is fairly constant; there are abundant sweat-glands on the snout and frill, but none elsewhere; the production of carbonic acid with varying temperatures of environment indicates that the duckmole can modify heat-loss as well as heat-production; its respiratory efforts do not increase with high temperatures.

Marsupials show evidence of utilising variations in heat-loss to an extent greater than the duckmole, but less than higher mammals; their respirations slightly increase in number at high temperatures.

Variation in production of heat is the ancestral method of homothermic adjustment. By developing a mechanism by means of which it can vary production in accordance with loss of heat, the warm-blooded animal has overcome one disadvantage of cold-blooded animals, viz. that activity is dependent on external temperature. It has thereby increased its range in the direction of low temperatures. Later, by developing a mechanism controlling loss of heat, it has increased its range in the direction of high temperatures, and has also rendered body temperature

* Quart. Journ. Micr. Sci., xliv. (1901) pp. 393–411 (1 pl.).
† Proc. Roy. Soc., lxviii. (1900) pp. 352–3.

largely independent of activity; these advantages have been gained by a greater expenditure of energy.

Variation in Echidna.*—Dr. R. Broom comments on the frequency of variability in regard to the dorsal-lumbar, sacral, and caudal vertebræ in *Echidna*, and describes a case in which there were eight cervical vertebræ. The eighth, which should have been the first dorsal, closely resembles the normal first dorsal save for its rudimentary ribs. The first dorsal bears ribs which articulate with the sternum in the position normally occupied by the second rib.

Evolution of the Auditory Ossicles.†—Dr. H. Gadow maintains the validity of the conception which he has previously expressed as to the homologies of the ossicles of the ear and neighbouring parts. He holds that the chain of bones and cartilages between the auditory capsule and the proximal part of the mandible is homologous wherever such a chain occurs; that this chain in its entirety is homologous with the whole hyomandibula of Elasmobranchs; that in the Tetrapoda this chain, in conformity with, and in adaptation to, or perhaps caused by, the flattened-down and broadened-out configuration of the suspensorial region of the skull, has been bent at an angle, the apex of which abuts against the tympanic membrane. The part of the chain between tympanum and auditory capsule has acted as a conductor of sound, ever since it was relieved of its primary suspensorial function. It is immaterial from a general point of view whether this chain consists of only two pieces (columella and extracolumella in Sauropsida), or forms three- or four-jointed pieces, as in Anura and Mammalia. The extracolumella is homologous with the malleus and incus. The string of connective-tissue, often cartilaginous, from the processus internus of the extracolumella to the articular, is homologised with the cartilaginous continuation of Meckel's cartilage into the malleus of fœtal and young mammals, and may be compared to the hyomandibular-mandibular ligament of hyostylic Elasmobranchs. Dr. Gadow's interesting paper, of which this report gives only a hint, is accompanied by some lucid figures, including one of the "terrible intermediate stage" involved on the rival interpretation—a critical stage when the Promammal could not use its jaw and could not hear.

Otoliths and Hearing.‡—Pierre Bonnier refers to Marage's recent argument that the dense labyrinth-fluid forms an excellent conductor for sound, and that the otoliths serve to maintain this acoustic conductibility. For ten years Bonnier has sought to show that neither the otoliths nor the "acoustic conductibility" have anything to do with hearing. In man, for instance, the calcareous masses are found in the utriculus and sacculus which are not auditory, and are absent in the cochlea; otoliths are most developed in Invertebrates and Fishes, which do not hear; from Amphibians onwards there is a diminution in the importance of the otoliths and a simultaneous development of hearing; in the development of Vertebrates the labyrinth-fluid is very rich in

* Proc. Linn. Soc. N. S. Wales, xxv. (1900) pp. 733-4 (1 fig.).
† Anat. Anzeig., xix. (1900) pp. 396-411 (6 figs.).
‡ Comptes Rendus, cxxxii. (1901) pp. 1367-9. Cf. this Journal, *ante*, p. 403.

lime-salts during the fœtal life, but gradually loses them as the ear begins to hear. The clinical evidence is even more convincing. It should be recognised that the acoustic conduction, the molecular transmission, has no direct importance in hearing, which is associated with the freedom of molar oscillation in the suspended media of the ear. The phenomena of audition are not acoustic, but are associated with the hydrodynamic phenomena of the internal ear. Neither otoliths nor acoustic conductibility have anything to do with hearing.

Otoliths of the Frog.*—M. Marage, answering P. Bonnier, points out that he reached two experimental results:—(1) That a liquid of 2·18 density was a very good conductor of sound; and (2) that one of the functions of the otoliths was to maintain the acoustic conductibility as constant as possible. He did not argue from frog to man.

That the otoliths are found in one region or another does not affect the fact of saline dissolution. The fact that the density of the fluid of the ear increases as one goes down the animal scale, may simply mean that, as the nervous system is less perfect, a better conductor of sound is needed. As far as he is aware, quantitative analyses of the fluid of the internal ear have not been made either during fœtal life or after birth. The clinical observations of Gellé are not admitted as relevant. Bonnier's statement of what occurs in the internal ear during audition is quite theoretical. Whether there are vibrations, or movements of fluid as a whole, or simply differences of pressure,—all is theoretical, but Marage's facts remain.

Circulation in Spleen.†—Dr. F. Weidenreich has made a detailed study of the course of the blood-vessels in the human spleen, and has found that they display some remarkable peculiarities. An explanation can be found only by comparing the spleen with the lymph-glands and the hæmolymph-glands recently investigated by Drummond and others. The author considers that those organs of the body which give rise to lymph-corpuscles can be arranged in a series:—(1) the hæmolymph-glands, the least specialised of all; (2) the spleen, which is intermediate as regards specialisation; (3) the true lymph-glands, which are the most specialised.

Reptiles of the Pacific Islands.‡—Dr. F. Werner prefaces his account of the reptiles of the Schauinsland expedition with a discussion of the distribution. The reptilian fauna of the Pacific islands is directly proportional to the distance of the islands from the centre of distribution, i.e. from New Guinea, and not from Australia, which has no species common to New Zealand or New Caledonia. Islands in the vicinity of New Guinea contain a number of peculiar species; but as the distance from this centre diminishes, the number of peculiar species rapidly decreases. Among lizards the skinks and geckos are widely distributed, but snakes no less than Batrachians diminish rapidly in passing eastwards from New Guinea. New Zealand, as regards its reptilian fauna, is very sharply separated from the other islands of the Pacific, all its species being peculiar.

* Comptes Rendus, cxxxii. (1901) pp. 1441–2.
† Arch. Mikr. Anat., lviii. (1901) pp. 247–376 (2 pls. and 1 fig.).
‡ Zool. Jahrb., xiv. (1901) pp. 380–7.

Suprarenals of Amphibians.* — O. V. Srdínko has studied the structure and development of these bodies in *Rana temporaria*, *R. esculenta*, *Bombinator igneus*, *Bufo vulgaris*, and *Hyla arborea*. They seem to form a blood organ, in which the blood undergoes peculiar changes. This interpretation is suggested by the occurrence, singly or in groups, of erythrocytes which react to potassium bichromate like the cells in the medulla, and also by the proportionally large number of venous spaces which are present in the interior of the suprarenals.

Regeneration in Amphibia.† — S. Prowazek records the minute cytological appearances presented during the regeneration of the tail in larvæ of the salamander, the axolotl, and *Triton alpestris*. His results agree generally with those previously obtained by Barfurth and Fraisse.

Appendages of the Branchial Arches in Fishes.‡ — Dr. Canna M. L. Popta describes these in a large number of forms, and shows—(1) that in all the cases which he studied they are specifically peculiar or diagnostic; and (2) that their form and development may be interpreted in relation to the form of the mouth and the nature of the diet.

Nervous System and Luminous Organs of Argyropelecus hemigymnus.§—Kurt Handrick, in the course of his study of the luminous organs and their innervation in this fish, has made a detailed study of the brain and nervous system generally. He finds that the great development of the eyes is associated with considerable modifications of the brain. Thus the optic thalamus is unusually large, and is furnished with an extra lobe, while similarly the optic lobes are greatly developed. The fore-brain is small, and is partially overlapped by the great optic lobes. Relatively to the size of the fish, the pineal body is very large; it is furnished with a solid stalk. Beneath the pineal organ there is a well-developed parapineal body, apparently homologous with the structure of the same name in Cyclostomes. It consists of a stalk, dilated where it leaves the brain, and expanding distally into a club-shaped swelling. The luminous organs consist of a superficial reflector, visible externally, and a deeper luminous body consisting of a pigment-sheath and the central light-producing gland-cells. The innervation of the organs is described in detail. At the sides of the body the author has discovered a peculiarly modified muscle band, which begins in the region of the first spinal nerve and extends backwards to the tail. Its function remains obscure.

Variations of Pelvic Plexus in Acanthias vulgaris.‖—R. C. Punnett finds considerable variation in the serial number of girdle-piercing nerves, in the number of post-girdle nerves, in the number of nerves forming the collector, in the number and position of the nerve-canals, in the number of fin-rays, and in the number of whole vertebræ.

Asymmetry occurred in an appreciable number of cases. There were differences in the two sexes, and the female is more variable. A

* Anat. Anzeig., xviii. (1900) pp. 500–8 (8 figs.).
† Arbeit. Zool. Inst. Wien, xiii. (1901) pp. 81–124 (3 pls. and 3 figs.).
‡ Ann. Sci. Nat. (Zool.), xii. (1900) pp. 139–216 (1 pl.).
§ Bibliotheca Zoologica, xiii. (1901) pp. 1–68 (6 pls.).
‖ Proc. Roy. Soc., lxviii. (1901) pp. 140–2.

well-marked correlation exists between the position of the girdle, on the one hand, and the number (*a*) of collector nerves, (*b*) of post-girdle nerves, and (*c*) of whole vertebræ. None was found between the number of the fin-rays and the number of fin-nerves.

At certain stages in ontogeny the number of collector nerves and of post-girdle nerves is greater than in the adult; the most caudal two or three form a posterior collector, never found in the adult.

"The different variations observed are not discordant with the view that the limb is capable of migrating along the body, on which view it must be supposed that a secondary rostral migration has followed a primary caudal one. Moreover, such a view receives confirmation from the existence of a posterior collector and of a more extensive anterior collector in certain embryonic stages."

Structure of Amphioxus.* — Dr. H. Joseph has made some new observations on various points connected with the minute anatomy of *Amphioxus*. He finds that the different staining reactions given by the epithelial investment of the primary and secondary gill-bars depend only upon their physiological relation to the cœlomic fluid. A remarkable abnormality of development in the branchial skeleton of a female specimen found at Naples is also described in detail. The abnormality is similar to one previously found by Benham.

Significance of Spiral Swimming.† — H. S. Jennings points out that swarm-spores, flagellate and ciliate infusorians, rotifers and many other lower organisms, as they pass through the water, revolve on their long axes, and thus follow a course that takes the form (as a rule) of a spiral. To understand the significance of this was perhaps impossible until the relation between it and the method of reaction to a stimulus in these organisms was known, and especially until it was recognised that the body of the organism bears a constant relation to the axis of the spiral,—that is, that the same side of the organism is always directed towards the outside of the spiral. This was pointed out by Jennings in previous studies.

It seems that the device enables the organism to follow a course which is practically a straight one; without such revolution many creatures merely describe small circles, making no progress. By means of the revolution, the organism compensates with absolute precision for any tendency or combination of tendencies to deviate from a straight course in any direction.

INVERTEBRATA.

Fauna of Baikal-Lake.‡ — Prof. A. Korotneff gives a brief report on the results of an excursion to this interesting lake. Sponges were represented by four species of *Lubomirskia* (with no gemmules), a species of *Ephydatia*, and *Spongilla microgemmata* sp. n.

Many specimens were obtained of the large slug-like *Dicotylus* (*Planaria*) *pulvinar*, of which Grube got only one; a description is given, and a new name, *Rimacephalus bistriatus*. A new fresh-water

* Arbeit. Zool. Inst. Wien, xiii. (1901) pp. 125–54 (2 pls.).
† Amer. Nat., xxxv. (1901) pp. 369–78 (11 figs.).
‡ Biol. Centralb., xxi. (1901) pp. 305–11 (1 fig.).

Nemertean—*Baicalonemertes* g. n.—without cerebral organs or eyes, but with a scimitar-like stilet, is perhaps intermediate between Meso- and Metanemertini. The interesting Annelid *Dybowscella*, described by Nussbaum, was re-found, represented apparently by a distinct species, *D. godlewskii*. Korotneff observed pale orange eggs in the tubes, with irregular cleavage and direct development; therefore the trochophores observed by Dybowski must belong to some other form. Molluscs were represented in the collection by various species of *Baicalia*, *Valvata*, *Benedicta*, &c. Among the abundant Bryozoa was a new Ctenostomid—*Echinella placoides* g. et sp. n.

Distribution of Marine Organisms.* — Prof. G. Pruvot, in an account of a dredging expedition off the coast of Gerona, gives a general summary of the contents of the hauls made on the different grounds, in order to show the relation between the bottom deposit and the nature of the fauna. He finds that though in some instances the sand fauna and the mud fauna are sharply separated, in others there is a mingling alike of the faunas and of the deposits, sufficient to justify his inclusion of the sand and mud areas in a single region—the coast region (*région côtière*). The intimate dependence between fauna and bottom deposit shows how closely the fauna of any particular littoral depends upon the geological character of the neighbouring land. The author is of opinion that a minute geological study of the coast affords the most hopeful prospect of a solution of the at present obscure problems of geographical distribution.

Mollusca.

Æsthetic Appreciation of Molluscs.† — Prof. K. Möbius maintains that delight in form and colour was the first impulse to making collections of mollusc-shells. "Beauty-feasts" came before Conchology. "Taste" is not a matter of personal caprice, but is deeply-rooted psychologically. After vindicating his position as a naturalist who takes the æsthetic point of view seriously, Möbius reviews the series of Molluscs, explaining why *Spondylus* is preferred to *Ostrea*, and *Cypræa* to *Voluta*, and *Nautilus umbilicatus* to *N. pompilius*, and so on. It is quite impossible to agree with all his verdicts, but his analysis of our more or less conscious æsthetic judgments, vaguely referred to taste or prejudice, is very suggestive.

α. Cephalopoda.

Chromatophores of Cephalopoda.‡ —Dr. Hans Rabl has studied the structure of these remarkable cells in a series of adult examples of the common species. The conditions found in *Eledone moschata* may be described. As in all Cephalopods, the skin consists of a one-layered cylindrical epithelium whose cells have a cuticular border. Between the epithelial cells are large gland-cells. Beneath the epithelium lies a layer of delicate connective-tissue with muscle-fibres, and then the

* Arch. Zool. Expér., ix. (1901) pp. 1–42 (15 figs.).
† Arch. Naturgesch., lxvii. (1901) Beiheft, Festschrift E. von Martens, pp. 1–8.
‡ SB. Akad. Wiss. Wien, cix. (1900) pp. 341–404 (4 pls.).

layer of chromatophores and iridocysts. The iridocysts are much-branched cells with a central nucleus; they contain bodies which reflect the light and give rise to the rainbow appearance of the skin. These the author calls *iridosomes*. The chromatophores can be distinguished into two sets, according to the distribution of their pigment. In the one—the vesicular type—the pigment granules are entirely peripheral, and are arranged in a single layer round the large central cavity. In the other or compact type the central cavity is absent and the pigment is uniformly diffused. In the former the nucleus is peripheral, in the latter it is central, and is remarkable in its staining reactions. The young chromatophores are without pigment, and are only distinguished by their size and their radiating fibres from the other connective-tissue cells. In these cells the mother-substance of the pigment appears later, and the pigment-granules gradually become differentiated in form and colour. The vesicular chromatophores are only a stage in the development of the compact form. The chromatophores are invested by a thin cell-membrane, not by flattened cells, and the radial fibres are inserted into this cell-membrane. The author believes that the radial fibres, by their contraction, enlarge the chromatophore, while the elasticity of the membrane contracts it, being assisted in the contracting process by the pigment-granules themselves, which are capable of streaming movements. The author denies the existence of the investing circle of cells described by other investigators. Chromatophores are continually being formed in adult cuttles, and there is a correlated degeneration of the existing ones.

Arterial Circulation of Nautilus pompilius.* — L. E. Griffin publishes figures and descriptions of the arteries of *Nautilus*, based partly on his own dissections, and partly on the figures and descriptions of Willey. He finds that the right side of the heart is slightly longer than the left, so that it is not perfectly symmetrical. The so-called auricles, which are merely distensions of the branchial veins, are not morphologically equivalent to the auricles of Gastropods and Lamellibranchs. In some instances the branchial veins enter the heart without showing any increase of diameter.

γ. Gastropoda.

Variations of Planorbis.†—Franz Hilgendorf returns to the beautiful results of his classic study (1866) of the transition from *Planorbis multiformis brachiformis* to *Planorbis multiformis oxystomis*. He re-expounds his results, answers some criticisms, and furnishes a convincing photographic plate. It is very satisfactory to have another utterance from the veteran investigator of the Steinheim Planorbids.

Evolution of the Gastropod Form of Body.‡—Dr. J. Thiele returns to a subject which he has discussed before, but it is difficult to make his interpretation clear without illustrative figures. He seeks to show that the shell could find a stable position only to the right of the apex of

* Circ. Johns Hopkins Univ., xix. (1900) pp. 53–6 (2 figs.).
† Arch. Naturgesch., lxvii. (1901) Beiheft. Festschrift E. von Martens, pp. 331–46 (1 pl. and 1 fig.).
‡ Tom. cit., pp. 9–22 (4 figs.).

the foot; the endeavour to attain this stable position was the reason for the forward displacement of the branchial cavity from its originally posterior position; the gonad supplied the impulse to the formation of the spiral shell, which was primitively so disposed that its free margin with the notch was turned backwards; the degeneration of the right gonad, associated with a protrusion of the visceral sac, led to a series of displacements; the apex of the visceral sac first inclined to the left, and then became coiled in a spiral; the visceral sac and the shell covering it thus disturbed the balance, and there came about a twisting of the shell-apex posteriorly and to the right.

Centrosome and Sphere in Crepidula.*—Prof. E. G. Conklin summarises that part of his work on the maturation, fertilisation, and cleavage of *Crepidula*, which bears upon the questions connected with the centrosome and centrosphere. He finds that there is a remarkable parallelism between nucleus and centrosome; both arise from granules derived from a mother structure, the chromosomes in one case and the central corpuscle in the other; in each case only a small fraction of the mother structure goes to form the daughter-structure. Both grow rapidly, absorbing achromatic substance from the cell-body, and then, by the dissolving of their outer membranes, the contents are set free in the cell-body, only the granules mentioned above persisting. The centrospheres are composed of a specific substance temporarily differentiated from the other cell-contents, which is not self-propagating, but arises anew in each cell generation. This substance forms a large part of the spindle and aster, and at the close of karyokinesis is collected into a large sphere surrounding the centrosome, which ultimately disintegrates into coarse granules. This sphere is apparently the homologue of Meves' idiozome.

Genus Harpa.† — Dr. R. Bergh describes the structure of *Harpa*, which has been rarely investigated. The animal has a very large somewhat flattened foot, which cannot be withdrawn into the shell, and is without an operculum. There is an anterior lateral notch, which divides the foot into an anterior crescentic broader portion, and a much longer pointed posterior portion. The hindmost part can be thrown off in autotomy. The respiratory tube is long. The long closely adjacent tentacles bear above their middle, externally, a strong optic prominence. In the structure of the nervous system there is a close resemblance to the Buccinidæ, but the ganglia are still more concentrated. There is a very narrow mouth-opening, a very long proboscis, a very small gullet, and a radula with three rows of teeth. The salivary glands are very strongly developed, but the intestine is not long, nor the "liver" large. The seminal duct is either an open groove along the posterior border of the very strong somewhat compressed unarmed penis, or it runs subcutaneously on and through this organ. The Harpidæ are probably close to the Olividæ. Bergh describes *H. ventricosa*, *H. rosacea*, *H. nablium*, and *H. minor*.

Structure of Neuroglia in Snail.‡ — H. Smidt corrects some errors in his previous descriptions of this substance. He now finds that the

* Anat. Anzeig., xix. (1901) pp. 280–7 (8 figs.).
† Zool. Jahrb., xiv. (1901) pp. 609–29 (1 pl.).
‡ Anat. Anzeig., xix. (1901) pp. 267–71 (5 figs.).

nuclei, which were not previously found in the glia-cells, are quite distinct if the preparations be not too deeply stained. Further, the characters of the glia-fibrillæ, as shown by his new preparations, are such as to bring his results more into line with those of Apáthy for Hirudineæ.

Spermatogenesis in Helix pomatia.* — S. Prowazek describes and figures the various stages in development of the spermatozoa of this species. The spermatogonia cluster in a grape-shaped fashion round the large basal cell, which is probably nutritive in function. The normal number of chromosomes, as shown by other authors, is twenty-four. In the division which forms the spermatocyte of the first order, the twenty-four chromosomes which first appear in some cases show a longitudinal splitting, and the forty-eight elements so formed unite in tetrads, so that the number is reduced to twelve. In the second spermatocyte division these twelve chromosomes split transversely, so that the daughter-cells have each twelve. The tetrads were only made out in rare cases.

With the conditions seen in *Helix* the author contrasts those found in the beetle *Oryctes nasicornis*, in which he has also studied the development of the spermatozoa.

Nervous System of Capulus hungaricus.†—The late Prof. Henri de Lacaze-Duthiers found that this Gastropod belongs to his type Strepsineura aponotoneura, the ganglia called pleural and pallial being close to the cerebral ganglia, and therefore displaced to the dorsal region, so that the commissure, which is twisted from its point of origin, also arises dorsally. Owing to the proximity of the cerebral ganglia, the sub-œsophageal commissure hardly exists at all. The pedal ganglia, here as always, are paired symmetrically; they are not near the pallial ganglia. In addition to the pallial ganglia, there are present four pairs of ganglia corresponding to those usually called sub-intestinal and visceral (here paired); but to these and the pallial ganglia the author preferred to give the general name of asymmetrical centre. This association of ganglia is always asymmetrical, even when, as in the present instance, all the ganglia are paired, and the author regards its dissociation into separate centres as a matter of great difficulty from the point of view of comparative anatomy. In *Capulus* this asymmetrical centre, in addition to the typical five ganglia, contains an accessory ganglion near the visceral ganglion.

Anatomy and Phylogeny of Chitonidæ.‡—Prof. Ludwig H. Plate, in continuation of his work on this subject, discusses the families Mopaliidæ, Acanthochitidæ, and Cryptoplacidæ, and sums up his researches in a general account of the structure, with a discussion of the origin and relationships. Some of the more general of his conclusions may be stated as follows. In the Chitons in general the degree of specialisation seems to bear a definite relation to the size of the body, the larger forms having always a more elaborate structure than the smaller. The size again appears to be related to the habitat, the largest

* Arbeit. Zool. Inst. Wien, xiii. (1901) pp. 197–236 (2 pls. and 2 figs.).
† Arch. Zool. Expér., ix. (1901) pp. 43–79 (1 pl.).
‡ Zool. Jahrb., Supp. v. vol. ii. (1901) pp. 281–600 (5 pls.).

forms being those which live freely between tide-marks, the region which is best suited to the needs of the animals, and which possesses the largest number of species. The organs of the body may be divided into three sets, according to the nature and degree of their variations in the different species. Thus foot, head, mouth-cavity, sub-radular organ, sugar-glands, and most of the central nervous system, are reckoned as stable organs: they vary very little in the different families. Other organs, such as the larval pedal gland, the mucus-producing ridges of the mantle border (*Schleimkrausen*), are to be regarded as regressive, occurring only in the simplest forms. Again, the cuticular structures of the mantle, the mantle itself, the shells, the lateral folds, the gills, the salivary glands, the stomach, liver, and gut, the nephridia, genital organs, heart and circulatory organs, nervous system and sense organs, are progressive organs, varying according to the degree of specialisation attained. A fourth class of organs are those which occur in only a single species or in a genus as adaptations to a special manner of life. Though the Polyplacophora and Aplacophora differ from one another very markedly, yet the resemblances are sufficient to justify the inclusion of both in the class Amphineura. The Solenogastres are to be regarded as a side-branch from the Chitonidæ stem; in almost all respects they are more lowly organised than the Chitonidæ. The author regards the segmentation of the shell in the Chitons as a consequence of the muscular movements involved in the curling inwards of the body. It has secondarily produced a pseudo-segmentation, which is most distinct in the muscles of the shell, but also affects, to a greater or less extent in the different species, the heart, arteries, and other organs. This pseudo-segmentation is independent of the repetition of the gills, which depends upon the size of the organism and its need for oxygen. The author believes that the only connection between molluscs and annelids is that both are descended from a turbellarian-like ancestor.

δ. Lamellibranchiata.

Development of Nucula delphinodonta.* — Prof. Gilman A. Drew has studied the development of this American species, in order to compare it with that of *Yoldia limatula.* He finds that, though the embryos resemble each other in most respects, the difference in the size and distribution of their surface cilia makes them appear different. In *Nucula* the test or surface cells (= velum) have their cilia uniformly distributed, while in *Yoldia* they are arranged in bands. The embryos of *Nucula* develop in the protecting brood-sac, and the test would appear to be functionless; it is shed much earlier than in *Yoldia.* The apical plate is extensive, but, like the test-cells, carries only short cilia. The foot is very small at the time when the test is shed, and seems never to be used in creeping. The pericardium appears to be schizocœlic in origin. The heart is formed round the intestine, but later becomes free from it and dorsal to it. At the time when the animals become sexually mature, the hypobranchial glands develop. They form the secretion which, when mingled with foreign particles, gives rise to the remarkable external brood-sac.

* Quart. Journ. Micr. Sci., xliv. (1901) pp. 313–91 (6 pls. and 10 figs.).

Arthropoda.

a. Insecta.

Maturation in the Eggs of Hive-Bees.* — A. Petrunkewitsch has made a careful study of this, and believes that he has securely established or confirmed the following conclusions. Eggs laid by the queen in drone-cells are always unfertilised. As in the fertilised ova, the first polar body is separated off by an equation-division. In the separation of the second polar body there is in all cases a reduction of the number of chromosomes to one-half. Similarly the first polar body always divides with a reduction, and the peripheral half is liberated from the ovum and perishes. The restoration of the number of chromosomes in the non-fertilised ova probably occurs by longitudinal splitting of the chromosomes, but with suppression of the corresponding division into two daughter-nuclei. The central half of the first polar body conjugates regularly with the second polar body, and thus arises a *Richtungscopulationskern* with the normal number of chromosomes. This nucleus (in the egg which develops into a drone) gives rise, by three divisions, to eight cells with "double" nuclei. In fertilised ova, and also in the "drone eggs" of fertile workers, the aforesaid nucleus forms a spindle, which either simply disappears, or gives rise to a number of cells (1–4). But these always show disruptive phenomena in the chromatin, and ultimately perish.

Endoderm of Insects.† — Dr. K. Escherich discusses the difficult question of the formation of the germinal layers in insect development, and concludes that the process is not essentially different from what occurs elsewhere. The differentiation of the two primary germinal layers takes place either by invagination or by immigration. When the endoderm-cells lose their connectedness and wander from their seat of origin into the yolk, then the mid-gut arises by a meeting of these "yolk-cells" on the surface of the yolk, a process observed in *Lepisma*, Aphides, and Phryganidæ. But if the endoderm-cells formed by gastrulation at the two poles remain in connection, then the mid-gut wall arises by proliferation from the two endoderm primordia. In this bipolar foundation of the endoderm the development of insects is unique, but not otherwise, and the peculiarity may be interpreted as a special adaptation to the form of the egg and the amount of yolk.

Nerve-Endings in Butterflies' Wings.‡ — Dr. K. Günther has followed the branching of the nerve which enters the wing. In many cases a fine end of a branch was seen to run into a specialised mononuclear cell, from which a process passes through a pore in the chitin to the base of but not into a scale. Thus the scale may have structural connections exactly similar to those of the well-known integumentary sensory hairs.

The author describes glandular scales, glandular hairs, sensory spines, and sensory cupolas. While some scales are glandular and others sensory, it may be that all are innervated. Thus in *Pieris napi*,

* Zool. Jahrb., xiv. (1901) pp. 573–608 (4 pls. and 1 fig.).
† Biol. Centralbl., xxi. (1901) pp. 416–31 (14 figs.).
‡ Zool. Jahrb., xiv. (1901) pp. 551–72 (1 pl.).

the glandular scales sometimes have sensory cells. As to the function of the sensitive scales, we may exclude the possibility of an olfactory function, for the nerve does not enter the scale, and there is no communication with the outer world. But are they auditory, or gustatory, or like the nerve-endings on bats' wings? Here experiment must come to the aid of histology.

External Sexual Organs in Male Lepidoptera.*—L. Poljanec finds that the last three segments of the abdomen (segments 8, 9, 10) may be modified in connection with reproduction in male butterflies. In neotropical forms apophyses occur both on tergite and sternite of the eighth segment, and two rami on the posterior border of the sternite. The ninth segment bears outgrowths to which the name of *sacci* is given, and also at its posterior border the outer valvæ, which are often asymmetrical. In some species inner valvæ are present, corresponding to the gonapophyses of other insects. Where the tenth segment is complete, it has the form of a bird's bill; its sternite exhibits a tendency to bend over in a dorsal and postanal direction. This segment bears traces of a telson. The penis is chitinous almost throughout, and is surrounded by a penis-armature. The external genital organs are usually furnished with hairs and bristles, which may be connected with nerve-endings.

Structure of Adult Female Mosquito.†—Dr. S. R. Christophers has studied the minute structure of *Culex* and *Anopheles*. In the alimentary canal the proventriculus of other insects is absent, but a fold occurs at the origin of the mid-gut which is undoubtedly its homologue. It consists of both ectoderm and endoderm, but is without chitin, and appears only to act as a muscular sphincter. In *Culex* the salivary glands are tubular, while in *Anopheles* they are sacculated. In both cases there are two types of gland acinus, the granular type and the clear or colloid-like type. Very little change in the glands occurs after feeding, a large amount of secretion remaining within the gland. The ova in *Anopheles* frequently contain a mass of Sporozoa.

Spermatogenesis in Staphylinus.‡—Nils Holmgren sums up the most important results of his study of spermatogenesis in this beetle. In winter in the adult *Staphylinus* there is a regeneration of spermatogenic elements from the cells of the testicular capsule. Verson's cell occurs in Coleoptera. The formed spermatogonia are of two entirely different sorts. There are two quite distinct series of spermatozoa. Old spermatozoa are normally destroyed by the activity of their cyst-cells, and undergo fatty degeneration. The fat accumulated in the cyst-cells serves for the nourishment of newly formed spermatozoa.

Development of Male Genitalia in Scolytidæ.§—L. Schröder briefly summarises the results of his researches on this subject. He finds that the first rudiment of the sexual ducts is a paired structure of mesodermic origin, which grows towards the end of the abdomen.

* Arbeit. Zool. Inst. Wien, xiii. (1901) pp. 155–96 (3 pls. and 5 figs.).
† Reports to Malaria Committee of Roy. Soc. Lond., iv. (1901) pp. 1–20 (6 pls.).
‡ Anat. Anzeig., xix. (1901) pp. 449–61 (5 figs.).
§ Zool. Anzeig., xxiv. (1901) pp. 460–1.

The second rudiment is ectodermal in origin, and arises as an unpaired median structure with a single lumen. The paired ducts which leave this rudiment partly unite to form the unpaired ductus ejaculatorius, while the remainder forms the ectadenia. The fact that the foundations of four testes are laid down points to a close connection between the Scolytidæ and the Curculionidæ.

Alimentary Canal of Dytiscidæ.*—L. Bordas has studied this in *Dytiscus marginalis*, *Cybister ræselii*, *Agabus chalconotus*, *Acilius sulcatus*, &c. Although the insects are mainly carnivorous, the length of the gut is very considerable, up to four times that of the body. The gizzard with its teeth and setigerous areas, and the rectal ampulla, are the most characteristic parts. The latter serves as a hydrostatic apparatus, as a defensive organ when the animal is out of water, and as a reservoir for excrement in its median and posterior parts. In *Agabus* the hind-gut enters the anterior extremity of the rectal ampulla, and the cæcal portion is rudimentary; in *Dytiscus* and *Cybister* the union is towards the middle of the ampulla; in *Acilius* it is towards the posterior end, thus leaving a long cæcal appendage.

Chromosomes of Hemiptera Heteroptera.†—Dr. T. H. Montgomery deals with the relations of the chromosomes in the spermatogenesis of species of *Tingis*, *Corixa*, *Cymus*, *Lygus*, &c., and calls attention to the importance of studying these comparatively in a large number of species of a group. "By such investigations not only may much of importance be obtained regarding the evolution of cell structures themselves, but by implication a criterion may thereby be obtained for testing genetic relationships." He gives special attention to the "chromatin nucleolus," a term applied to "that peculiar nuclear element which is a chromosome peculiarly modified in preserving its form and dense structure, which chromosomes, as a rule, show only in the height of mitosis, through every stage of the spermatogenetic cycle." The chromatin nucleoli are interpreted as representing chromosomes on the way to disappearance during progressive evolution. He concludes by expressing his conviction as to the persistence of the chromosomes from generation to generation in spite of a great amount of metabolic change.

Taming a Larval Dragon-Fly.‡—Frau Maria Sondheim describes the behaviour of a larva of *Æschna grandis* in her aquarium. It learned to take flies from her fingers held just under the surface of the water; it even crept on to a finger and devoured its fly while sitting there; it followed its keeper's movements, and used to remain stationary for an hour or so close to the glass side of the aquarium with its head turned towards her. The pet was unfortunately lost at the time of pupation.

Peculiar Glands in Trichoptera Larvæ.§—Andreas Martynow describes a remarkable series of unicellular glands, found in *Phryganea varia* and other larval Trichoptera, in pairs from the second thoracic to the ninth abdominal segment. The glands open to the exterior by

* Comptes Rendus, cxxxii. (1901) pp. 1580–2.
† Proc. Acad. Sci. Philadelphia, 1901, pp. 261–71 (1 pl.).
‡ Biol. Centralbl., xxi. (1901) pp. 317–9.
§ Zool. Anzeig., xxiv. (1901) pp. 449–55 (5 figs.).

a duct lined with chitin, and the large constituent cell of each appears to lie deeper than the hypodermis. In addition, other unicellular glands occur in connection with the tracheæ, into whose lumen they open. Further, a pair of compound tubular glands was found in the last abdominal segment, which open to the exterior, and appear to be typical Gilson's glands. The function of all these glands remains uncertain.

Scale Insects.—Miss R. W. Patterson * has studied the life-history of the three known species of the genus *Cerococcus*, which occur on Californian oaks. One of the species—*Cerococcus ehrhorni*—occurs in apparent symbiosis with a white fungus, which appears to live on the honey-dew formed by the scale. In this species only a thin waxen case is formed, but *C. quercus* secretes a large amount of bright yellow wax which forms a case surrounding the insect. The eggs are laid within the case, the body of the female shrinking greatly afterwards, so that the lumen of the case is filled up with the eggs.

S. I. Kuuwana † describes three new species of Californian Coccids belonging to the genus *Eriococcus*, and also notes the discovery in California of *Pseudolecanium tokionis* Ckll., a coccid first found in Tokyo, Japan.

Mr. G. A. Coleman ‡ describes as *Dactylopius sequoiæ* sp. n., a scale found by him on the redwood (*Sequoia sempervirens*) near Stanford University. Both sexes were found, and the life-history was followed from the egg. The male has well-developed wings, but no attempt at flight was observed.

Skinkai Inokichi Kunwana § has visited all the main islands of Japan, except Shikoku, in order to study the distribution and natural enemies of the San José scale (*Aspidiotus perniciosus*). Prof. Vernon L. Kellogg, who writes a preface to his report, is of opinion that Kuwana's results tend to settle in the affirmative the disputed question as to whether Japan is or is not the home of this destructive insect; but it is to be noted that the scale was in no instance found upon a wild tree. The scale is very widely distributed in Japan, but except in a few places is not abundant enough to endanger the orchards. It seems to have several insect enemies, especially an Aphelinid fly and one of the Coccinellidæ. The weight of Japanese opinion would seem to incline against the view that it is a native species, and it is believed by Japanese gardeners to be more destructive to foreign than to native trees.

Defensive or Odoriferous Glands of Cockroach.||—L. Bordas finds on the postero-abdominal region of the males of *Periplaneta orientalis* and *P. americana* a large compound arborescent gland, resting on the ventral wall. It is formed of a series of ramifying dichotomising tubes, which some observers have connected with the genital apparatus. There is no reservoir, but the duct opens by an oval orifice below the penial tube. The secretion is a volatile alkaline liquid, of strong odour, suggesting mice or decomposing cheese. Although the secretion is

* Contributions from the Hopkins Laboratory of the Leland Stanford Jun. University, xxv. (1901) pp. 387–98 (3 pls.).

† Tom. cit., pp. 399–408 (2 pls.). ‡ Tom. cit., pp. 409–20 (1 pl.).

§ Tom. cit., pp. 1–14 (1 fig.). || Comptes Rendus, cxxxii. (1901) pp. 1352–4.

continuous, it may be accelerated in times of danger. There seems no doubt that the organ is a defensive odoriferous gland, like that in many beetles.

Intestinal Secretion in Crickets.*—L. Léger and O. Duboscq describe (1) the secretions included in the epithelium of the mid-gut of *Gryllus campestris* and *G. domesticus*; (2) the expulsion of these secretions; and (3) their appearance when free in the lumen of the intestine.

The facts described suggest that the secretion consists in a chromatolysis of the nuclei of the epithelium, which may divide amitotically during their emigration. The nuclei seem to degenerate into a hyaline substance. The nucleolus does not seem to have anything to do with it. Perhaps the main interest of the research is in the analogy between the figures of mid-gut secretion in insects and those given by Heidenhain and by Nicolas in respect to intestinal secretion in Vertebrates.

Collembola of Switzerland.†—Dr. Joh. Carl publishes the second instalment of his work on this subject. He adds seventeen species, some of them new, and one variety to the list, giving a present total of ninety-three species and sixteen varieties.

β. Myriopoda.

Absence of Variation in a Swarm of Myriopods. ‡—A. V. Mauck reports on a swarm of myriopods (*Fontaria virginiensis*) which lasted during the early hours for a few days in August 1898, near the Indiana University Biological Station at Vawter Park. "Other swarms of myriopods have been reported, and are comparable with the swarms of the Palolo worm during its breeding season." [Is not this going rather far?] Bullman § has described the swarms of this same *Fontaria virginiensis*; Verhoeff ‖ has told how the migration of *Brachyiulus unilineatus* made a railroad track in the Hungarian district of Alföld so slippery that a train was unable to proceed, though the rails were sanded.

Of the swarm Mauck reports, 1309 individuals were preserved for statistical study, all adults and all about the same size. Males (with 30 pairs of legs) formed 47·517 p.c.; females (with 31 pairs of legs) formed 52·4828 p.c. No variation was observed in the number of segments, nor in the number and symmetry of the limbs, nor in the number (7) of antennary segments.

Ventral Nerve-Cord of Myriopods.¶—Dr. G. Rossi notes that in *Iulus terrestris* the nerve-cord is a flattened cylinder without ganglia, commissures, or connectives. Four pairs of nerves (pedal and lateral) occur in each movable segment of the body. The cord consists of four parts:—(1) an external, nucleated sheath; (2) a lacunar or reticular tissue with numerous tracheæ; (3) unipolar pyriform granular nerve-cells, especially on the ventral side; and (4) an internal mass of nerve-fibrils.

* Arch. Zool. Expér., viii. (1900) Notes et Revue, pp. xlix.–lvi. (19 figs.).
† Rev. Suisse Zool., ix. (1901) pp. 243–78 (1 pl.).
‡ Amer. Nat., xxxv. (1901) pp. 477–8.
§ Bull. U.S. Nat. Mus., 1893, No. 46, p. 75.
‖ Cf this Journal, 1900, p. 667.
¶ Atti (Rend.) R. Accad. Lincei, x. (1901) pp. 319–24 (3 figs.).

In *Scolopendra cingulata* the nerve-cells are concentrated in ganglia and are absent from the connectives. Sections show an external sheath, a lacunar or reticular tissue, nerve-cells, and central fibrils, as in *Iulus*.

ε. Crustacea.

Contributions to Life-History of Edible Crab.*—H. C. Williamson has made a notable contribution to our knowledge of the life-history of *Cancer pagurus*, as important practically as it is interesting theoretically. A female capable of being fertilised is marked by the width of the vagina and the size of the spermatheca; but while a crab measuring $4\frac{1}{8}$ in. across is capable of fertilisation, many crabs measuring $4\frac{1}{8}$–$5\frac{3}{8}$ in. across are not fertilised. It is likely that the males copulate only with females which have just cast the shell, while the new shell is pliable. A crab does not always cast immediately after hatching; it very often carries eggs two years in succession; this may depend on the store of sperms in the spermatheca. The crab spawns offshore in deep water in November, December, and January; in summer it migrates to the warmer water near the shore. The number of eggs carried increases with the size of the crab from about half a million to three millions. In the male maturity occurs at a somewhat less size than in the female. The three external sexual characters, i.e. the differences in the abdominal appendages, breadth of abdomen, and form of carapace, are discussed.

In the small crabs of the beach there appears to be a slight majority of females; in the adult creel crabs the majority is on the side of the males. The ecdysis is briefly described, and notice is taken of the attendant physiological conditions. While the principal time of casting is from July to September (both inclusive), casting takes place during a large portion of the year, from May to November inclusive. In the stage immediately preceding the adult condition, from 3–4 in. in breadth, the crab probably casts only once a year, but before that oftener. The average ratio of growth on casting, perhaps $\frac{1}{3}$ to $\frac{1}{4}$ of the original size, has not been accurately determined. Regeneration of the appendages takes place only when the crab is *preparing* to cast, and the repair of injuries to the carapace takes place only at the same period, or during the time the crab is soft. In adult crabs the new limbs cannot reach the normal size until after at least two moults. The rate of growth in crabs is subject to many irregularities. A probable life-history is as follows:—The crab, hatched in inshore waters, reaches a size of about an inch, passes into the beach group, grows to about $2\frac{1}{2}$ in. across, leaves the beach for the littoral waters just below low-water mark, grows to about 4 in., joins the mature group, and takes part in the great seasonal migrations. But this summary gives only the headings of a most interesting and valuable contribution.

Otocyst of Decapod Crustacea.†—C. W. Prentiss has made an extended series of researches, histological and physiological, on this subject. The material included adults and developing larvæ of Macrura (especially *Palæomonetes*) and Brachyura (*Carcinus*). Only some of the most striking of his results can be mentioned. The thin chitinous

* Rep. Fishery Board for Scotland, xviii. (1901) pp. 77–143 (4 pls.).

† Bull. Mus. Comp. Zool. Harvard, xxxvi. (1901) pp. 167–251 (10 pls.). Cf. *ante*, pp. 515, 516.

lining of the otocyst-sac bears in Macrura a single sensory prominence, and in Brachyura three sensory regions. The hairs borne on these regions are heavily fringed and often bent or hooked. In Macrura they are attached to the wall of the sac by a thin bulb of chitin; in Brachyura the base of the hair-shaft is inserted into a cup-like depression. In addition to these otolith hairs, there are in the lobster and in Brachyura very long and delicate free hairs (thread-hairs). The otoliths are renewed after each moult; they may be free or attached to the sensory hairs. They are absent in the Brachyura except in the megalopa stage. Where they are attached to the hairs, glands, similar to the tegumentary glands, are present beneath the sensory cushions which bear the hairs. In decapods with free-swimming larval stages, the otocyst develops as an invagination of the dorsal ectoderm of the basal segment of the antennule, and becomes functional only at the fourth moult after hatching. The matrix cells from which the sensory hairs are to arise appear in the first larva; invagination begins at the second larval stage; in the third the hairs appear below the floor of the shallow sac; while at the fourth they become functional, and the otoliths appear. The zoea of the crab has no functional otocyst. In the megalopa it is open and contains otoliths and hairs; later it loses the otoliths and becomes closed. Structurally, the otocysts of decapods may be compared to the utriculus of a Vertebrate like *Myxine*, the sensory cushion of *Palæomonetes* recalling the crista acustica, while the more elaborate otocyst of the crab approaches in general structure the utriculus of the higher Vertebrates. There is no evidence that the otocyst has anything to do with audition, but much to show that, together with the eyes and the tactile bristles, it functions as an equilibrating organ. In free-swimming decapods the otocyst is by far the most important of these static organs, its removal resulting in a great loss of the power of orientation. In adult Brachyura the otolith-hairs have become practically functionless, but the slender free hairs are so modified as to respond directly to the attraction of gravity.

Pacific Crustacea.* — Prof. H. Lenz describes the Crustacea of Schauinsland's expedition. The collections included ninety-nine species, of which three are new—a species of *Hippolyte*, one of *Eupagurus*, and one of *Pinnotheres*.

Eyes of Entomostraca.†—J. Kunstler and Ch. Gineste find that in certain of the lower Crustacea there is a distinct articulation between the crystalline cone and the rhabdom. The rhabdom is a cellular product of a mother-cell, just as the crystalline cone is a product of a crystalline cell. The rhabdom mother-cells cannot be regarded as retinal cells in the ordinary sense, for they form with the rhabdom an indivisible uninucleated whole. Further details and figures are promised.

Structure of Amœboid Corpuscles in Crustacea.‡—J. Kunstler and Ch. Gineste find that the lacunæ of the general parenchyma in certain of the lower Crustacea contain corpuscles of remarkable structure, which tend to show that protoplasm is not quite so simple as some modern investigations would suggest. Both cytoplasm and nucleus have a

* Zool. Jahrb., xiv. (1900) pp. 429–82 (1 pl.).
† Proc. Verb. Linn. Soc. Bordeaux, 1901, 7 pp. ‡ Tom. cit., 3 pp. and 4 figs.

vesicular structure, but within each vesicle lies a granulated body, attached to the wall of the vesicle by radiating bands. The whole of the cytoplasm displays this remarkable structure, and the chromosomes of the nucleus similarly consist of rows of these peculiar vesicles.

New Entozoic Copepod.* — Miss A. L. Embleton has found within the rectum of a Japanese *Echiurus* (*E. unicinctus*), a copepod to which she gives the name of *Goidelia japonica* g. et sp. n.; it occurred in association with a Protozoon parasite, probably a new species of *Trichodina*. The copepod belongs to the family Clausidiidæ Auct. (Hersiliidæ Canu), but differs from the members of the known genera in that the male and the female very closely resemble one another, and the male is not attached to the female. The new form is without eyes; the first antennæ have only five segments; the second antennæ terminate in a powerful hooking apparatus; the mandibles are without accessory parts, and are very small and claw-like; the first maxillipede is degenerate in the male and the second in the female, while in the male the second maxillipede is powerful and chelate; the thoracic legs are all similar, and are without sucking discs. The associated protozoon was not sufficiently well-preserved for much of its structure to be made out.

Development of Leptodora hyalina.† — Dr. E. Warren publishes a preliminary account of the development of the nauplius of this primitive daphnid, the material having been obtained from Lake Bassenthwaite. The special object of the investigation was to determine whether a cœlom does or does not occur in the embryo, but the specimens obtained were all free-swimming with well-developed muscles, so that the question could not be decided. The antennary and maxillary glands seem both to be purely ectodermal in origin, the end-sac being merely a terminal dilation of the glandular tube, and not mesodermic in origin. No trace of cœlom sacs was observed.

Swedish Cladocera.‡ — Prof. W. Lilljeborg deserves to be warmly congratulated on the publication of this great monograph on the Cladocera of Sweden, which has been his ambition since he began to work at the subject in 1853.

Annulata.

Origin of Annelid Mesoderm.§ — E. Meyer re-publishes in German his elaborate paper on the development of Annelids which first appeared in Russian in 1898. The work, which is a continuation of the author's previous researches on the structure of the Annelid body, has a much wider range than is indicated in the above title, and the general conclusions only can be indicated here. A detailed study of the development of a series of Annelid larvæ has led him to distinguish between two different categories of mesoderm structures, the embryonic mesenchyme and the "cœlothelium," and also between two body-cavities, the primary and the secondary. The embryonic mesenchyme is not a morphological entity, but consists of a collection of tissues, containing

* Journ. Linn. Soc. (Zool.), xxviii. (1901) pp. 211–29 (2 pls.).
† Proc. Roy. Soc., lxviii. (1901) pp. 210–8 (6 figs.).
‡ Nova Acta R. Soc. Sci. Upsal, xix. (1901) vi. and 701 pp. and 7 pls.
§ MT. Zool. Stat. Neapel, xiv. (1901) pp. 247–585 (6 pls.).

the rudiments of many organs and tissues united into an apparent whole. On the other hand, the mesothelium or cœlothelium is phylogenetically a primitive organ, similar to the ectoderm or endoderm, and originated in the germ-cells of the primitive multicellular animals. In consequence, the author rejects entirely Faussek's theory that the secondary body-cavity had primarily an excretory significance; it was primarily a space in which the genital products originated and ripened.

Notes on Dybowscella baicalensis.— W. Zykoff* notes, in regard to this interesting form described by Prof. J. Nusbaum from Lake Baikal, that it is not the first recorded fresh-water Polychæte, and that it may have been described before. For in 1858, Prof. Jos. Leidy found in the Schuylkill River, at Fairmount, Philadelphia, a small Polychæte which he named *Manayunkia speciosa*. A comparison of Leidy's description and figures with those given by Nusbaum leads Zykoff to conclude that the Baikal form belongs to the genus *Manayunkia*, and probably to the same species. This would be interesting as an instance of discontinuous distribution.

Nusbaum † expresses his pleasure at learning from Prof. A. Giard that *Dybowscella baicalensis* does not stand alone. Besides Leidy's *Manayunkia speciosa*, there is A. G. Bourne's *Haplobranchus æstuarius* from brackish water (1883), and Giard's *Caobangia billet* from freshwater in Tonkin. Nusbaum notes that *Caobangia* and *Manayunkia* are hermaphrodite and have green blood, while *Dybowscella* has the sexes separate and has colourless blood; and there are other differences. After some reference to Polychætes from brackish water, e.g. *Nereis diversicolor*, Nusbaum has a little to say about the exceedingly characteristic structure of the Nephridia in *Dybowscella*, which have some resemblance to those in Chætogastridæ and fresh-water leeches.

Structure and Habits of Ammocharidæ.‡—A. T. Watson has made a series of observations on *Owenia*, both native and Mediterranean specimens, with special reference to the tube and tube-building. The tube consists of an internal tough translucent sheath, prolonged forward into a cone bearing a minute aperture at its tip, and an investment of fragments of shell and stone. The fragments are free from one another, and are attached by one side only to the tube, which in certain stages of contraction gives the characteristic imbricated appearance. The animal is nocturnal, but not, as has been supposed, exclusively sedentary; it is capable of a considerable amount of movement, carrying its tube with it. The metastomium (*Lippenorgan*) is of great importance in tube-building, and supplies the cement by means of which the foreign particles are attached to the translucent sheath. The sheath itself is formed by the secretion of the thread-glands. Among other results obtained by the research, the author finds that the cephalic lobe has an opening to the exterior, a phenomenon found in some Oligochætes, but not hitherto described in Polychætes. Further, it was found that the spermatozoa leave the body by two tubular openings on the ventral wall of the anal extremity; the male protrudes some 20 mm. of the body from the tube at the time, so that dispersion is relatively

* Biol. Centralbl., xxi. (1901) pp. 269-70. † Tom. cit., pp. 270-3.
‡ Journ. Linn. Soc. (Zool.), xxviii. (1901) pp. 230-60 (3 pls.).

rapid. In the females similar genital openings are present, but the ova escape much more slowly than the sperms. In aquaria the discharge of sperms by a male appears to stimulate all surrounding ripe animals, and they similarly discharge their products. The development of the eggs was watched, and the identity of the young with the *Mitraria* of Metschnikoff established.

Respiration in Spirographis spallanzanii.* — M. Bounhiol noticed that when the water in the aquarium was not changed this Annelid left its tube in 10–12 hours, as if to accelerate the cutaneous respiration. This led him to a series of experimental studies on the respiratory activity. The co-efficient of respiratory activity varies considerably according to the conditions; the animal shows a remarkable plasticity. Small specimens breathe for equal weights much more actively than large ones, the surface being relatively greater in the former. After loss of the gill, there is a rapid compensation by increase of the cutaneous respiration. The cutaneous method is much the more important, effecting at least three-quarters of the total respiration.

Structure of Saccocirrus.† — E. S. Goodrich has studied this worm (*S. papillocercus*) at Naples, and has been able to amplify and correct previous observations. He finds that the last 10–12 segments have neither parapodia nor chætæ; there is a stomatogastric nervous system; in the male genital region the nephridia open into the cœlom, and also into the ducts of the sperm-sacs, while in the female the corresponding nephridium opens by a minute pore into the base of the spermathecal duct. As in *Protodrilus*, there is a special head-cavity, which is probably the cœlom of the first segment. In a discussion on the systematic position, the author emphasises the affinities with *Polygordius* and *Protodrilus*, and maintains that the so-called primitive characters of the two latter (absence of parapodia and chætæ, &c.), are really the result of specialisation. He suggests the suppression of the group Archiannelida, and the inclusion of the three genera in Lankester's group Haplodrili, as specialised offshoots of the Annelid stem, and not as ancestral forms.

Structure and Affinities of Echiurus unicinctus. ‡ — Miss A. L. Embleton has obtained numerous specimens of this Japanese Echiuroid from Tokyo, and has for the first time subjected it to a thorough examination. She finds that it differs so much from the British *E. pollasii* as to suggest the necessity for the formation of a new genus. There is no extensible proboscis, this being represented merely by a short blunt prostomial lobe. There is no trace of a closed vascular system, hitherto believed to be characteristic of Echiuroids. There is a definitely marked band of compound glands in the skin, and a single circlet of perianal hooks. The inner funnels of the segmental organs are produced into long tapering arms which are spirally grooved and densely ciliated. The mesentery or diaphragm, present alike in *E. pallasii* and in *Thalassema neptuni*, are here absent, and the alimentary canal does not appear to be divided into regions. On the other hand, except for the perianal bristles in *E. pallasii*, that species resembles *Thalassema*

* Comptes Rendus, cxxxii. (1901) pp. 1348–51.
† Quart. Journ. Micr. Sci., xliv. (1901) pp. 413–28 (3 pls.).
‡ Trans. Linn. Soc. (Zool.), viii. (1900) pp. 77–97 (4 pls.).

neptuni very closely in all those points in which it differs from the Japanese form. These facts seem to render a redistribution of the species into genera necessary.

Annelids from Patagonia and Chile.*—Prof. E. Ehlers describes the Annelids of Plate's expedition. The collections include sixty-five species, of which over twenty are new. These are briefly described here, and are to be discussed more fully later.

Supra-œsophageal Ganglia of Lumbricus agricola.†—J. De Meyer distinguishes:—(A) a palpar region including (1) a pair of internal ganglia forming an "anterior brain," (2) a pair of external superior nerves, (3) a palpal area with tactile structures, and (4) the internal roots of the peri-œsophageal connectives; and (B) a syncipital region including (1) peripheral ganglia forming a "posterior brain," (2) a pair of internal inferior nerves, (3) a syncipital area with optic and tactile organs, and (4) the external roots of the peri-œsophageal connectives. These two regions are the homologues of the palpar and syncipital regions in Polychætes; the nuchal region is undeveloped.

Oligochætes of Switzerland.‡—Dr. K. Bretscher has continued his observations on this subject by a survey of some new districts. The survey has not only resulted in the discovery of some new species, but has also shed some light on the causes influencing distribution. The first factor determining the distribution, especially of the Enchytræidæ, is the amount of water present in the soil, the worms being intolerant of dryness. The geology of the district influences its Oligochæte fauna in so far as it affects the depth of soil. Thus the Göschenalp has a very shallow crust of soil, and is remarkably poor in worms. The author also discusses some of the interesting questions connected with the fauna of the small Alpine lakes, liable alike to be dried up in summer and frozen in winter.

Nematohelminthes.

Modes of Reproduction in Nematodes.§ — E. Maupas has made a biological study of much importance on numerous species of nematode worms. (1) In 18 species, 16 of which are new, distinct males are absent; out of a total of 34 species reported on by Maupas and others, 25 are hermaphrodite, and 9 are parthenogenetic. (2) Neither the hermaphrodite nor the parthenogenetic forms show any structural peculiarity except as regards the gonads, but all have a feminine aspect. Three species, *Rhabditis elegans*, *R. caussaneli*, and *Diplogaster robustus*, are ovo-viviparous; the rest are oviparous, but the eggs may have to undergo 3 or 4 or all of their cleavages before liberation. (3) The hermaphrodites are protandrous (proterandric) and autogamous. (4) The hermaphrodite forms produce (*a*) spermatozoa, which are stored in the seminal receptacle of the uterus, (*b*) a number of eggs which are fertilised, and (*c*) a larger number ($\frac{2}{3}$ or more of the total) which are not fertilised and simply abort. It seems as if the male, or rather the

* Zool. Jahrb., Supp. v. vol. ii. (1901) pp. 251–72.

† Ann. Soc. Belge Microsc., xxvi. (1899–1900, published 1901) pp. 146–64 (3 figs.).

‡ Rev. Suisse Zool., ix. (1901) pp. 189–223 (1 pl.).

§ Arch. Zool. Expér., viii. (1900) pp. 463–624 (11 pls.).

spermatogenetic, activity were insufficient to provide spermatozoa for all the eggs.

(5) Among the hermaphrodites a few males may occur—0·13 per 1000 for *Diplogaster robustus*, 1·5 per 1000 for *Rhabditis elegans*, 7 per 1000 for *R. perrieri*, 20 per 1000 for *R. duthiersi*, 45 per 1000 for *R. viguieri*. There is nothing abnormal in the structure of these occasional males. (6) They seem, however, to have almost quite lost their sexual instinct and appetite; they have the inertia of females; 272 were placed with 313 females, and 20 fertilisations occurred—13 in one species (*R. marionis*) whose hermaphroditism is incomplete. (7) They may be called atavistic males, reminiscent of the primitive diœcism.

(8) The progressive elimination of the male type is forcibly suggested by the partial hermaphroditism of some forms in which the gonad of one side occasionally produces eggs only (*R. duthiersi*), or in which this may be true even of both gonads (*R. marionis* and *R. viguieri*). In these species the occurrence of occasional males is most frequent, viz. in the order mentioned, 20, 7·6, 45 per 1000 females. (9) This implies a substitution of the hermaphrodite for the diœcious state, and Maupas argues that this and not the opposite process has been the general mode of origin of hermaphroditism. (10) It also seems clear that the hermaphroditism has been evolved only in the feminine type, which conserves the more primitive characters. (11) Everything points to the general conclusion that the male and female germ-nuclei are absolutely equivalent, both morphologically and physiologically.

(12) In *R. elegans*, *R. marionis*, and *R. duthiersi*, the occasional males were got to impregnate hermaphrodites which had exhausted their own sperm. In the two last-named species the issue of this heterogamic fertilisation resulted in quite normal individuals; in *R. elegans* there was a marked "arrenotokous" influence, the proportion of males (usually 1–2 per 1000) rose to 463 per 1000, re-establishing an approximate equilibrium of the sexes, or, more strictly, resulting in an approximate equilibrium between hermaphrodites of feminine build and quasi males; for these males were as usual practically non-sexual—they did not copulate.

(13) Experiments on *R. elegans* and *R. caussaneli* as to the possible influence of age and nutrition on the numerical proportions of the sexes gave no result, except that the total number of eggs was greater when the food was abundant. The sexuality of the individuals and of their reproductive cells is irrevocably determined from the time of the maturity of the original germ-cells, i.e. from the beginning of the life of the parent.

(14) The continuance of autogamic reproduction was observed in three cases for 40–50 generations, and the result was always degeneracy —abortion, weakness of larvæ, sterility. But the degeneracy always appeared suddenly, when the surrounding temperature rose to 23°–24° C., and Maupas thinks that the rise of temperature was really the cause.

(15) Seven parthenogenetic species (in six genera) were observed—*Rhabditis schneideri*, *Cephalobus dubius*, *C. lentus*, *Plectus cirratus*, *Aphelenchus agricola*, *Alaimus thaumugadi*, *Macrolaimus crucis*. Of the first-named, 4039 adults were observed, without hint of a male; but the author admits that males may occur as rarities. (16) In conclusion, Maupas refers to the extraordinary reproductive diversity which his

studies have revealed, and to the apparent independence of the reproductive life of the species from the somatic life of the individual.

Propagation of Blood Filariæ.*—G. Noè has continued his experiments on the mode of propagation of *Filaria immitis*, and confirms the conclusions which he previously reached along with Prof. Grassi. The experiments were made on dogs, and the results obtained are convincing (*veramente brillanti*). The parasite passes from one host to another solely by means of the mosquito's puncture after the fashion already indicated, and to suppose any other mode of infection is quite gratuitous.

Fixation of Intestinal Parasites.†—Dr. A. Rizzo describes different modes of attachment. In *Sclerostomum equinum* and *Scl. tetracanthum*, as in *Uncinaria*, there is formed, at the point where the worm adheres to the mucous membrane, a special interlocking arrangement—" una clava di aspirazione." There is a papilla round which the buccal capsule fits, and into which the two strong chitinous buccal teeth of *Scl. equinum* are inserted. The mode of adhesion in *Trichocephalus affinis* is also described in detail, with special reference to a longitudinal granular striated region near the anterior and on the ventral surface, which has been interpreted as an adhesive organ of copulation, which is, however, more likely adapted to parasitic fixation.

Platyhelminthes.

Oogenesis in Thysanozoon brocchi.‡—R. Schockaert finds that within the nucleus of the oocyte in this form there appears at a very early stage a non-granular filament, quite distinct from the chromatin thread, which frequently divides transversely to form two threads. The single or double filament elongates and thickens, and ultimately applying itself to a nucleolus, diminishes to form a band surrounding part of the nucleolus, and quits the nucleus. If the filament has divided, then the two filaments with their adjacent nucleoli occur at opposite poles of the nucleus; if it remains single till this stage, division now occurs, and the two centrosomes are formed. The stage at which division occurs determines whether the centrosome appears single or double from the first. These results should be compared with those of Gérard, to which they are prior.

Oocyte of Prostheceræus vittatus.§—O. Gérard has studied the processes of maturation and fertilisation in this Polyclad. The following are among the more striking of his results. The oocyte of the first order contains an oval nucleus with a single nucleolus, which early disappears and appears to feed the nucleus. Within the nucleus there occurs in addition a slender filament, the centrogenic element, possibly of nucleolar origin, more likely formed of nuclein. This filament grows as the other egg-elements grow, and when the chromatin reaches the skein-stage, divides into two secondary filaments, which travel towards the opposite ends of the nucleus, and then, passing into the cytoplasm, form the central corpuscles. The central corpuscles seem to increase

* Atti (Rend.) R. Accad. Lincei, x. (1901) pp. 317–9.
† Tom. cit., pp. 309–17 (3 figs.).
‡ La Cellule, xviii. (1901) pp. 37–137 (4 pls.).
§ Tom. cit., pp. 141–248 (3 pls.).

in size, but this is merely due to the accumulation of extraneous substance around them. In reality they diminish in size from the time of their formation, and produce a substance which is the cause of the karyokinetic changes.

Reproductive Organs of Planaria maculata.* — W. C. Curtis describes for the first time the structure and development of the gonads of this common American form. The eggs are laid in May and June, but the young do not appear to develop reproductive organs until the approach of autumn, as specimens found in summer show no trace of these. Worms taken in September and October show ovaries and testes, but not the ducts nor the genital atrium; the genital products apparently ripen slowly, as little change occurs in the gonads during the formation of the accessory organs. The general arrangement of the organs is similar to that found in other Planarians.

Tasmanian Land Planarians.† — T. Steel discusses the general characters of the planarians of Tasmania, and describes two new species and a new variety. He finds that there is nothing peculiar about the planarians of Tasmania as contrasted with those of Australia. The peculiar species do not differ from the common species more than the peculiar species of one district of Australia differ from those of another. Of the twelve known Tasmanian species, six are common in Australia, and six are peculiar.

Australian Land Planarians.‡ — T. Steel describes several new species, the most interesting being *Geoplana fuscodorsalis* and *G. arenicola* from Perth, Western Australia. Both were found in dry sandy soil, in a district where the dry season lasts eight months, and the soil in summer becomes baked to a depth of two feet. As yet the means by which the creatures withstand the prolonged drought has not been discovered. The author's observations show that the diet of the land planarians is not vegetable matter, as was supposed by Darwin, but consists of insects, earthworms, slugs, and *Peripatus*. They entangle their prey in the slimy mucus secreted by the surface of the body, and suck the soft contents by means of the suctorial tube protruded from the peripharyngeal aperture. In regard to the method of laying of the large egg-capsule, the author confirms Dendy's observations that this takes place by rupture of the dorsal body-wall. The rent rapidly heals after the extrusion of the capsule.

Turbellarians of Switzerland.§—Dr. W. Volz reviews the Turbellarian fauna of Switzerland, giving notes on habitat, the literature, &c. He also describes several new species, including *Mesocastrada fuhrmanni* g. et sp. n., and *Diplopenis tripeti* g. et sp. n.

Revision of the Family Bothriocephalidæ.‖ —V. Ariola gives us a history of the study of Bothriocephalidæ, a diagnosis of all known species with their inevitable synonyms, a list of hosts, an account of

* Circ. Johns Hopkins. Univ., xix. (1900) pp. 56–9 (9 figs.).
† Proc. Linn. Soc. N. S. Wales, xxv. (1900) pp. 618–31 (1 pl.).
‡ Tom. cit., pp. 563–80 (1 pl.).
§ Rev. Suisse Zool., ix. (1901) pp. 137–88 (4 pls.).
‖ Arch. Parasitol., iii. (1900) pp. 369–484. See Zool. Centralbl., viii. (1901) p. 499.

the geographical distribution, and a bibliography going back to 1542. The family Bothriocephalidæ s. str. is divided into three sub-families—Diplogoninæ, Mesogoninæ, and Pleurogoninæ. In the first the genital apparatus is double in each proglottis, in the two other sub-families it is single, but the opening is on the flat surface in Mesogoninæ and on the lateral margin in Pleurogoninæ.

Rostellum of Davainea.*—Dr. A. Breazzano discusses the morphology of the rostellum, with special reference to *Davainea cesticillus*, *D. tetragona*, and *Chapmania tauricollis*. The rostellum in these forms is represented by a bulb with a retiform content, and on this bulb there are attached and distributed various muscular strands belonging to the internal longitudinal system of the strobila. In short, there is a *rudimentary* rostellum.

Nemertea from Chili.†—Dr. E. Isler finds that the Plate collection of Nemerteans includes only Metanemertea and Haplonemertea, belonging to the genera *Eunemertes*, *Amphiporus*, *Tetrastemma*, *Eupolia*, *Lineus*, *Cerebratulus*, and *Micrura*. Five new species are included.

Incertæ Sedis.

"Ciliated Urns" of Gephyreans.‡—Ch. Gineste adopts for these obscure elements the names *Pompholyxia* and *Kunstleria*, suggested respectively by Fabre-Domergue and Delage, with the correlated assumption of their parasitic nature. He doubts, however, the view of Delage and others that they are to be regarded as Mesozoa, and represent typical gastrulæ. The occurrence, among the various methods of reproduction, of a simple Protozoon type of division, leads him to regard them as of Protozoon origin, but exhibiting many peculiarities which are to be directly ascribed to the peculiar habitat. In another note the author discusses the "enigmatical vesicles" found within the general cavity of *Phymosoma granulatum* and other Sipunculids. These occur together with typical forms of *Pompholyxia* and *Kunstleria*, and the author brings forward evidence to show that they are a form of *Kunstleria*, and give rise to the normal form by a process of alternation of generations.

Echinoderma.

Development of Ophiura brevispina.§—Caswell Grave finds that this species is peculiarly favourable for the study of certain problems connected with Echinoderm morphology, and that its larva is of the remarkable type first figured by Krohn. The eggs are large, and at first floating, but later the larvæ become uniformly ciliated and are capable of swimming below the surface. Gastrulation by invagination does not seem to occur, but there is apparently a process of splitting in an originally solid planula. The posterior enterocœles are fused, and the pouch so formed gives rise to the hydrocœle. The stone-canal arises before the pore-canal, which is a remarkable reversal of the

* Atti R. Accad. Sci. Napoli, xi. (1901) 7 pp. and 1 pl.
† Zool. Jahrb., Supp. v. vol. ii. (1901) pp. 273–80.
‡ Proc. Verb. Soc. Linn. Bordeaux, 1901, 10 pp. and 8 pls.
§ Mem. Acad. Sci. Baltimore, viii. (1900) pp. 83–100 (3 pls.).

usual conditions. When sixty hours old the larva becomes club-shaped, the posterior thickened region containing all the organs, and the anterior region being apparently the homologue of the larval organ of *Asterina gibbosa* and of the stalk of *Antedon*. As in *Antedon* the young larva is uniformly ciliated, while the later larva has bands of cilia, and there are some other resemblances between the larvæ of the two forms. The *Ophiura* larva shows no trace of the ordinary pluteus stage, but it is nevertheless free-swimming and not developed in a brood-pouch. This fact and the resemblances to the larva of *Antedon* lead the author to believe that the larva is one of primitive type. The relation of the larval symmetry to the adult is such that the ventral and dorsal regions of the larva are equivalent to the oral and aboral regions of the adult, there being no secondary twisting during development.

Development of Cribrella oculata.* — Dr. A. T. Masterman publishes a preliminary note on this subject. He finds that segmentation is at first total and unequal, but later free-cell formation occurs, and a solid morula results whose cells are all of the same size. In some cases normal gastrulation occurs, in others the hypoblast is formed by multipolar gastrulation, or by multipolar ingression of single cells. The larva when hatched is uniformly ciliated, and shows an epiblast with a pit at the posterior end which probably represents the blastopore. The mesoblast is formed from two rudiments, one arising from the anterior end of the hypoblast and the other from its posterior end. The anterior forms right and left hydrocœle and preoral cœlom, the posterior left and right enterocœle. Of these, the preoral cœlom forms chiefly the axial sinus, while the right hydrocœle disappears; the left enterocœle gives rise mainly to the hypogastric cœlom and the right to the epigastric cœlom. The anterior cœlomic rudiment gives rise to a small thin-walled vesicle which resembles the preoral sac of *Balanoglossus*.

Optic Organs of Starfishes.† — W. Pfeffer has made a study of these organs which have been repeatedly described. The radial nerve expands at the tip of the arm, and thus forms a bed for the optic organ which lies at the base of the "feeler," the blind end of the water-vessel,—both being protected, when the ambulacral groove contracts, by the spines and by the conically pointed terminal tube-feet without suctorial discs. The optic cushion shows the same elements as are found associated with the radial nerve itself, but in different proportions, —e.g. supporting cells, cuticula-cells (forming cuticle and lens), and epithelial sensory cells. The most important elements, however, are the retinal cells, each of which consists of a cell-body, a thread-like proximal portion, and, situated on the cell-body, the so-called rod, very delicate and refractive.

(1) In one group of species there is a diffuse distribution of the retinal or optic cells over the whole optic cushion (*Astropecten pentacanthus* and *A. Mülleri*); (2) in a second group, the optic cells are restricted to certain regions, the optic grooves—e.g. *Astropecten aurantiacus*, *Palmipes membranaceus*, and *Solaster papposus*, with *Luidia ciliaris* as intermediate between (1) and (2); (3) in a third group there

* Proc. Roy. Phys. Soc. Edin., xiv. (1901) pp. 310-3 (1 pl.).
† Zool. Jahrb., xiv. (1901) pp. 523-50 (1 pl.).

are again optic grooves; but on the inner side of the cuticula, which closes the grooves, a lens has developed (e.g. *Asterina gibbosa*, *Asterias glacialis*, *Echinaster sepositus*). These different cases are described and compared with optic organs in other animals.

Polarity of Oocyte, Ovum, and Larva of Strongylocentrotus lividus.*—Prof. Th. Boveri finds that the polarity of the larva may be securely traced back to the oocyte of the first order, and with the strongest probability to the oogonia of the germinal epithelium. The basal and the free surface in the latter correspond to the animal and vegetative pole of the oocytes. In the oocytes liberated from the ovarian wall the animal pole is marked by the canal of the gelatinous envelope and by the eccentricity of the germinal vesicle. The two cleavages of the oocytes always take place at the animal pole; the polar bodies emerge through the above-mentioned canal. In the ovum which results the pigment previously uniformly distributed in the periphery is concentrated in an annular zone, at right angles to the axis of the egg, and belonging to the vegetative half. The segmentation is continued in strict relation to this polarity. Especially is the differentiation of the larval organs determined by the three zones on the ovum, marked by the pigment-ring. The vegetative unpigmented cap forms the primary mesenchyme and the larval skeleton; the pigmented zone forms the gut and its derivatives, the unpigmented animal half forms the ectoderm and its differentiations.

North American Holothuroids.†—H. L. Clark contributes to the useful series of synopses of North-American Invertebrates a brief account of the Holothuroids, reducible to not more than forty-seven species, a list of the specific names no longer even tolerable, an artificial key of the genera (*Synapta*, *Chirodota*, *Myriotrochus*, *Eupygus*, *Trochostoma*, *Caudina*, *Psolus*, *Thyonepsolus*, *Thyone*, *Cucumaria*, *Mülleria*, *Stichopus*, and *Holothuria*), and a key to the species under each genus.

Cœlentera.

Variations of a Newly-Arisen Species of Leptomedusoid.‡—A. G. Mayer has made a careful study of the variations of *Pseudoclytia pentata*, a Leptomedusoid of the family Eucopidæ, which he discovered in large numbers at the Tortugas, Florida. It differs from all other Hydromedusæ in that it normally possesses five radial canals, five lips, and five gonads, all 72° apart, instead of four of these various organs, 90° apart as in other Eucopidæ. In the structure of its tentacles, otocysts, gonads, and manubrium, the general shape of its bell, and the arrangement of tentacles and otocysts, *Pseudoclytia pentata* is very closely similar to *Epenthesis folleata* McCrady, except that the former is pentamerous while the latter is tetramerous. The two medusæ are, however, different in colour, so that one can readily distinguish quadratic aberrations of *P. pentata* from normal specimens of *E. folleata*, and, *vice versa*, pentamerous individuals of *E. folleata* from normal *P. pentata*. But the two are so similar that it seems safe to conclude that *P. pentata*

* Zool. Jahrb., xiv. (1901) pp. 630–53 (3 pls.).
† Amer. Nat., xxxv. (1901) pp. 479–96 (27 figs.).
‡ Sci. Bull. Brooklyn Inst., i. (1901) pp. 1–27 (2 pls.).

has been derived from some species of *Epenthesis*, which, if not identical with, was closely allied to *E. folleata*.

In *P. pentata* the lips show a decided tendency to revert to the ancestral condition of four lips, but the radial canals do not, inclining rather toward the production of even more than five canals. Those with five radial canals show a decided tendency to have also five lips, but the correlation becomes less and less perfect the more the medusæ depart from the normal. The greater the departure from the normal, the less likely are the radial canals to be radially symmetrical, and the more likely are they to be irregular. Among those in which the canals are not radially symmetrical, 66·66 p.c. have these organs bilaterally arranged; and in the case of forms with non-radially symmetrical lips 71 p.c. are bilateral. When radial symmetry is lost there is a decided tendency to bilateral symmetry. One half of the abnormal individuals are radially symmetrical.

The more abnormal the medusoids the less their fertility; thus the variability is a slight disadvantage to the species as far as productiveness is concerned. The reduced fertility and the prevalent irregularity of the abnormal individuals may account for their inability to initiate new species. Monsters with two manubria suggest the mode of origin of polygastric forms, such as *Gastroblasta timida*, *G. raffaelei*, *Multioralis ovalis*, &c.

The variations of *P. pentata* are closely similar to those of *Epenthesis folleata*, but more numerous.

Thus *Pseudoclytia pentata* has all the interest of a new race; it is very successful; it is very variable; and in its variations it illustrates the manner in which other newly-arisen races of animals may have suddenly given rise to still more diverse species. The abnormal individuals labour under two disadvantages;—they are less fertile, and they are somehow handicapped by the disturbance of symmetry.

Hydroids from the Pacific.* — Dr. Cl. Hartlaub describes the Hydroids obtained by Schauinsland's expedition, comprising fifteen species from the South Island of New Zealand, all belonging to the Antarctic fauna; fourteen species of Arctic character from the vicinity of Vancouver; and a single species from the Sandwich Islands. Of the New Zealand forms five are European, including the common *Clytia johnstoni*, now first recognised as a member of the New Zealand fauna.

Anatomy and Development of Cassiopea xamachana.† — Dr. R. P. Bigelow publishes a full account of this interesting medusa from Jamaica, found by Dr. Field in 1891, and already briefly described. It seems to differ only slightly from *C. andromeda* Eschscholtz and *C. polyphoides* Keller, and it is possible that Fewke's *C. frondosa* is merely a variety. The Jamaican specimens show great variability, especially as regards the number of rhopalia and of marginal lobes in the paramereres, points of importance, because the former character has been regarded as of generic and the latter as of specific value. In both cases the additional members are not intercalated fortuitously, but manifest a constant regard for the symmetry of parts. In the endo-

* Zool. Jahrb., xiv. (1901) pp. 349–79 (2 pls.).
† Mem. Boston Soc. Nat. Hist., v. (1901) pp. 191–236 (8 pls.).

derm, as well as in the mesoglœa, green bodies occur which give the iodine test for starch and are apparently symbiotic Algæ. These are present in both the adults and larvæ, and enable both to live in shallow lagoons in water which would be too poor in oxygen for most marine animals. Developing eggs were not met with, but the abundant scyphistoma larvæ were found to be multiplying rapidly by budding. The buds when set free resemble planulæ, except that they possess a well-defined mesoglœa and four septal muscles. The mouth arises at the former point of attachment, while the distal end of the bud becomes the stem. There is no evidence of any invagination of ectoderm in the formation of the mouth, both the gullet and the gastric pouches being lined with endoderm. Generally, it may be said that there is no evidence of the existence of an anthozoon stage in the larvæ produced by budding. The scyphistoma becomes metamorphosed into the young medusa, but a small basal segment remains which, after the setting free of the medusa, develops into a perfect scyphistoma and repeats the process. This basal segment is closely analogous to the planula-like buds formed from the young scyphistoma.

Movements of Medusæ.*—J. von Uexküll has studied *Rhizostoma pulmo* in the living condition, in order to re-investigate the question of the relation of the marginal bodies to the rhythmic contractions. He finds that the marginal bodies are not centres presiding over the rhythm; they are nothing more than receptive organs for mechanical stimuli. At every stroke they swing to and fro on their stalks, and thus give rise to a stimulus which spreads over the nerves, reaches the muscle-centre, and thus leads to the contraction of the muscles. The first stroke, in a medusa which has been lying at rest, is due to a spontaneous muscular contraction, and occurs equally in a specimen from which the marginal bodies have been removed.

Alcyonarians of the Gulf of Lyons.†—The late Prof. H. de Lacaze-Duthiers had, as one of his last pieces of work, made a study of *Sympodium coralloïdes* and *Rolandia coralloïdes* g. et sp. n. He contrasted the two forms, as regards zoanthodeme, sarcosome, spicules, polypes, and so on, describing and drawing in his characteristic fashion with no hint of diminution of skill or loss of cunning.

Protection of the Young in Actiniaria.‡—O. Carlgren describes the various modes:—(1) The embryos may develop in the cœlenteric cavity; in the Arctic genera *Urticina* and *Actinostola*, they remain there till they have several circles of tentacles. (2) The embryos may be attached to the body-wall and develop there, (*a*) without there being brood-pouches (*Epiactis prolifera*), or (*b*) in special brood-cavities formed by invaginations of the body-wall. These may be numerous and arranged in longitudinal rows, and each may contain one young one or a few. (*Pseudophyllia arctica*, *Epiactis marsupialis* sp. n., *Epigonactis fecunda* and *E. regularis*, *Leiotealia spitzbergensis*, *Condylactis georgiana*); or there may be only a few (6) large brood-cavities, each with numerous embryos (*Marsupifer valdiviæ* sp. n.).

* MT. Zool. Stat. Neapel, xiv. (1901) pp. 620–6.
† Arch. Zool. Expér., viii. (1900) pp. 353–462 (5 pls.).
‡ Biol. Centralbl., xxi. (1901) pp. 468–84 (13 figs.).

Septa and Mesenteries of Madreporaria.* — S. E. Duerden has studied the disputed questions connected with the order of the appearance of septa and mesenteries in living and preserved specimens of certain West Indian forms. He finds that the first six pairs of mesenteries differ so much in their mode of origin and significance from the others as to deserve a special name. He therefore calls them *protocnemes*, and the subsequently developed ones *metacnemes*, the associated septa being *protosepta* and *metasepta*. He finds that in *Manicina areolata* the twelve protocnemes arise in bilateral pairs in a definite order, which is probably the same throughout the Madreporaria and Actiniaria; two pairs of directives are always present; the first four pairs of protocnemes are the earliest to unite with the stomodæum, and a long interval may elapse before the fifth and sixth pairs become complete and the metacnemes appear; the development of the protocnemes in asexually produced buds is in close agreement with that of sexually produced polypes; most of the polypes of the genera *Madrepora* and *Porites* never pass beyond the protocnemic stage. With regard to the metacnemes the results are stated as follows. In most coral polypes the addition of mesenteries beyond the primary six pairs always takes place in successive unilateral pairs, the corresponding pairs on each side being usually simultaneous and always exocœlic; the first cycle of metacnemes (six pairs) arises in successive pairs from one aspect of the polype (sulcar or ventral) to the other (sulcular or dorsal), the pairs afterwards becoming equal; the second cycle consists of twelve pairs, of which six arise in succession from one aspect of the polype to the other, and all on the same aspect of the first-cycle metacnemes; the remaining six pairs appear in the same succession but on the reverse aspect. In *Porites* the additions of mesenteries beyond the six primary pairs take place in bilateral pairs in only one region and within one enterocœle, the mesenteries remain unicyclic, and the unilateral pairs beneath the stomodæum consist of alternately longer and shorter mesenteries. In these respects the metacnemes of *Porites* differ from those of all other known coral polypes. In Actiniaria the metacnemes in the Hexactiniæ are similar to those of most Madreporaria; those of Zoantheæ approach somewhat to the conditions seen in *Porites*, while those of Cerianthеæ resemble those of *Porites* very closely. It would seem, therefore, that *Porites* bears the same relation to the other Madreporaria as *Cerianthus* does to the other Actinaria. In *Porites* both metacnemes and metasepta arise in the same manner as in many of the extinct Palæozoic corals. All the evidence seems to show that the protoseptal phase has always been hexameral in the Zoantharia, and that it is only with the metasepta that the distinctive characters—cyclical or bilateral—truly commence. The author considers that the arrangement of the septa and mesenteries on the cyclical or bilateral plan should constitute the basis for a primary sub-division of corals.

Madreporaria from the Sandwich Islands and Samoa.† — Prof. Th. Studer comments on the fact that, while in the Central Pacific the Madrepores and most of the Astræidæ reach their northern limit, in

* Circ. Johns Hopkins Univ., xix. (1900) pp. 47–53 (12 figs.).
† Zool. Jahrb., xiv. (1901) pp. 388–428 (9 pls.).

the Eastern region they extend much further north. These northern forms appear stunted, but their existence can only be explained by the equatorial current called Kuro-Sudo, which carries larvæ northwards from the reefs of Formosa and the Philippines, much as the Gulf Stream of the Atlantic renders the coral reefs of Bermuda possible, though in this case the effect is much more marked. Similarly, the resemblance between the coral fauna of Panama and of Hawaii is explained by the set of the current off the American coast. The author's specimens, obtained by Schauinsland's expedition, include twelve new species, mostly of the genus *Porites*, of which many are peculiar to the Sandwich Islands.

Cilia of Ctenophora and Ciliary Insertion in General.*—P. Vignon describes the cilia in various Ctenophora. Each ciliary fibre is chromatic throughout its length, but the insertion is cytoplasmic, not chromatic. An analogous case is referred to in the larva of *Chironomus*, and a long list is given of the various modes of ciliary insertion—on functional centrosomes, on so-called centrosomes, on the nucleus, in the perinuclear cytoplasm, with or without superficial granulation, and so on.

Protozoa.

Intra-vitam Staining.† — S. Prowazek gives a preliminary account of the results obtained by treating various living Protozoa and other animals with neutral red.

Rhizopods of the Lake of Geneva.‡—E. Penard, on account of the doubts which have been expressed as to the validity of the peculiar species of Rhizopods described by him in this lake, has subjected the fauna to a new and thorough revision. He finds that the deep-water Rhizopod fauna consists of 32 species, of which 23 are absolutely peculiar either to this lake or to the lakes of Switzerland in general. When the Rhizopods of the ponds, swamps, &c., of the neighbourhood are added, the total, exclusive of the ill-defined species of *Amœba*, is raised to 180 species; in other words, about 90 p.c. of the known Rhizopods occur in the vicinity of Geneva. From this the author argues that if the 23 species were not truly peculiar to the lake, some proportion at least of them must have been discovered elsewhere. He has succeeded now in finding some of these deep-water forms on the shores of the lake, a fact which renders less obscure the problem of transmission from one lake to another. He believes that, just as there is a special Rhizopod fauna peculiar to certain habitats, e.g. *Sphagnum*-bogs, so there is a special deep-water Rhizopod fauna. As yet this is known only in the Swiss lakes, but it will probably be also found elsewhere. Apart from these faunas peculiar to special habitats, the Rhizopods are generally cosmopolitan. This is probably also true of other Protozoa and of Protophyta.

Radiolaria Tripylea of the Mediterranean.§—Dr. A. Borgert points out that although these Radiolarians increase in number as the equator

* Comptes Rendus, cxxxii. (1901) pp. 1346–8.
† Zool. Anzeig., xxiv. (1901) pp. 455–60.
‡ Rev. Suisse Zool., ix. (1901) pp. 225–41.
§ MT. Zool. Stat. Neapel, xiv. (1901) pp. 239–46 (1 pl.).

is approached, yet there are far more species known from the Atlantic than from the Mediterranean. This is probably due to want of careful research. He places the number of species at 31, as compared with Haeckel's 18. Lists of the species are given, and certain new forms are figured and described.

New Infusorians.*—N. M. Stevens describes as *Licnophora macfarlandi* sp. n., and *Boveria subcylindrica* g. et sp. n., two Infusorians found within the respiratory tree of *Holothuria californica*. Both occur attached to the lining membrane of the tree, but there is no evidence that they are injurious; both apparently feed on particles in the incoming water, or on waste material furnished by the host. Conjugation was not observed in either case, but lateral or oblique fission occurs. Prior to division the mouth and peristomial spire seem to atrophy, and later reappear in the daughter-cells.

Cell-division in Polytoma.†—S. Prowazek has studied the nuclear changes during division in *Polytoma uvella*. Usually repeated divisions take place within the external pellicle, so that 8 daughter-cells are formed; but as the dividing-energy begins to diminish, the number falls to 4 or 2. The resting nucleus is rounded, and contains a deeply-staining internal body, which the author prefers to designate only by a general title. Connected by a thread with this central body is a minute corpuscle, which, as division begins, travels out of the nucleus and divides. In the cytoplasm it becomes surrounded by a clear area, but the later stages are difficult to follow. The nucleus elongates, and then displays a spindle, division occurring by the indirect method. The body mentioned above, which migrates from the nucleus, must be regarded as a centrosome.

Genus Dinobryon.—J. Brunnthaler ‡ gives descriptions of all those species of this genus which form colonies, comprising the sub-genus *Eudinobryon* Lauterborn. He gives keys and tables, notes on distribution, and figures of several of the species.

E. Lemmermann,§ writing on the same subject, gives descriptions of the sub-genera *Epipyxis*, *Dinobryopsis*, *Eudinobryon*, their species and varieties, with a general discussion of distribution, a historical survey, and a general account of the structure, habits, and life-history. The investment gives a definite cellulose reaction, and contains within it a very delicate cell which is more or less contractile, and is narrowed posteriorly or drawn out into a stalk. Anteriorly it bears two flagella; the nucleus is usually central, and the cell contains two chromatophores. Reproduction takes place by longitudinal division, and as the chromatophores do not split, each cell contains only one; one only of the new cells has an eye-spot. Another form of reproduction is by the formation of resting spores.

Peridinieæ of Norwegian Lakes.‖ — H. Huitfeldt-Kaas finds that the Norwegian lakes contain five species of Peridinieæ, as contrasted

* Proc. Cal. Acad. Sci. Zool., iii. (1901) pp. 1–42 (6 pls.).
† Oesterreich. Bot. Zeitschr., li. (1901) pp. 51–60 (1 pl.).
‡ Verhandl. Zool.-bot. Ges. Wien, li. (1901) pp. 293–306 (5 figs.).
§ Ber. Deutsch. Bot. Ges., xviii. (1901) pp. 500–24 (2 pls.).
‖ Videnskab. Skrift. Christiania, i. (1900) 8 pp. and 1 pl. See also Bot. Centralbl., lxxxv. (1901) pp. 241–2.

with the four present in the lakes of Holstein. One of the five—*Ceratium hirundinella*—is common to both districts, while three of the remainder constitute new species. Of these *Peridinium willei* sp. n. is one of the largest of the known fresh-water forms ; it lives in both deep and shallow water, and occurs at all seasons of the year. The most abundant form is *Ceratium hirundinella*, which occurs alike in the great lakes and in the small ponds, often in vast numbers.

Tentaculifera.* — René Sand completes his monograph with an account of his particular observations on *Dendrocometes paradoxus*, *Ophryodendron belgicum*, *Podophrya limbata*, 2 species of *Tokophrya*, 6 species of *Acineta*, *Solenophrya crassa*, 4 species of *Ephelota*, and *Podocyathus diadema*.

Mosquitoes and Malaria.†—Dr. G. H. F. Nuttall publishes a brief chronological account of the experimental work done by all the observers who have studied malaria since the publication of Sacharoff's papers in 1893 and 1895. His object is to show the part played by the different workers in the discovery of the relation of mosquitoes to malarial disease, in order to settle some of the disputed questions in regard to priority. The result of the chronological record is to emphasize the importance of Ross's discoveries, both in themselves and as furnishing a guide to subsequent investigators.

New Gregarine.‡—L. Léger finds that *Pinnotheres pisum*, so often found in the common mussel, is infested with a Gregarine similar to that which Frenzel described as *Aggregata*. The sporozoites are formed directly within the cyst, without the appearance of sporocysts. As these stages are found only in the general cavity of the body, though other stages occur in the lumen and in the epithelium of the gut, the author calls the parasite *Aggregata cœlomica* sp. n. The cœlomic cyst presents some remarkable resemblances to the ripe oocyst of the malarial parasite in *Anopheles*.

Sporulation of Monocystis agilis.§—G. Cecconi has made an independent study of this subject. The nucleus of an adult is spherical, with a distinct membrane and a large globular vacuolated karyosome. This nucleus is destined to disappear when two Gregarines encyst ; the karyosome loses its central position, comes into contact with the nuclear membrane, and gives off part of its content. Thus arises a spindle—the secondary nucleus—which gives origin by successive mitotic divisions to a large number of sporoblast nuclei, while the primary nucleus dwindles away. The sporoblasts having been definitely formed, they conjugate in pairs, and young sporocysts result. These divide after a fashion which may be described as intermediate between the direct and the mitotic methods, and the result, after several stages, is the formation of 8 spores, which develop into young Gregarines.

Gregariniform Stage in the Cycle of the Malarial Hæmatozoon.‖ — A. Billet, in following the development of Laveran's hæmatozoon, has

* Ann. Soc. Belg., Micros. xxvi. (1899–1900) published 1901, pp. 13–119, (8 pls.).
† Quart. Journ. Micr. Sci., xliv. (1901) pp. 429–41.
‡ Comptes Rendus, cxxxii. (1901) pp. 1343–6 (1 fig.).
§ Bull. Soc. Bot. Ital., 1901, pp. 132–5.
‖ Comptes Rendus, cxxxii. (1901) pp. 1433–5 (7 figs.).

given particular attention to the gregariniform stage which occurs in the course of the endogenous or asexual multiplication. It has been vaguely called the amœboid phase, but gregariniform is more accurate. It is the truly active phase during which the parasite develops at the expense of the blood-corpuscle. It recalls, on the one hand, the forms of *Hæmogregarina* in the blood of Amphibians and Reptiles, and on the other hand, the true Gregarines of Arthropods.

Gametes of Stylorhynchus.*—Louis Léger describes the structure, movements, and conjugation of the gametes of several species of *Stylorhynchus*. Each is a naked cell, with a granular cytoplasm, a circular nucleus at one end, a flagellum at the other. The flagellum is continued as an axial filament to a little corpuscle immediately below the nucleus. This may be compared to a basilar body, but it seems to the author more like the centrosome of a typical spermatozoon.

Chitonicium simplex.†—Prof. Ludwig H. Plate describes in more detail and figures the cell-parasite which he has previously noted as occurring in the mantle-chamber of *Ischnochiton imitator*. The young parasite is intracellular, and has a very indistinct cell-membrane; the older free forms are rounded, with a distinct nucleus and well-defined membrane. Multiplication takes place, either within or outside the cell, by simple division. No trace of a sexual process could be observed. The systematic position of the parasites is uncertain, but the absence of chlorophyll or of cellulose suggests that they are not of plant nature. They produce considerable injury to the epithelium of the host, resulting often in extensive sloughing of the cells.

* Comptes Rendus, cxxxii. (1901) pp. 1431–3 (4 figs.).
† Zool. Jahrb., Supp. v. vol. ii. (1901) pp. 601–6 (1 pl.).

BOTANY.

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

α. Anatomy.

(1) Cell-Structure and Protoplasm.

Movements of Nuclei.*—M. Körnicke confirms the correctness of his previous observations that, under certain conditions, nuclei have the power of passing through the cell-wall. In the case of the large nuclei of the pollen mother-cells of *Crocus* this is effected by means of the protoplasmic connections which are clearly shown by treatment with chromic acid, both in the state of rest and in division. In the first case, when a nucleus approaches a cell-wall, protrusions take place through the pores. The portions which pass through often again unite, so that a normal nucleus is formed, passing through the cell-wall. The nucleole usually remains in the older cell. Sometimes the nuclei occupied a central position, but had protrusions with rounded ends, or a portion of the nuclear thread projecting into a neighbouring cell. Connections were thus frequently established from cell to cell. All the cells in a pollen-chamber would sometimes exhibit this partial passage of nuclei. A complete passage was never observed.

Centrosome-like Structures in the Vegetative Cells of Vascular Plants.†—B. Němec has observed, in many cases, in the vegetative cells of the higher plants, during the process of nuclear division, structures which bear a strong superficial resemblance to centrosomes. These he divides into two classes:—(1) Structures which occur also in resting cells, and which lie, in nuclear division, at the poles of the achromatic figure (*Diplazium pubescens*, *Blechnum brasiliense*); (2) Structures of which no trace is to be found in the cytoplasm of the resting cell, but which appear as the poles of the fully developed achromatic figure, and disappear when the reconstruction of the daughter-nucleus is completed. These latter include three kinds of corpuscles:—Structures which are differentiated in the cytoplasm directly at the poles of the achromatic figure at the end of prophasis, and exhibit no demonstrable genetic relation to the nucleoles (*Dracæna arborea*); and corpuscles which arise at the poles by the transformation of achromatic fibrillæ at the end of metakinesis, and have the appearance of small roundish nucleoles (*Allium*); or appear in the form of thick irregularly circumscribed masses of protoplasm after metakinesis is completed (pollen mother-cells of *Nymphæa alba*).

Structures of the kind under consideration may appear in resting cells. Those which appear in ferns bear the strongest resemblance to true centrosomes. They are usually solitary and of irregular form.

* SB. Niederrhein. Ges. Nat. u. Heilkunde, Bonn, 1901. See Bot. Ztg., lix. (1901) 2te Abt., p. 187.

† Ber. Deutsch. Bot. Ges., xix. (1901) pp. 301–9 (1 pl.).

But the author does not regard them as true centrosomes; they are rather specialised masses of kinoplasm, perhaps rudimentary centrosomes.

Lignification of the Cell-wall.* — For the determination of the degree of lignification of the cell-wall, P. Sonntag prefers chemical analysis to the test usually employed, the intensity of staining with phloroglucin and hydrochloric acid. By analysis you get a percentage of 58·7 of ligneous substances in cocoa-fibre, and 59 in the wood of *Caryota*. With increase of lignification the capacity of the membrane for swelling diminishes. The swelling always takes place at right angles to the direction of the pores. The firmness of wood depends not only on the degree of lignification, but also on the size and number of the pores. The autumn wood of *Pinus sylvestris* and *Abies pectinata*, which has only small pores, possesses a degree of firmness represented by 45·4 and 45·5 respectively; while the spring wood of the same trees, which has numerous large pores, has a firmness of only 19·65 and 20·0 respectively.

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

Nitrogenous Contents of Green Leaves.†—E. Winterstein finds the nitrogenous constituents of green leaves to correspond closely in their reactions to those of fungi. In the residue which remains after treating pulverised green leaves with dilute and 1 p.c. alkali, the proportion of nitrogen was found to vary between 0·60 p.c. (*Lolium perenne*) and 6·20 p.c. (*Spinacea oleracea*).

New Chromogen producing a Red Pigment.‡ — Prof. H. Molisch finds in *Schenckia blumenaviana*, a Rubiaceouss plant from Brazil, a carmine-red pigment, which, however, appears only when the part of the plant in question is wounded or withered. It is probably the result of the action of an enzyme on the chromogen. It was found in the root, leaf, and stem, as well as in the flowers, and colours not only the cell-contents, but also the cell-wall. The chromogen is not rubian, and the pigment is not identical with alizarin, purpurin, anthocyan, phycoerythrin, or any other known red pigment of plants.

Leptomin.§—Prof. S. H. Vines objects to this term, proposed by Raciborski for the substance found by him as a widely distributed cell-content in the vegetable kingdom, inasmuch as it has no special connection with sieve-tissue. He also dissents from Raciborski's theory ‖ that it plays the part of hæmoglobin in the animal kingdom as a carrier of oxygen. Prof. Vines gives also the result of experiments which appear to show the very partial distribution of this substance in fruits, oils, and seeds.

(3) Structure of Tissues.

Effect of Low Temperatures on Meristematic Tissues.¶—B. Němec states that if turgescent root-tips of *Allium Cepa* are transferred directly

* Ber. Deutsch. Bot. Ges., xix. (1901) pp. 138–49 (1 pl.).
† Tom. cit., pp. 326–30. ‡ Tom. cit., pp. 149–52.
§ Ann. of Bot., xv. (1901) pp. 181–3. Cf. this Journal, 1899, p. 44.
‖ Cf. this Journal, 1898, p. 551.
¶ SB. k. Boehm. Ges.Wiss., 1899, No. 12. See Bot. Centralbl., lxxxvi. (1901) p. 237.

from water of 21° C. to water of 2·5° temperature, they contract to the extent of from 1·7 to 2·9 p.c. The difference between the longer and shorter axes of the protoplasts is greatly reduced; and the process of nuclear division is altogether suspended.

Sanio's Tracheids.*—According to O. G. Petersen, the only constant and valid distinction between Sanio's tracheids and ordinary libriform cells is the absence in the latter of areolated pores. If a vertical section exhibits pores in the form of small lenses (*lentilles*), the elements in question are tracheids; if the pores have the form of striæ, they are libriform. This distinction refers especially to the elements of the xylem. The tracheids of Conifers may be regarded as the prototype of both kinds of cell in Angiosperms.

Laticifers of Euonymus.†—L. Guignard records the occurrence of laticifers in *Euonymus japonicus* and in all other species of the genus examined. They occur in the form of latex-cells in the phloem-region, and are filled with a substance possessing properties similar to those of caoutchouc and gutta-percha. The differentiation of the latex elements takes place at a late period in the stem; in *E. japonicus* it is recognised, at the extremity of the branches, only in the secondary tissue; in the root they appear earlier; they are to be found in the officinal bark of the root of *E. atropurpureus*, In none of the species examined were they found in the leaf, the petiole, the pith, or the cortical parenchyme. Other genera of the order Celastraceæ are destitute of these laticifers.

Secreting Apparatus of Compositæ.‡—M. Col commences an account of the secreting apparatus in the Compositæ, with a description of the arrangement in *Gazania splendens*. He regards this genus and *Gundelia* as presenting connecting links between the Cynareæ and the Ligulifloræ. Not only is the presence or absence of a secreting apparatus inconstant in different genera belonging to the same family, but different parts of the same plant may differ in this respect. Thus, in *Silybum marianum*, the lower part of the stem is characterised by the presence of secreting canals, the upper part by laticiferous tubes.

Stem of Dalbergia paniculata.§—T. G. Hill describes the peculiar structure of the stem of this tree from northern and central India, belonging to the Leguminosæ. The peculiarity consists in the presence of broad concentric masses of xylem alternating with narrow soft layers of a fibrous substance. The narrow zones are of the nature of phloem, accompanied by a certain amount of cambium. The phloem contains well-marked sieve-tubes with sieve-plates. The xylem-masses present no special character. The peculiarity of structure is attributed to the formation of successive cambium rings.

(4) Structure of Organs.

Opening and Closing of Flowers.‖—A. Burgerstein gives the result of a series of observations made by the late Prof. A. v. Kerner on the

* Overs. k. Dansk. Vidensk. Selsk. Forhandl., 1901, pp. 95–108 (French abstract).
† Comptes Rendus, cxxxii. (1901) pp. 1354–6.
‡ Journ. de Bot. (Morot), xiii. (1899) pp. 234–52; xv. (1901) pp. 166–8.
§ Ann. of Bot., xv. (1901) pp. 183–6.
‖ Oesterr. Bot. Zeitschr., li. (1901) pp. 185–93.

period of opening and closing of flowers. Among the more interesting of these are the following:—The fact that some flowers remain open for a longer period in summer than in spring is not due to the direct effect of the increase in light, but to an increase in temperature resulting from the absorption of light. With many flowers the opening is not the result of growth, but of changes in the turgor due to transpiration. In some cases (*Hemerocallis flava*, *Hibiscus trionum*), flowers which in the summer remain open only for a single day, will, in the autumn, open on two or three days in succession.

Floral Organs of the Discifloræ.* — L. Beille points out that the andrœcium of the Discifloræ (in which class he includes the Euphorbiaceæ) presents itself in three types,—the isostemonous, the polystemonous, and the diplostemonous; the latter may be eudiplostemonous, when the outer whorl of stamens are placed opposite the sepals, or obdiplostemonous, when they are placed in front of the petals. In the Euphorbiaceæ all three types of andrœcium occur. The highest type of the obdiplostemonous Discifloræ occurs in the Rutaceæ, Diosmeæ, Zygophylleæ, Aurantieæ, and Anacardiaceæ; in the Rhamneæ, Ampelideæ, Celastrineæ, Staphyleæ, and Ilicineæ, it is simplified by the suppression of one of the two whorls of stamens. Of the eudiplostemonous Discifloræ the highest type is found in the Melieæ and Coriarieæ; in the Sapindeæ, Hippocastaneæ, and Acerineæ, it is again simplified by suppression.

Inflorescence of the Asclepiadeæ.† — G. O. A. Malme has studied the nature of the extra-axillary inflorescence in a large number of Asclepiadeæ natives of Brazil. From a comparison with those species in which the inflorescence is truly axillary, the author comes to the conclusion that in all cases it owes its true origin to an axillary bud, from which position it has in certain cases become more or less displaced. The extra-axillary position of the inflorescence is in all cases associated with a very great size of leaf.

Heterogyny of Ephedra campylopoda.‡ — Dr. F. Cavara argues in favour of the specific distinctness of this form from *E. fragilis*, on the ground of the constant presence of rudimentary female flowers in the male inflorescence. He thinks it probable that *E. campylopoda* is a survival of a primitive type of the genus with androgynous flowers. The paper concludes with a preliminary note on the process of amitotic division of the nuclei in the endosperm.

Pappus of Compositæ. § — R. Frieb distinguishes, from a structural point of view, three types of pappus in the Compositæ:—(1) In the great majority of the genera—*Hieracium*, *Solidago*, *Senecio*, *Crepis*, *Aster*, *Eupatorium*, *Erigeron*, *Inula*, &c.—the cells of the pappus rays put out projections in the form of teeth or spines on their tranverse septa. This form is adapted either for carriage by the wind or for adhering to the fur of animals. (2) In *Centaurea*, *Serratula*, and some other genera, all

* Comptes Rendus, cxxxii. (1901) pp. 1497-9.

† Öfv. k. Vetensk.-Akad. Förh., Stockholm, 1900, 23 pp. and 9 figs. See Bot. Centralbl., lxxxvi. (1901) p. 417.

‡ Bull. Soc. Bot. Ital., 1901, pp. 37-41.

§ Oesterr. Bot. Zeitschr., li. (1901) pp. 92-6 (10 figs.).

the cells of the pappus are prolonged, giving it a pinnate structure; this is especially adapted for carriage by the wind. (3) The fine divisions of the pappus are themselves provided with trichomic structures, and these are most of all fitted for conveyance by the wind.

Ovary of Parnassia.*— I. H. Burkill gives the result of further observations respecting the variation in the number of carpels (3–5) in mature fruits of *Parnassia palustris*. They confirm Payer's statement that the flower is zygomorphic in its early stages of development, the zygomorphy nearly or entirely disappearing in the mature state.

Seed of Hernandia.†—E. Heckel calls attention to the remarkable structure of the seed in the Madagascan genus *Ravensara*, belonging to the Lauraceæ [or Thymelaceæ], as described by Baillon; the seed being divided into six compartments springing from the receptacle. He finds a somewhat similar structure in two species of *Hernandia* also belonging to the Lauraceæ, but produced by a different process, viz. the division of the cotyledons themselves into lobes, perfectly separable by septa, which do not spring from the receptacle, and are not woody, as in *Ravensara*, but are unlignified, and have their origin in the testa of the seed.

Pneumatophores.‡—The structure of the breathing pores is decribed by M. Westermaier, especially in *Sonneratia indica*, and their connection with respiration pointed out. That they are not true roots, but organs *sui generis*, is shown by the cork mantle, the absence of a true root-cap, and the order and place of appearance of the primordial vessels.

Structure of the Sprouts of Woody Plants.§— M. Dubard has examined the anatomical structure of the sprouts (*rejets*) which appear on most trees and shrubs when in full vigour and after the cutting down of the trunk:—from the root in *Populus*, *Ulmus*, *Corylus*, *Lycium*, &c.; from dormant buds in *Quercus*; from the cambial zone in *Quercus*, *Populus nigra*. These shoots present many of the characters of herbaceous plants; in their rapid growth, elongated internodes, well developed and persistent stipules, scattered buds, a smaller differentiation of the tissues, especially of those connected with protection or support; in the smaller production of phloem in comparison to the xylem; in a smaller development of assimilating tissue; and in the much smaller excretion of calcium oxalate.

Polypompholyx and Byblis.‖—F. X. Lang has made a study of these two genera of insectivorous plants from Western Australia.

Of *Polypompholyx*, belonging to the Utricularieæ, two species were examined, *P. multifida* and *P. tenella*. They have no true root, its function being assumed by runners springing from the base of the flowering shoot and fixing the plant to the soil by their numerous slimy glands. The bladders agree in their development with those of *Utricularia*. They are of two forms,—long-stalked and adhering to the soil, and

* Ann. of Bot., xv. (1901) pp. 186–92 (1 fig.). Cf. this Journal, 1896, p. 325.

† Comptes Rendus, cxxxii. (1901) pp. 1584–6.

‡ Bot. Unters. im Anschluss an eine Tropenreise, Freiburg, 1900 (3 pls.). See Bot. Centralbl., lxxxvi. (1901) p. 392.

§ Comptes Rendus, cxxxii. (1901) pp. 1356–8.

‖ Flora, lxxxviii. (1901) pp. 149–206 (1 pl. and 80 figs.).

short-stalked, projecting somewhat above the surface of the substratum; both kinds contain algæ and remains of larvæ and of nematodes. The mature bladder (of both kinds) has three mouths, opening into a horse-shoe-shaped funnel, which is in direct communication with the cavity; these are protected by external flaps; the interior wall of the cavity is furnished with glands and four-armed absorbing hairs. There are only two stamens, with the rudiment of a third and sometimes of a fourth.

Byblis gigantea has been erroneously placed in the Droseraceæ. The sympetalous corolla, the single integument to the seed, the bilocular ovary, and other characters, show its alliance to the Lentibulariaceæ. The glands on the leaves exhibit a close resemblance to those of *Pinguicula*. The endosperm puts out remarkable haustoria; the embryo-sac has the elongated form characteristic of Scrophulariaceæ and Lentibulariaceæ; there are five stamens of somewhat unequal length; the corolla is regular.

β. Physiology.

(1) Reproduction and Embryology.

Division of Embryo-sac Mother-cells.*—M. Körnicke traces a close resemblance between the processes of nuclear division in the origin of the embryo-sac mother-cells and the corresponding processes in the pollen mother-cells; the objects observed being species of *Iris*, *Yucca*, *Canna*, and *Podophyllum*. In neither case is there any reduction division, the reduction in the number of chromosomes being completed before the prophase of the first division of the nucleus of the embryo-sac mother-cell. The two divisions from which the four cells are formed belong to the same type in each case. Variations in the details occur in both processes; e.g. unequal size of the chromosomes in *Yucca*; incomplete separation of a chromosome in the first division in *Iris*; S-like curvature of the spindle in *Yucca*; its intranuclear origin in *Iris pseudacorus*. In opposition to earlier statements, the formation of four cells was observed in all the objects, showing a tendency towards the production of tetrads, although the conditions of space necessitate an axial arrangement. The division of the embryo-sac mother-cell in all the plants examined are true tetrad divisions. In *Podophyllum peltatum*, which often has two embryo-sac mother-cells, the author sometimes found each to be surrounded by a peculiar nucellus, both nucelli being enclosed in a common outer integument.

Embryo-sac of Peperomia.†—Prof. D. H. Campbell supplements his previous account of the peculiar phenomena connected with the process of impregnation by further observations on several species, of which he gives the following summary.

All species of *Peperomia* seem to agree in having regularly 16 nuclei in the embryo-sac, instead of the normal number of 8. There is no trace of the marked polarity usually observed in Angiosperms. One of the nuclei at the micropylar end enlarges somewhat, and there is an

* SB. Niederrhein. Ges. Nat. u. Heilkunde, Bonn, 1901. See Bot. Ztg., lix. (1901) 2te Abt., p. 186.

† Ann. of Bot., xv. (1901) pp. 103–18 (1 pl.). Cf. this Journal, 1900, pp. 217, 690.

accumulation of cytoplasm about it to form the egg-cell. From 1 to 3 other nuclei are found near the egg-nucleus, and these may show a more or less regular aggregation of cytoplasm about them, and may possibly be the equivalents of the synergids. They take no part in impregnation. Several (usually eight) nuclei fuse to form the endosperm nuclei, and are the homologues of the polar nuclei of typical Angiosperms. The embryo remains very small, and shows no differentiation when the seed is ripe. The divisions of the endosperm nuclei are always accompanied by the formation of cell-walls. The hard coat of the fruit is mainly formed from the innermost layer of cells of the pericarp. The author regards these phenomena as confirming the view that the fusion of the polar nuclei in typical Angiosperms is in no sense a sexual process.

In *Peperomia*, according to the author, we have the most primitive type of Angiosperms yet described. As to its systematic position, it cannot be separated from the other Piperaceæ, but it shows several significant resemblances to the lower Monocotyledons, especially to the Araceæ.

Cross-Pollination and Self-Pollination.—Dr. W. Taliew * finds in *Vicia pannonica* and *V. striata* a similar contrivance for promoting the carriage of pollen by insects to that which exists in other Papilionaceæ.

J. Rompel and R. Stäger † discuss the mode of pollination of *Victoria regia*, which is not at present accurately known. It is in all probability effected by beetles.

O. Kirchner ‡ records observations on the mode of pollination of upwards of 70 European plants. The following may be noted as among the more interesting:—*Allium ochroleucum* affords the first recorded example of gynodiœcism in the genus. In *Serapias longipetala* there is no possibility of spontaneous autogamy, although the flowers are destitute of nectar. *Montia rivularis* presents points of structure which greatly favour spontaneous autogamy. In *Silene Elizabethæ* the 5 outer and longer stamens mature before the 5 inner and shorter ones; and although proterandrous, autogamy is at least not impossible. In *Polycarpon tetraphyllum* and *Illecebrum verticillatum* the flowers do not always remain closed, as has been stated. In *Lunaria rediviva* spontaneous autogamy appears unavoidable, although the flower is very fragrant. In *Capparis spinosa* it appears scarcely possible. Of the 47 species of *Saxifraga* belonging to the German flora, 27 are proterandrous, 8 proterogynous, and 8 doubtful. Of the 15 German species of *Linum*, 10 are heterostylic, and 5 homostylic. In *Hibiscus trionum*, a peculiar bending downwards of the style ensures autogamy. In *Hypericum Androsæmum*, although homogamous, autogamy appears to be impossible. *Daphne Laureola* is proterogynous, and autogamy scarcely possible. *D. Blagayana* appears, on the other hand, to be adapted to autogamy by homogamy, although strongly scented. In *Orlaya platycarpos* autogamy can take place readily.

* Beih. z. Bot. Centralbl., x. (1901) pp. 139–40.

† Natur u. Offenbarung, xlvi. (1900) pp. 449–57, 628–9. See Bot. Centralbl., lxxxvi. (1901) pp. 59, 60.

‡ Jahr-Heft. Ver. vaterl. Naturk. Württemberg, lvi. (1900) pp. 347–84; and lvii. (1901) pp. 1–42. See Bot. Centralbl., lxxxvi. (1901) p. 396.

Ornithophilous Plants.*—R. Marloth states that there can be no doubt that in South Africa the honey-birds (locally known as sugar-birds and sun-birds) visit flowers primarily for the sake of the honey, though they do occasionally feed on insects. He names a number of additional species of *Erica* which are fertilised by honey-birds. Altogether 40 species of South African plants, belonging to 19 genera and 12 families, are at present known as being regularly visited by Nectarinieæ, including 12 species of *Cynniris* and 2 of *Promerops*. In the Proteaceæ, of which 13 ornithophilous species are known, cross-pollination is rendered almost inevitable by the very strongly pronounced proterandry. The very strong hairiness of the ovary of *Protea mellifera* does not assist in pollination, but in the dispersion of the seeds.

Hybridisation of Peas and Beans.†— E. Tschermak gives the details of a large series of observations made with the view of determining the relative value of different characters in influencing the results. Among other points he notes that no direct influence could be detected of the pollen on the seeds, especially on the form of the cotyledons, or on the colour of the testa. He maintains the possibility of the strengthening of ancestral characters in the hybrid; also the production, in particular cases, of new characters not possessed by the parent forms. Two undoubted cases are recorded of the appearance in this way of entirely new characters.

Physiology of Reproduction.‡—Dr. G. Klebs sums up his general conclusions, already published, with regard to the antagonism between growth and reproduction, by which term he understands the formation of germs which detach themselves from the parent plant, and which are distinguished in form and structure from the vegetative parts of the plant. A brief *resumé* is given of all important researches on reproduction published during the last few years.

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

Capacity of Plants to live without Oxygen.§— From experiments, made chiefly on *Zea Mays*, A. Nabokich concludes that the growth of the higher plants does not, in most cases, cease when altogether deprived of oxygen; nor do they become entirely insensitive to external irritations. No formation of chlorophyll appears to take place, even when exposed to light. It is probable that some seeds can germinate without oxygen; but this does not appear to be the case with the spores of fungi.

Carbon-dioxide Assimilation of Leaves in Winter. ‖ — F. Czapek confirms the statement of previous observers that, in our climate, leaves which persist through the winter lose their starch in the late autumn, starch-grains being again formed in the chloroplasts in early spring. The stomates are closed throughout the whole winter, and the starch has

* Ber. Deutsch. Bot. Ges., xix. (1901) pp. 176–9. Cf. this Journal, *ante*, p. 435.
† Tom. cit., pp. 35–51.
‡ Op. cit., xviii. (1900) Gen.-Vers.-Heft, pp. 201–15. Cf. this Journal, 1900, p. 701.
§ Op. cit., xix. (1901) pp. 222–36 (5 figs.).
‖ Tom. cit., pp. 120–7.

usually quite disappeared from the guard-cells. This phenomenon corresponds with the formation of saccharose in potatoes at a low temperature. The lowering of the temperature of the cytoplasm appears to increase its attractive force for sugar; but the reason of this is at present unexplained.

Effect of Mineral Salts on Assimilation.* — From a series of experiments on *Ulva latissima*, E. A. Newell Arber derives the following general conclusions:—Distilled water is, after a short time, fatal, owing to the absence of dissolved salts; with tap-water, a large amount of carbon assimilation takes place; but the maximum (in the case of *Ulva*) only with sea-water. Sodium chloride appears to be absolutely indispensable, in the case of marine plants, for even a moderate amount of carbon assimilation; the maximum degree of concentration with this salt is probably between 1 and 5 p.c. None of the other salts which form the principal constituents of sea-water can take its place; and the absence of any one of them, provided the others were present in normal amount, did not cause any inhibition; while the presence in distilled water of either calcium sulphate or potassium chloride appears to inhibit carbon assimilation almost completely.

Excentric Growth in Thickness.† — A. Ursprung discusses this subject from a mathematical point of view, and comes to the general conclusion that the explanation of an excentric growth in thickness of stems and branches must be sought for in mechanical forces.

Sensitiveness of Plants to small amounts of Potassium Salts.‡ — H. Coupin finds that plants are as sensitive to minute quantities of nutrient substances (salts of potassium) in the soil as they are to minute quantities of toxic substances. In the case of Bordeaux wheat, he gives the following as the minimum proportions of potassium salts which can be utilised by the plant:—carbonate 0·000,000,1; phosphate 0·000,000,25; sulphate 0·000,000,8; chloride 0,000,003; nitrate 0·000,004.

Absorption of Phosphorus and Sulphur during Germination.§— G. André states that during the first few days of germination a seed will lose from 25 to 33 p.c. of its dry weight. But, while the amount of organic matter has diminished, the seed will have absorbed mineral substances (silica and lime) from the soil; the absorption of phosphoric acid and potassium taking place at a later period. In the case of the scarlet-runner (*Phaseolus multiflorus*), the amount of sulphur (including that present in the albuminoids) increases regularly, and at the time when the plant has attained the original weight of the seed, is $2\frac{1}{2}$ times as much as at the period of germination. On the other hand the amount of phosphorus remains stationary, and increases only with the increase in the amount of nitrogen.

Action of Low Temperatures on the Germination of Seeds.‖ — Dr. A. Jencic confirms the statement that, when seeds have been air-

* Ann. of Bot., xv. (1901) pp. 39-69.
† Ber. Deutsch. Bot. Ges., xix. (1901) pp. 313-26 (1 pl.).
‡ Comptes Rendus, cxxxii. (1901) pp. 1582-4. Cf. this Journal, *ante*, p. 302.
§ Tom. cit., pp. 1577-9.
‖ Oesterr. Bot. Zeitschr., li. (1901) pp. 268-9. Cf. this Journal, 1900, p. 84.

dried, exposure to a very low temperature ($-18°$ C.) accelerates their germinating powers. This he thinks may possibly be due to a transformation, under the influence of severe cold, of insoluble carbohydrates into such as are soluble in water.

Germination of Bertholetia.* — W. Watson gives an account of experiments on germinating the seeds of the Brazil-nut, *Bertholetia excelsa*, at Kew. The fruit contains from 15 to 20 nuts; the outside of the pericarp is as hard as well-seasoned oak; the inner lining is even harder, smooth, and glass-like; at the apex of the fruit is an aperture closed by a plug formed from the hardened calyx. Germination begins within the fruit, and may go on for six years before the seedling becomes finally established. Many shoots resulting from the germination of the seeds perish in their attempt to escape from the pericarp, and are replaced by others. The pericarp remains perfectly hard and undecayed, but air and light are at length admitted to the germinating seedlings by the decay of the plug which closed the aperture through which they finally emerge.

Recent Work on Transpiration.† — A. Burgerstein continues his useful materials for a monograph on the phenomena of transpiration in plants, which he classifies under the following heads:—Literature (since 1889); methods of investigation; intracellular and epidermoidal transpiration; transpiration from leaves; palisade-tissue; transpiration of halophytes; transpiration of succulent plants; influence of light on transpiration; influence of temperature and moisture; anæsthetics; carbon dioxide; transpiration in warm and moist tropical lands; special observations (Orchideæ, seeds, &c.); means for the protection and promotion of transpiration; secretion of water, hydathodes; influence of transpiration on the changes of form in plants.

(3) Irritability.

Hygroscopic Movements in Plants.‡—Dr. U. Giovannozzi classifies the various hygroscopic movements in plants under the following heads:—(1) Movements for the protection of pollen (bracts of the Cynaraceæ; opening and closing of anthers); (2) For protection against desiccation (thallus of Hepaticæ; Mosses; Grasses); (3) Opening and closing of Fruits; (4) For the dispersion or burying of Seeds (torsion of the awns of Geraniaceæ and Grasses); (5) For the dissemination of spores (Ferns; Fungi; Lichens; Algæ); (6) Movements of the branches of Conifers.

The most common mechanism which produces hygroscopic movements is the superposition of two tissues one of which has a greater capacity for swelling than the other. This applies to all cases except the movements of the leaves of *Gynerium*, a grass (which are described in detail), and of many Fungi, Lichens, and Algæ. Compact tissues, composed of thick-walled and especially of sclerenchymatous cells, have a greater power of absorbing water than those composed of thin-walled

* Ann. of Bot., xv. (1901) pp. 99–102 (2 pls.).
† Verhandl. k. k. Zool.-bot. Ges. Wien, li. (1901) pp. 49–106. Cf. this Journal, 1890, p. 361.
‡ Nuov. Giorn. Bot. Ital., viii. (1901) pp. 207–37 (1 pl.).

cells. This appears to be opposed to the facts in the case of the movements of the awns of *Pelargonium*, *Stipa*, &c., where the large-celled tissues with thin-walled cells seem to have the greatest power of swelling; but this is owing to a confusion between the apparent swelling of the tissue and the actual swelling of the cell-wall. Torsion, as in the awns of Geraniaceæ, the legumes of Papilionaceæ, &c., results from the presence of a very hygroscopic tissue on the face which is internal in respect to the torsion. The protection of the pollen and of the fruits in the Cynaraceæ is effected by the movements of special organs, the bracts of the involucre. Hygroscopic movements may take place in dead as well as in living tissues.

Plagiotropic Change of Orthotropous Roots.* — B. Němec recalls the fact that when not very young roots of seedlings are placed in water or moist air in a reversed position, they become, after a short time, plagiotropic. This he shows to result from the fact that in such orthotropous roots which have become plagiotropic, the accumulations of protoplasm acquire the same distribution as in plagiotropic lateral roots.

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

Formation of Proteids in Plants.†—W. Zaleski has already pointed out that the increase in the amount of proteids in the germinating bulbs of onions is not due to the process of germination, since it takes place also when the bulb is in a resting condition. Further experiments now show that the cutting up of roots and tubers into small pieces greatly promotes the activity of the production of proteids; and this appears to be due to the increase in the amount of surface exposed to the action of oxygen. It does not take place in an atmosphere devoid of oxygen.

Growth of the Bamboo.‡ — K. Shibata finds that, when vegetation commences (in Japan) the reserve-starch is quickly transformed into cane-sugar, glucose being produced only as a transitory formative material. In the copious decomposition of albuminoids in the rapidly growing shoots tyrosin is formed in considerable quantities, while asparagin can be detected only locally. Nitrates are formed in the young secondary roots, which are always infested by a fungus. Other inorganic substances detected were potassium, calcium, magnesium, phosphorus, chlorine, and sulphur.

Normal and Intramolecular Respiration. § — Prof. G. J. Peirce points out that the object of respiration in plants is not the maintenance of a certain body temperature, together with the production of energy needed for doing work, as in warm-blooded animals; it is merely the production of energy for doing work, as in cold-blooded animals.

The diastase formed in the germinating seed, dissolving the starch deposited in the seed as a reserve-food-material, and converting it into sugar, makes the reserve-food available for at least three purposes:—(1) for the construction of nitrogenous compounds (amides and pro-

* Ber. Deutsch. Bot. Ges., xix. (1901) pp. 310–3 (5 figs.).

† Tom. cit., pp. 331–9. Cf. this Journal, *ante*, p. 438.

‡ Journ. Coll. Sci. Imp. Univ. Tokyo, xiii. (1900) 69 pp. and 3 pls. See Bot. Ztg., lix. (1901) Abt. ii. p. 155.

§ Amer. Nat., xxxv. (1901) pp. 463–75.

teids); (2) for the formation of cellulose; (3) for the liberation of energy by respiration, nutrition, and growth. The enzymes formed by the lower plants are also useful in more than one way, not the least important use being the conversion of irrespirable into respirable substances.

The sulphur bacteria (*Beggiatoa*, *Chromatium*, &c.) obtain most, if not all, of their kinetic energy by oxidising sulphur compounds. Such bacteria as *Crenothrix*, which live in water rich in iron, obtain their kinetic energy by oxidising ferrous compounds.

Respiration of Dormant Seeds.* —In the case of *Hordeum distichum*, R. Kolkwitz finds the amount of carbon dioxide given off to depend to a remarkable extent on the moisture of the atmosphere. When air-dried the grains contain from 11 to 12 p.c. of water, and the amount of CO_2 then given off does not exceed 0·33–1·5 mgrm. per kgrm. per hour. With an increase of moisture in the air the respiration increases very rapidly in intensity, until, when it has reached 33 p.c., the amount of CO_2 given off has mounted to 2000 mgrm. per kgrm. per hour. Even when cut into small pieces or crushed, the power of respiration is not altogether lost. The vitality of dormant protoplasm must be even greater than has hitherto been supposed.

Respiration of the Olive.† —C. Gerber has made a series of observations on the value of the respiratory quotient $\frac{CO_2}{O}$ in the formation of oil in the olive. The ripening of the olive may be divided into three periods:—During the first period the fruit contains mannite which has been transferred from the leaves, and the respiratory quotient is less than unity, about 0·92. During the second period, in which the colour of the olive changes from green to violet, the mannite is partially oxidised, and the value of the quotient rises to 1·40. It is during this period that the greatest production of oil takes place. During the third period, in which the colour of the fruit changes from violet to black, a further production of oil is effected at the expense of the remaining mannite and other carbohydrates, and this is accompanied by a gradual decrease in the respiratory quotient, until it again becomes less than unity.

Combined Action of Diastase and Yeast on Starch-Granules.‡— G. H. Morris has shown that when certain ungelatinised starch-granules are submitted to the joint action of malt extract and yeast, the quantity of starch decomposed by the joint action is about three times that dissolved by malt extract alone. The combined action occurs only with those starches which are attacked in the ungelatinised form by diastase, such as barley or malt starch. The granules of potato starch are not acted on by diastase even in the presence of yeast.

γ. General.

Production of New Forms.§—Prof. R. v. Wettstein sums up the state of our knowledge as to the fresh formation of forms in the vege-

* Ber. Deutsch. Bot. Ges., xix. (1901) pp. 285–7.
† Journ. de Bot. (Morot), xv. (1901) pp. 9–22, 88–94, 121–36.
‡ Proc. Chem. Soc., xvii. (1901) p. 178.
§ Ber. Deutsch. Bot. Ges., xviii. (1900) Gen.-Vers.-Heft, pp. 184–200.

table kingdom (previous to the publication of de Vries's "mutation theory"). It is impossible to refer all the phenomena with which we are acquainted under this head to similar causes. In contrast to the phenomena of domestication or artificial selection, the author considers that in nature, natural selection is only of indirect importance in the production of new forms. Characters derived from organisation are modified by the fixing of those connected with adaptation, by crossing and by heterogenesis.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Anatomy of Loxsoma.* — Using Van Tieghem's term solenostelic in preference to the one in more common use, gamostelic, D. T. Gwynne-Vaughan defines a solenostelic stem as one in which the vascular tissue is arranged in a single hollow cylinder, with phloem and phlœoterma on either side, the complete continuity of which is interrupted only by the departure of the leaf-traces, the gaps thus produced being closed up in the internode above before the departure of the next leaf-trace. In the case of ferns, where this structure occurs more often than in other classes of vascular plants, the solenostelic arrangement of the vascular tissue is probably more primitive than the polystelic. According to Jeffrey's terminology,† the anatomy of ferns may be regarded as a special type of "amphiphloic phyllosiphony."

In *Loxsoma*, which belongs to the solenostelic type, the stem is characterised by the occurrence of scattered islets of parenchyme among the sclerotic general ground-tissue. The protoxylem proper to the stem consists of narrow scalariform tracheids evenly distributed around the external periphery of the xylem-ring. The root presents no special peculiarity of structure. In a transverse section of the petiole the vascular strand has a horse-shoe form. The protoxylem elements of the petiole, which are spiral and annular, are collected into definite endarch groups.

As regards its affinities, *Loxsoma* is, on the side of its anatomy, more nearly related to *Dennstædtia* (*Dicksonia*) and to the solenostelic Polypodiaceæ than to any other family of ferns.

K. Giesenhagen ‡ points out an inaccuracy committed by Mr. Gwynne-Vaughan in quoting his description of the vascular system of the Hymenophyllaceæ.

Muscineæ.

Conducting Tissue-System of Bryophyta.§ — A. G. Tansley and Miss Edith Chick describe the structure, and discuss the origin, of the conducting tissue of Bryophyta, which must be of a totally different origin from that of Pteridophyta, since it is confined mainly to the gametophyte generation.

In the Hepaticæ, as a rule, there is no differentiated water-conducting tissue; but in three genera—*Pallavicinia*, *Symphyogyna*, and *Hymenophyton*—most of the species of which are tropical, a portion of

* Ann. of Bot., xv. (1901) pp. 71–99 (1 pl.).
† Cf. this Journal, 1900, p. 686.
‡ Tom. cit., pp. 433–4.
§ Tom. cit., pp. 1–38 (2 pls.).

the thallus is differentiated into very primitive water-conducting strands.

In the rhizome of the Polytrichaceæ there is a much stronger differentiation. The authors propose, for the water-conducting tissue as a whole, the term *hydrom*, the water-conducting cells themselves being *hydroids*. The group of sieve-tube-like cells are termed *leptoids*, these being surrounded by a starchy parenchyme or *amylom*. The tissue-system of the rhizome of the Polytrichaceæ is practically identical with that of the root of a vascular plant; but the pericycle and endoderm are less complete. The tissues of the central cylinder may be classified into hydrom, leptom, and conjunctive tissue (stereom and unlignified cells with or without starch). They are marked by an entire absence of pits. In the aerial stem the highly developed stele is essentially double in nature, consisting of a central primitive hydrom-cylinder, originally developed, and still serving to supply the apical bud, sexual organs, and sporogone with water; and of a double peripheral mantle of hydrom and leptom separated by a starchy hydrom-sheath (amylom); all three layers being composed of the joined traces of leaf-bases. The stem-stele and leaf-bundles, while originating quite independently, form together a complicated conducting system for carrying water to the leaves and carrying away from them the formed food-material.

Nuclear Division in Pellia.* — Prof. B. M. Davis has carefully followed out the processes connected with the division of the nucleus in the formation of the spores in this genus of Hepaticæ. The following are among the more interesting results.

At the time of sporogenesis the nucleus comes to occupy the geometrical centre of the 4-lobed spore mother-cell, and there passes through synapsis previous to the first mitosis. Emerging from synapsis, the nucleus presents a delicate spirem-thread, which soon segments into the chromosomes. The first indication of spindle development appears in a zone of granular kinoplasm closely investing the nucleus. There is never, as has been stated, a true quadripolar spindle. There are two successive mitoses in the spore mother-cell, with a short period of rest between them. The poles of the spindles are never occupied by bodies comparable to centrospheres or centrosomes. The rod-shaped chromosomes split longitudinally in each mitosis. Following the mitoses in the spore mother-cell, each nucleus takes up a position in the centre of the spore, assuming a resting condition. They increase in size, and soon prepare for division, passing the synapsis. Two centrospheres with radiations resembling asters are organised during the prophase, and these develop the poles of the spindle; but the author has not been able to satisfy himself that the centrospheres were permanent structures, or that they ever divided. There is no trace of centrosphere or aster at the anaphase or beside the resting nucleus. There are eight chromosomes in the gametophyte, sixteen in the sporophyte.

In reply to doubts as to the correctness of previous observations, Prof. J. B. Farmer † reiterates his statements of the presence of a quadripolar spindle, and of the existence of centrospheres in the divisions of the nucleus in the spore mother-cells of *Pellia epiphylla*.

* Ann. of Bot., xv. (1901) pp. 147–80 (2 pls.). Cf. this Journal, 1894, p. 591.
† Tom. cit., pp. 431–3. Cf. this Journal, 1896, p. 90.

Makinoa.* —V. Schiffner has had the opportunity of examining afresh the structure of this Japanese genus of Hepaticæ (*M. crispata*). Confirming in the main the descriptions of previous observers (with a few corrections), he makes the following additional observations. The genus possesses amphigasters, composed of short segmented hairs, usually consisting of 5 cells, the terminal one being club-shaped. They are placed in three irregular rows on each side of the mid-rib. The presence of apical elaterophores in the sporogone has also been overlooked. The apex of the sporogone is composed of three or four layers of nearly cubical cells, the inner and superficial of which become the elaterophores, which exhibit no annular or spiral thickenings. The thickening-bands of the elaters occur only in their central portion, and consist of two intercrossing spirals, which, however, completely coalesce on one side of the elater into an uninterrupted thickening-band.

With regard to the systematic position of *Makinoa*, Schiffner places it among the Leptotheceæ, from the remaining genera of which it is distinguished by the presence of strongly developed apical elaterophores, by the structure of the elaters, and by the antherids being arranged in a closed inflorescence imbedded in the frond.

Elaterophores of Calycularia.†—F. Stephani contests the accuracy of the term as applied to the so-called elaterophores of *Makinoa* and other Hepaticæ. He regards them as simply a residue of the tissue which conveys the food-material during the development of the capsule. They are too short to be able to perform the function which has been assigned to them, that of promoting the gradual rather than the sudden escape of the spores.

Viviparity in a Liverwort. ‡ —Prof. C. Massolongo describes a case of viviparous growth in *Lophocolea Hookeri*. In a specimen which came under his observation, the small teeth in one of the leaves were replaced by buds which were differentiated in their upper part into an axial or cauline region furnished with minute leaves and even amphigasters, and at the base with more or less elongated rhizoids.

Characeæ.

Geotropic Curvature of the Roots of Chara. § — K. Giesenhagen has studied this phenomenon especially in *Chara fragilis*, *fœtida*, and *aspera*. He finds, in the root-hairs, refractive particles similar to those which have been observed in other geotropic organs, imbedded in the protoplasm. These particles appear to be of a higher specific gravity than the surrounding protoplasm. The movements of these particles have apparently a direct connection with the geotropic movement.

Algæ.

Ceramothamnion, a New Genus of Florideæ.‖ — H. M. Richards has found a new red sea-weed on the shores of Bermuda, growing on

* Oesterr. Bot. Zeitschr., li. (1901) pp. 82–9 (1 pl.).
† Tom. cit., pp. 256–8.
‡ Bull. Soc. Bot. Ital., 1901, pp. 169–72 (2 figs.).
§ Ber. Deutsch. Bot. Ges., xix. (1901) pp. 277–85 (1 pl.).
‖ Bull. Torrey Bot. Club, xxviii. (1901) pp. 257–65 (2 pls.).

Codium tomentosum, which he makes the type of a new genus, and names *Ceramothamnion Codii* g. et sp. n. The following is the diagnosis of the genus :—Plant consisting of prostrate filaments giving rise above to erect filaments and below to rhizoids. Erect and prostrate filaments alike in structure, monosiphonous throughout, with small cells collected at the nodes; growing tip straight, never circinate; chromatophores rhodophyceous, in elongated bands running almost the length of the internodal cells; antherids, tetraspores, and polyspores present; tetrasporanges borne at nodes, cruciate, provided with enveloping sterile cells, proliferating by successive formation of new tetrasporanges inside the old ones. The proliferation of the tetrasporanges is a special feature of the genus.

Tetrasporange of Polysiphonia.*—F. Heydrich has followed out in detail the fertilisation of the tetrasporange in *Polysiphonia violacea*. The sporange-segment consists, at a certain period, of ten cells,—a central cell, four long pericentral cells, two short pericentral cells, a tetrasporange mother-cell (protospore), a stalk-cell, and a wedge-shaped lateral cell. The contents of these cells are described in detail, as well as the pitting of the cell-walls through which the protoplasmic connections take place. The mother-cell of the tetrasporange appears to have no true pitting. The young tetrasporange consists, at the outset, of two free cells. A true union or fusion appears to take place between the protospore and the stalk-cell, resulting in the production of tetranuclei or tetraspore nuclei.

The author's observations appear to confirm the suspicion of some previous observers that the tetraspores, at least of *Polysiphonia*, are of sexual origin.

Chambers and Pores in the Cell-wall of Diatoms.†—O. Müller continues his investigation of this subject, especially in the species *Stephanopyxis Palmeriana*, *Sceletonema costatum*, *Lauderia annulata*, *Eupodiscus Argus*, and *Triceratium favus*. He finds treatment with hot solution of sodium carbonate or of potassium hydrate useful in studying the structure of the cell-wall.

In *Stephanopyxis Palmeriana* he has determined that the spines which connect the cells with one another are tubes, to which are attached three or four delicate rings arranged spirally. Their purpose is evidently to assist in the connection of the protoplasm of the individual cells. The same probably occurs in many other diatoms, among which *Melosira granulata* may be specially mentioned.

In *Sceletonema costatum* and *Lauderia annulata* a similar connection between the protoplasm of adjoining cells occurs, without which the division of the free superficial protoplasm could not take place. The formation of the tubes is probably effected by direct excretion from the threads of protoplasm. The same is the case with the canals of *Triceratium favus*, with subsequent production of the wing-like appendages, as in *Stephanopyxis*.

* Ber. Deutsch. Bot. Ges., xix. (1901) pp. 55–71 (1 pl.).
† Tom. cit., pp. 195–210 (1 pl. and 3 figs). Cf. this Journal, *ante*, p. 306.

Fungi.

Phosphorescent Fungi.* — D. M'Alpine enumerates the species of Fungus in which phosphorescence [more properly luminosity] has been observed, twenty-one in all; of which five are peculiar to Australia, and eleven belong to the genus *Pleurotus*. The luminosity is not due to the presence of phosphorescent bacteria, but to a process of combustion in the fungus itself, confined to the living tissue. It is entirely dependent on the presence of oxygen and on a sufficiently high temperature, but is not affected by moisture. The author regards the light as proceeding, not from within the organism, but from excreted luminous metabolic products. It is probably useful to the fungus in attracting insects which assist in the dissemination of the spores.

Enzyme of Monilia sitophila.† — According to F. A. F. C. Went, this mould-fungus is employed in Western Java for decomposing arachis-seed cake; it also occurs on putrefying bread and wheat flour, and on dead leaf-sheaths of the sugar-cane. It has a bright orange-red colour, the pigment being produced only in the presence of light (blue and violet rays). An enzyme, which the author terms *maltoglucose*, is exclusively and very unequally secreted when the mould is supplied with certain carbohydrates. It is formed in large quantities when raffinose, maltose, dextrin, or starch is present; also in the presence of cellulose, galactose, xylose, and sucrose; it is not secreted when the carbonaceous food supplied is glycerol.

Sporange of Cystopus Tragopogonis.‡—P. A. Dangeard has observed, in this parasite, very common on species of *Tragopogon* and other Compositæ, that the nuclei in the conids towards the interior of the leaf differ from those in the superficial cells of the leaf in being pyriform instead of spherical, and in being attached to the ectoplasm by a kind of pedicel. He compares this with similar phenomena in the Ascomycetes and in *Vaucheria*, and connects it with the formation of the flagellum of zoospores.

Behaviour of the Cell-nucleus in the Zygospores of Sporodinia grandis.§—E. Gruber has again studied the processes connected with the formation of the zygospore in this fungus. He is unable to confirm the peculiarity described by Léger as the formation of "embryospheres." In the mode of conjugation of the gametes he agrees with that writer. In the newly formed zygote are a large number of nuclei uniformly distributed through the protoplasm; at a later period the larger number of them are crowded at the periphery, but no difference could be detected between these and the central ones. The subsequent fate of these nuclei was not determined with certainty. On germinating the nuclei pass in large numbers into the germinating tube.

The author believes that the processes connected with fertilisation in *Sporodinia grandis* agree in essential points with those observed in

* Proc. Linn. Soc. N. S. Wales, xxv. (1900) pp. 548-58 (2 pls.).

† SB. k. Akad. Wetensch. Amsterdam, iii. (1901) pp. 489-502. See Journ. Chem. Soc., 1901, Abstr. ii. p. 411.

‡ Le Botaniste (Dangeard), vii. (1901) pp. 279-81 (1 fig.).

§ Ber. Deutsch. Bot. Ges., xix. (1901) pp. 51-5 (1 pl.). Cf. this Journal, 1898, p. 657.

other Phycomycetes, with which he compares them. It is probable that conjugation takes place between the nuclei which remain behind in the centre of the zygote.

Biology of Leptomitus lacteus.* — R. Kolkwitz has succeeded in growing in the laboratory this fungus which has its home in impure water. Very little, however, is recorded of its mode of life, except that its growth resembles that of *Saprolegnia*, to which it is nearly allied. It would appear to be certainly not an obligatory parasite.

Rhizophagus populinus.† — Further study by P. A. Dangeard of this parasite of the roots of the poplar has confirmed his opinion that it belongs to the Chytridinieæ. Its effects are exceedingly destructive; not only does it use up the nutritive substances carried to the cortex by the root-hairs; it completely digests also the contents of the cortical cells, and prevents the roots from fulfilling their function. The formation of spherical cysts was observed, but not that of zoospores.

Chytridium transversum.‡—P. A. Dangeard describes the various stages of development on this parasite of *Chlamydomonas pulvisculus* and *Gonium pectorale*. He has observed both zoospores and cysts, the latter being unquestionably of a non-sexual character.

Biology of Bulgaria.§ — R. H. Biffen has studied the life-history and the effects on dead oak-wood of the saprophytic fungus *Bulgaria polymorpha*, which is a facultative parasite. The most noteworthy point in the structure of the fungus is the dimorphism of the ascospores; four in each ascus having thick dark brown walls, and four being colourless and thin-walled. The two kinds of spore apparently behave alike on germination. The result of the action of the fungus on oak-wood is to dissolve and probably decompose the lignin and to dissolve the pectates of the middle lamella.

New Genus and Species of Laboulbeniaceæ.‖ — In addition to his previous numerous discoveries, R. Thaxter now describes a number of new species of this order, parasitic on the bodies of insects, belonging to the genera *Stigmatomyces*, *Arthrorhynchus*, *Rhizomyces*, and *Dimeromyces*; also the following new genus:—

Ceraiomyces g. n. Structure of perithecium as in *Laboulbenia*; its stalk-cell united to the free base of the free stalk-cell of the appendage, which bears a well-differentiated basal cell terminally. On the end of this are borne antheridial branches, the successive cells of which produce terminally either successive secondary branchlets, or antherids, or both; receptacle 2-celled.

Conjugating Yeast, Zygosaccharomyces g. n.¶ — B. T. P. Barker isolated from commercial ginger a yeast which was cultivated on beer-wort gelatin, beer-wort agar, potato, bread, ginger, and in beer-wort. A yeast-ring is formed in old cultures in many liquid media, but no film was produced. The vegetation of the cultures consists of

* Ber. Deutsch. Bot. Ges., xix. (1901) pp. 288–91.

† Le Botaniste (Dangeard), vii. (1901) pp. 285–7 (2 pls.). Cf. this Journal, 1897, p. 60.

‡ Tom. cit., pp. 282–4 (1 fig.).

§ Ann. of Bot., xv. (1901) pp 119–34 (1 pl.).

‖ Proc. Amer. Acad. Sci., xxxvi. (1901) pp. 397–414. Cf. this Journal, 1900, p. 617.

¶ Proc. Roy. Soc., lxviii. (1901) pp. 345–8.

typical ovoid and round yeast-cells, and in the older cultures a few sausage-shaped, and many irregular cells also, some of the latter containing spores.

Reproduction by budding in a typical yeast-like manner is the usual method of growth, the optimum temperature being 25°–30° C. Reproduction by spores occurs under the usual conditions of spore-formation for the Saccharomycetes. The spore-containing cells differ from those of most other Saccharomycetes in being compound cells, which have conjugated by means of a beak developed from each, the tips of the beaks fusing after the manner of many Algæ and Fungi. In a few hours after fusion, as observed in hanging drops of distilled water, the protoplasm began to contract in the cells, and small round masses were formed; these eventually developed into the spores. The size of the ripe spore is 4–5 μ, and the number in each compartment of the mature cell varies from 1 to 4, the most common arrangement being 2 in each. The spores germinate in a normal manner; after swelling they bud like ordinary yeast-cells. The irregular-shaped cells are apparently such as have made attempts at spore-formation, but have failed, owing either to lack of energy or substance in themselves, or to unfavourable external conditions. Stained preparations showed that the tips of the beaks are occupied by a deeply stained mass which is nuclear in character. The two masses fuse together, and afterwards divide into two again. Hence the process may be regarded as a simple sexual act somewhat similar to that occurring in the process of spore-formation of *Schizosaccharomyces octosporus*.

Alcoholic fermentation is produced in beer-wort by this yeast. It also ferments levulose vigorously and dextrose and saccharose slightly. Maltose, lactose, and dextrin are not fermented.

The author regards the fusion process as a true sexual process, such as is now known to occur in many fungi; and, as all the other characters of this yeast accord with those of *Saccharomyces*, proposes to place it in a new genus *Zygosaccharomyces*.

Sporulation of Schizosaccharomycetes.*—A. Guilliermond, from a study of *Schizosaccharomyces octosporus*, confirms the observations of Schiönning relative to the formation of asci from the fusion of two cells. He has also observed the presence of a nucleus consisting of a nucleole surrounded by a zone of nucleoplasm and a limiting membrane. The nucleus divides and afterwards participates in the fusion. Hence in *S. octosporus* conjugation precedes the formation of asci, and the phenomena may be regarded as a clear case of isogamy.

In *Schizosaccharomyces Pombe* analogous phenomena may be observed, and the histological appearances which accompany the conjugation of the two gametes are practically identical with those in *S. octosporus*, i.e. the protoplasm of the ascogenous cell is completely hollowed out into vacuoles containing a number of red grains which persist after the formation of spores in the epiplasm. The nuclei of the two primitive cells blend in the junction-tube, then the nucleus resulting from the fusion divides after a while into two daughter nuclei, which migrate back to the cells, where they participate in the formation of two spores at each of the two extremities of the ascus.

* Comptes Rendus, cxxxiii. (1901) pp. 242–4.

Fermentation Experiments with different Yeasts and Sugars.*—It is not easy, says P. Lindner, to discriminate between species of yeast by their morphological characters. The author sought for a criterion in their action on different kinds of sugar. The experiments were made in hollow-ground slides, the cavity being filled with some sugar dissolved in sterile water, and a yeast added. Air was excluded by means of a covering-glass and a vaselin ring. In this way the appearance of the gas-bubbles and the intensity of the fermentation could be measured. Some 3000 observations were made. It was found that arabinose, xylose, and rhamnose were not fermented. Inulin was attacked by many yeasts, and glucose by almost every species. Mannose was often fermented, but not by all the glucose fermenters. Fructose behaved like glucose. Cane-sugar was frequently fermented, but milk-sugar only by a few species. Melibiose, α and β methylglucosid, &c., were attacked by only a few species. Conversely, certain groups of yeasts were characterised by their behaviour to different kinds of sugar, for example, *Schizosaccharomyces*, milk-yeasts, and so on.

Some yeasts, such as those of importance in distilling, brewing, and baking, high and low ferments, received special attention. The practical outcome of these researches is that it is really possible to recognise a yeast merely by its fermentative power.

Albumen in Yeast.†—Th. Bokorny has shown that yeast contains both albumen and albumose, and has also demonstrated the probability of the presence of pepsin, at any rate, the presence of a ferment resembling pepsin.

Yeast Cultivated from Intestinal Contents.‡—Dr. Lommel describes a yeast which was isolated from the intestinal contents of a child dead of infectious jaundice. On agar most of the colonies showed asteriform processes, but many were quite circular. The individual cells were oval to round; nearly all exhibited a more or less refractive area, and many were found sprouting. In the radiating processes the cells were often thinner and longer. The yeast was cultivated successfully on various media.

Parasitic Fungi.—Prof. J. C. Arthur and W. Stuart § give a detailed account of the life-history, the injury inflicted on the crop, and the best means of combating, the "corn-smut," the correct name of which they assert to be *Ustilago Zeæ* (Beckw.) Ung., rather than *U. Maydis*.

Prof. J. C. Arthur ‖ gives a full account of the "asparagus-rust," *Puccinia Asparagi*.

A number of fungus-diseases of the orange-tree are described by F. Noack,¶ three of which are attributed to new species,—*Mycosphærella Lœfgreni*, *Didymella Citri*, and *Septoria Lœfgreni*.

* Wochenschr. f. Brauerei, 1900, Nos. 49–51. See Bot. Centralbl., lxxxvi. (1901) p. 250.

† Zeitschr. f. Spiritus-Industrie, xv. i. (1900) and Feb. 1900. See Bot. Centralbl., lxxxvi. (1901) p. 326.

‡ Centralbl. Bakt., 1te Abt., xxix. (1901) pp 972–5 (2 figs.).

§ Twelfth Ann. Rep Indiana Agric. Exp. Stat., 1898–99, pp. 84–135 (4 pls. and 1 fig.). ‖ Thirteenth Ann. Rep. Indiana Agric. Exp. Stat., 1899–1900, pp. 10–4.

¶ Zeitschr. f. Pflanzenkrankheiten, x. (1900) pp. 321–35. See Bot. Centralbl., lxxxvi. (1901) p. 248.

D. Macalpine * gives a detailed account of the fungi parasitic on the various species of *Citrus* grown in Australia. He enumerates no less than 82 species, of which 51 are described as new.

D. Griffiths † describes a new ergot, *Claviceps cinereum* sp. n., parasitic on two grasses, *Hilaria mutica* and *H. cencroides*, in Arizona.

Uredineæ. ‡ — Pursuing his researches on the heterœcism of the Uredineæ, E. Fischer distinguishes three types of leptoform:—(*a*) forms with two kinds of teleutospore, fixed, germinating at once, and then hibernating (*Puccinia Veronicarum*); (*b*) teleutospores of one kind only, formed several times in the course of the year (*P. Malvacearum*); (*c*) teleutospores of one kind only, formed only once in the course of the year; the mycele hibernates in the leaves (*P. Buxi*, *Chrysomyxa Abietis*), or in buds which, in the spring, form teleutospore-bearing shoots (*P. Thlaspeos*). A new heterœcious *Puccinia* is described, *P. Actææ Agropyri*, parasitic on *Agropyrum caninum*, and forming æcidia on *Actæa spicata*. Other observations on parasitic *Pucciniæ* are recorded.

Rabenhorst's Cryptogamic Flora of Germany, &c. (Fungi imperfecti).—With Part 75, A. Allescher commences the second volume of this section of Rabenhorst's great work. The fifth division of the Sphærioideæ, the Phæosporeæ, are characterised by their spherical, elliptic, or ovate spores, unseptated, and olivaceous or rust-coloured. They comprise the genera *Sphæropsis* (55 sp.), *Coniothyrium* (109), *Næmosphæra* (6), *Sirothecium* (1 sp.), *Levieuxia* (1 sp.), *Chætomella* (6), *Haplosporella* (19), *Cytoplea* (1 sp.), and *Discomycopsis* (1 sp.). The sixth section, the Phæodidymæ, are distinguished from the previous section by their uniseptate spores. It comprises the genera *Microdiplodia* g. n., *Diplodia*, *Macrodiplodia*, *Chætodiplodia*, *Diplodiella*, *Pellionella*, and *Botryodiplodia*, of which, in Parts 76 and 77, the first genus is fully described, with its 102 sp., followed by *Diplodia* with 224, *Macrodiplodia* with 2, *Chætodiplodia* with 6, *Diplodiella* with 12, and *Botryodiplodia* with 15 sp. The 7th section, the Phæophragmiæ, is characterised by having elliptical or fusiform rust or olive-coloured spores with two or more septa. It comprises 8 genera,—*Hendersonia*, *Couturea*, *Wojnowicia*, *Angiopoma*, *Cryptostictis*, *Prosthemium*, and *Hendersonula*. Six species of *Hendersonia* are described in this part.

Hydnum. § — H. J. Banker gives a monograph (with clavis) of the species (40 in all) of *Hydnum* belonging to the section Mesopus, with directions for collecting, preserving, &c.

Mycorhiza of Arctic Plants. ‖ — H. Hesselman has made a careful study of the mycorhizæ which infest the roots of arctic plants, and which he finds to be very numerous.

In all the species of *Salix* examined (about 18) he finds a mycorhiza

* Fungus-diseases of *Citrus* Trees in Australia, Melbourne, 1899, 132 pp. and 31 pls. See Bot. Centralbl., lxxxvi. (1901) p. 276.

† Bull. Torrey Bot. Club, xxviii. (1901) pp. 236–41 (2 figs.).

‡ Ber. Schweiz. Bot. Ges., x (1900) 9 pp.; and xi. (1901) 14 pp. See Bot. Ztg., lix. (1901) Abt. ii. p. 108. Cf. this Journal, 1899, p. 66.

§ Bull. Torrey Bot. Club, xxviii. (1901) pp. 199–222.

‖ Bih. k. Svensk. Vetensk.-Akad. Handl., xxvi., 46 pp., 3 pls., and 5 figs. (Swedish, with German abstr.). See Bot. Centralbl., lxxxvi. (1901) p. 239.

constantly present. In *S. polaris* and *herbacea* the adventitious roots are not attacked by the hyphæ, only the slender lateral roots; the mycorhiza produces a coral-like appearance in the root: the root-tip assumes a hemispherical form; the root-cap is well developed, but consists of a smaller number of layers than the normal; the hyphæ enter the root immediately behind it, forming a cap composed of a single layer of cells.

In *Polygonum viviparum* the author records the first example of the occurrence of a mycorhiza in a green herbaceous plant. It appears to be constant in this species; also in *Dryas octopetala*, where it branches in a coral-like manner. Its occurrence in these two species is not confined to the Arctic circle. *Diapensia lapponica* contains an endotropic mycorhiza resembling that of the Ericaceæ. In the Arctic Ericaceæ a mycorhiza appears to be universal; the author records it in the following species:—*Azalea procumbens*, *Andromeda hypnoides*, *A. tetragona*, *Ledum palustre*. *Oxycoccos palustris*, *O. microcarpus*. *Phyllodoce cœrulea*, *Rhododendron lapponicum*. *Vaccinium uliginosum*, *V. vitis-idæa*. Among Orchideæ it occurs in *Habenaria obtusata*, *H. albida*, and *Chamæorchis alpina*.

Trichosporum Beigelii.*—P. Vuillemin describes a fungus which is designated *Trichosporum Beigelii* Rabenhorst. Its plastids are thick-walled cells with nuclei varying from $0 \cdot 3$–$0 \cdot 5\ \mu$, the cells ranging from $2 \cdot 5\ \mu$ to $4 \cdot 5\ \mu$. These cells lie in a mucilaginous matrix derived from the superficial lamella of the membrane. The fungus causes nodosities on hair, and sections made through these nodosities show long series of cells arranged radiately, though on superficial examination they look like a dense irregular reticulum or feltwork.

Myxomycetes.

Dictydium umbilicatum.†—E. Jahn has studied in detail the development of this very polymorphic Myxomycete. The following are the more important points in his observations of the differences between the Cribrarieæ (*Cribraria* and *Dictydium*), and the remaining Mycetozoa.

The plasmode contains pigment not found in other forms. This pigment is blue in *Dictydium*, greenish or nearly black in *Cribraria*. *Dictydium* contains granules, found in no other group, of a substance which he calls *dictydin*, characterised by its remarkable resistance to acids and alkalies. It appears to be a subsidiary product of metastasis which is apparently of further use in *Dictydium*. They are not of a proteid character, and the author compares them with similar bodies in the Rhizopods. The spores do not germinate. No swarm-spores or myxamœbæ have at present been observed. The cell-wall never gives the reactions of cellulose. The sporanges are not formed by creeping on a stalk, but by the pinching in of an external membrane. It is assisted by bands formed out of the granules of dictydin.

The Cribrarieæ must be characterised, not by the absence of a capillitium, but by the occurrence of the granules of dictydin. Such forms as *Tubulina* and *Licea*, although wanting in a capillitium, should not be placed among the Cribrarieæ.

* Comptes Rendus, cxxxii. (1901) pp. 1369–71.
† Ber. Deutsch. Bot. Ges., xix. (1901) pp. 97–115 (1 pl.).

Protophyta.

α. Schizophyceæ.

Boundary-cells and Cell-contents of the Cyanophyceæ.* — F. Brand has investigated the appearance and structure of the "boundary-cells" (*Grenz-zellen*) found in almost all species of Nostocaceæ. He observed in *Nostoc commune* two different kinds of vegetative cell, one considerably smaller than the other, and producing filaments of smaller diameter. These latter arise from the division of the contents of heterocysts which occur in the outer layers of the colony; their cells gradually increase in size until the filaments attain the ordinary diameter. Some of the heterocysts do not break up, but remain in connection with the neighbouring vegetative cells by threads of protoplasm passing through the cell-wall; these vegetative cells then become capable of multiplication under favourable conditions. Similar phenomena occur in some of the Scytonemeæ.

With regard to the occurrence of red granules in the "water-bloom," resulting from the accumulation of some species of Cyanophyceæ, the author dissents altogether from the theory that they contain some special gas. In *Polycystis ochracea* and *Anabæna flos aquæ* they make their appearance at first only in the periphery of the colony; in the central cells only when the colony is fully developed. Similar red granules occur in *Phormidium ambiguum*, *Lyngbya æstuarii*, and *Oscillatoria princeps*, which do not form "water-bloom"; also in the "boundary-cells" of *Nostoc commune*. The nature of the pigment was not determined.

β. Schizomycetes.

Light of the Phosphorescent Bacteria of the Baltic.†—G. Tarchanoff gives an abstract of a series of observations on the influence of different conditions on the luminous activity of bacteria from the Baltic. Fresh cultures give the strongest light, especially when the bouillon is kept moving and is mixed with air. The light may last from two weeks to three months. It is a manifestation of respiration, and is closely associated with the consumption of oxygen; its appearance is apparently periodical, but without any regularity. When at rest the luminous layer is limited to the surface of the bouillon. These bacilli are more resistant to cold than to heat, their optimum temperature being 7°–8° C. Daylight appears to be harmful. Some chemical agents, such as chloroform, ether, alcohol, potassium cyanide, rapidly extinguish the light, as also do bile, carbonic acid, and acids generally. To many other chemical reagents the light is indifferent. Strong induced and galvanic currents drive it to the negative pole, from which it after a time disappears. The extinction of the light is, however, not due to loss of vitality, for the introduction of air causes the reappearance of the light. Mechanical movement is followed at first by increase of light, but after a time by dimness and extinction.

Frogs may be rendered luminous by introducing into the dorsal lymphatic sacs a few cubic centimetres of luminous bouillon. The whole

* Ber. Deutsch. Bot. Ges., xix. (1901) pp. 152–9 (4 figs.).
† Comptes Rendus, cxxxiii. (1901) pp. 296–9.

animal is more or less lighted up, and may be photographed by the aid of this bacterial luminosity. This phenomenon lasts 3 or 4 days only, after which the animal returns to its normal condition. Warm-blooded animals are not amenable to this phosphorescence.

Bacterial Diseases of Plants.* — Dr. E. F. Smith contributes the second portion of his reply to A. Fischer's "Answer." † The controversy took its rise in statements made in Fischer's *Lectures*, 1897, wherein it was laid down that, with the exception of the root-nodules of Leguminosæ, we know of no single instance where bacteria invade the closed living cells of plants. According to Fischer, the bacteria are metatrophic and accidental, and there is no such thing as bacterial disease of plants. Dr. Smith took exception to these and other assertions,‡ and his position may be summed up in his own words, "there are probably as many plant diseases due to bacteria as there are animal diseases caused by these organisms"; and good reasons were adduced in support of the author's views which on *a priori* grounds alone were probable. Fischer's "Answer" consisted chiefly of unscientific asseveration and academic sarcasm. In his reply Dr. Smith discusses the question very thoroughly, and with the advantage of personal knowledge and experience. In the first part § he deals with the cases of *B. amylovorus*, *B. oleæ*, and *B. hyacinthis septicus*, and in the second part with *B. tracheiphilus*, *Pseudomonas campestris*, and *B. Solanacearum*. According to Fischer the uninjured plant is impregnable to the attacks of bacteria, and even if injured, the wounded area is soon shut off by the development of an inpenetrable layer of corky tissue. The facts and arguments adduced by Smith go to show that this hypothesis is at variance with observation and experiments, and the position is supported by numerous photographs and photomicrographs.

Bacteroids of Leguminosæ Nodules.‖ — Dr. L. Hiltner claims that he has known for some years that bacteroids can be produced in artificial media; and though he admits Stutzer's claim to priority of publication, he desires to make clear his knowledge of the fact since the winter 1895–6. His observations also show that the shape of the bacteroids does not depend exclusively on the species of host plant, but in some measure on the species of bacterium.

Acidophilous Bacteria.¶ — In the course of investigations on the so-called acidophilous bacteria met with in the stools of sucklings, Dr. A. Rodella isolated an organism with the following characteristics. In direct preparations from the stools it appeared as a rodlet 2–8 μ long, straight or somewhat curved, and occasionally with rounded ends. It was easily stained, and was not decolorised by Gram's method. In cultures it exhibited an extreme pleomorphism, viz. short rodlets, filaments, chains, and branched forms. It was a potential aerobe and anaerobe, and grew best at incubation temperature. On agar the growth was slightly raised, circular, and transparent. Bouillon was at first rendered turbid,

* Centralbl. Bakt., 2te Abt., vii. (1901) pp. 88–100, 128–39, 190–9 (11 pls. and 43 figs.). Cf. this Journal, 1900, p. 713.

† Op. cit., v. (1898) p. 279.

‡ Tom. cit., pp. 271–8.

§ Tom. cit., pp. 810–7.

‖ Op. cit., vi. (1900) pp. 273–81.

¶ Op. cit., 1te Abt., xxix. (1901) pp. 717–24 (1 pl.).

subsequently becoming clear and depositing a sediment. It was not pathogenic to guinea-pigs. The investigations also showed that this microbe could live in symbiosis with *B. coli*, and that, though originally isolated by means of acid bouillon, it grew better on alkaline than on acid media. Hence the term acidophilous is hardly correct.

Differential Diagnosis of certain Anaerobes.* — Dr. E. Klein gives the following differential points for discriminating between *Bacillus butyricus*, *B. enteritidis sporogenes*, *B. cadaveris sporogenes*, and *B. mucosus*.

B. butyricus. (1) A cylindrical rodlet averaging from 2·5–3·5 μ in length and 0·8–1·25 μ in breadth; stains well by Gram's method. (2) The spores are oval, 1·6 μ long and 1 μ broad, and are stainable by the usual methods. (3) On gelatin it forms spherical colonies with filamentous processes; the medium is not liquefied; produces gas. (4) On agar the colonies are grey, round, and flat; no spores and much gas. (5) Milk is rapidly coagulated with acid reaction and marked odour of butyric acid; no spores and much gas. (6) It grows well on blood-serum, which is slowly liquefied. (7) It is not pathogenic.

Bacillus enteritidis sporogenes. The characters of rodlet and spore are the same as for *B. butyricus.* (3) It slowly liquefies gelatin and forms gas. (4) On agar the colonies are round, and later become slightly indented; much gas and no spores. (5) Same as *B. butyricus.* (6) Blood serum is slowly liquefied. (7) Virulent.

Bacillus cadaveris sporogenes. (1) Cylindrical and filiform rodlets, very motile, and staining by Gram's method. (2) Spores are unipolar, oval, 1·6 $\mu \times 1\ \mu$. (3) Gelatin is quickly liquefied, with disagreeable odour and much gas. (4) On agar the colonies have numerous outgrowths; much gas and many spores. (5) Milk is slowly decomposed with offensive odour; much gas and many spores are formed. (6) Blood-serum is rapidly liquefied, with offensive odour and rapid formation of spores. (7) Not pathogenic.

Bacillus mucosus. (1) Cylindrical and filiform bacilli, 5–6 μ long, which do not stain by Gram's method. (2) Spores oval, 2·2 $\mu \times 1{\cdot}3\ \mu$, central. (3) Grows only on sugar-gelatin, which is slowly liquefied; spore formation. (4) On agar-agar thin surface growth with flakes in the condensation water; much gas; spore formation. (5) Milk is coagulated with acid reaction; spore formation. (6) Does not grow on blood-serum. (7) Not pathogenic.

Acid-fast Tubercle-like Schizomycetes.†—Dr. Hölscher communicates the results of experiments made with three kinds of acid-fast bacteria: the butter bacillus Petri-Rabinowitsch, the grass bacillus, and the Timothy-grass bacillus Moeller. The chief differences were found to be that culturally the pseudo-bacilli were distinguished from true tubercle bacilli by their growth at lower temperatures, and by their pigment formation. When taken directly from the animal body, their cultivation is easy and the growth luxuriant, while tubercle bacilli develop with difficulty, and the growth is scanty. While the pseudo-bacilli are pathogenic to animals, they do not give rise to tuberculosis,

* Centralbl. Bakt., 1te Abt., xxix. (1901) pp. 991–4.
† Tom. cit., pp. 425–8.

and, notwithstanding many resemblances to tubercle bacilli in their action, they approximate to the suppuration bacteria. To distinguish between the two kinds a bacterioscopic examination is insufficient; the safest test is a pure culture; even experiments on animals may be misleading in the early stage.

Clouding of White Wine.*—R. Greig Smith investigated the causes of the turbidity which affects South Australian Chablis, and found it to be due to the presence of an aerobic polymorphic bacterium. The variability of the morphotic elements appears to depend on the composition of the medium, and, as was determined by experiment, alcohol was the ingredient which was most stimulating to its development. The bacterium forms acid, apparently acetic acid; its optimum temperature is 25°; it does not grow under anaerobic conditions. Pasteurisation experiments with infected wine showed that heating the wine to 43° destroyed the organism without affecting the brightness or the bouquet.

Bacterial Flora of Sydney Water Supply.†—In a second communication R. Greig Smith, after discussing the value and importance of the various methods used for isolating bacteria from water, describes the cultural characters of the microbes not included in the former contribution. In the second series are noticed *Micrococcus pyogenes* γ *albus* Rosenbach, *Bacillus mesentericus niger* Lunt, *Bacterium cloacæ* Jordan, *Bac. coli com.* Escherich, and Bacteria i., ii., and iii.

Bact. i. differs only in size from *Bac. aquatilis communis* Zimm.

Bact. ii. is a motile rodlet with rounded ends, measuring $0 \cdot 4 \times 0 \cdot 8 – 1 \cdot 2\ \mu$. It is decolorised by Gram's method. It belongs to the typhoid group, but has many points of difference from *B. typhosus*; its nearest ally is *B. pinnatus* Ravenel.

Bact. iii., an oval actively motile rodlet, $0 \cdot 3 \times 0 \cdot 6\ \mu$, not stainable by Gram's method. The growth on gelatin is white, the medium being slowly liquefied. It was cultivated also on agar, litmus-lactose-agar, bouillon, milk, and potato. It produces gas and indol, and reduces nitrates to nitrites. This organism may be identical with *Bact. Kralii* Dyar.

Relative Abundance of Bacillus coli communis in River Water.‡—One of the most important conclusions drawn by Prof. E. O. Jordin from a very large number of observations is that the relative abundance of *B. coli* in river water is an index of the self-purification of streams; for if this near ally of the typhoid bacillus perishes speedily and in large numbers in a given stretch of river, there is good reason to suppose that the typhoid bacillus itself will not survive exposure to the same conditions. The rate of mortality among colon bacteria indicates more surely than any other factor the death-rate among typhoid bacilli under a similar stress. Whenever we find that an extensive mortality occurs among colon bacteria, in the present state of our knowledge we are justified in assuming that the fatality among typhoid bacteria has been at least equally great.

* Proc. Linn. Soc. N. S. Wales, xxv. (1900) pp. 650–8.
† Tom. cit.. pp. 740–59. Cf. this Journal, *ante*, p. 196.
‡ Journ. Hygiene, i. (1901) pp. 295–320.

Biochemical Difference between two principal Vinegar Ferments.* —G. Bertrand and R. Sazerac point out that, while the sorbose bacterium, *Bacterium xylinum* Brown, rapidly oxidises glycerin and transforms it into dioxyacetone, *Mycoderma aceti* scarcely at all affects that substance.

Oxidation of Propylglycol by Mycoderma aceti.†—A. Kling, who had already noticed that propylglycol is fermented by the sorbose bacterium, recently experimented with *Mycoderma aceti*, and found that, though a little more active than the sorbose bacterium, its oxidising action resulted in the formation of acetol.

Active Principle of Typhoid Cultures.‡ — Paladino-Blandini isolated two substances from typhoid cultures, one a greyish-white substance having the chemical characters of a nuclein, the other yellowish-brown, in shining fragile scales, and having the properties of a nucleo-albumen. The agglutinating power was found to depend on the presence of the nucleo-albumen, which was also capable of endowing the blood of animals treated with it with the power of agglutination. This nucleo-albumen is unable to act without the presence and assistance of leucocytes.

Bacillus terrestris sporigenes.§ — Dr. W. Rullmann describes a spore-forming bacillus which occurs in soil and on floors. Some of its characteristics resemble those of the typhoid bacillus, while others recall the lactic acid bacteria. Its origin and its rapid spore-formation suggest the designation *Bacillus terrestris sporigenes.* It is a rodlet with rounded ends, from 1·5–9 μ long and 0·5–0·75 μ broad. In bouillon it forms unjointed threads which, in ten days, run into filaments 60–70 μ long. Its optimum temperature lies between 22° and 37°. During the first 24 hours of a culture it exhibits lively movements and has 8–16 peritrichous flagella. It is decolorised by Gram's method, but less quickly than the typhoid bacillus. On agar the growth is bluish-white and moist looking; cultures at 37° exhibit copious spore-formation, and at 22° sporogenous bodies (Babes-Ernst). It does not produce gas or acidulate milk or form indol.

Gelatin is not liquefied, and many of the colonies are indistinguishable from those of typhoid. It is not pathogenic to mice, guinea-pigs, or rabbits.

Morphology of Staphylococcus albus.‖ — E. Saul makes a preliminary communication on the morphology of the colonies of *Micrococcus albus.* In order to study these, cultures were made from single germs. This end was attained by dilution or by allowing a bouillon culture which had been mixed with 60 p.c. glycerin to stand for some days. Grown in this way, deep-lying agar colonies exhibited three types: discoid, spherical, and stellate. Superficial colonies were always circular.

* Comptes Rendus, cxxxii. (1901) pp. 1504–7.
† Op. cit., cxxxiii. (1901) pp. 231–3.
‡ Riforma Med., 1901. See Brit. Med. Journ., 1901, Epit. 438.
§ Centralbl. Bakt., 1te Abt., xxix. (1901) pp. 969–72.
‖ Hygienische Rundschau, x. pp. 575–7. See Bot. Centralbl., lxxxvi. (1901) p. 227.

Sections made by treating the material with formalin and imbedding in celloidin showed a perfect regularity in the structure of the colony. The pigment varied with the age of the colony, being white at first, then developing a brown pigment which gradually lost colour. The superficial colonies were never brown, but at most were yellowish. In later stages crystals of triple phosphate were observed.

Vibrio bresmiæ.* — R. Greig Smith isolated from a dead bream a bacterium which is pathogenic to fish. It is a rodlet with rounded ends, ranging from 0·45–0·7 μ in breadth and from 1·2–1·5 μ in length. In the animal tissues it has a distinct capsule. It stains well, is actively motile, and has a polar flagellum $1\frac{1}{2}$–3 times the length of the cell. It liquefies gelatin, the growth-deposit being white. On agar the superficial colonies are white, the deeper ones yellowish-brown. Bouillon becomes turbid, and after the lapse of seven days a slight indol reaction is obtainable. It reduces nitrate to nitrite; in litmus-milk the casein is partly dissolved and partly precipitated, while the litmus is first reddened and finally bleached. The vibrio grows better at 22° than at 37°. It is a preferential aerobe and a potential anaerobe. It does not produce phosphorescence when cultivated in sea-water media or on fish-muscle. The author designates the bacterium by the name *Vibrio bresmiæ* (low Latin Bresmia, bream).

Action of Grass Bacillus ii. on Cold-blooded Animals.†—Dr. Freymuth found that by injecting grass bacillus ii. Moeller into the peritoneal sac of frogs, appearances resembling those of true tuberculosis were produced. The nodules were found to contain numerous acid-fast bacteria. An interesting point mentioned is that this grass bacillus, which in agar culture is quite different from tubercle bacillus, exhibited branchings after an eight days' sojourn in the peritoneal sac of frogs, and became indistinguishable from the true tubercle bacillus. This is contrasted with the result obtained after injecting fish tubercle, which culturally resembles true tubercle, into the peritoneal sac of toads. In eight days this organism presented appearances resembling the coccus form of Moeller's organism.

Bacillus Gangrænæ Pulpæ. — Prof. J. Arkövy ‡ makes some additions and corrections to a previous communication on *B. gangrænæ pulpæ*, the characters of which are now described as follows. This bacterium is a bacillus with rounded ends which, by means of peritrichous flagella, is endowed with lively movements. It forms large oval centrally placed spores which are very resistant to external influences. The bacilli germinate through an equatorial rent in the spore-membrane. After moving about for a variable length of time, they pass into a resting condition and form filaments. The bacillus is an aerobe, and grows but slowly under anaerobic conditions. It is stained by Gram's method. *B. gangrænæ pulpæ* is allied in some respects to the group of hay bacilli, and in others to the group of potato bacilli, but is not identical with any hitherto described species.

Dr. J. Madzsar § records experiments on the resistance of the spores

* Proc. Linn. Soc. N. S. Wales, xxv. (1900) pp. 605–9.
† Centralbl. Bakt., 1te Abt., xxix. (1901) pp. 530–1.
‡ Tom. cit., pp. 745–51. Cf. this Journal, 1898, p. 579.
§ Tom. cit., pp. 751–5.

of *B. gangrænæ pulpæ.* To steam they were more resistant than anthrax spores, retaining their vitality for 20–25 minutes. An immersion in 1 per thousand sublimate solution for 24 hours had no effect on their vitality, and in 1 p.c. sublimate they were alive after one hour, while a 3 p.c. solution took half an hour to kill them. In strong hydrochloric acid they were killed in about one minute.

Branched Filaments in Diphtheria Cultures.*—Ar. Cache describes and depicts the appearances observed in old diphtheria cultures. The growth was taken from a culture in Ouchinsky's medium, made some months previously, was of a yellowish-white colour, and was formed on the surface of the liquid. Microscopical examination showed that the membrane consisted of branched and interlacing filaments, containing highly refracting granules. The morphological alterations were accompanied by modifications in the physiological characters. Thus the filtrate of the cultures was but feebly toxic, and gelatin was slightly liquefied. It did not stain by Gram's method.

Destruction of Tubercle Bacilli in Oil.†—A. Gottstein and H. Michaelis conclude from their experiments that heating oil containing tubercle bacilli for five minutes at 87° C. is sufficient to sterilise it.

Microbe of the Diarrhœa of Young Calves.‡—Lesage and Delmer describe a coccobacillus which they have found to be the infective agent of the diarrhœa of young calves known in Ireland as "white scour." It is a motionless polymorphic bacterium. It is aerobic, and is not easily cultivated *in vacuo.* It does not pass through filter F. It is easily stained, but not by Gram's method. It grows well on agar and on gelatin; the latter medium is not liquefied. Peptonised bouillon becomes turbid in 24 hours at 38°, and a characteristic odour, which passes off in 3–4 days, is exhaled. The reaction is alkaline. It does not grow on potato. It does not produce indol, and has no action on sugars. Milk is not changed. The virulence of the cultures kept in closed tubes is retained for a long time. Injected into rabbits it produces septicæmia with diarrhœa. It appears to gain access through the umbilical vein in young animals, and through the nasal passages in older ones. The organism belongs to the group designated by Lignières *Pasteurella.*

Rat Plague.§—Dr. A. Edington was called to investigate the cause of the great mortality among rats in South African seaports in the early part of this year, the suspicion being that they were dying of bubonic plague. In a preliminary communication the author records experiments showing that there is a disease of the rat communicable to guinea-pigs but not to rabbits, and to which rabbits are also refractory even after it has been passed through the guinea-pig; and since inoculation of the rabbit with this rat bacterium in its virulent form gives no protection against subsequent inoculation with bubonic plague, it seems clear that the rat plague cannot be bubonic plague. Moreover the

* Centralbl. Bakt., 1te Abt., xxix. (1901) pp. 975–80 (3 figs.).
† Deutsch. Med. Wochenschr., xxvii. (1901) pp. 162–3.
‡ Ann. Inst. Pasteur, xv. (1901) pp. 417–39.
§ Lancet, 1901, i. pp. 159–3 (4 figs.); and ii. pp. 287–8.

peculiar susceptibility of pigeons to the rat disease also indicates a difference between that malady and bubonic plague.

Inoculation of the Soil with Alinit. * —L. Malpeaux made pot and field experiments with oats, maize, and white mustard. The results indicated that alinit, which may be considered as a bacterial manure, only acts in soil rich in organic matter by rendering available the insoluble nitrogenous substances present. Consistent results were obtained in the pot experiments ; but on a larger scale the results were conflicting, and the conclusion is drawn that alinit has no favourable effect on ordinary arable soil.

* Ann. Agron., xxvii. (1901) pp. 191–206. See Journ. Chem. Soc., 1901, Abstr. ii. p. 417.

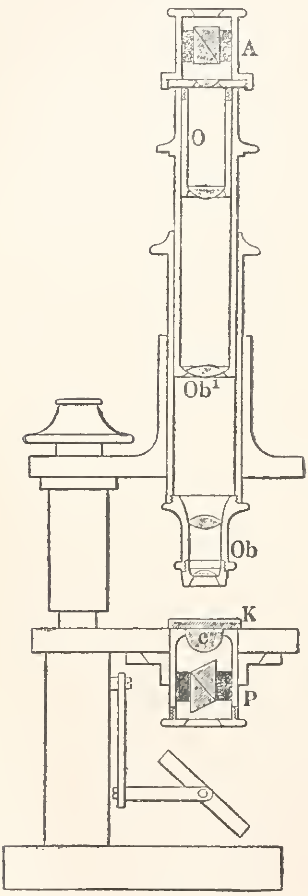
MICROSCOPY.

A. Instruments, Accessories, &c.*

(1) Stands.

Ordinary Microscope arranged for Axial Images of Doubly Refracting Bodies.†—Prof. L. Dippel, after referring to the importance of applying microscopic investigation to organic preparations, and after mentioning the assistance derivable from polarised light, describes how inquirers, not provided with special petrological or polarisation Microscopes, may yet make successful use of an ordinary working instrument.

Fig. 104.



Instead of a Bertrand's lens, he inserts into the long tube an auxiliary Microscope of about 80 mm. focus, in connection with a weak ocular (2 Zeiss) of 30–25 mm. focus, set in the ordinary short draw-out tube. The arrangement is seen in fig. 104:—P, the polariser; C, the condenser; K, the crystal plate; Ob, the objective system of the Microscope; Ob′, the objective system of the auxiliary Microscope; O, the ocular; A, the analyser.

In order to convert rectilinearly polarised into right-handed circularly polarised light, a quadrant mica slip is introduced between the polariser and analyser, in such a way that its axial plane makes an angle of 45° with the plane of rotation with the two crossed polarising prisms. The author gives ten figures of the results obtained by his apparatus; they include both uniaxial and biaxial crystals taken in different planes.

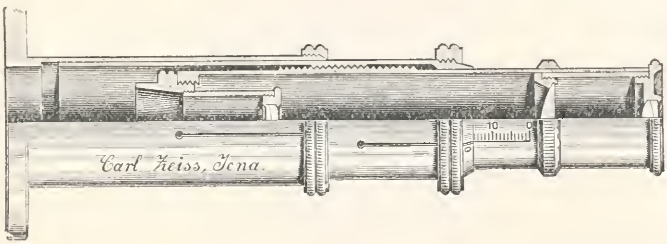
Zeiss' Focussing Microscopes.—In many cases it is found that the ordinary focussing glass fails to satisfy the requirements of copying processes. Sometimes the magnification is not sufficient, or

* 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., 1900, pp. 145–55 (11 figs.). A similar arrangement was described in Journ. R.M.S., 1892, pp. 683–4.

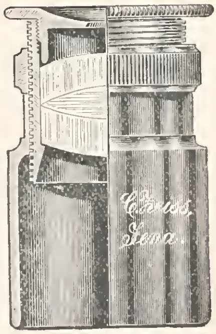
inconvenience may be experienced in using the lens owing to the necessity of having to bring the eyes close to the object under examination. The focussing Microscope (fig. 105) is intended to obviate both faults. as it has a magnifying power equal to about 28 diameters, and allows of the eye being kept at a convenient distance from the object. The instrument is fitted with a double action for rough and fine focussing. When used, it is firmly held with the left hand between the base-plate and the nearest milled clamping ring, and the clamping ring is then loosened. The tube is then held with the right hand at the fixed milled band

FIG. 105.



above the zero mark of the millimetric scale, and roughly focussed by sliding the tube in or out of the sleeve held in the left hand; the clamping ring is then tightened. The fine focus is then obtained by screwing the tube in or out of the second or upper sleeve. Before this can be done, the second clamping ring (situated on the $\frac{1}{10}$ division outside of the tube) must be loosened. The millimetre scale on the tube, in conjunction with another graduation on the upper edge of the sleeve, enables one to read at a glance quantities as small as $\frac{1}{10}$ mm., and to estimate correctly $\frac{1}{100}$ mm., so that the most minute differences of distance between two objects can be estimated almost down to $\frac{1}{100}$ mm.

FIG. 106.



Zeiss' Focussing Glass.—This apparatus is an auxiliary, primarily intended for viewing transparent objects, either for sharply focussing the picture on the ground glass screen, or for testing negatives required for copying processes as to their precision and quality. The lens is supplied in the form of mount shown in fig. 106, and in three magnifying powers, viz. 6, 10, 16 diameters. The first and second are preferable for focussing, the second and third are for the examination of negatives. When used, the milled clamping ring is first unscrewed, and the instrument placed upon the ground glass screen or negative; the lens is then sharply focussed by screwing the cell in or out by means of its projecting upper edge. Subsequent disturbance is prevented by carefully screwing the clamping ring back again.

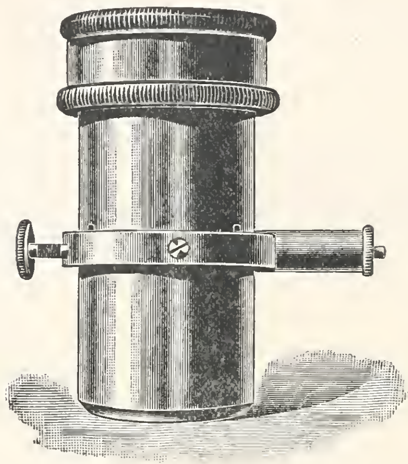
KOHN, R.—**Versuche über eine Elektrochemische Mikroskopie und ihre Anwendung auf Pflanzenphysiologie.** (Investigations concerning an Electrochemical Microscopy and its application to Plant Physiology.)

Prag (H. Mercy Sohn), 1901, 36 pp.

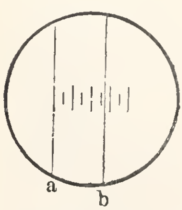
(2) Eye-pieces and Objectives.

Hartwich's New Ocular Micrometer.*—Prof. Hartwich, of Zurich, has designed his instrument to facilitate measurements in those cases

Fig. 107.



where the general tint of the preparation renders difficult the perception of the micrometer lines. The sliding part, instead of containing two movable threads, has only one movable *b*; the second thread *a* being fixed over the zero of the scale (fig. 108). The movable thread is worked by an exterior micrometer screw (fig. 107). It cannot be brought nearer to the fixed thread than the first graduation, and thus the minimum reading is unity; in the other direction it can be moved to the fullest extent (50 divisions). The object must be adjusted on the stage so that one boundary is under the fixed thread; *b* is then moved into position. The eye-piece is then raised, if necessary, in order to read the distance between the threads. In another form of the instrument both threads are movable, and each is manipulated by a separate micrometer screw.

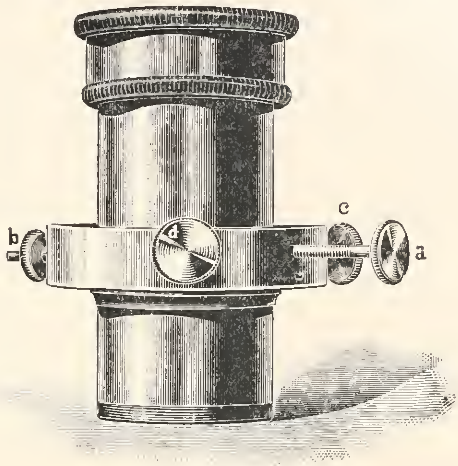


Hartwich's new Micrometer Ocular with Fixed Object-Stage.†—Messrs. Zulauff and Tschokke, the makers of Hartwich's micrometer above described, have adapted the instrument for the use of a Microscope with fixed object-stage. The arrangement for a movable thread remains unaltered. It is pushed forward by the screw *a* (fig. 109), and pushed back by the spiral spring *b*, when the screw is reversed. Instead of a

* Zeitschr. wiss. Mikr., xvii. (1900) pp. 156–8 (2 figs.).
† Tom. cit., pp. 432–5 (2 figs.).

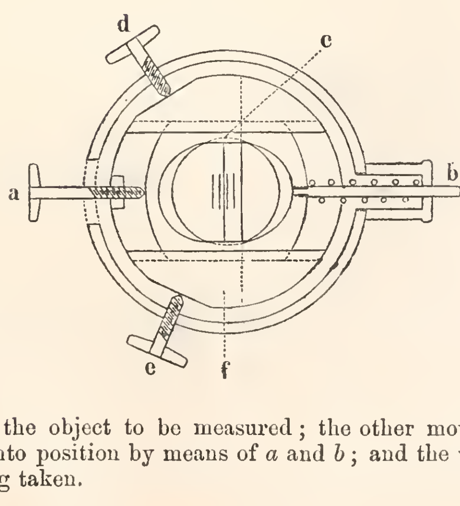
second movable thread, the whole ocular micrometer is moved by the two screws *a* and *e* (fig. 110); the arrangement being contained in the box which is clearly shown in the lower part of fig. 109. In use the object

Fig. 109.



is brought exactly into the midst of the field, and by means of the two screws *a* and *e* the first division of the scale is brought over one of the

Fig. 110.



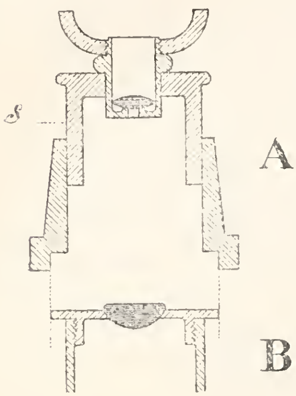
boundaries of the object to be measured; the other movable thread is then brought into position by means of *a* and *b*; and the whole is raised and the reading taken.

Strehl, K.—Theorie des Zweilinsigen Objectivs. (Theory of the Two-Lensed Objective.) *Zeitschr. f. Instrumentk.*, XXII. (1901) p. 10.

(3) Illuminating and other Apparatus.

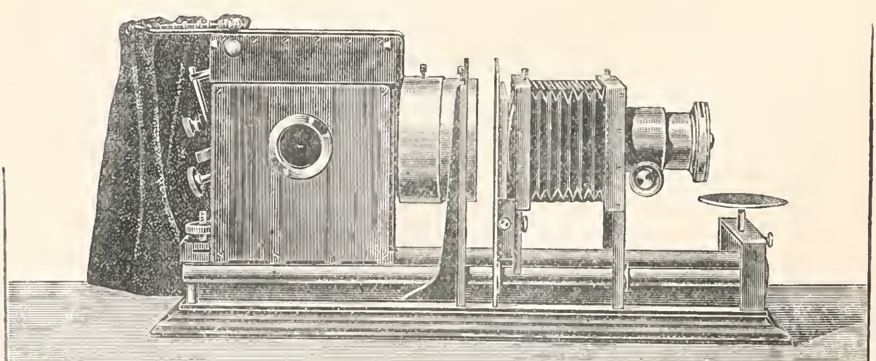
New Arrangement for Viewing Diffraction Spectra.* — Mr. J. Rheinberg finds that the best method of viewing diffraction spectra is to mount in a short tube the objective of one of the 7*s.* 6*d.* toy Microscopes, which is in effect a lens of about $\frac{1}{4}$ in. focus stopped down to an actual aperture of about 1 mm. This diffraction ocular, as it may be called, shows the spectra splendidly, magnifying them at the same time. It gives plenty of light, and the spectra cannot shift. Fig. 111 clearly shows the arrangement. A is the ocular fitting on to the top of B, the usual eye-piece. The sliding collar *s* allows of adjustment to any power eye-piece. The spectra viewed in this way are not those formed at the back of the objective, but those re-formed above the eye-piece.

Fig. 111.



Sanger, Shepherd, & Co.'s Improved Optical Lantern.—Fig. 112 shows a lantern of the highest class especially suited to the requirements of a scientist. The whole of the framework is extremely rigid. The lantern body is entirely constructed of metal truly finished to gauge; the stage for jet or arc lamp fits the body accurately, and is provided with every adjustment. The optical base consists of a series of stout truly-fitted brass tubes, all of which, with the exception of the

Fig. 112.



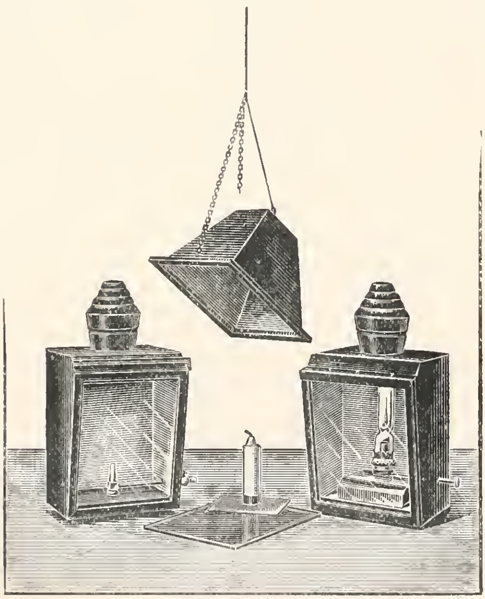
rear pair, are entirely removable. The condensers are fitted in bayonet-clutch cells; they can be instantly changed, and are carried by a plate fitted to the large stout cast-brass uprights. The slide stage is carried

* Journ. Quek. Micr. Club, 1901, pp. 63–4 (1 fig.).

by a separate pair of tubes, and can be brought close up to the condenser, or pushed forward to allow of the use of an alum or glycerin tank. A vertical adjustment is provided for the stage platform, so that carriers of varying depths can be accurately centred and levelled without the use of packing pieces. A third pair of tubes carries the optical front, fitted with movable slip-up panels for easy exchange of objectives, or Microscope, polariscope, or spectroscope fronts.

Sanger, Shepherd, & Co.'s Safe Lights for Dark Room Illumination.— These (fig. 113) are in reality lanterns of japanned tin plate frame, and are adapted for candle, paraffin, or gas. The burner

Fig. 113.



can be adjusted from the outside. The glass forms a light-filter; it is made by combining fired stained glasses, and is therefore somewhat thicker than the usual coloured glass. The filters are made in four tints suitable for plates of different kinds of sensitiveness.

Müller's Rotary Slide Carrier.* — Dr. Müller, of Tübingen, seeks to overcome the difficulties attendant on the usual to-and-fro push carrier for lantern slides. His apparatus consists of a vertical frame of about 38 cm. diameter rotary about a horizontal axis A, and the whole is set on a bearer T which is clamped on to the optical bench. In the frame are four circular perforations (dotted in figs. 114 and 115) of 13·5 cm. diameter, so arranged that their centres pass successively through the optical axis as the frame is rotated, a catch H fitting into

* Zeitschr. wiss. Mikr., xvii. (1900) pp. 162-6 (2 figs.).

Fig. 114.

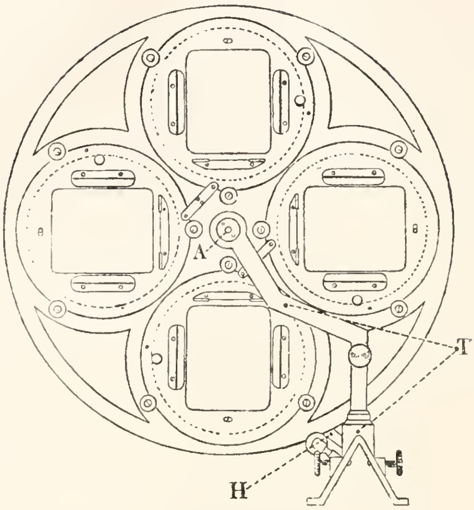
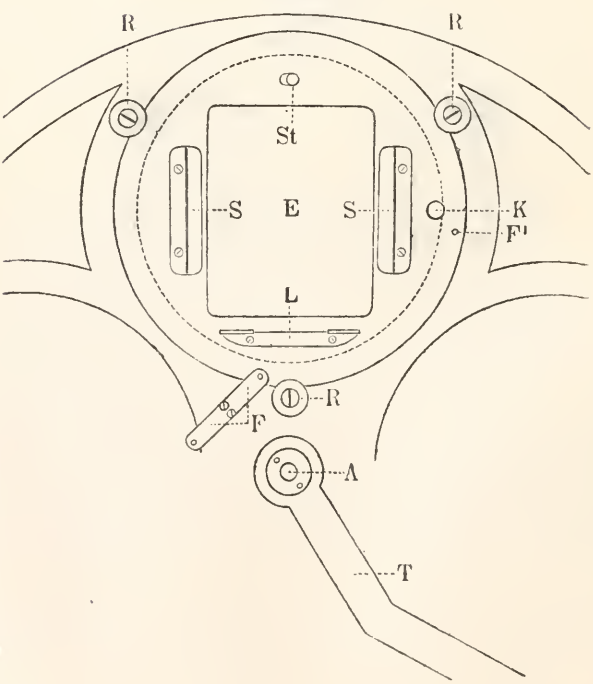
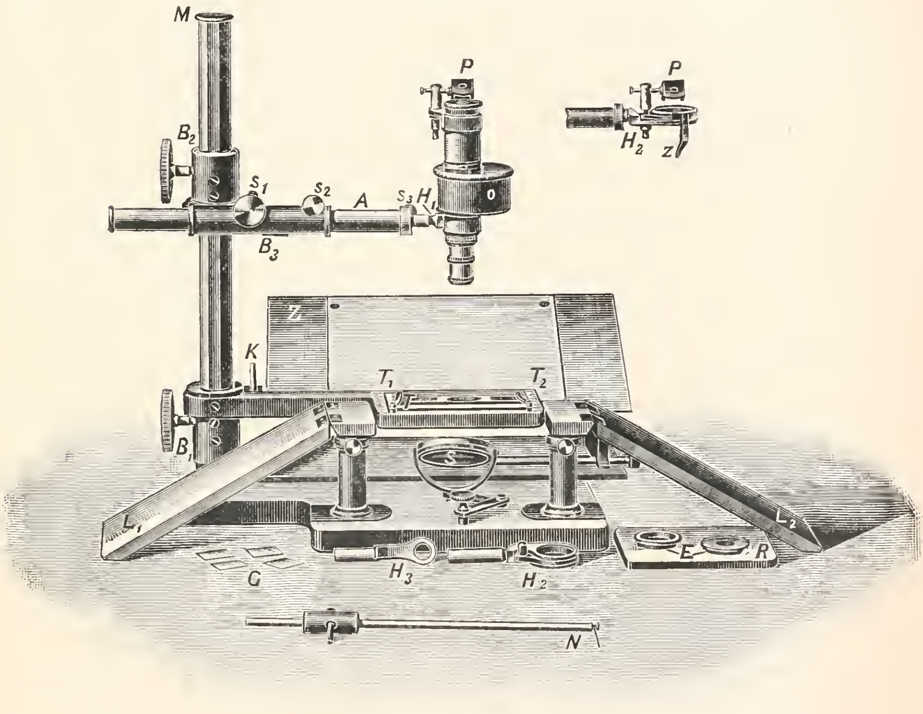


Fig. 115.



a slot and stopping the rotation at the right moment. On this frame are four smaller round plates, the exchange plates, of 15 cm. diameter, which rotate easily between the three rollers R (fig. 115); they are rectangularly perforated at E, and bear the clips S for a slide. The knob K serves for the proper adjustment of the exchange plate with its slide. The security of the slide is provided for by the grooved clips S on the long sides, and by a projecting fillet on the inner short side of the orifice; the other short side has a spring pin over which the slide is pushed, which then immediately rises and holds the slide. The dimensions of the orifice are 7·5 by 9 cm.

FIG. 116.



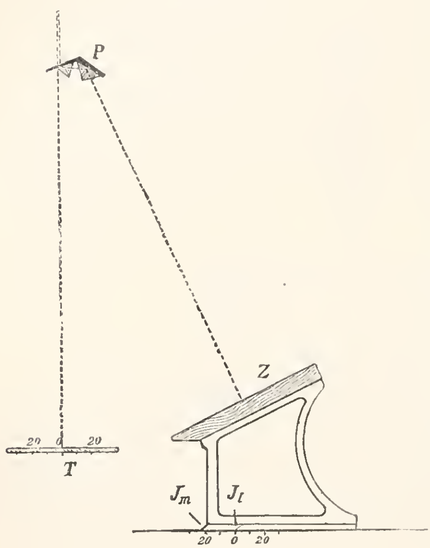
The great advantage of the arrangement is that the operator has thorough control over the insertion of the slides without leaning over the instrumemt.

Berger's Drawing Apparatus for Small Magnifications.*—This apparatus is shown in fig. 116. On a cast-iron base-plate stands a strong metal pillar M, on which slide two collars B_1 and B_2. To B_1 a frame-shaped object-table is attached; it can be swung aside by the pin K, and replaced by an object placed on the base-plate. In the frame of the

* Zeitschr. f. Instrumentenk., 1901, pp. 171–5 (3 figs.).

object-table a glass plate can be set, or a small drawing-board when the apparatus is to be used for drawing to a reduced scale. With transparent objects illumination is effected by a mirror S, or by a piece of white paper. The collar B_2 bears on its under side a hollow cylinder, in which works a rod carrying at its distal end the Microscope with reversing eye-piece. The Microscope fits loosely into ring-shaped holders H_1, H_2, H_3, and may be replaced by spectacle glasses of various strengths or by ordinary loups. The drawing-prism (camera lucida) is fastened on to the ocular tube of the Microscope in the usual way, the right position being indicated by a pin, over which the slit of the clamping-ring slides. The Microscope is so set in the holder H that the rotation-pin of the drawing-prism is parallel to the front edge of the drawing-board. This drawing-board Z is placed on a perforated desk-shaped frame, which slopes at an angle of 25° to the horizon, and which, sliding in a groove of the ground-plate, can be pushed backwards and forwards perpendicularly to the front edge of the object-table, and can be clamped in any desired position. In order to attain a drawing of uniform magnification, it is necessary that the distance between the pupil of the drawing-prism (a small circular opening of the prism-holder) and the drawing-plan should be constant. There are two scales T_1 T_2 on opposite sides of the object-table, and two similar scales (fig. 117) on the drawing-frame, and two on the base-plate. When the adjustments are made, a line joining the two zeros on the object-table will be parallel to the zero line on the drawing-frame. When, therefore, the arm A of the Microscope is moved in and out of its sheath B_3, the whole of the object can be searched and delineated on the drawing-board.

Fig. 117.



Acetylene Gas for Bacteriological Laboratories.* — C. H. Higgins advocates the use of acetylene gas for isolated bacteriological laboratories. For general purposes it is preferable to ordinary coal gas, and makes a most excellent artificial light for microscopical work, its spectrum being very nearly identical with that of the sun, lacking only the ultra-violet rays. The form of generator advised is one in which, by a mechanical arrangement, the carbide is dropped into a large body of

* Centralbl. Bakt., 1te Abt., xxix. (1901) pp. 794–7.

water; from this generator it is passed into a gas-holder. When the gas is used up the gas-holder falls, and this action causes another charge of carbide to drop into the water. The generator should have two gas mains, one of 2-in. pressure for lighting and incubator purposes, and another of 4-in. pressure for Bunsen burners and gas stoves.

ENGELMANN, TH. W.—**Ueber ein Mikrospektralobjectiv mit Normalspectrum.**
Arch. f. Anat. u. Physiol., 1900, *Physiol. Abth. Supp.*, p. 338.

WEINSCHENK, DR. ERNST—**Anleitung zum Gebrauch des Polarisationsmikroskops.** (Guide to the use of the Polarising Microscope.)
[The author seems to have written a very thorough and valuable treatise.]
Herder (Freiburg im Breisgau), 123 pp. and 100 figs.

(4) Photomicrography.

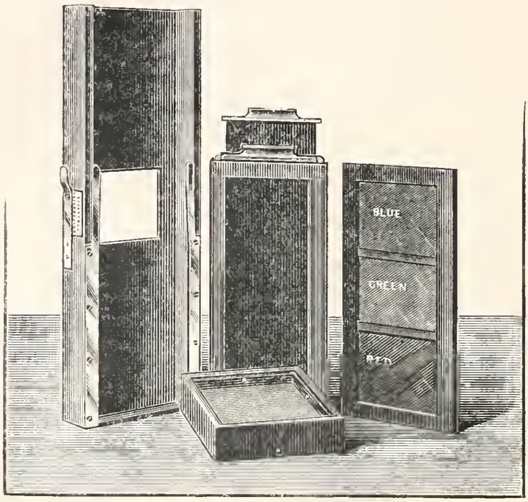
Instantaneous Photography of Growing Crystals.* — Th. W. Richards and E. H. Archibald, who have studied the growth of crystals by means of instantaneous photography, used Bausch and Lomb's outfit. Between the Microscope and camera was placed, in a light-tight box, a revolving shutter which allowed an exposure of a tenth of a second. A Henrici hot-air motor, combined with speed-reducing double pulleys, enabled the experimenter to use any rate of revolution desired. Two different arrangements were adopted, the first of which caused the successive impression of a bright image in a dark field, and the second registered dark images in a succession of bright fields. In carrying out the first of these two methods it was found more convenient to move the crystallising solution than to move the photographic plate. By the foregoing methods it was found possible to take very frequent photomicrographs of crystals during their birth and growth. An enlargement of over four thousand diameters was obtained, and both common and polarised light were used. Only substances with high melting points were examined, and the crystallisation was always from aqueous solution. No properly focussed image in any of the plates seemed to be devoid of crystalline structure. The growth in diameter during the first second of the crystal's life was found to be vastly greater than during the subsequent period. The authors' observations do not lend support to the notion that crystals develop from a transitory liquid phase.

Sanger, Shepherd, & Co.'s Process of Natural Colour Photography.— Fig. 118 represents the apparatus used by Messrs. Sanger, Shepherd, & Co. for colour-record negatives of any object. The apparatus known as a repeating-back is attached to any front-focussing quarter, half, or whole-plate camera by means of a panel cut to correspond, and interchangeable with the ordinary dark slide. This does not interfere with the use of the camera for ordinary work, while it allows of the attachment being adjusted for use in a few seconds. An outer case (on left of figure) carries the frame with the three colour filters and the double dark slide holding two spectrum plates. The colour-filter frame is furnished with lugs which engage with the dark slide so that both move together. The first exposure through the red filter is made with the filter-frame and dark slide at the right-hand end

* Proc. Amer. Acad. Arts and Sci., xxxvi. (1901) pp. 341–53 (3 pls.).

of the repeating-back. For the exposure through the green filter the frame and slide are pushed to the left hand until the pin of a spring latch drops into a depression in the colour-filter frame. For the blue filter exposure the colour-filter frame and dark slide are pushed completely over to the left.

FIG. 118.

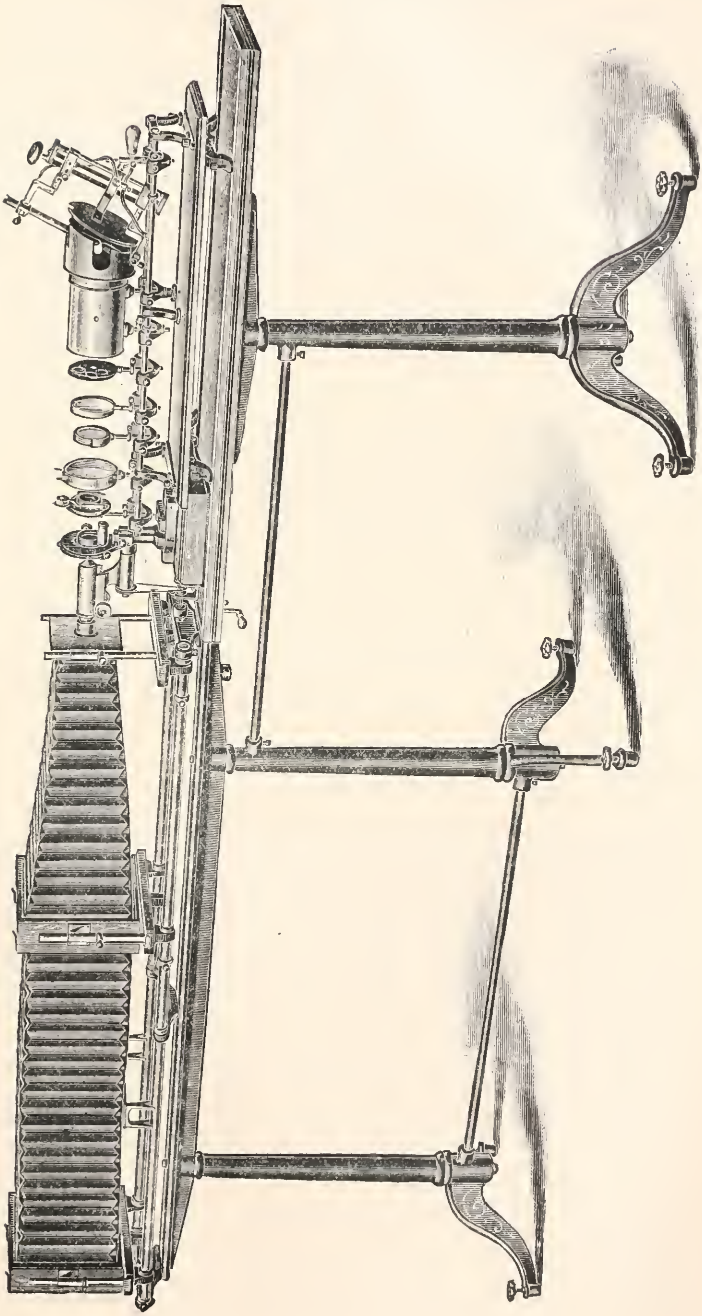


Buxton's Photomicrographic Apparatus.* — The great feature in this arrangement (fig. 119) is that the table which carries the optical bench is made to revolve. This allows the operator to sit comfortably on a stool and make the rough focussing. This table is then swung into place, and the camera, on a second (fixed) table, is then adjusted. The separation and combination of tables renders necessary some special means of coupling the focussing rods of the fine adjustment, and the following method is adopted:—On the table of the optical bench, directly beneath the fine adjustment head of the Microscope, is situated a milled wheel on suitable standard, and a belt from this wheel extends to the fine adjustment head of the Microscope. Through the axis of the wheel is located a rod carrying at the end towards the camera a clutch which can be quickly connected with the focussing-rod of the camera by sliding adjustment operated by a milled head. The optical bench must, of course, be brought to its proper position with relation to the camera in order to make this connection, and for this purpose a lever, shown in the illustration, is provided.

Sanger, Shepherd, & Co.'s Filters for Photomicrography.— Fig. 120 shows this apparatus. The filters are made to order for any double stain in bacteriological work, so as to photograph the stains either in black or white. The green filters are especially recommended

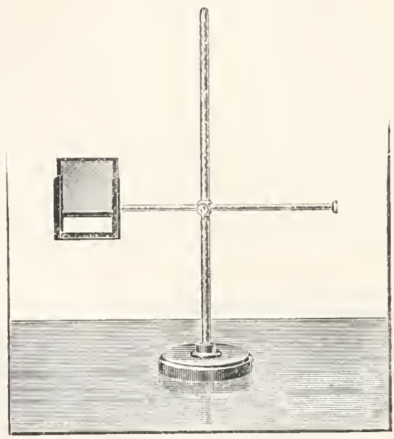
* Journ. App. Micr., 1901, pp. 1366–72 (7 figs.).

Fig. 119.



for improving the definition of imperfectly corrected objectives. Red, orange, yellow, and blue filters are also made.

FIG. 120.



(6) Miscellaneous.

CHEYNEY, J. S.—On the Proper Thickness of Cover-Glass.
Micr. Bull., 1901, Feb. p. 1.

ZEISS, C.—Ein neuer beweglicher Objecttisch. (A new Movable Object-stage.)
Zeitschr. f. Instrumentenk., XX. (1900) p. 325

B. Technique.*

(2) Preparing Objects.

Fixation of Embryonic and Young Cartilage.† — As well as the ordinary fixatives, E. Retterer uses the following solutions for observing transitional stages of cartilage. Mixture A: 3 p.c. chromic acid solution 66 vols.; formol 33 vols.; acetic acid 8 vols. Mixture B: 5 p.c. platinum chloride solution 50 vols.; formol 50 vols.; acetic acid 3 vols. Fresh rib cartilages of young animals, guinea-pigs, rabbits, or cats, were immersed in one or other of these solutions for 6 to 12 hours. They were then washed in water, dehydrated in alcohol, and treated for sectioning in the usual manner.

Fixing Flagellata.‡ — H. Plenge fixes Flagellata in the following ways. A drop of the culture fluid containing Flagellata is pipetted on to a slide and spread out into a thin layer. The organisms are then killed with osmic acid vapour or by the addition of a drop of 1 p.c. osmic acid solution to the water. A cover-glass provided with four wax

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

† Journ. Anat. et Phys., xxxvi. (1900). See Zeitschr. wiss. Mikr., xviii. (1901) pp. 71–3.

‡ Zeitschr. angew. Mikr., vii. (1901) pp. 19–20.

feet is put on. Water is first run through, and afterwards the different staining fluids. This procedure is tedious, and involves great loss of material. A better method is to lay a drop of the culture fluid on a slide or on a cover-glass, and kill the animals with osmic acid vapour or by means of a drop of some other fixative such as cold saturated sublimate solution, Hermann's fluid, or picrosulphuric acid. The fluid is allowed to evaporate in the air until only a trace of moisture remains. The slide or cover-glass is then placed in absolute alcohol for 24 hours, to which, if sublimate have been used, some tincture of iodine must be added. The preparations are then treated like stuck-on sections, and there is no considerable loss of material. If the culture fluid contains a large quantity of bacteria, these organisms may be washed off with alcohol when the layer has not completely dried.

Fixing Blood Preparations with Chloroform.*—O. Josuë has found chloroform to be an excellent fixative for blood-films. The film is prepared in the usual way, dried in the air, and then immersed in chloroform for about two minutes. It is then allowed to dry, and afterwards stained and mounted.

Method for Examining Ocelli of Insects.†—W. Redikozew adopted the following procedure. Immediately after decapitation the heads were fixed in picrosulphuric acid, picro-acetic acid, sublimate, or in sublimate with 2 p.c. acetic acid. After washing out the fixative, the objects were preserved in 70 p.c. alcohol. The preparations were stained with a combination of borax-carmine and Lyons-blue, by immersing the object for 24 hours in borax-carmine and incubating at 45°, and then extracting for one or two hours with 1 p.c. hydrochloric acid. The mass was then imbedded and sectioned. The sections were after-stained for one or two minutes in $\frac{1}{4}$ p.c. Lyons-blue solution in 70 p.c. alcohol.

For isolating the ocelli the following maceration fluids were used. NaCl solution with 0·2 p.c. acetic acid, incubated at 45°; 0·005 p.c. chromic acid; 10 p.c. alcohol; also eau de Javelle much diluted. Pigment was removed by means of 25 p.c. nitric acid or by a mixture of chromic and acetic acid. For softening the cuticula for sections, eau de Javelle, though satisfactory, requires to be used with great care, and the mouth and the opening in neck must be stopped with paraffin.

Method of Finding Tubercle Bacilli in Sputum.‡ — De Lannoïse and A. Girard place the sputum in about 10 times its bulk of eau de Javelle diluted to one-third, and shake the mixture energetically from time to time. It is then allowed to sediment for 24 hours, or better is centrifuged. To the sediment, which amounts to about 2–3 ccm., are added 5 or 6 drops of normal NaHO or KHO. In this way NaCl is formed. The tube is then filled up with sterilised water and centrifuged again. The sediment is spread on slips or slides and treated in the usual way.

Behaviour of Spores and Fat-Drops in Bacteria to Eau de Javelle and Chloral hydrate Solution. § — Prof. A. Meyer has already pointed

* C.R. Soc. Biol., liii. (1901) p. 642.
† Zeitschr. wiss. Zool., lxviii. (1900) pp. 581–624 (2 pls.).
‡ Archiv. Gén. de Méd., 1900, Supplement to Oct. No.
§ Centralbl. Bakt., 1te Abt., xxix. (1901) pp. 809–10. Cf. this Journal, 1900, p. 370.

out that fat is an important reserve-substance of bacteria, being deposited in the form of drops in the cytoplasm of these plants. He had also found that these fat-drops are an important criterion for many species, but that at certain stages the appearances of spores and fat-drops so closely resembled each other that they could not be distinguished by the ordinary known reactions. He now finds that a solution of 5 grm. chloral hydrate in 2 grm. water is an excellent medium for distinguishing between fat-drops and spores. If, for example, a sporange of *Bacillus tumescens* which contains both a spore and fat-drops, be placed in this reagent, the fat is at once dissolved, while the spore stands out quite distinctly. This procedure renders unnecessary any special method for staining spores; for if the material be treated by the choral solution, it brings out the spore too distinctly to be mistaken for anything else.

Eau de Javelle also has a characteristic reaction to ripe spores and fat-drops. If some bacterial material containing both spores and fat-drops be stirred up with a drop of Javelle's solution, it will be found that the protoplast of the sporanges and of the bacterial oidia is dissolved, while the membrane is at first unaffected. Like the membrane of the spore, bacterial fat is also resistant to the action of eau de Javelle, and by means of this reagent can be macrochemically isolated. Bacterial fat then is easily soluble in chloral hydrate, and is only slowly attacked by eau de Javelle.

(3) Cutting, including Imbedding and Microtomes.

Delépine Improved Microtome.*—Messrs. R. and J. Beck have made some additions and improvement to the Delépine microtome previously described (fig. 121). The knife-carrier and rails are longer, the stand is of larger size, and has an extra supporting upright. The knife-carrier is 9 in. long, and is provided with two handles, forming a tie at each end. The whole is made from one solid gun-metal casting. The carrier has a travel of $7\frac{1}{2}$ in. without leaving the rails. Along the upper faces of the carrier are two grooves in which run the clamps holding the razor. These may be placed so that the razor is either at right angles or at any obliquity to the angle of cut, the razor being held rigidly at each end. The clamps are so arranged that they are higher than the knife-edge, and thus the entire length of a 6-in. blade may be used for an oblique cut. The blade itself may be tilted by the set-screws of the clamp. The illustration shows the instrument arranged for the oblique knife.

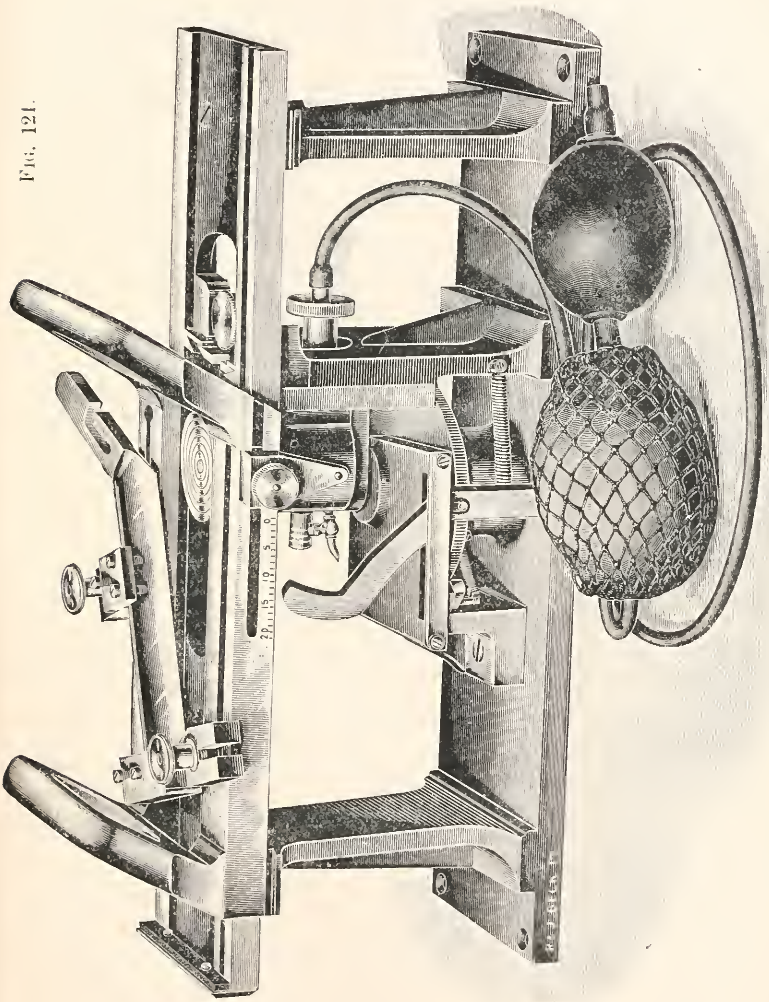
Fiori's Automatic Microtome.†—Prof. A. Fiori has devised an automatic microtome (fig. 122) in which, by a double and simultaneous movement of the knife-bearer and object-carrier, the knife and preparation are made to meet in a very neat way. The movement is a gliding one, and is therefore similar to that of the sliding microtomes, though obtained in a different way and by means of a lighter instrument. The principal features in this instrument are that the knife-carrier has fixed to its lower end a grooved plate with a handle at one end. In the

* R. and J. Beck's List, 1901. Cf. this Journal, 1900, p. 128.

† Malpighia, xiv. (1900) pp. 411–24 (6 figs.).

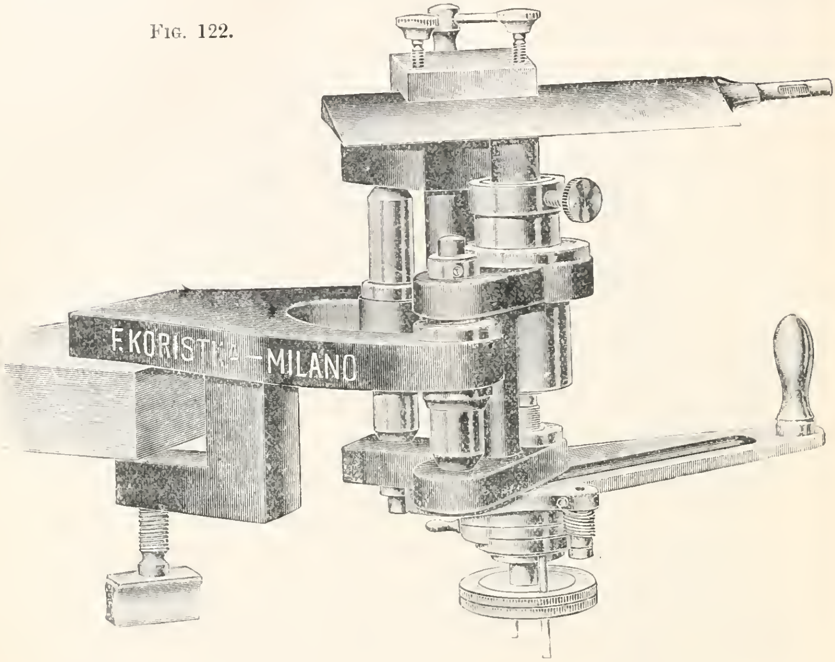
groove works a knob projecting from the under surface of the vertical axis of the object-carrier. When the knife-carrier moves, the object-holder is borne along the groove towards the edge of the knife. According to the relative positions of the knife and the groove, so is the

FIG. 121.



length of the movement of the object-carrier—indeed this movement may be reduced to zero. To the micrometer screw is attached a toothed wheel which is actuated by a hook fixed to the grooved plate. This arrangement effects the automatic raising of the preparation, and may be made to vary from 0·005 mm. to 0·1 mm. The gape of the jaws of the object-carrier is 14 mm.; the greatest length of the run of the preparation along the knife-edge is 11 cm. Any razor can be used in this microtome.

Fig. 122.



New Freezing Microtome for use with Carbon Dioxide Tanks.*—Prof. C. R. Bardeen has devised a microtome for use with carbon dioxide tanks. The illustrations show the machine ready for use, and the apparatus in section (figs. 123, 124). The apparatus is supported by the nozzle of the carbon dioxide tank, and the valve of the tank controls the escape of gas into the tube K D. From this tube the gas escapes into the chamber beneath the microtome plate, and makes its way out through a spiral passage. By this device the maximum freezing power is secured.

The mechanism for regulating the thickness of the sections consists of a movable wheel 1, which moves up and down on a screw-thread, cut 25 threads to the inch, one revolution of the wheel, therefore, raising or lowing it a millimetre. The margin of the wheel is divided up into spaces representing 20 microns. The knife slides on glass guides.

The advantages claimed for this apparatus are that but little carbon dioxide is wasted; the temperature of the freezing stage can be controlled, the machine and tank may be readily carried about. It is simple in design, strong, and unlikely to get out of order.

* Bausch and Lomb's Cat. B, 16th edition; also Journ. App. Microscopy, iv. (1901) pp. 1320–3 (2 figs.).

Fig. 123.

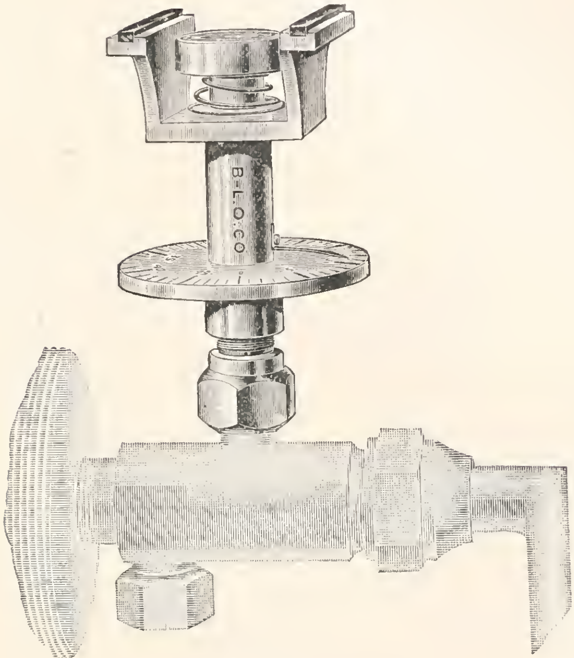
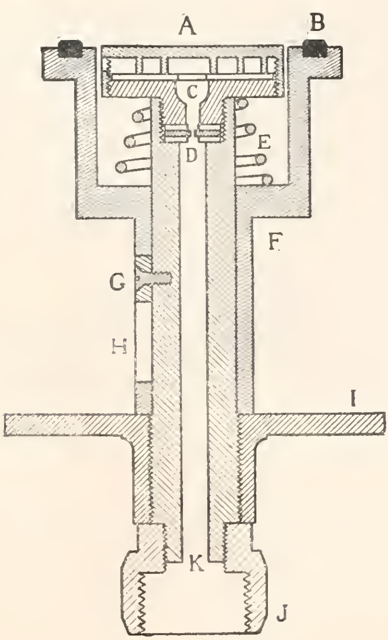


Fig. 124.



Minot Automatic Precision Microtome.*—This microtome is adapted for paraffin and celloidin preparations. Its present form (fig. 125) embodies several important improvements. The feeding arrangement and

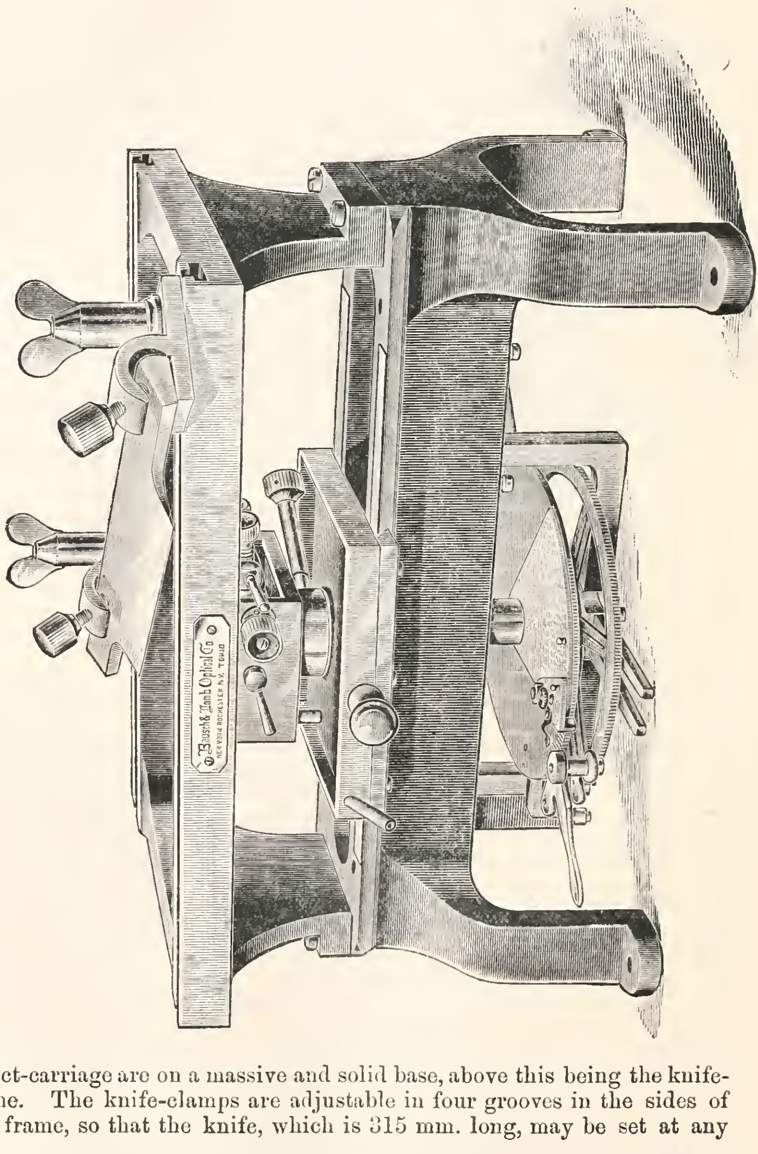


Fig. 125.

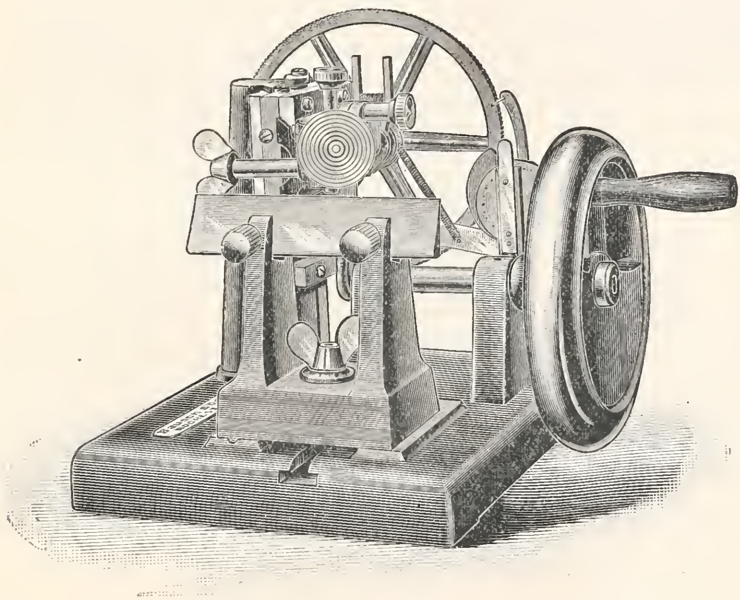
object-carriage are on a massive and solid base, above this being the knife-frame. The knife-clamps are adjustable in four grooves in the sides of the frame, so that the knife, which is 315 mm. long, may be set at any

* Bausch and Lomb's Cat. B, 16th ed., pp. 10, 11; and also Journ. App. Microscopy, iv. (1901) pp. 1318–20. Cf. this Journal, 1899, p. 104.

angle and in any position. The object-holder is the Naples universal clamp. The vertical motion of the feed-screw is transmitted to the object-carrier through a triangular prism. The object once adjusted, cutting is effected by backward and forward motion of the carriage. The feed ranges from 1 to 60 microns. The knife is bilaterally symmetrical in section, the edge is straight, and the handles by which the knife is clamped to the frame are continuations of the blade itself and have the same angles.

Minot Automatic Rotary Microtome.*—In this instrument (fig. 126) several improvements have been made, and increased accuracy has been

Fig. 126.



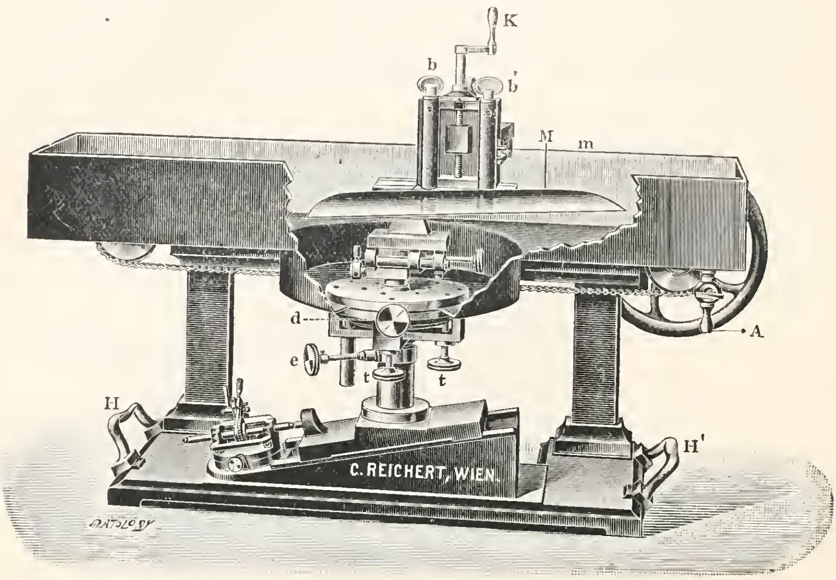
obtained by means of better tools for planing the sliding surfaces, cutting the micrometer screw, and cutting the teeth of the feed-wheel. Other improvements have rendered the microtome more convenient to use, the most important being alterations in connection with the automatic feed, the addition of a brake, the provision of a split nut for the micrometer screw, which closes automatically, and more careful balancing of the main wheel.

Microtome for Cutting under Water.†—Dr. J. Starlinger describes C. Reichert's microtome for cutting under water. The body is made out of cast iron, and the smaller parts are nickel-plated. The most im-

* Bausch and Lomb's Cat. B, 16th ed., pp. 8 and 9; also Journ. App. Microscopy, iv. (1901) pp. 1317–8.
† Zeitschr. wiss. Mikr., xvii. (1900) pp. 435–40 (3 figs.).

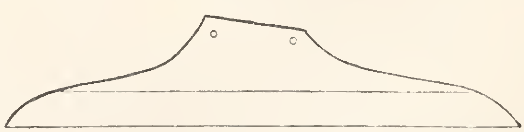
portant features are the knife-carrier, the object-carrier, and the micrometer. The knife-carrier works along a slide, and has a sweep of 40 cm. long. In raising the knife the coarse adjustment is made by a screw, the fine adjustment by moving the object-carrier upwards on the inclined

Fig. 127.



plane (fig. 127), by means of the micrometer screw. Perhaps the most interesting feature is the novel shape of the knife (fig. 128). It is 28 cm. long, and cuts perfect sections 9 to 11 cm. in size. The instrument may be used as an ordinary microtome by merely removing the

Fig. 128.



clamp and reservoir. The microtome is easily manipulated, its construction is strong, and it produces faultless sections of large size.

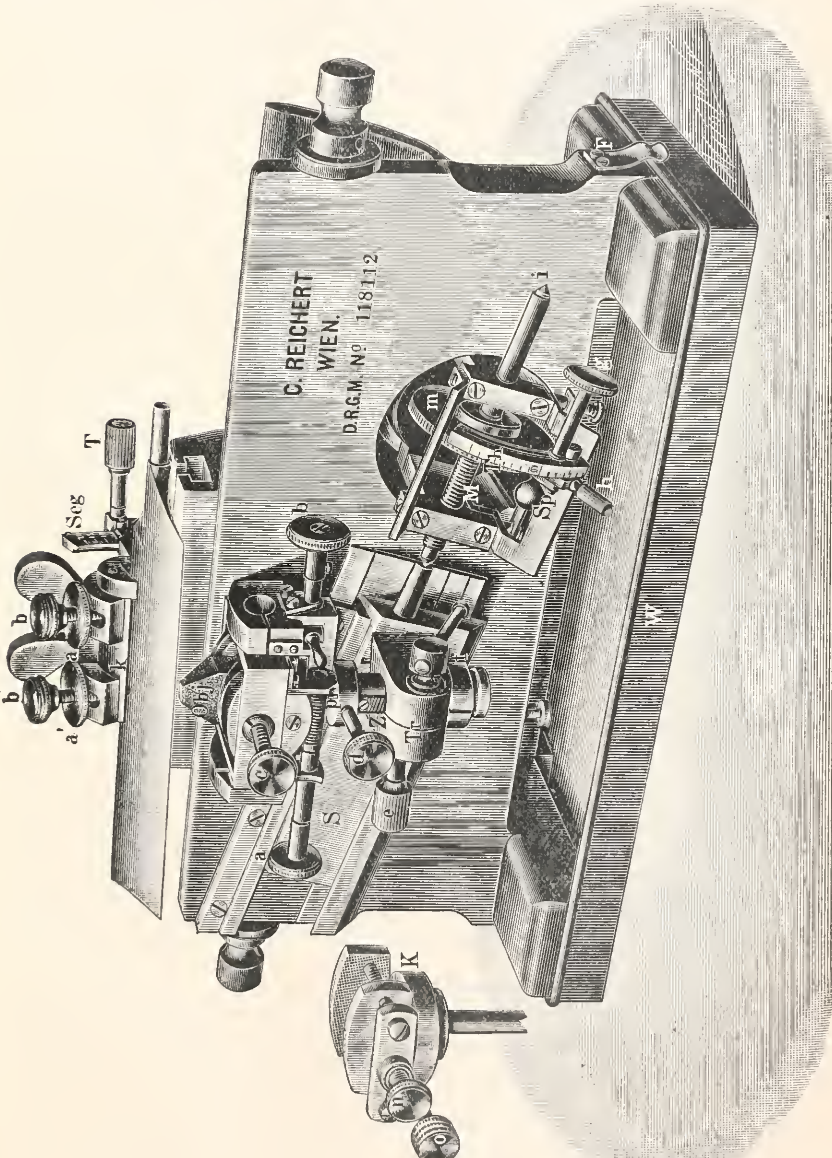
Reichert's new Microtome with Inclined Plane and Endless-working Micrometer Screw.*—The great advantages of the construction of this microtome (fig. 129) are not merely that the object-holder works on an inclined plane, and in a strong frame between two swallow-tailed metal guides, but that the micrometer screw, when it has worked out,

* Zeitschr. wiss. Mikr., xvii. (1900) pp. 159–62 (1 fig.).

can, by means of a simple and ingenious arrangement, be rotated through 180°, so that a kind of perpetual motion results.

The microtome is made of cast iron of suitable strength and stability, and the knife-slide has a working distance of 28 cm. The knife-slide,

Fig. 129.



on three accurately worked projecting guides, is also heavy, and is thoroughly secured by means of a clamp; a slip of the knife in the cutting of hard objects is impossible.

The object-slide, 7·5 cm. long, is solidly built, and moves on an inclined plane only 12·5 cm. long, which makes an angle of 15° with the horizon. It moves with perfect safety and rigidity between two metal guides, and on account of the inclination of its path, the horizontal projection of its movement is proportionately slow.

The object-holder is easily adjustable in the three directions of space, in the vertical by rack-and-pinion, and can, by the simple action of a screw *d*, be set higher or lower, or even removed altogether.

The micrometer screw is fixed, that is, it is never necessary to remove it from the mother screw. The fine adjustment is by a micrometer screw of the construction usual with microtomes; a circular sheath with accurately divided toothed periphery enveloping the screw. A circular segment *h*, graduated in degrees, can be pushed into position, and adjusted so that the number of teeth (1 tooth = 1 μ) can be set. By moving the handle *h*, the upper end of the circular segment strikes against a metal cross-piece, which serves as a stop, and thus rotates the toothed wheel, and moves on the micrometer-screw so that uniformly thick sections are automatically obtained. When the micrometer-screw is quite run out, it can, in a circular notch of the vertical guide of the microtome, be rotated through 180°, and then commence again, the other end of the micrometer-screw being now in contact with the object-slide. Thus the result is an uninterrupted working of this screw. In order to acquire contact with the micrometer-screw in this new position, the object-slide must be pushed back about 25 mm. The corresponding slight difference (about 7 mm.) of height between knife-edge and cutting plane of the preparation can now be easily set right by means of the pinion *Tr*.

The arrangement is especially useful in serial-section making.

(4) Staining and Injecting.

New Reaction for Woody Tissue.* — C. Mäule has found that woody tissue, treated with permanganate of potash, followed by hydrochloric acid and ammonia, turns red. 1 grm. of permanganate is dissolved in 100 ccm. water, and the sections are immersed for 5 minutes. They are then decolorised in HCl for 2 or 3 minutes. After the addition of ammonia, or holding them over a bottle containing ammonia, they turn red. The reaction may be hastened by heating the permanganate on the slide, and instead of ammonia caustic potash or soda may be used. The time the permanganate takes to act varies with different plants, the Coniferæ being especially resistant.

Researches with Neutral Red.† — Prof. S. Mayer reports on some researches made with neutral red, a pigment which in many cases will impart an *intra vitam* staining to cell-granules. According to Mayer, the pigment is not poisonous, and is possessed of great staining power. Frog and salamander larvæ were immersed in dilute solutions, and soon

* Fünfstück's Beitr. z. wiss. Bot., iv. (1900) pp. 176–85. See Zeitschr. wiss. Mikr., xviii. (1901) pp. 108–10.

† SB. Prager Vereins "Lotos." See Zeitschr. wiss. Mikr., vii. (1901) pp. 20–1.

acquired a red colour, which they retained for a long time after removal to pure water. Salamanders were injected in the peritoneal sac, and frogs and toads in the dorsal lymph-sac. Mammals received an injection of 0·1 grm. to 100 ccm. of a 0·5 p.c. salt solution either in the jugular vein or subcutaneously. It was found that not only cell-granules, but also many other parts, were stained; among these may be mentioned the nuclei of the nervous system, the cells of hyaline cartilage, fat-cells, and sarcolemma. The most striking reaction was the staining of degenerated nerve-fibres. After death the red colour changes to yellow in many organs.

Modification of the Iron Hæmatoxylin Staining Method.* — A. Ch. Haemers immerses the whole object in a 5 p.c. solution of iron alum for 2–8 days. After having been quickly washed in distilled water, the piece is transferred to 1 p.c. hæmatoxylin solution for 4–8 days. During this period the fluid should be renewed two or three times. After removal the preparation is washed in water and dehydrated in alcohol of increasing strength. When the spirit is no longer cloudy, it may be imbedded in paraffin or celloidin. The sections may be contrast stained with Lichtgrün or with fuchsin. This method is successful after fixing with chrom-osmic-acetic acid, with platinum-osmic-acetic acid, or with Müller's fluid.

Intra vitam Staining of Micro-organisms.†—A. Cortes, who has recorded numerous observations showing the utility of *intra vitam* staining, has now published drawings of numerous examples of micro-organisms stained while alive with methylen-blue and other pigments.

Staining Tubercle Bacilli and Spores by the Aid of Potassium percarbonate and Hydrogen peroxide.‡ — Dr. A. Müller has found that for demonstrating tubercle bacilli in fuchsin-stained preparations, the treatment with acid may be omitted, and replaced by potassium percarbonate $K_2C_2O_6$, or still better, by alkaline peroxide of hydrogen. The preparations do not suffer by protracted action of these reagents, and the procedure is therefore specially suitable for material which contains very few tubercle bacilli. The same reagents can be used with advantage in spore-staining. After staining the film with carbol-fuchsin, the cover-glass is washed with dilute spirit (60–70 p.c.), or with water, and is then transferred to a freshly made 5–10 p.c. solution of potassium percarbonate for at least a quarter of an hour, after which it is washed with water and stained with methylen-blue. Peroxide of hydrogen alkalinised immediately before use by means of soda or potash solution acts more rapidly and effectively than the potassium percarbonate. For spores, the method gives better results with anilin-water-fuchsin than with phenol-fuchsin.

Staining with Brazilin.§—Prof. S. J. Hickson gives the following method for staining with brazilin ($C_{16}H_{14}O_5$), which is extracted from the wood of *Cæsalpinia echinata*.

The sections are placed in a solution of iron-alum (1 p.c. iron-alum

* Zeitschr. wiss. Mikr., xviii. (1901) pp. 33–4.

† C.R. Assoc. Française Avance. des Sci., 1900, 9 pp., 3 pls., and 19 figs.. Cf. this Journal, 1900, p. 625.

‡ Centralbl. Bakt., 1te Abt., xxix. (1901) pp. 791–4.

§ Quart. Journ. Micr. Sci., xliv. (1901) pp. 469–71.

in 70 p.c. alcohol) for one to three hours, and then, after slight washing in 70 p.c. alcohol, in a 0·5 p.c. solution of pure brazilin in 70 p.c. spirit. Three to sixteen hours are required to give a good sharp definition. After staining, the sections are washed in pure 70 p.c. spirit, passed through the usual stages, and mounted. Over iron-hæmatoxylin this method possesses two advantages: the sections are never taken down into water, and the number of washings is considerably reduced. The results are satisfactory, for not only is brazilin a definite chromatin stain, but in nearly all tissues some parts of the cytoplasm are also stained, though of a different colour, and with some tissues it is a triple stain.

Methylen-Azur and the Red Reaction of Methylen-Blue.* — Dr. L. Michaelis points out that the metachromatism of alkaline methylen-blue solutions is due to the presence of the decomposition product methylen-azur, called by Nocht "the red from methylen-blue," while methylen-red is an impurity introduced in or unremoved by manufacture. He has devised the following method of making an azur-methylen-blue. 2 grm. of medicinal methylen-blue are dissolved in 200 ccm. of water, and to the solution 10 ccm. $\frac{1}{10}$ normal soda solution are added. The solution is then heated and kept boiling for $\frac{1}{4}$ hour. The fluid is allowed to stand till it cools, when 10 ccm. $\frac{1}{10}$ normal sulphuric acid are added, after which it is filtered.

For staining purposes one part of the solution is mixed with 5 parts 1 per thousand eosin solution and the mixture well shaken. The preparations are left in the solution for $\frac{1}{4}$ hour, after which they are washed in water, dried, and mounted. Differentiation in alcohol or in eosin solution is unnecessary.

Microscopic Injections with Cold Fluid Gelatin.†—Dr. J. Tandler prepares a stained injection mass which remains fluid in the following way:—5 grm. of finely divided pure gelatin are soaked in 100 grm. of distilled water and afterwards heated. When the gelatin is melted, Berlin-blue is added, and then 5–6 grm. of potassium iodide are gradually worked in. As a rule the mass will keep fluid and injectable down to 17° C., but should it set, the addition of more iodide will prevent the recurrence. Some crystals of thymol should be added, and the mass preserved in stoppered bottles. The animals should be injected immediately after death, and then the pieces to be preserved are immersed in 5 p.c. formol. This fixative is very advantageous for staining and decalcification afterwards, as the chemical changes which take place are very slight.

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

New Formula for Preserving Zoological and Anatomical Specimens.‡—G. Marpmann finds that by adopting the following formula the alcohol may be omitted from his method. The preparations are first immersed in the following mixture:—sodium fluoride 50; formaldehyde (40 p.c.) 20; water 1 litre. From this fixative solution they are transferred to the preservative fluid, composed of glycerin 28° B 5 litres;

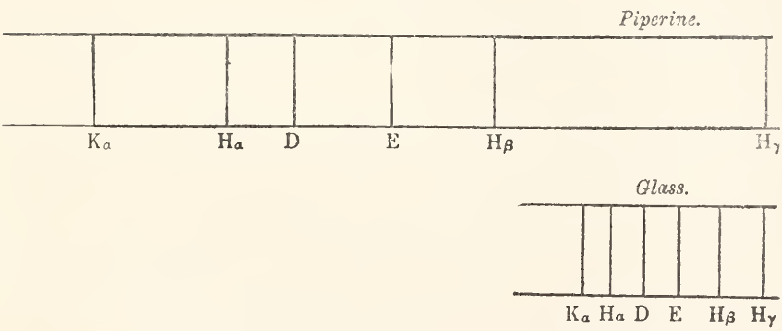
* Centralbl. Bakt., 1te Abt., xxix. (1901) pp. 763–9.
† Zeitschr. wiss. Mikr., xviii. (1901) pp. 22–4 (1 pl.).
‡ Zeitschr. angew. Mikr., vii. (1901) p. 14. Cf. this Journal, 1899, p. 456.

water 10 litres; magnesium chloride 1 kilo; sodium fluoride 0·2 kilo. In this fluid zoological preparations, especially reptiles, preserve their natural colours, as also do most anatomical preparations. Should the preserved material require to be sectioned, it must be treated with water 3 or 4 times to extract the preservative and then immersed in alcohols of increasing strength. If soap be used the material may be imbedded direct.

Colloid Form of Piperine, its Refractive and Dispersive Powers.* —H. G. Madan has found that, in order to ensure with approximate certainty the conversion of crystalloid piperine into colloid piperine, an exposure to a temperature of not much less than 180° for a period of not much less than one hour is required. Prepared in this way piperine will retain for at least $2\frac{1}{2}$ years the colloid condition without alteration, closely resembling ordinary "rosin" (colophony) in appearance, but not quite so brittle.

Colloid piperine possesses a higher refractivity than most other resins

Fig. 130.



Comparative length of the spectra of piperine and glass.

or resin-like substances, and its dispersive power is still more remarkable, = 0·142. The diagram (fig. 130) shows the extent of the piperine spectrum as compared with that given by a prism of dense flint glass having the same refracting angle. From its high refractivity piperine seemed likely to be useful in the construction of certain kinds of polarising prisms, but owing to the extraordinarily high dispersive power, the critical angles for the different rays of the visual spectrum differ so widely that the prism is practically useless unless monochromatic light be employed.

(6) Miscellaneous.

Polarised Light for Investigating Nerve-Fibres.†— K. Brodmann has investigated the appearances of normal and of degenerated nerve-fibres by the aid of polarised light. The principal feature of normal nerve-fibres was their strongly negative double refraction, while degenerated nerves lost this attribute in proportion to the amount of degenera-

* Trans. Chem. Soc., lxxix. (1901) pp. 922–7 (1 fig.).
† Neurol. Centralbl., xix. (1900) p. 1154.

tion; so that when excessive the reversal of the characters of negative double refraction is obtained.

Degenerated fibres in a nerve-trunk can be detected by this method, which is quite simple and satisfactory.

Cooling Paraffin Section Blocks.* — The useful device of smearing the surface of the paraffin block to prevent the curling of sections is, says R. von Lendenfeld, attended with two inconveniences; one is that you must wait while the paraffin sets, the other that the block softens from the repeated application of hot paraffin.

These inconveniences may be obviated by directing a current of cool air on the block. A rubber tube is connected at one end with a water-bellows, the other with a glass tube drawn out to a point. The tube is provided with a stop-cock to regulate the pressure of air. The air passes through a Woulff's bottle to the tube; in the bottle are placed pieces of ice to cool the air.

Methods in Plant Histology.†—Prof. C. J. Chamberlain's work on histological technique for botanical students will be very acceptable to many workers. The first part deals with the principles and processes of microtechnique, while the second part is devoted to the application of the principles to special cases. In the first part are considered the apparatus; the reagents for killing, fixing, and staining; the procedures necessary in the paraffin, celloidin, and glycerin methods. In the second part a series of forms has been selected for demonstration, which will serve not merely for practice in microscopical technique, but will also furnish the student with preparations for a fairly satisfactory study of plant structures from the Algæ up to the Angiosperms.

Chabry's Apparatus.‡—Fr. Kopsch describes an improved Chabry's apparatus for observing ova and minute objects. The alterations chiefly consist in mechanical improvements, the apparatus being practically the same as that previously described in this Journal.

Methods of Determining the Abundance of Bacillus coli communis in River Water.§—Prof. E. O. Jordan adopted two methods: one, the carbol-broth method for highly polluted waters; the other the dextrose-broth method for relatively pure waters. In the first procedure a measured quantity of water in carbol-broth was submitted to a preliminary incubation. The broth was prepared by adding 1 ccm. of 1 p.c. solution of carbolic acid in sterile water to tubes containing 9 ccm. of sterile broth. The broth was first rendered neutral to phenolphthalein, and then acidified by the addition of 5·5 ccm. of normal acid per litre.

1 ccm. of a suitable dilution of the water was added to a tube and incubated at 38° C. for 18–24 hours. Plates were then made of litmus-lactose-agar (5 ccm. normal alkali per litre). If red colonies developed on the medium at 38° C., they were transferred to tubes and tested for gas formation, indol-production, coagulation of milk, and liquefaction of gelatin.

In the alternative procedure, the water was introduced directly into

* Zeitschr. wiss. Mikr., xviii. (1901) pp. 18–9.
† Univ. Chicago Press, 1901, vi. and 159 pp. and 74 figs.
‡ Internat. Monatschr. Anat. u. Phys., xvii. (1900) pp. 125–37 (2 figs.). Cf. this Journal, 1888, p. 801.
§ Journ. Hygiene, i. (1901) pp. 295–320.

dextrose-broth fermentation tubes without preliminary incubation. This broth was prepared with fresh meat, from which the muscle sugar had been removed by Smith's method, and to this sugar-free broth 1 p.c. of dextrose was subsequently added. The broth was made neutral to phenolphthalein. After inoculation with the water the tubes were incubated at 38° C. for 48 hours, gas readings being taken at 24 hour intervals. At the end of 48 hours all tubes showing the formation of gas were removed from the incubator, cooled to room temperature, and the absorption of CO_2 determined by the addition of a 2 p.c. solution of NaOH.

Method of Isolating the Typhoid Bacillus.* — R. Cambier noticed that typhoid bacilli pass through the pores of coarse porcelain in times proportionate to their motility, and also that the typhoid pass through more quickly than other bacteria. This observation was applied to the isolation of typhoid bacilli in the following manner. A bougie filter containing the suspected water is immersed in clear bouillon and incubated at 38°. Directly the bouillon becomes turbid, a small portion is pipetted off and cultivated on other media, such as milk, potato, etc., and further tested by means of the serum reaction. In this way typhoid bacilli have been easily detected in Seine and Marne water. The method is also applicable to stools.

In connection with this method the author states that the typhoid bacilli isolated by the foregoing procedure were agglutinated only by strong doses of very active serum. This, however, does not afford any ground for contesting their typhoid nature; for he has found that when coli and typhoid bacilli have lived in association, the typhoid requires a strong serum to agglutinate it, and the coli acquires the property of becoming agglutinated by typhoid serum.

Technical Microscopy.†—Prof. T. F. Hanausek's Text-book of Technical Microscopy is the first German manual which embraces the whole subject since the appearance of Wiesner's Introduction to Technical Microscopy in 1867. The reader is presumed to possess more than a mere rudimentary knowledge of animal and vegetable histology, and of chemistry, since this text-book appeals more to advanced workers, and is made to comprise more information in a given space than could be done if elementary principles had to be discussed. The work is divided into two parts: the first deals briefly with the Microscope and its accessory apparatus, and with the necessary reagents; in the second portion is described the microscopy of the more important types of raw material, such as starch, animal and vegetable fibres, stems, roots, leaves, flower, fruit, seeds, bone, teeth, and horn.

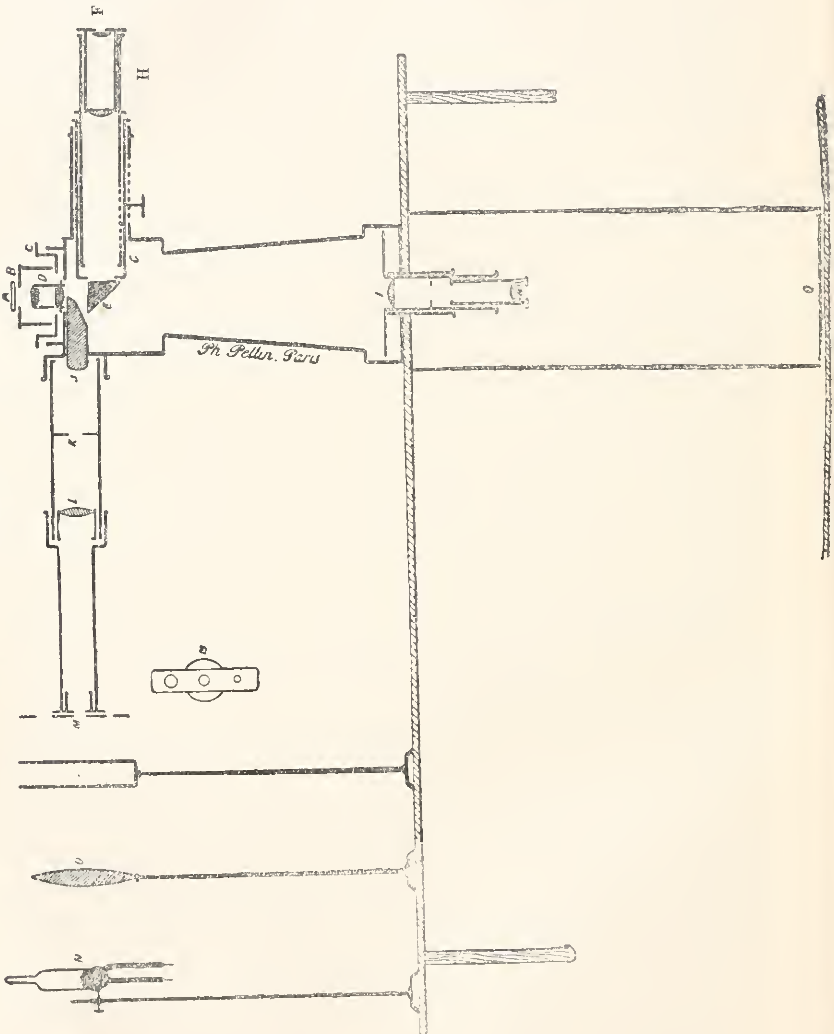
The last chapter deals rather curtly with micro-chemical analyses. The volume is well printed and illustrated.

Technology of Microscopic Metallography. ‡ — Prof. Le Chatelier, in the course of a paper full of practical details on the above subject, describes a special Microscope made for him by Pellin, of Paris. Its construction, with the complete illuminating apparatus, is shown in

* Comptes Rendus, cxxxii. (1901) pp. 1442–4.
† Stuttgart, 1901, x. and 456 pp. and 256 figs.
‡ Metallographist, 1901, pp. 1–22 (19 figs.).

fig. 131. A is the piece of metal under examination; B, the support; C, the fine adjustment for focussing the objective; D, the objective; E, totally reflecting prism; F, the eye-piece; G, a movable tube carry-

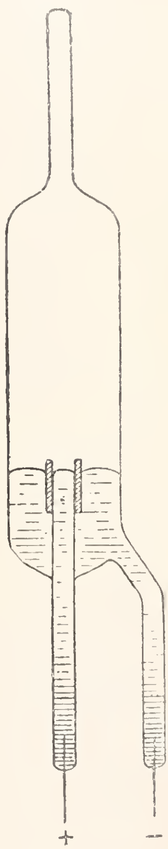
Fig. 131.



ing the prism; H, the tube carrying the eye-piece; J, the illuminating prism; K, the iris diaphragm; L, the condensing lens; M, the diaphragm; N, the source of light; O, the lens; P, the absorbing cells; Q, the photographic plate. The objective D is directed upward, so that, if necessary, very bulky pieces may be examined; moreover, it is only necessary to prepare one flat surface in the specimen. The eye-piece is placed horizontally, and receives the image by the reflection of a totally reflecting prism E placed under the objective. The examination can, therefore, be conveniently carried on while the operator is sitting in front of a table.

The adjustment is done through a screw collar surrounding the objective and receiving the support B. The surface under examination must be absolutely perpendicular to the axis of the objective. The supports which rest upon three points have a very uniform thickness, so that the preparation is in the proper position. In a Microscope for the examination of metal the illuminating arrangement requires the most delicate regulation, and it is generally accomplished tentatively by adjusting a number of movable pieces. But in this instrument only two adjustments are required, the proper *opening* and proper *position* of a single diaphragm M placed in such a way that its *opening* regulates the angle of the beam of light which falls upon the preparation. This angle must vary with the nature and the quality of the objective. The greater the angle, the greater the effect of the spherical aberration; and, on the contrary, the smaller the angle, the greater the chromatic aberration. The best definition is obtained with a certain mean angle which must be found tentatively in each case. The *position* of the diaphragm M regulates the mean inclination of the beam of light falling upon the preparation. To obtain the greatest clearness, its direction should be nearly vertical; but in order to reduce the amount of light reflected by the lenses, and sent back to the eye, it is necessary to give a more inclined direction to the beam of light. If the inclination is what it should be, most of the light reflected in this way is stopped by the illuminating prism itself. This diaphragm M is placed at the principal focus of the complex optical system made of the objective D, the illuminating prism J, and the lens L. To ascertain its proper position, the image of a luminous point placed at a distance of two or three metres above the objective is located by means of a magnifying glass. This determination is done once for all for each objective, and the corresponding position, in each case, of the draw-tube carrying the diaphragm is noted. As a source of light, if the object is to be viewed only with the eye, a Welsbach lamp is the most convenient. For photomicrography, the whole of the photographic outfit is placed vertically below the objective. If white light is to be used, a Welsbach lamp, an acetylene flame, or an oxyhydrogen light are very satisfactory. But it is preferable to use a monochromatic source of light, because so-called achromatic and apochromatic objectives are never completely free from chromatic aberration. A

Fig. 132.



mercury arc in vacuum lamp gives excellent results. The form used by the author is shown in fig. 132. The upper vacuum space is very large, so as to increase the radiating surface, and therefore decrease the heating of the lamp. The central tube is covered with a refractory coating which greatly lengthens the life of the lamp. With a projection eye-piece an exposure of from one to two minutes is required. This lamp should preferably be worked by a continuous current. The difference of electro-motive force between the two poles varies from 15 to 25 volts as the lamp gets heated. Three amperes is the best current intensity for normal work.

Fig. 133, plate IX., is an interesting example of abnormal structure in grey cast iron, etched with tincture of iodine. It was photographed by the above apparatus, and the magnification is 660 diameters.

Iron and Phosphorus.*—J. E. Stead, after an extensive examination of samples of phosphorised iron, finds that they may be conveniently divided into 4 classes, according to the percentage amount of phosphorus. (1) From 0 to 1·70 p.c. (2) From 1·70 to 10·2 p.c. (3) From 10·2 to 15·58 p.c. (4) From 15·58 to 21·68 p.c. Alloys containing much above 21 p.c. of phosphorus have not been investigated, as they are of little metallurgical value. The selected photomicrographs will give an idea of the micro-structure.

Fig. 134, plate IX., is the type of all the metals in the first class. The crystalline grains are polygonal, and are solid solutions of Fe_3P in iron. The grains, under like conditions of heating and cooling, increase in size with the increase of phosphorus ($\times$ 50).

Fig. 135 contained about 8 p.c. of phosphorus. The broad light parts are crystallites of the metal containing about 1·7 p.c. phosphorus. The white mottled ground mass is the eutectic containing 10·2 p.c. phosphorus ($\times$ 250).

Fig. 136, plate X., contained 10·2 p.c. phosphorus, and is the eutectic of phosphorus and iron. It has only one critical point at about 950° C. ($\times$ 350).

Fig. 137 contained 11·07 p.c. phosphorus, and shows sections of rhombic or oblique idiomorphic crystals of Fe_3P imbedded in a ground mass of the eutectic ($\times$ 60).

Mr. Stead's second paper is wholly based upon micro-structure, and is illustrated by a series of important photomicrographs. He summarises his results under eleven heads, which are briefly :—

(1) That on melting saturated solid solutions of iron phosphide in iron with carbon, the latter causes a separation of the phosphide near to the point of solidification, which appears in the solid metal as a eutectic in irregular-shaped areas. A residuum always remains in solid solution.

(2) That the residuum appears to be retained in the pearlite.

(3) That a portion of the iron phosphide in steels containing less than 0·10 p.c. of phosphorus is thrown out of solution by carbon when it exceeds 0·9 p.c., and the phosphide so separated is liable to form a brittle cell-structure enveloping the grain, yielding a more or less fragile mass.

* Metallographist, 1901, pp. 89–114, 199–236 (27 figs.).

FIG. 133.

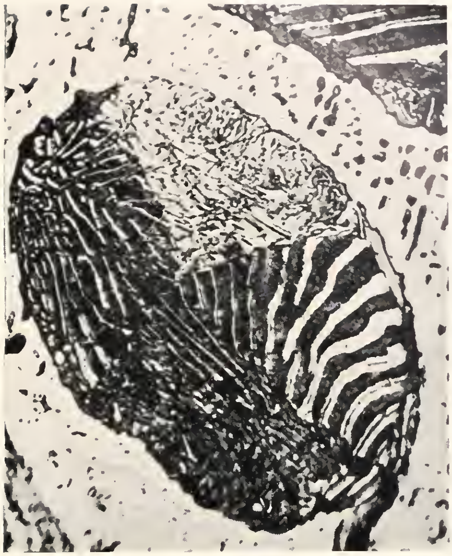


FIG. 134.

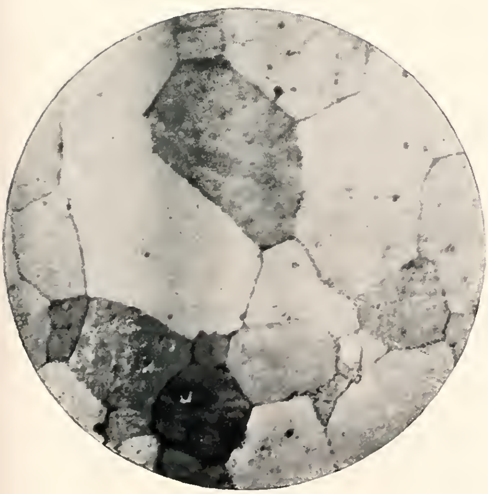
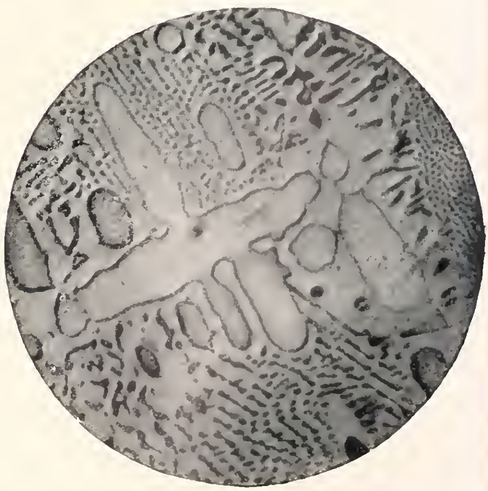


FIG. 135.



[Face p. 608.

Fig. 136.

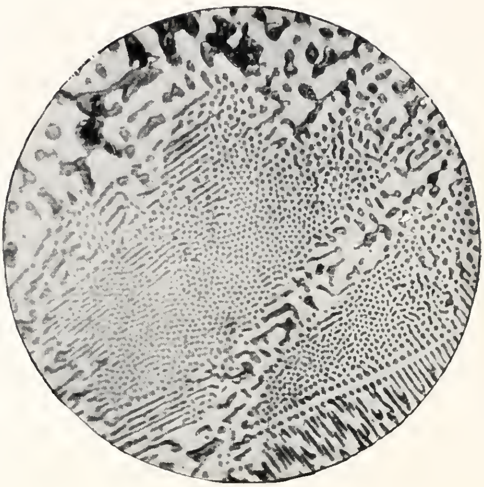


Fig. 137.

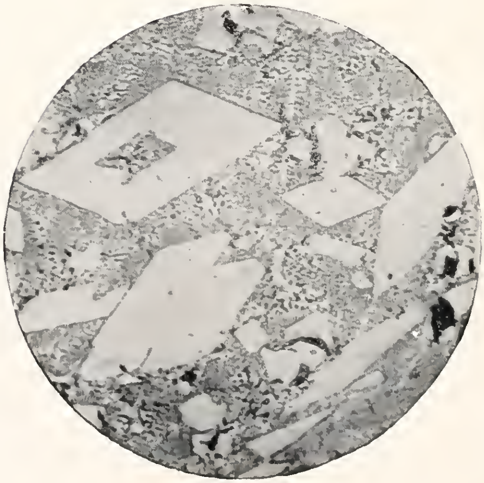


Fig. 138.

Fig. 139.

Fig. 140.

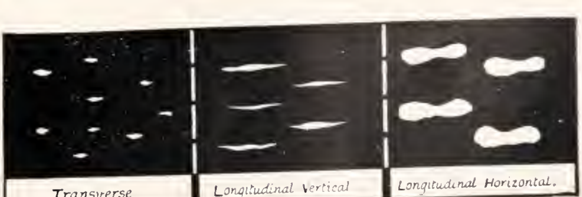


Fig. 141.

Fig. 142.

Fig. 143.

Face p. 609.]

(4) That when phosphoretic iron is carburised by the cementation process, the carbon at once causes a separation of phosphide from the solid iron, if it is saturated with phosphide.

(5) That if highly phosphoretic steel containing much carbon is heated to above the melting point of the phosphide eutectic in contact with some absorbent material, the eutectic simply liquates out of the mass, and is retained in the surrounding substance.

(6) That when the phosphide eutectic is expelled from the iron by the absorption of carbon in the cementation furnace, a large part of it liquates out of the mass, and falls in the liquid state into the surrounding charcoal.

(7) That when saturated solid solutions of phosphide in iron are heated or cooled, they show no thermal critical point at Ar_3, and the structure is not broken up even when the temperature exceeds 1000° C.; therefore there can be no allotropic change from the *Beta* to the *Gamma* modification by heating to 1000° C.

(8) That the proportion of PH_3 given off on dissolving phosphoretic irons free from carbon is approximately inversely in proportion to the amount of phosphorus.

(9) That when carbon is introduced into irons containing from 0·03 to 0·10 p.c. of phosphorus, the proportion of phosphine liberated on solution of the metal steadily decreases with each increment of carbon.

(10) That the amount of carbon capable of being absorbed in the blast-furnace and crucible by metal containing phosphorus depends upon the proportion of phosphide of iron present. Pure iron free from phosphorus will combine with nearly 5 p.c. of carbon.

(11) That phosphorus does not appear to cause the separation of graphite from metals high in carbon.

Practical Problems in the Metallography of Steel.* — Prof. J. O. Osmond points out that in many cases the Microscope is capable of giving warning of the dangerous character of a steel, chemically, and apparently mechanically, safe.

The micrograph fig. 138, plate XI., shows the transverse section of a rail web reheated to 900° C., and allowed to cool in air; and this web exhibits the same structure in all the three planes of section presently to be referred to.

The micrograph fig. 139 shows the structure when the rail was slowly cooled in the re-heating furnace during a period of 50 hours.

In fig. 138 the pale ferrite has imperfectly segregated in the form of ragged and broken cell-walls imperfectly environing cells of pearlite mixed with unsegregated ferrite.

In fig. 139 the pale ferrite and dark granular pearlite have perfectly segregated mainly in the form of thick alternating laminæ. The structure last named must be regarded as highly dangerous, because, under vibration the adhesion between the constituents is liable to gradually loosen and finally to be destroyed. Nevertheless, mechanical tests would initially reveal little difference in the ductility of the two pieces of rail.

The majority of published micrographs exhibit only a single plane of transverse section. Such representation can give only a very partial

* Nature, lxiii. (1901) pp. 613–4 (3 figs.).

knowledge of what may be termed the solid geometry of steel. In rolled metals it is necessary to make three micrographs in three planes of section at right angles to one another, and from these the exact form in which any constituent exists in the mass can be determined.

Fig. 140 shows the appearances presented by grains of manganese sulphide under such conditions.

Prof. Osmond makes known a simplified method of preparing metallic sections for the Microscope. He takes two pieces of hard wood, 12 by 9 by 1 in., planed dead smooth on one side; then by means of liquid glue two sheets of the London Emery Works Co.'s Atlas cloth, No. 0, are evenly attached to the smooth faces. The glue is allowed to set under strong pressure. Next, by means of a smooth piece of steel, he rubs off from one of the blocks as much as possible of the detachable emery. This block is now No. 2 block; the other is No. 1.

The steel section, say $\frac{1}{8}$ in. thick and $\frac{1}{2}$ in. diameter, is rubbed for one minute on No. 1, the motion being straight, not circular; then, for the same time, and in the same manner, on No. 2. The bright but visibly scratched section is then placed in a glass etching dish 3 by 1 by $\frac{1}{2}$ in., and the steel covered with nitric acid sp. gr. 1·20. In a few seconds the evolved gases adhering to the section change from pale to deep brown, and effervescence ensues. Then the acid is quickly washed away under the tap, and the piece is for a minute immersed in a second dish containing rectified methylated spirit. When the section has been dried by being pressed several times on a soft folded linen handkerchief, it is ready for examination. The structure will be clearly exhibited, the innumerable fine scratches visible before etching having virtually vanished. The micrographs illustrating this abstract were prepared in a few minutes by this process.

Crystallography of Iron.*—MM. Osmond and Cartaud have continued their investigations on this subject. Their paper includes a historical sketch and a description of their methods. The results, which are highly interesting and are illustrated by a large number of beautiful photomicrographs, will be gathered from the following selections.

Fig. 141, plate XII., shows some isolated crystals, especially cubes ($\times$ 250, vertical illumination).

Fig. 142 is an example of some pyramidal cubes obtained in one of the experiments ($\times$ 400, vertical illumination). They are probably tetrahexahedra. Both the above were obtained by the reduction of ferrous chloride.

Fig. 143 is an example of a dendritic mass of crystals ($\times$ 25, oblique illumination). Three main dendrites start from the same centre, forming angles of 120°, while their lateral branches form angles of 60° with the dendrites' axis. A fourth dendrite, projecting laterally, rests upon the plane of the three others, and could not be focussed; it is indicated by a cloudy appearance.

Structure of Phosphoretic Pig Metals.†—J. E. Stead points out that ordinary etching fails to distinguish between carbides and phosphides

* Metallographist, 1900, pp. 275-90; and 1901, pp. 119-49, 236-52 (84 figs.).

† Tom. cit., pp. 261-6 (7 figs.).

of iron. The best way of treating a specimen is to heat the polished metal upon a hot plate until it assumes a tint purple to the naked eye. The various constituents oxidise at different rates, and assume corresponding coloured films. Heated in this way pearlite assumes a blue tint with brown-red worm-like layers of carbide of iron, and the phosphide of iron a pale yellow colour. The sulphides do not apparently change colour, but are easily detected, as they appear of a slate colour.

The phosphides seem to occur in the eutectics as Fe_3P and as a *definite* chemical compound.

Present Position of the Solution Theory of Carburised Iron.* — A. Stansfield's conclusions are:—

(1) That carbon is less soluble in iron when presented in the form of graphite than when presented in the form of cementite.

(2) That the apparent reversal of this in steel is due partly to the absence of nuclei of graphite on which further deposits might take place; partly to the length of time required for the separation of the graphite, involving as it does the gradual passage of carbon through the iron to reach the nuclei; and partly to the mechanical pressure which must oppose the formation of graphite in solid steel.

Casting on Mica of Metallographic Preparations.†—H. T. Hannover has found that, in obtaining soft alloys for microscopical examination, it is an excellent plan to pour out the melted mass on a plate of mica instead of upon a plate of glass. The trouble arising from the liability of the glass to crack is in this way avoided.

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* Metallographist, 1900, pp. 300–14 (4 figs.).
† Op. cit., 1901, pp. 29–30 (1 fig.).

OSMOND, F., & G. CARTAUD—**On the Crystallography of Iron.**

[The authors arrive at results which differ but little from those of Mr. Osmond's previous experiments. These were:—(1) Iron, in its three states, crystallises in the cubic system; (2) Gamma-iron, generally in octahedra, more or less perfect; (3) Beta-iron and alpha-iron in cubes; (4) Beta-iron and alpha-iron form isomorphous mixtures; (5) Gamma-iron does not form isomorphous mixtures with beta-iron; (6) The transformation of gamma-iron into beta-iron appears to include a change in the planes of symmetry.]

Metallographist, III. (1901) pp. 236–52 (9 figs.).

RÖTTGER, H., & L. SCHMELCK—**Apparatus for obtaining Water-Samples for Bacteriological Examination.** *Chemiker Zeitung*, 1900, pp. 873 and 1035.

See *Bot. Centralbl.*, LXXXVI. (1901) p. 40.

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[Discusses the photomicrographs of Mr. F. C. Lau, reproduced in the July (1900) number of the *Metallographist.*]

Metallographist, July 1901, pp. 252–7 (1 fig).

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[A useful practical paper.]

Metallographist, Oct. 1900, pp. 314–20: and *Journ. of App. Micr.*, March 1900, p. 786 (2 figs.).

A.L.S. del. Highley lith. Hanhart imp

FUNGI ON FARM SEEDS.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

DECEMBER 1901.

TRANSACTIONS OF THE SOCIETY.

IX.—*Fungi found on Farm Seeds when tested for Germination; with an Account of two Fungi new to Britain.*

By A. Lorrain Smith.

(*Read October 16th*, 1901.)*

Plate XIII.

For the last two years I have been assisting in the botanical work undertaken for the members of the Royal Agricultural Society by the consulting botanist, and during that time I have had a great deal to do with testing the germination of grasses, clovers, and other farm seeds. If the seeds are slow in germinating or unsound, they are liable to be attacked by various fungi, and it has been interesting to note the constantly recurring moulds. The saucers on which the

EXPLANATION OF PLATE XIII.

Fig. 1.—*Sepedonium xylogenum* Sacc. *a*, branches with developing spores from a culture × 500. *b*, mature spores × 500.

" 2.—*Fusarium commutatum* Sacc. *a*, sporophores with developing spores × 90. *b*, mature spores × 500.

" 3.—*Langloisula microspora* sp. n. Fertile branches and spores × 500.

" 4.—*Stemphyliopsis heterospora* g. et sp. n. Fertile hyphæ and spores × 500.

" 5.—*Rhizopus umbellatus* sp. n. *a*, sporangiophore with columellas × 90. *b*, sporangium × 250. *c*, rootlets × 250. *d*, spores × 500.

" 6.—*Mucor erectus* Bain. *a*, sporangiophore × 250. *b*, columella × 500, spores × 500.

" 7.—*Mucor racemosus* Fres. *a*, hyphæ with chlamydospores × 250. *b*, sporangium with spores × 250. *c*, empty sporangium × 250. *d*, spores × 500.

" 8.—*Mucor spinosus* Van Tiegh. *a*, branching sporangiophore × 90. *b*, columella and spores × 500.

" 9.—*Sphæronemella oxyspora* Sacc. *a*, pycnidia × 35. *b*, sporophores and spores × 500.

* The first part of this paper, dealing with the fungi on germinating farm seeds, was read before the meeting of the British Mycological Society at Exeter on September 25th, 1901.

seeds are germinated are thoroughly cleansed by immersion in strong acid solution, and by subsequent washing and scrubbing. It is impossible in such work absolutely to preclude fungoid infection from the surrounding atmosphere during the progress of germination; but all ordinary means are employed to secure cleanliness and speedy growth of the seeds; and the evident conclusion is that the spores of most of the fungi that develop in the germination case have been brought into the laboratory with the samples. The rough pods of sainfoin carry most spores, and become very quickly covered with a rich mycelial growth. Smooth seeds, such as rye-grass and meadow fescue, germinate, as a rule, without showing any mould. It is, however, the quality of the seed that is the influencing factor. Fresh healthy well-filled samples germinate without any trace of fungi appearing; others, of the same kind but from a different sample, become mouldy in a few days. Unless the seeds have quite lost their vitality, the fungi do not really injure them or prevent the embryo sending out its rootlets, and clovers can grow when the outer coat is invisible owing to a thick crop of *Chætomium*.

My list of fungi is not exhaustive, as some forms, no doubt, have escaped observation; but a varied and interesting collection has already been made.

The higher fungi are not largely represented; there are no Basidiomycetes; and, as yet, only three Ascomycetes have been noted. Two of these belong to *Chætomium*, a genus of Pyrenomycetes. They are saprophytic and superficial on whatever substance they grow. *Chætomium Kunzeanum* Zopf, which is perhaps the most frequently met with, has a small elliptical fruit crowned at the summit by a bristly head of olive-brown hairs, which are unbranched, wavy, and somewhat rough when mature. *C. elatum* Kunze, which occurs also very frequently on the same kinds of seeds, is darker in colour, and the hairs of the crown are branched and very rough from the beginning. The ascospores of both species are a dull olive-brown. They grow on decaying vegetation, *C. elatum* more especially on grass. In the germination case they grow on grasses and clovers, and occasionally on turnip seeds. There is no doubt that towards the end of each seed season, the laboratory must be well furnished with *Chætomium* spores, and that may doubtless account for some of the infection. I have germinated some of the ascospores on a gelatin plate, and have obtained a beautiful growth of the *Oidium*-like conidial form, a creeping mycelium with upright conidiophores bearing a terminal chain of conidia, but I have never detected any conidial growth on the seeds.

The remaining Ascomycete, *Gymnoascus Reesii* Baran., I found on carrot and on turnip seed. It usually grows on decaying organic substances such as dung, and it is easy to understand how the spores might be blown by the wind on to the ripening seeds. *Gymnoascus* is one of the less highly organised Ascomycetes, the peridium is composed of loose much-branched yellowish hyphæ, which surround the fertile filaments. When mature, the walls of the small globose asci disappear, but the minute spores retain for a time the form of the ascus. The fungus was attached loosely to the spines of the carrot seed, and seemed to have little organic connection with it; in this resembling the *Chætomiums*, which often grow on the awns of the grasses. Many of the smaller fungi grow with very little nutrition; those I have been watching often spread from the seeds to the germinating saucer, and grow vigorously on the porcelain, apparently on nothing, though doubtless some seed had lain on the spot and left some of its substance behind.

The Hyphomycetes bulk very largely in this flora of seed-fungi. The two ubiquitous species *Aspergillus glaucus* Link, and *Penicillium glaucum* Link, appear continually. *Cephalosporium Acremonium* Corda, *Sporotrichum laxum* Nees, and *Acremonium alternatum* Link, are not infrequent. These all grow on decaying vegetation, and are very common moulds. *Trichoderma viride* Pers., the conidial form of *Hypocrea rufa*, I have found several times, and have cultivated it on a gelatin slide; there was a beautiful growth in three days of upright branching colourless conidiophores bearing the groups of bright green spores at the tips of the branches. A form of *Sepedonium*, plate XIII. fig. 1, entirely colourless, formed a white tuft on a grass seed. The spores, which are borne at the tips of delicate hyphæ, are globose and rather large, measuring about 18–20 μ in diameter. They have a thick epispore, and are warted when mature. It agrees with the characters given of the species *S. xylogenum* Sacc., which has been found in Italy growing on wood. I have also to record in the Mucedineæ a specimen of *Botrytis vera* Fr., distinguished from other members of the genus by the lax branching of the sporophores. It grew on turnip seed.

Among the Dematieæ, *Macrosporium commune* Rabenh., the conidial form of *Pleospora herbarum*, occurs most frequently. *Helminthosporium gramineum* Rabenh. I have detected once on a grass seed. It is a parasite of cereals, destroying the leaves and so weakening the plant and injuring the grain. Some barley affected by it was sent into the laboratory during the summer of 1900. I have one record of *Stachybotrys alternans* Bonord. It is a fairly common mould, and grows by preference on damp blotting-paper. *Stysanus stemonites* Corda, one of the Stilbeæ, by no means a rare fungus, has occurred several times on grass seeds.

Fusarium roseum Link, which formed its delicate rose-tinted cushions on clover seed, is a member of the Tubercularieæ. In a culture I made it grew in a very straggling fashion, and budded off a succession of spores from the tips of the branches. It has been recorded on decaying leaves and stems. Another species, *F. commutatum* Sacc. (plate XIII. fig. 2), is new to this country; it falls under Saccardo's group "*sporodochia laxa, effusa, byssina.*" On clover seed it hardly looked like a *Fusarium*, but on a culture plate it formed lax cushions; the spores are three-septate and measure $20–25 \times 4–5\ \mu$. There is one difference between this species and the type in that the sporophores are septate, otherwise Bonorden's drawing exactly represents the habit of the fungus, and "*sporophoris continuis*" may not be a constant character.

There are two forms of Hyphomycetes that have puzzled me a good deal. The first grew on a seed of *Festuca pratensis*, and from the character of the hyphæ and spores I have placed it in the hitherto monotypic genus *Langloisula* of Ellis and Everhart. The hyphæ are much larger, the spores also are larger, more deeply coloured, and not so pear-shaped as in the American species, *L. spinosa*. I therefore consider it to be a distinct species, and have named it *L. macrospora* (plate XIII. fig. 3). I fear the genus, however, rests on too narrow a foundation of divergence from other forms, and the species might have been included in *Acremoniella*. The other specimen has baffled all my attempts to place it under any recorded genus. It is in form and habit something like a *Stemphylium*, and, but for the lack of colour, I would have classed it under that genus. There is only one genus recorded under the group Mucedineæ-hyalodictyeæ, and it is entirely different in form from the fungus I have been dealing with. I have been compelled to establish a new genus, which I have named *Stemphyliopsis* g. n., to connect it with its nearest ally among the Dematieæ; the species I have called *heterospora*, plate XIII. fig. 4. The spores are exceedingly varied in form and size, and are borne at the tips of short branches from the main hyphæ. They are warted when mature, and the whole plant remains colourless after some weeks' culture. I succeeded in reproducing it on a gelatin plate. I got the original specimens on turnip seed and on clover seed.

The Mucorineæ are the sole representatives of the Phycomycetes that have appeared in the germinating case, and *Rhizopus nigricans* Ehrenb. most frequently of all. It grows on any kind of seed, though on the whole it is partial to the grasses. It spreads very quickly, and in time extends over the whole available space. I have found another form also with rootlets somewhat similar to those of *Rhizopus*, which on that account I have included in the same genus. The sporangiophores rise singly from the runner-like hyphæ, and near the top they form an umbel of four short branchlets, each of which is terminated by a subglobose smooth sporangium. The tip of the branchlet expands gradually into the subglobose columella, to the base of which part of the sporangium wall remains attached after the dispersal of the spores. The whole plant is entirely colourless; the spores are small, oblong, and blunt at the ends. From the mode of branching I have named it *Rhizopus umbellatus* (plate XIII. fig. 5). In one instance I found the main sporangiophore terminate in a sporangium with one side branchlet imperfectly developed; all the other examples have the umbellate head of branches. I have only found it once on clover seed, associated with another *Mucor*. It is entirely microscopic, and I have not succeeded in cultivating it. The *Mucor* in which it was entangled, if indeed it was not parasitic on it, I have determined to be *Mucor erectus* Bain. It forms delicate silky white tufts 2 or 3 centimetres in length. The hyphæ branch frequently, and the very unequal branches terminate in a small yellowish sporangium. A distinctive feature of this species is the septum that is always present just above the points where the branch is given off. I found it on turnip and carrot seeds, and I got a further abundant growth on a mixture of gelatin and bean decoction. *Mucor erectus* has been found in Europe on bread, plum decoction, and potatoes, but this is the first record for Britain. I have not yet been able to induce the growth of zygospores. *M. racemosus* Fres. (plate XIII. fig. 7) appeared on clover seeds. It is easily recognisable from the chlamydospores, which are produced in great abundance on the hyphæ and sporangiophores. I hardly think it is new to this country, but I cannot find any published record of its occurrence. It grows on a great variety of substances, and is very common on the Continent.

Description of New Species.

Langloisula heterospora sp. n., plate XIII. fig. 3.

Fungus consisting of entangled much-branched septate hyphæ, 5–8 μ in width, the branches varying much in length from 12–40 μ, tapering to a sharp point, colourless, bearing a single spore at the tip; spores brown, ovate, with a thick epispore, slightly pointed towards the base, where there is a small clear spot, warted when mature, 25–30 $\times$ 15–20 μ.

Spreading over a grass seed in the germinating case.

Stemphyliopsis g. n.

Hyphæ intricately branched, colourless, septate; spores terminal on the branches, elliptical or subglobose, 2–many-septate and muriform, colourless.

S. heterospora sp. n., plate XIII. fig. 4.

Growing in tufts up to 2 mm. in height, consisting of a tangled mass of colourless rather delicate hyphæ with numerous short branchlets; spores varying in form and size, elliptical, from 12–8 μ up to 25 $\times$ 15 μ, or subglobose about 15 $\times$ 12 μ, transversely septate and 2- or more-celled or cruciate and muriform, colourless, warted when mature.

On clover and turnip seed in the germinating case.

Rhizopus umbellatus sp. n., plate XIII. fig. 5.

Spreading hyphæ with sucker-like roots, delicate, about 8–10 μ in width; sporangiophores rising singly from the runner-like hyphæ up to 500 μ in length, and branching above in an umbellate manner; secondary branches usually four, sometimes septate, slightly wider at the top, and terminated by a subglobose sporangium 50×60 μ; sporangium-wall delicate, attached to the base of the columella; columella globose, 30 μ in diameter: spores minute, oblong, blunt, 5×2 μ. The whole plant colourless.

On a seed of red clover in the germinating case, entangled with *Mucor erectus*.

The two other fungi that I have included in this paper are new to Britain. *Mucor spinosus* Van Tiegh. (plate XIII. fig. 8) grew on a cherry leaf in the spring of this year, when I was keeping the leaf moist in order to develop some other fungi I observed on it. This *Mucor* is distinguished only by the spinous processes at the top of the columella, which seem to have the effect of keeping at least some of the spores attached to the columella after the sporangium has burst; it differs from Van Tieghem's description in the appearance of the mature spores, which are minutely warted. The other is a member of the Nectrioideæ. I found it at Llanymawddwy, in North Wales, in August 1900. The clear glistening perithecia were studded all over a dry and blackened agaric, and looked like glandular hairs. They proved on examination to be perithecia, and I believe it to be *Sphæronemella oxyspora* Sacc. (plate XIII. fig. 9). The only previous records of this fungus are from America, and it was named and rather shortly described by Berkeley as *Sphæronema oxyspora*. Saccardo placed it in the genus *Sphæronemella*, and queried it as perhaps an Ascomycete, *Eleutheromyces*. The specimen from Wales proves the correctness of the original determination, and there can be little doubt that we are dealing with the same plant, though the distribution is a little peculiar. The spores are colourless and measure up to 7 μ in length; the appendages measure about 3 μ. They are a little larger than the ascospores of *Eleutheromyces*.

Specimens and slides of the fungi have been placed in the herbarium of the British Museum, Cromwell Road.

X.—*Report on the Recent Foraminifera of the Malay Archipelago collected by Mr. A. Durrand, F.R.M.S.—Part XII.*

By Fortescue William Millett, F.R.M.S.

(*Read October 16th*, 1901.)

Plate XIV.

Lagena marginata var. *semimarginata* Reuss, plate XIV. fig. 1.

Lagena No. 64 Von Schlicht, 1870, Foram. Septarienthones von Pietzpuhl, p. 11, pl. iv. figs. 4–6; and No. 65, p. 11, pl. iv. figs. 10–12. *L. marginata* var. *semimarginata* Reuss, 1870, Sitzungsber. k. Akad. Wiss. Wien, vol. lxii. p. 468. *L. marginata* var. *semimarginata* (Reuss) Fornasini, 1891, Foram. Plioc. del Ponticello di Savena, pl. ii. fig. 11. *L. marginata* var. *semimarginata* (Reuss) Morton, 1897, Proc. Portland Soc. Nat. Hist., vol. ii. p. 117, pl. i. fig. 5.

In this form the curved spines of the foregoing variety are still more depressed, and extend inwardly, forming a broad keel on either side of the neck, which keel may or may not be continued in the shape of a narrow band around the periphery of the test.

It is not uncommon in Area 2; and as figured by Von Schlicht and F. W. O. Rymer Jones, some of the specimens are rounded at the base, whilst others are acuminate.

Lagena staphyllearia Schwager sp., plate XIV. fig. 2.

Fissurina staphyllearia Schwager, 1866, Novara-Exped., Geol. Theil, vol. ii. p. 209, pl. v. fig. 24. *Lagena vulgaris* var. *spinicosto-*

EXPLANATION OF PLATE XIV.

Fig. 1. — *Lagena marginata* var. *semimarginata* Reuss. × 100.
„ 2. „ *staphyllearia* Schwager sp. × 100.
„ 3. „ *marginata* var. *seminiformis* Schwager. × 100.
„ 4. „ *marginato-perforata* Seguenza. × 100.
„ 5, 6. „ *Elcockiana* sp. n. × 135.
„ 7. „ *squamoso-marginata* Parker and Jones. × 100.
„ 8, 9. „ *lagenoides* Williamson sp. × 100.
„ 10, 11, 12. „ *formosa* Schwager. × 100.
„ 13. „ *bicarinata* Terquem sp. × 100.
„ 14, 15, 16. „ *auriculata* Brady. × 135.
„ 17. „ *quadrangularis* Brady. × 100.
„ 18. „ *Orbignyana* var. *calcar* Millett. × 135.
„ 19. „ „ „ *Walleriana* Wright. × 100.
„ 20. „ „ „ *castrensis* Schwager. × 100.
„ 21. „ „ „ *pulchella* Brady. × 100.
„ 22. „ „ „ *variabilis* Wright. × 135.
„ 23. „ „ „ *clathrata* Brady. × 100.

marginata Rymer Jones, 1872, Trans. Linn. Soc., vol. xxx. p. 57, pl. xix. figs. 34, 35. *L. staphyllearia* (Schwager) Brady, 1884, Chall. Rept., p. 474, pl. lxix. figs. 8–11. *L. staphyllearia* (Schwager) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 331, pl. x. figs. 50, 51, 99. *L. staphyllearia* (Schwager) Flint, 1899, Rep. U.S. Nat. Mus. for 1897 (1899), p. 307, pl. liv. fig. 1.

In the examples of this species described by Schwager, the periphery is rounded as in *L. lævigata*, but in most of the figures given by other authors, the margin is shown carinate as in *L. marginata*.

The Malay specimens, which are very few in number, and are found only in Area 2, are of the latter form.

Regarding the distribution of the species, Brady writes: "In the North and South Atlantic *L. staphyllearia* has only been observed at great depths, namely at four Stations, ranging from 2200 to 2750 fathoms; but in the Southern Ocean and the South Pacific it occurs also from time to time in shallow water near the coast-line."

Dr. Egger records it from various 'Gazelle' Stations ranging from the West Coast of Africa to New Guinea, and at depths varying from 57 to 1720 fathoms.

The 'Albatross' locality, according to Flint, is the Caribbean Sea near Aspinwall, 896 fathoms.

Lagena marginata var. *seminiformis* Schwager, plate XIV. fig. 3.

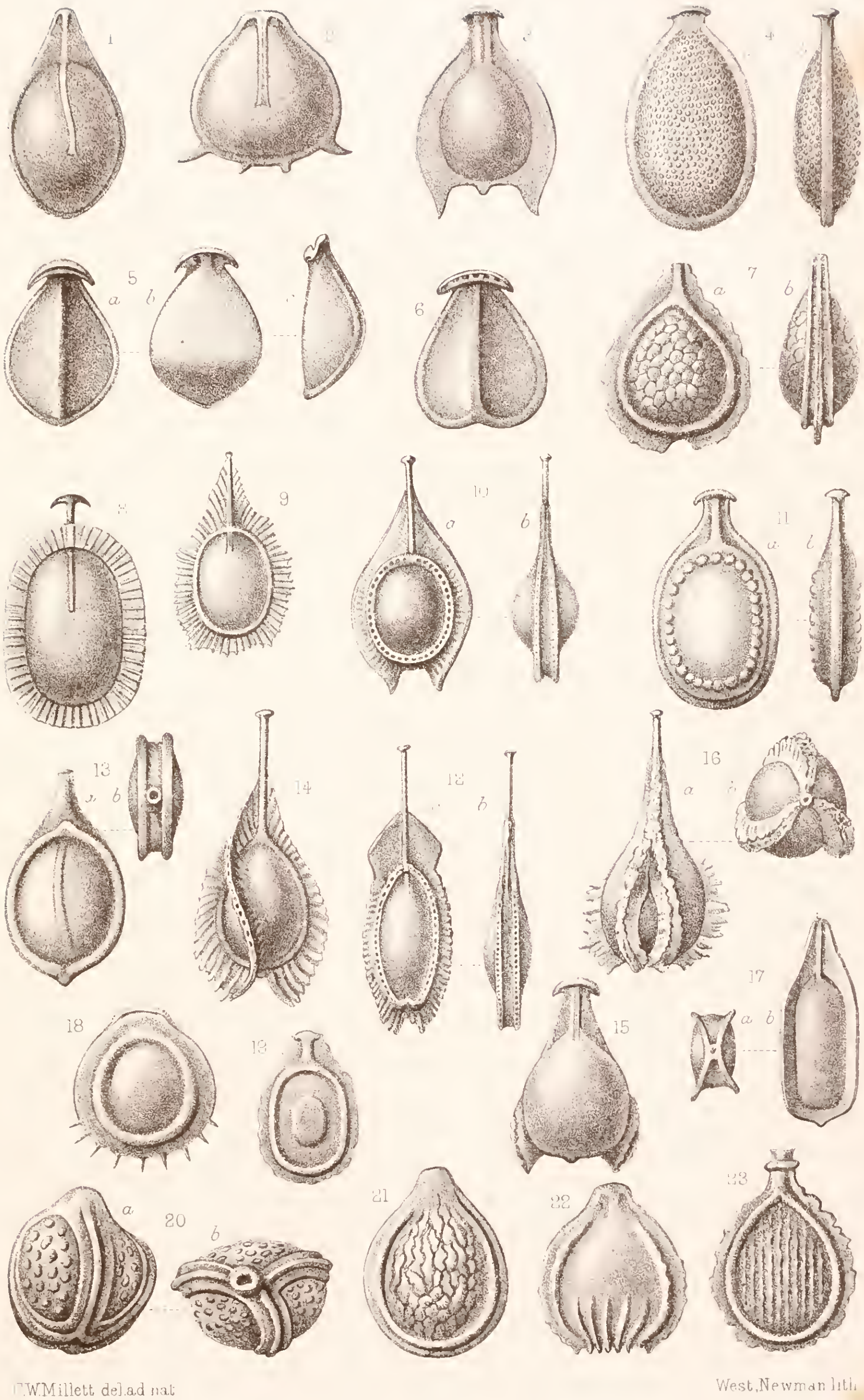
Miliola stiligera (?) Ehrenberg, 1854, Mikrogeologie, pl. xxxi. fig. 6. *Lagena seminiformis* Schwager, 1866, Novara-Exped., Geol. Theil, vol. ii. p. 208, pl. v. fig. 21. *Entosolenia marginata* (?) Chimmo, 1878, Nat. Hist. Euplectella, p. 21, pl. vi. fig. 20. *Fissurina diptera* Seguenza, 1880, Atti R. Accad. Lincei, ser. 3, vol. vi. p. 332, pl. xvii. fig. 37. *L. seminiformis* (Schwager) Jones, 1895, Palæont. Soc., p. 200, pl. vii. fig. 10.

In this variety the apertural curved spines are still further developed, and form a broad wing which embraces usually the whole of the peripheral margin of the test.

It is a marked peculiarity of the Malay Archipelago forms of *L. marginata* that they show a strong tendency to a duplication of the marginal carina, the space between the two keels being either void or filled up with cellular matter. This, under ordinary circumstances, might be considered a valid reason for treating the two forms as distinct species; but seeing that the arrangement prevails in nearly every form of *L. marginata* and its allies, it may be looked upon in the present instance as a local peculiarity, bearing in mind, however, the great extent of the region involved.

Under the name of *L. seminiformis*, Egger * figures, but does not

* Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. pl. x. figs. 19, 87, 88.



C. W. Millett del. ad nat. West, Newman lith.

FORAMINIFERA OF MALAY ARCHIPELAGO.

describe, two examples whose affinities, however, seem to be rather with *L. semimarginata*.

Brady speaks of it as essentially a deep-water species.

L. seminiformis with the single keel is very rare in the Malay Archipelago; but the form with the double keel is not infrequent, and passes insensibly into *L. formosa*.

To its fossil localities may be added the Tertiary beds of St. Erth, and the Coralline Crag of Broom Hill.

Lagena marginato-perforata Seguenza, plate XIV. fig. 4.

Lagena marginato-perforata Seguenza, 1880, Atti R. Accad. Lincei, ser. 3, vol. vi. p 332, pl. xvii. fig. 34. *L. castrensis* (?) (Schwager) Brady, 1884, Chall. Rept., p. 485, pl. lx. fig. 3.

The compressed *Lagenæ* having circular markings of various descriptions on their opposite faces are very abundant in the Malay Archipelago, and all the named varieties are represented. That with a single keel is the variety of *L. marginata* named by Seguenza *L. marginato-perforata*; the double keeled form, which corresponds to *L. bicarinata*, is the *Fissurina punctata* of Seguenza; whilst the triple-keeled, which is a variety of *L. Orbignyana*, has received from Schwager the name *L. castrensis*, from Schlumberger the name *L. variolata*, and has been named by Burrows and Holland *L. lacunata*.

Although the forms which have been accepted and named are thus acknowledged, it must be urged, that even if it were zoologically correct to receive these markings as distinctive characters, yet in practice it would be highly inconvenient, as each kind of ornament, whether a dot, pit, bead, vesicle, or perforation, would have to be considered separately, in connection not only with the number of the keels, but with the position of the aperture, whether sessile or pedunculate, and with the size and plan of arrangement of the markings; thus leading to the creation of varieties in a geometrical ratio not pleasant to contemplate.

The forms named occur in abundance all over the Malay Archipelago, that with the single keel being the most numerous.

Lagena Elcockiana sp. n., plate XIV. figs. 5, 6.

Test oval or pyriform, compressed; periphery carinate or bordered. One face curved from the oral to the aboral extremity; the opposite face composed of two plane surfaces, which, projecting from the lateral margins, meet at the centre and form a straight ridge which extends from the aperture to the base of the shell. Aperture a curved slit on one side of a projecting crescent-shaped process, with recurved ends, which overlaps the face bearing the central ridge. Length 0·16 mm.

The shell is very delicate and translucent. The central ridge may be either acute or carinate, and sometimes there are a few bars across the aperture.

At first sight this might be mistaken for one of the trifacial varieties of *Lagena*; but a close examination proves that the resemblance is superficial, and that the triangular shape of the section results from the diverse form of the two opposite faces.

This variety is named after Charles Elcock, of Belfast, at the request of Mr. Durrand, and as a token of his esteem.

It is very rare in the Malay Archipelago, and is found only at a few Stations in Area 2.

Lagena radiato-marginata Parker and Jones.

Lagena radiato-marginata Parker and Jones, 1865, Phil. Trans., vol. clv. p. 355, pl. xviii. fig. 3. *Fissurina radiato-marginata* (P. and J.) Seguenza, 1880, Atti R. Accad. Lincei, ser. 3, vol. vi. p. 136. *L. radiato-marginata* (P. and J.) Brady, 1884, Chall. Rept., p. 481, pl. lxi. figs. 8, 9.

This beautiful form is very abundant in the Malay Archipelago, and occurs at several Stations in both Areas.

The specimens are fine, and are remarkably uniform in size, shape, and ornamentation.

Found by Parker and Jones on the coral reefs of Australia; and fossil at Bordeaux. Seguenza reports it from the Miocene of Southern Italy. The 'Challenger' Stations are Nares Harbour, Admiralty Islands, 37 fathoms; and Raine Island, Torres Strait, 155 fathoms.

Lagena Wrightiana Brady.

Lagena Wrightiana Brady, 1884, Chall. Rept., p. 482, pl. lxi. figs. 6, 7. *L. Wrightiana* (Brady) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 334, pl. x. figs. 42, 43.

This, although equally widely diffused in the Malay Archipelago, is less abundant than the preceding variety. It is more diversified in its characteristics, the grooves often being curved and sometimes bifurcated, and they do not always leave a smooth space in the centre of the faces.

The only 'Challenger' locality is Nares Harbour, Admiralty Islands, 37 fathoms. The 'Gazelle' Stations for the very minute examples recorded by Dr. Egger, are Mauritius, 190 fathoms; and West Australia, 196 fathoms.

Lagena squamoso-marginata Parker and Jones, plate XIV. fig. 7.

Lagena squamoso-marginata Parker and Jones, 1865, Phil. Trans., vol. clv. p. 356, pl. xviii. fig. 2. *Fissurina squamoso-marginata* (P. and J.) Seguenza, 1880, Atti R. Accad. Lincei, ser. 3, vol. vi. p. 136. *L. squamoso-marginata* (P. and J.) Brady, 1884, Chall. Rept., p. 481, pl. lx. fig. 24. *L. squamoso-marginata* (P. and J.) Dreyer, 1891, Jenaische Zeitschr. für Naturwiss., vol. xxvi. p. 396, pl. xxvii. fig. 241.

According to the figure given by Parker and Jones, this form has but one keel, and may therefore be treated as a variety of *L. marginata*. All the examples from the Malay Archipelago have the triple keel, which indicates their affinity with *L. Orbignyana*, and still more closely with *L. castrensis*, since the hexagonal areolations appear to be produced by the enlargement and crowding together of the circular surface ornaments of that variety.

The *L. squamoso-alata* of Brady * differs but little in its general form from *L. formosa*, and may be regarded as a reticulate variety of that species.

In the Malay Archipelago *L. squamoso-marginata* is rare, and is confined to Area 2.

Parker and Jones found it in the white mud of the Australian coral-reefs; and also record it fossil from the Tertiaries of San Domingo.

Brady (Chall. Rept.) writes: "The species occurs at three points in the North Atlantic, the depths varying from 422 to 816 fathoms; on the Australian coral-reefs; and on the west coast of New Zealand, 1100 fathoms."

It is recorded fossil by Seguenza from the Miocene and Pleistocene of Italy.

L. squamoso-alata, according to Brady, "has been met with at three 'Porcupine' Stations in the North Atlantic, west of Ireland, at depths of 173 fathoms, 630 fathoms, and 1445 fathoms respectively."

Lagena lagenoides Williamson sp., plate XIV. figs. 8, 9.

Entosolenia marginata var. *lagenoides* Williamson. 1858, Rec. Foram. Gt. Britain, p. 11, pl. i. figs. 25, 26. *Lagena lagenoides* (Will.) Reuss, 1862, Sitzber. k. Akad. Wiss. Wien, vol. xlvi. p. 324, pl. ii. figs. 27, 28. *L. lagenoides* (Will.) Balkwill and Millett, 1884, Journ. Micr., vol. iii. p. 82, pl. ii. fig. 11. *L. lagenoides* (trigonal) (Will.) Balkwill and Wright, 1885, Trans. R. Irish Acad., vol. xxviii. p. 341, pl. xii. fig. 22. *L. lagenoides* (Will.) Brady, Parker, and Jones, 1888, Trans. Zool. Soc., vol. xii. p. 223, pl. xliv. fig. 23. *L. serrata* Schlumberger, 1894, Mém. Soc. Zool. Fr., vol. vii. p. 258. pl. iii. fig. 7. *L. lagenoides* (Will.) Goës, 1894, K. Svenska Vet.-Akad. Handl., vol. xxv. p. 83, pl. xiii. fig. 752. *L. lagenoides* (Will.) Jones, 1895, Palæont. Soc., p. 201. *L. lagenoides* (Will.) Morton, 1897, Proc. Portland Soc. Nat. Hist., vol. ii. p. 118, pl. i. fig. 5.

This protean variety is abundant in Area 2, and occurs sparingly at a few Stations in Area 1. Both of the forms indicated by Williamson's figures are plentiful. In the longer of the two the marginal keel or wing is double, and the interspace is more or less occupied by cellular or granular matter; in the shorter form the wing is less complex; in both, the tubular neck projects into the body of

* Chall. Rept., p. 481, pl. lx. fig. 23.

the shell, and is central and free; in these respects differing from the other compressed *Lagenæ* in which, as a rule, the entosolenian tube is attached throughout its whole length to the internal surface of one of the faces of the test. The trifacial form *L. trigono-ornata* Brady is represented by a few feeble examples.

Living, the species is widely distributed. Fossil, it has been recorded from the Miocene deposits of Sicily; from the Pleistocene of Canada; from the Coralline Crag; and from the Tertiary beds of St. Erth.

Lagena lagenoides var. *tenuistriata* Brady.

Lagena tubulifera var. *tenuistriata* Brady, 1881, Quart. Journ. Micr. Sci., vol. xxi. n.s. p. 61. *L. lagenoides* var. *tenuistriata* Brady, 1884, Chall. Rept., p. 479, pl. lx. figs. 11, 15, 16. *L. lagenoides* var. *tenuistriata* (Brady) Balkwill and Millett, 1884, Journ. Micr., vol. iii. p. 82, pl. ii. fig. 12.

This variety is less abundant than the type, and like it, is more plentiful in Area 2.

Lagena formosa Schwager, plate XIV. figs. 10, 11, 12.

Lagena formosa (pars) Schwager, 1866, Novara-Exped., Geol. Theil, vol. ii. p. 206, pl. iv. fig. 19. *L. formosa* (Schwager) Brady, 1884, Chall. Rept., p. 480, pl. lx. figs. 10, 18–20, 8?, 17? *L. lagenoides* (Will.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 335, pl. x. fig. 85. *L. formosa* (Schwager) Jones, 1885. Palæont. Soc., p. 202, pl. vi. fig. 6.

This species seems to differ from *L. lagenoides* only in the raised border which immediately surrounds the body of the test. As in *L. lagenoides*, the form varies considerably. In the example represented by fig. 11 the raised border is composed of beads instead of the usual punctate ornament.

It is rare in the Malay Archipelago, although found in both Areas.

Group of *Lagena bicarinata*.

Lagena bicarinata Terquem sp., plate XIV. fig. 13.

Fissurina bicarinata Terquem, 1882, Mém. Soc Géol. Fr., sér. 3, vol. ii. p. 31, pl. ix. fig. 24. *Lagena bicarinata* (Terquem) Balkwill and Millett, 1884, Journ. Micr., vol. iii. p. 82. pl. ii. fig. 4; and trifacial pl. iii. fig. 9. *L. bicarinata* (Terq.) Balkwill and Wright, 1885, Trans. R. Irish Acad., vol. xxviii. p. 342, pl. xii. fig. 30. *L. bicarinata* (Terq.) Wright, 1886, Proc. Belfast Nat. Field Club, App. ix. p. 320, pl. xxvi. fig. 8. *L. bicarinata* (Terq.) Halkyard, 1889, Trans. and Ann. Rept. Manchester Micr. Soc., p. 66, pl. ii. fig. 1. *L. bicarinata* var. *placentina* Fornasini, 1901, Mem. R. Accad. Sci. Ist. Bologna, ser. 5, vol. ix. p. 51, fig. 5.

Published forms nearly allied, or possibly identical.

Fissurina marginata Seguenza, 1862, Foram. Monotal. Miocen. Messina, p. 66, pl. ii. figs. 27, 28. *F. capillosa* Schwager, 1866, Novara-Exped., Geol. Theil, vol. ii. p. 210, pl. v. fig. 25. *F. foliacea* Seguenza, 1880, Atti R. Accad. Lincei, ser. 3, vol. vi. p. 306, pl. xvii. fig. 13.

Although this species occurs in the Malay Archipelago in a variety of forms and with diverse surface ornaments, in none of them are to be found the two concentric circular costæ characteristic of the examples from the Eocene of the neighbourhood of Paris.

The form which is most abundant is that with the faces covered with minute dots, to which allusion has already been made in treating of *L. marginato-perforata*.

L. bicarinata occurs at several Stations, but is most plentiful in Area 2.

It has been found fossil in the Eocene of Paris; in the Tertiaries of St. Erth; and in the Neogene of Italy.

Lagena auriculata Brady, plate XIV. figs. 14, 15, 16.

Lagena auriculata Brady, 1881, Quart. Journ. Micr. Sci., vol. xxi. n.s. p. 61. *L. auriculata* Brady, 1884, Chall. Rept., p. 487, pl. lx. figs. 29, 33, and ? 31.

As shown by Brady's figures, this is a very variable species, and in the Malay Archipelago it occurs in many forms, ranging from a smooth test similar to that of *L. lævigata*, with a small loop on either side of the base, to the complex form with an extended neck, and provided with a luxuriant tubulated wing. This latter variety is usually much contorted, as represented by fig. 14. The trifacial variety is represented by fig. 16.

Essentially a deep-water species; being found, according to Brady, at depths of from 1370 to 2740 fathoms in the North and South Atlantic and South Pacific; whilst off Gomera, Canaries, in only 620 fathoms, the specimens were small and poorly developed. In view of these facts it is interesting to note that the species is abundant and varied in the shallow waters of the Malay Archipelago, and deficient only in size, being about one-half the length of the deep-water examples.

It occurs in more or less abundance at several Stations, and, like several other species of *Lagena*, is most plentiful in Area 2.

Lagena quadrangularis Brady, plate XIV. fig. 17.

Lagena quadrangularis Brady, 1884, Chall. Rept., p. 483, pl. cxiv. fig. 11.

This is a very rare species, and has hitherto been found only at Raine Island, Torres Strait, 155 fathoms.

Brady's figure is drawn from an imperfect specimen; I have examples from the same locality, and in these the neck is elongated and terminates in a prominent lip.

In the Malay Archipelago examples these features are not so well defined.

It has been found only at Station 25 in Area 2.

Group of *Lagena Orbignyana.*

Lagena Orbignyana Seguenza sp.

Entosolenia marginata (pars) Williamson, 1858, Rec. Foram. Great Britain, p. 10, pl. i. figs. 19, 20. *Fissurina Orbignyana* Seguenza, 1862, Foram. Monotal. Miocen. Messina, p. 6, pl. ii. figs. 65, 66. *Lagena Orbignyana* (Seguenza) Balkwill and Millett, 1884, Journ. Micr., vol. iii. p. 81, pl. iii. fig. 1. *L. Orbignyana* (Seguenza) Brady, Parker, and Jones, 1888, Trans. Zool. Soc., vol. xii. p. 222, pl. xliv. fig. 20. *L. Orbignyana* (Seguenza) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 333, pl. x. figs. 89–91. *L. Orbignyana* (Seguenza) Grzybowski, 1895, Rozprawy Wydz. Mat.-Przyr. Akad. Umiej-Krakowie, vol. xxx. p. 291, pl. x. fig. 4. *L. Orbignyana* (Seguenza) Jones, 1895, Palæont. Soc., p. 204, pl. vii. fig. 13. *L. Orbignyana* (Seguenza) Flint, 1899, Rep. U.S. Nat. Mus. for 1897 (1899), p. 308, pl. liv. fig. 4. *L. Orbignyana* (Seguenza) Egger, 1899, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xxi. p. 104, pl. v. figs. 8, 9.

Little need be said about this ubiquitous species. Here as elsewhere it occurs in great abundance and in great variety of form, the trifacial variety *L. trigono-marginata* Parker and Jones being included.

Lagena Orbignyana var. *calcar* Millett, plate XIV. fig. 18.

Lagena Orbignyana var. *calcar* Millett, 1898, Trans. R. Geol. Soc. of Cornwall, vol. xii. p. 175, pl.

Hitherto recorded only from the Tertiary beds of St. Erth. In the recent specimens the spines are smaller and more numerous.

It is very rare, and occurs only at a few Stations in Area 2.

Lagena Orbignyana var. *castrensis* Schwager, plate XIV. fig. 20.

Lagena castrensis Schwager, 1866, Novara-Exped., Geol. Theil, vol. ii. p. 208, pl. v. fig. 22. *Entosolenia variolata* Schlumberger, 1882, Feuille Jeunes Nat., p. 25, pl. i. fig. 3. *Lagena scarenæensis* Hantken, 1883, Ertek. termesz. Köreböl, vol. xiii. p. 24, pl. i. fig. 9. *L. castrensis* (Schwag.) Balkwill and Wright, 1885, Trans. R. Irish Acad., vol. xxviii. p. 341, pl. xii. figs. 20, 21. *L. castrensis* (Schwag.) Egger, 1893, Abhandl. k. bayer. Akad. Wiss., Cl. II. vol. xviii. p. 333, pl. x. figs. 71, 72. *L. lacunata* (Burrows and Holland) Jones, 1895, Palæont. Soc., p. 205, pl. vii. fig. 12. *L. castrensis* (Schwag.) Flint, 1899, Rep. U.S. Nat. Mus. for 1897 (1899) p. 308, pl. liv. fig. 5.

This variety occurs in great abundance at many Stations in both Areas.

There is considerable diversity in the surface ornamentation, as well in the nature as in the arrangement of its components.

As a matter of convenience, in the synonymy are included all the described varieties of *L. Orbignyana* in which the surface markings are circular, without regard to their being depressions or elevations, or to any other character which they may happen to possess.

Trifacial varieties of this form are very uncommon, and for this reason an example having this character has been selected for illustration.

Lagena Orbignyana var. *Walleriana* Wright, plate XIV. fig. 19.

Lagena Orbignyana var. *Walleriana* Wright, 1886, Proc. R. Irish Acad., ser. 2, vol. iv. p. 611; and 1891, ser. 3, vol. i. p. 481, pl. xx. fig. 8.

This variety is very rare, and has been found only at Station 22, in Area 2.

Wright reports it from various Stations off the south-west of Ireland, at depths ranging from 53 to 345 fathoms.

It is not uncommon in the Tertiary beds of St. Erth; and in the fossil examples the central boss is often replaced by a ring of corresponding size.

Lagena Orbignyana var. *pulchella* Brady, plate XIV. fig. 21.

Lagena pulchella Brady, 1866, Rept. Brit. Assoc. (Nottingham) p. 70. *L. pulchella* Brady, 1870, Ann. and Mag. Nat. Hist., ser. 4, vol. vi. p. 294, pl. xii. fig. 1. *L. pulchella* (Brady) Balkwill and Millett, 1884, Journ. Micr., vol. iii. p. 81, pl. ii. fig. 13; and pl. iii. fig. 11. *L. pulchella* (Brady) Balkwill and Wright, 1885, Trans. R. Irish Acad., vol. xxviii. p. 342, pl. xii. fig. 19.

In the Malay Archipelago this variety is rare, although it occurs at Stations in both Areas.

The irregular branching or reticulated costæ proper to this form are often mixed with the circular vesicles usually found in *L. castrensis*. This is shown in the specimen selected for illustration.

Lagena Orbignyana var. *variabilis* Wright, plate XIV. fig. 22.

Lagena Orbignyana var. *variabilis* Wright, 1891, Proc. R. Irish Acad., ser. 3, vol. i. p. 482, pl. xx. fig. 9.

The Malay Archipelago examples are not so elongated as that figured by Wright, and but for the riblets would not be distinguishable from *L. Orbignyana*. They are also smaller than the Irish specimens, and altogether more delicate in structure.

It is by no means uncommon in the Malay Archipelago, and occurs at several Stations, but most abundantly in Area 2.

Joseph Wright records it as frequent at 750 fathoms off the west coast of Ireland, and adds that he has met with it in several of the 'Porcupine' soundings from the North Atlantic.

Lagena Orbignyana var. *clathrata* Brady, plate XIV. fig. 23.

Lagena clathrata (Brady) Balkwill and Millett, 1884, Journ. Micr., vol. iii. p. 82, pl. ii. fig. 14; and pl. iv. fig. 3. *L. clathrata* Brady, 1884, Chall. Rept., p. 485, pl. lx. fig. 4.

Typical examples are rare, the parallel costæ being usually represented by lines of closely set beads; other specimens resemble *L. variabilis* in having the ribs radiating from the base.

It is found in both Areas, but always in small quantities.

The only localities recorded hitherto are shore-sands, Galway (Balkwill and Millett); and sands dredged near the islands to the south-west of New Guinea, notably off the Ki Islands, 580 fathoms; and off Aru Island, 800 fathoms (Brady).

NOTE.

The Abbe Diffraction Theory.

By J. W. Gordon, F.R.M.S.

In June last I had the honour of submitting to the Royal Microscopical Society a paper upon the Abbe theory of the Microscope. The paper was devoted to an examination of that theory; but at the end of it I added a suggestion for the improvement of the image by the use, in a manner described, of a concave lens to spread the transmitted wave-front. The suggestion was made to illustrate the practical significance of the questions discussed, was confessedly immature, and was submitted for further consideration and criticism.

Since reading that paper I have myself seen cause to criticise that suggestion adversely; and in the hope of saving trouble to any Fellows of the Society who may have thought the matter worth following up, I take the liberty of communicating the criticism.

It appears then, as the result of calculating out the effect of introducing a concave lens into a Microscope in the manner suggested, that improved definition will indeed result, but that incidentally the scale of the image itself will be reduced, and that the diminution in the diameter of the antipoint will be no more than proportionate to this diminution in the scale of the image. This last result I did not foresee: for, although I had made experiments before submitting my paper, I had not made calculations to test the suggestion. The experiments misled me, for I obtained better resolution with the proposed adjunct than without it; but the calculation leaves no room for doubt that this was due only to facilitated manipulation, and that with sufficient care I could have obtained the same resolution either with or without the appliance. For, since the diameter of the antipoint and the diameter of the image change in one and the same proportion, the resolution of the image must remain unchanged.

SUMMARY OF CURRENT RESEARCHES

RELATING TO

ZOOLOGY AND BOTANY

(PRINCIPALLY INVERTEBRATA AND CRYPTOGAMIA),

MICROSCOPY ETC.*

ZOOLOGY.

VERTEBRATA.

a. Embryology.†

Discovery of Merogony.‡—Prof. Yves Delage replies to Boveri's claim to be the sole discoverer of merogony, by a historical account of the earlier investigations of the brothers Hertwig (1887) and of his own work. He sums up by saying that the first stimulus came from the experiments of the brothers Hertwig, that Boveri followed with a proof of the fertilisation of *scheinbar kernlose Fragmente*, and that Delage himself first definitely proved that the fragments fertilised by him were non-nucleated. The paper also includes a discussion of the question of the permanence of the chromosomes. Delage considers that it is proved that a self-regulation of the number of the chromosomes takes place, and this disproves Boveri's theory of their individual permanence.

Cytoplasmic Maturation and Experimentally Induced Parthenogenesis.§—Prof. Yves Delage emphasises the distinction between the cytoplasmic and the nuclear maturation of eggs; and shows that the number of chromosomes is a specific character of the cell re-established (after merogony for instance) by auto-regulation. In short, the individuality of the chromosomes is a myth.

Experiments on the ova of sea-urchins, &c., lead him to conclude:—(1) that the hypertonicity of the solutions is a favourable, but not essential, condition; (2) that different salts have a specific action independent of their molecular concentration; (3) that salts of manganese are even more energetic than those of alkalis; and (4) that temperature alone, especially at a "critical moment," may induce parthenogenesis in *Asterias*. Temperature, hypertonicity, the nature of the salt, very slight acidification with HCl, may combine in their influence.

The moment when the nuclear sap diffuses into the cytoplasm is the

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

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

‡ Arch. Zool. Expér., ix. (1901) pp. 33–9. Cf. this Journal, *ante*, p. 255.

§ Comptes Rendus, cxxxiii. (1901) pp. 346–9.

critical moment when various stimuli may induce parthenogenetic development. In the case of *Asterias* these stimuli sometimes occur "naturally." In most of the experiments with *Asterias* the extrusion of the second polar body was inhibited by the artificial conditions.

Origin of Germ-cells in Chick Embryo.*—Prof. M. Nussbaum brings forward some evidence, which he does not regard as quite sufficient, to show that the primitive ova arise from "sex-cells" which on the second day of incubation are seen to lie apart in the splanchnopleure of the posterior region of the body. They divide mitotically and are shunted towards the middle, and seem to form the germinal primordium.

Structure of Embryonic Bone-marrow.†—J. Aug. Hammar points out that it is commonly stated that the bone-marrow of the human fœtus is of the red type, but that this statement is only true in the later stages. At the time of its first appearance, the bone-marrow has the characters of a richly vascular connective-tissue, leucocytes being absent. At the beginning of the fourth month of intra-uterine life, a lymphoid infiltration begins, and continues as the ossification of the bone proceeds, until typical red-marrow is formed. This red-marrow is but a stage in the development of yellow-marrow, which has thus two antecedent stages.

Brain of Erinaceus.‡—Gösta Grönberg has investigated the development of the brain in the hedgehog, as a primitive type of Eutherian Mammals. His results show the existence of certain detailed homologies with structures found in the lower Vertebrates, not hitherto described; but generally speaking they only confirm the views currently held as to brain development. A distinct superior commissure was discovered in front of the epiphysis, and the processus infundibuli was found to be homologous with a part of the saccus vasculosus of Fishes and Amphibians.

Mammalian Spermatogenesis.§ — H. Schoenfeld begins a contemplated series of studies on this subject with an account of the period of growth of the genital cells in the bull. He finds that during this period, the spermatocytes of the first order undergo a series of nuclear changes resulting in the formation of twelve annular chromatic segments. These annuli are formed by the fragmentation of a longitudinally split chromatic rod, and the subsequent fusion of the extremities of the double segments thus produced. The spireme results from the juxtaposition of tetrads, formed by the division of chromatic granules. The chromatic granules in their turn arise from the union of chromatic microsomata, produced by the disintegration of nuclear chromoplasts. The linin supporting the spireme is not the same as that which exists in the nuclei of the spermatocytes at the time of their formation; this disappears entirely. Until the moment when the spireme undergoes longitudinal division, the nuclear chromatin is in the state of synapsis, that is to say, it is under the attractive influence of the central corpuscles, the attraction being especially marked at the moment when the tetrads are in existence.

* Verh. Anat. Ges., 15 Vers., in Anat. Anzeig., xix. Erg.-Hft. pp. 38-40.
† Anat. Anzeig., xix. (1901) pp. 567-70 (3 figs.).
‡ Zool. Jahrb., xv. (1901) pp. 261-384 (6 pls. and 18 figs.).
§ Arch. Biol., xviii. (1901) pp. 1-72 (2 pls.).

The author is of opinion that the synaptic state is merely the expression of a more intimate relation between archoplasm and nucleus, and it is probable that this relation becomes less close as soon as the chromatic rings are constituted. Further, he does not believe that during the growth-period of the spermatocyte, the chromatic elements undergo a simple growth; rather they exhibit a radical transformation, probably involving a new formation of chromatin.

Development of Striped Muscle.*—E. Godlewski finds that, in mammals, the myoblasts can be distinguished from the other cells by their granular nature. At the time of their conversion into muscle-cells, the myoblasts become elongated, and the granules arrange themselves in longitudinal rows, thus forming very fine primitive fibrillæ. The transverse markings on these fibrillæ are due to processes of differential growth. In heart-muscle, the fibrillæ are absolutely independent of the cell-territories. Increase in the number of fibrillæ is probably due to the longitudinal splitting of the primitive ones.

Development of Teeth in Sus scrofa.†—Dr. P. Adloff finds that in the domestic pig the first premolar becomes differentiated at the same time as the other milk-teeth, but lags behind the others, and becomes the last member of the milk-dentition to be developed. In the lower jaw, in connection with the first premolar, there are two rudimentary tooth-germs. If this premolar is regarded as a member of the permanent dentition, then these two rudiments must be looked on as a rudimentary milk-predecessor and a pre-lacteal germ. If, as the author inclines to believe, the first premolar is itself a milk-tooth, then both these rudiments must be regarded as pre-lacteal germs. Pre-lacteal germs were also found in connection with the second upper and the first lower incisor. An interesting point is the development of a tooth-germ behind the third incisor, which appears to fuse with that tooth, and perhaps represents an ancestral fourth incisor. The author regards these results as proving that concrescence is no longer a hypothesis, but a fact demonstrable in the ontogeny.

Tooth-genesis in the Caviidæ.‡—H. W. Marett Tims has cut sections of the jaws in a number of fœtal guinea-pigs. He believes that the five posterior tooth-germs (cheek-teeth) all belong to the permanent series, the first and fourth having vestigial remains of milk predecessors in the shape of spherical clusters of cells, the concentric bodies. The second tooth-germ forms the deciduous molar, shed before birth, and not replaced, though the first cheek-tooth drops backwards and occupies its position. From the pattern of this deciduous tooth, the author regards it as the first of the so-called molar series; but his discovery of the milk rudiments mentioned above tends to break down the distinction between molars and premolars, and to show further that the molars belong to the permanent dentition. No evidence of a pre-milk dentition was found. His results in regard to the cusps of the cheek-teeth tend to confirm the author in his view that the Rodentia are derived from the Multituberculata.

* Bull. Internat. Acad. Sci. Cracovie, 1901, pp. 146–58 (1 pl.).
† Anat. Anzeig., xix. (1901) pp. 481–90 (6 figs.).
‡ Journ. Linn. Soc. (Zool.). xxviii. (1901) pp. 261–90 (7 pls. and 1 fig.).

V-shaped Centrosomes.* — Dr. K. v. Korff has found these in spermatocytes of various beetles, e.g. *Hydrophilus*, *Feronea*. As they were originally described by Meves in the male genital cells of a butterfly, it is possible that they are widely spread in Insects. In beetles they were found in the spermatocytes of the first order, and were of large size. The two halves were originally at an angle of 90°, and the two centrosomes separated by a greater or less distance; but at the beginning of the first mitosis they separated from one another and travelled to the poles of the nucleus. Later, each V splits into two rods, the halves travelling in the daughter-cells to opposite poles. These rods form the centrosomes of the second maturation division. Similar V-shaped centrosomes were found in the spermatocytes of the first order in the domestic duck, and formed rods in the second division after a similar fashion.

Cephalic Mesoblast in Larus ridibundus.† — H. Rex finds that in early embryos the mesoderm in the region of the auditory pit segments into two parts, the dorsal and the ventral mesoderm. The ventral portion gives rise to the so-called connecting-plate (*Verbingdungsplatte*), and the heart primordium; the dorsal to the mesoderm of the hyoid arch. In the earlier stages of development, the dorsal and ventral mesoderm of the mandibular region are distinctly separated, but this distinct limitation is lost in the later stages. The mesoderm of the mandibular arch, from which the trigeminus muscle arises, is in direct connection with the primordium of the heart. On the other hand, the mesoderm of the hyoid arch, from which the facial muscle arises, originates only from the connecting-plate, and has no connection with the future heart.

Development of Shoulder-Girdle in Birds.‡ — Dr. Wlodzimierz Kulczycki's observations on this subject have led him to the conclusion that the clavicles in birds are not, as has been supposed, preformed in cartilage, nor is there, as Gegenbaur stated, a strip of cartilage in the embryonic clavicle. The author fails to find any pre-existing cartilage at all, and believes that the clavicle is purely a dermal bone, which cannot be homologised with the whole clavicle of mammals, for it only corresponds to the dermal element of that bone. In the bird, clavicle, coracoid, and scapula arise from a common primordium, but the clavicle becomes differentiated early, and ossifies without the intervention of cartilage, while the other two bones are preformed in cartilage.

Development of Nostrils in Lizard.§—Dr. Karl Peter, in his study of embryos of *Lacerta*, found the peculiar swelling in the vicinity of the neuropore, which Kölliker described in various gnathostomate vertebrates, and homologised with the swelling in the cyclostomes from which part of the unpaired nostril arises. Peter followed the changes undergone by this "unpaired olfactory organ" of Kölliker, with a view to deciding the question of its homologies. He finds that the structure arises during the closing of the neuropore, and speedily undergoes degeneration. It does not possess the characters of a sensory plakode,

* Anat. Anzeig., xix. (1901) pp. 490–3 (7 figs.).
† Tom. cit., pp. 417–27 (15 figs.). ‡ Tom. cit., pp. 577–90 (3 figs.).
§ Arch. Mikr. Anat., lviii. (1901) pp. 640–60 (1 pl.).

and the true paired olfactory areas have no relation to the neuropore. Further, the view that it is merely a mechanical result of developmental processes is confirmed by the fact that similar swellings occur during the closure of the lens-vesicle and the ear-vesicle. An examination of the other vertebrates on which Kölliker based his view shows that the conditions seen there are capable of a similar explanation, and that there is no proof that Kölliker's interpretation is the right one.

Development of Nasal Cavity in Amphibia.* — Dr. V. Hinsberg finds that in Anura and Urodela the first rudiment of the olfactory plate results from proliferation of the sensory layer of the ectoderm. The superficial layer of the ectoderm takes no part in the process, and soon disappears over the centre of the olfactory plate. The method of formation of the olfactory lumen differs considerably from that obtaining in Amniota, the olfactory plate fusing with the epithelium of the buccal cavity while itself still a solid cell-mass. Later, the olfactory lumen breaks through into the *endodermal* part of the mouth-cavity, and not into the *ectodermal* as in Amniota. The method of formation of the olfactory lumen differs in detail in the Anura and the Urodela. In both the originally simple lumen becomes complicated by the development of blind sacs, more elaborate in the Anura than in the Urodela.

Dorsal Groove in Egg of Triton tæniatus.†—Dr. Paul Röthig notes briefly the various interpretations offered of this structure, the *Rückenrinne* of Hertwig, the *sillon médian* of Bambeke, and figures a series of sections made by himself. The sections entirely confirm O. Hertwig's view that the furrow marks the area in which the lips of the blastopore fused together during the earlier stages of development.

Function of Infundibulum in Larval Fish.‡—J. Boeke suggests that the infundibulum in larval bony fish may serve as a sense-organ. He finds that in eggs ascribed to the Murænoidea, the cells in embryos of three days old are of two distinct kinds, sense-cells and supporting-cells. The former have large circular nuclei, and are furnished with a brush of long cilia. When the embryos leave the egg-membrane, the infundibulum is very distinct, and the sense-cells have become modified in form, being now furnished with a peculiar crown, apparently formed from the cilia of the earlier stage, the crown being borne on the protruding conical tips of the cells. In this form the organ remains constant till the critical period, and is believed by the author to be a functional larval organ. It occurs in similar form in other pelagic Teleosts, e.g. *Scorpæna* and *Fierasfer*.

Lorenzini's Ampullæ in Selachians.§—W. Minckert finds that these organs are developed from the basal layer of the epidermis in embryos of *Spinax* and *Acanthias*, and are derived from groups of specialised epidermal cells. They originate at the same time as the sensory canals.

Development of Teleosteans. ‖ — A. Swaen and A. Brachet publish the second part of their work on the organs derived from the mesoblast

* Arch. Mikr. Anat., lviii. (1901) pp. 411–82 (2 pls. and 1 fig.).
† Anat. Anzeig., xix. (1901) pp. 561–7 (5 pls.).
‡ Op. cit., xx. (1901) pp. 17–20 (2 figs.). § Op. cit., xix. (1901) pp. 497–527.
‖ Arch. Biol., xviii. (1901) pp. 73–190 (8 pls.). Cf. this Journal, 1899, p. 571.

in bony fish. Some of their results may be summed up as follows. In many fish (*Trutta*, *Solea*, *Clupea*, &c.) the primitive lateral plate divides into an internal part forming the intermediary cells, and an external part, the secondary lateral plate, which later divides into the excretory canal and the lateral plate. In *Leuciscus* and *Exocœtus*, the primitive lateral plate divides at once into three parts, the intermediary mass, the excretory canal, and the lateral plate. In regard to the pronephros, the authors believe that their results show that the evidence that it primitively existed throughout the segmented region of the trunk in Teleosteans, is at least as conclusive as that in the case of Amphibians and Cyclostomes. There is a true though rudimentary pronephric chamber, its extent varying in the different species. The aorta, the cardinal veins, the red blood-corpuscles, originate from the intermediary cells, without assistance from hypoblast or sclerotome. The sclerotomes furnish only the axial mesenchyme.

Development of Lepidosiren paradoxa.* — J. Graham Kerr summarises his observations on this subject as follows. The segmentation cavity arises from intercellular chinks, its roof early becomes two-layered, and assumes the character of epiblast. Gastrulation occurs for the most part by a process of true invagination. There is no true epibole, the spreading of small over large cells taking place by delamination. Before the segmentation cavity disappears, it is penetrated by a sponge-work of small blastomeres. The rudiments of notochord and mesoderm are at first quite continuous across the middle line, but the notochord remains attached to the hypoblast for some time after the mesoderm has separated off at each side. The mesoderm grows outwards on each side by delamination from the large yolk-cells, and the myocœle arises by the breaking-down of cells in the middle of the myotome. At a later stage, the myotome wall is composed of a single layer of regular columnar cells. The first formed mesenchyme arises from sclerotomic outgrowths, assisted to a slight extent by proliferation from the subchordal hypoblast. The solid neural keel arises by thickening of the deep layer of the epiblast. In its early stages the development of *Lepidosiren* closely resembles that of *Protopterus*, and both developments agree very closely with that of the Urodele Amphibians and of *Petromyzon*, while there is a general resemblance to the conditions seen in Ganoid fishes. The material upon which the research was based was very extensive, and the results emphasise the large amount of variability which exists among embryos of the same stage.

b. Histology.

Histology of Functional Mammary Glands.† — Dr. Donato Ottolenghi finds that the secretion of milk is an active function of the mammary gland-cells, which is not necessarily associated with the degeneration of the cells, though, as a consequence of their great activity, the cells tend to die more or less speedily, according to the individual and the amount of secretion. These dying cells are replaced by the karyokinetic division of the remaining cells, though direct division also

* Quart. Journ. Micr. Sci., xlv. (1901) pp. 1–40 (4 pls. and 4 figs.).
† Arch. Mikr. Anat., lviii. (1901) pp. 581–608 (2 pls.).

occurs at times. The leucocytes assist in producing the milk, and some of them pass into the secretion as Nissl's corpuscles, where they cannot be distinguished from the corpuscles of epithelial origin. In certain cases, e.g. the guinea-pig, the different parts of the gland are not all simultaneously functional. In the cow, resistant bodies recalling the corpora amylacea of the prostate occur, and with them phagocytes are found, which have a destructive action on the bodies.

Histiochemistry of Cartilage.*—Dr. Alfred Moll finds that Tänzer's solution (orcein) differentiates between embryonic cartilage and other embryonic tissues, and between embryonic cartilage and adult cartilage. It stains embryonic intercellular substance blue and adult red, except such structures as the cartilage capsules, which seem to remain in their embryonic condition.

Nerve-endings in Lymphatics of Mammals.† — K. A. Kytmanof finds that the lymphatics are rich in nerves and nerve-endings, the nerves being chiefly non-medullated. They form reticuli of four types:—(1) the adventitial reticulum, (2) the supramuscular reticulum, (3) the intermuscular reticulum, (4) the sub-endothelial reticulum. Sensory nerve-endings are present both in the tunica adventitia and in the tunica media, and the unstriped muscle-fibres of the tunica media have also free motor nerve-endings. In general, the innervation of the lymphatics closely resembles that of the arteries.

Degeneration of Nerve-cells in Guinea-pig.‡ — M. Mühlmann has studied the minute structure of the nerve-cells of the guinea-pig at different ages, in order to ascertain whether there are any changes corresponding to those which occur in man with advancing age. He finds that in this case also globules of fat make their appearance in the cells, differing from those of man only in that they are not associated with pigment. The process is one of partial fatty metamorphosis; it does not involve the whole cell, and does not appear to lead to the death of the cells.

Nerve-endings in Arteries.§—A. W. Rachmanow finds that Vater-Pacinian corpuscles are present in the tunica adventitia of the aorta in man and mammals, and probably in the coat of the other great vessels as well.

Structure of Blood-plates (Thrombocytes).—Dr. M. C. Dekhuyzen,‖ Fr. Kopsch,¶ and P. Argutinsky,** in three separate papers, confirm and amplify the discovery made independently by the first-named and by Deetjen, that the blood-plates are amœboid nucleated cells. Dekhuyzen has studied the blood in a number of animals, and finds that in worms, Echinoderms, Molluscs, Crustacea, and Vertebrates, including Mammals, there are cells of similar type and function. These cells are amœboid, finely granular, and spindle-shaped, with oval nuclei; in circulating blood the surface is smooth, but the cells are readily injured, and, on quitting the vessels, produce slender amœboid protoplasmic lamellæ,

* Arch. Mikr. Anat., lviii. (1901) pp. 483-6 (1 pl.).
† Anat. Anzeig., xix. (1901) pp. 369-77 (6 pls.).
‡ Tom. cit., pp. 377-83 (3 figs.). § Tom. cit., pp. 555-8 (1 pl. and 2 figs.).
‖ Tom. cit., pp. 529-40 (7 figs.). ¶ Tom. cit., pp. 541-51 (5 figs.).
** Tom. cit., pp. 552-4.

which unite with neighbouring cells, and form cell-masses. The function must in all cases be regarded as the same, the cells tending to check hæmorrhage when the vessels are injured.

Kopsch figures and describes preparations which entirely confirm Deetjen's results, while Argutinsky describes similar results obtained during observations on the blood in malaria. The point emphasised by all is the relation now proved to exist between the thrombocytes of mammals and those of other animals.

Minute Structure of Gills in Teleosteans.* — Dr. Marianne Plehn finds that each gill-lamella bears lateral alternating folds, in which only the respiratory interchange takes place. Each fold is covered by a one-layered epithelium, resting upon a nucleated basal membrane. Beneath the epithelium is a single row of remarkable cells, corresponding to the endothelial cells of the gill-capillaries. These cells are connected together above and below, but leave in the middle intercellular spaces in which the corpuscles of the blood slowly circulate, apparently under considerable pressure. The endothelial cells themselves seem highly plastic and yielding, so that the corpuscles are capable of forcing themselves between them, and so producing different appearances in surface view, according to the degree of turgidity of the gill. There is however never a continuous path for the blood, but always an interrupted network of corpuscles among the endothelial cells. A similar form of capillaries has been described in the lung of *Proteus*.

Minute Structure of Cartilage.† — Josef Schaffer has studied the cartilage of the tail in Ammocœtes and the adult *Petromyzon*, and finds that, in its first rudiment, the cartilage is a syncytium. It consists of a honeycomb of cells, the spaces containing nucleated corpuscles and themselves constituting the future ground-substance. This *prochrondral* ground-substance undergoes microchemical change, and becomes the *protochrondral* ground-substance. Growth of the cartilage takes place both by intussusception and by apposition, owing to the conversion of neighbouring indifferent cells into perichondrium. The periaxial supporting-tissue in the vicinity of the tail-fin exhibits a peculiar vesicular form. Its cells in part become hyaline and fat-containing, and between them there develops a fibro-membranous matrix containing indifferent cells. The proximal ends of the cartilaginous rays develop at the expense of this vesicular supporting-tissue. The so-called capsules—differentiations of the matrix—first appear in *Petromyzon fluviatilis*, and arise from the cartilage cells, just as the rest of the matrix does. Other differentiations of the matrix give rise to different modifications of cartilage in the adult.

Position of Centrosome in Resting Cells.‡ — Prof. O. zur Strassen finds that, at each resting stage in the segmenting ova of *Ascaris*, the centrosome lies in the axis of the cell near its distal pole, i.e. between the nucleus and the centre of the exposed surface of the blastomere, and that this position is always attained, though it may involve a considerable

* Zool. Anzeig., xxiv. (1901) pp. 439–43 (5 figs.).
† Zeitschr. wiss. Zool., lxx. (1901) pp. 109–70 (2 pls.).
‡ Arch. f. Entwickmech., xii. (1901) pp. 134–61. See Amer. Nat., xxxv. (1901) pp. 780–1.

migration on the part of the centrosome. This points to a fundamental polarity in epithelial cells.

Comparative Anatomy of Cervical Sympathetic System.*—Dr. M. Jaquet has taken a comparative survey of this portion of the nervous system, from the appearance of ganglia without a cord in the larval lamprey to the state of affairs in man. A somewhat primitive state is represented in some fishes, where the sympathetic is related to five cranial nerves much as it is to the rachidian nerves; a condensation gradually occurs, marked finally by the establishment of a single superior cervical ganglion. Although the pneumogastric has at first to discharge work which in higher forms falls to the sympathetic system, it is far from losing influence as the latter increases. It cannot be denied, however, that there is a distinct correlation in their degree of development.

c. General.

Quantitative Study of Variation.†—Prof. C. B. Davenport has done a useful service in presenting a history of the development of this study, from Quetelet and Galton to Pearson and Weldon. "The quantitative study of biology, the modern impulse to which we owe to Galton, has been furnished with good methods by Pearson. Already the application of these methods has borne fruit in our knowledge of the types of biological frequency curves, and their change with changing place and environment. The idea of correlation has received a precise definition. The results of experimentation have been quantitatively expressed. The rôle of natural selection, the method of evolution, and the laws of inheritance, are being discovered. Already we are able to predict greater results from the quantitative method in biology, especially when combined with experimentation, than any which have yet appeared."

Accessory Adrenal Bodies in Mammals.‡—Josef Wiesel found accessory adrenals in connection with the epididymis in 79 per cent. of new-born male infants, but after birth they gradually disappear, and later become vestigial. They have no medulla, but the cortex has the usual structure. In the rat, accessory adrenals of similar structure are frequent, and undergo hypertrophy if the main glands be extirpated. Under these circumstances they do not develop a medulla, which is an additional proof that the functions of the two regions of the gland are different. Probably the function of the medulla is taken on by some other part of the sympathetic, as it chiefly consists of nervous elements of the sympathetic.

Breeding-habits of Xenopus lævis.§—E. J. Bles finds that at the breeding-season in this frog, the whole inner side of the arm in the male, from the axilla to the tips of the fingers, develops minute pointed spines, and becomes darkened in colour. The roughening is present on all that part of the arm and hand which presses against the female, and is found on the back and not the palm of the hand. The male produces

* Bull. Soc. Sci. Bucarest, x. (1901) pp. 240–302 (13 pls.).
† Proc. Amer. Ass. Adv. Sci., 49th Meeting, 1900, pp. 197–203.
‡ SB. Akad. Wiss. Wien (sec. iii.), cviii. (1899) pp. 257–80 (1 pl.).
§ Proc. Cambridge Phil. Soc., xi. (1901) pp. 220–2.

a continuous metallic-like croak, while the female is perfectly mute. The eggs are extruded and fertilised one at a time, and are placed each on a leaf, to which their sticky surface causes them to adhere. Some 400–500 eggs were laid, and hatching occurred 30–36 hours after oviposition. The animals bred in a water-lily tank of a temperature of 22°–24° C. at the end of February, instead of in August, the breeding-season at the Cape.

Breeding-habits of Chromis philander.*—N. Abraham has observed the habits in captivity of a Chromid fish, identified by Dr. Günther as this species. A male was observed with ova distending the mouth-cavity, and was removed to a separate aquarium. Within the cavity the eggs hatched, and for two weeks the young were observed within it through the transparent integuments. At the end of this time some sixty young were noticed swimming freely in the aquarium, but all returned to the mouth of the parent on any alarm, and were always collected in this way at sundown, being apparently retained within the mouth till morning. This continued for about five days, after which the male ceased to notice the young.

Algæ on Hair of Sloth.† — R. Lydekker discusses the interesting questions connected with the green algæ-bearing hair of the two sloths. He points out that in the three-toed sloth the algal cells are lodged in the cracks of the extra-cortex of the hair, while the different species of alga found in the two-toed sloth lives in the furrows present in the cortex, the extra-cortex being absent in this case. There is reason to believe that the two sloths have been independently derived from ground-sloths, which in all probability had unspecialised hair, not capable of lodging algæ. It would thus appear that the remarkable habit of having symbiotic algæ on the hairs must have been acquired independently in the two forms. The young in both cases are probably infected by their parents with the algal spores.

Adaptation in a Deer.‡—R. Lydekker describes a variety of *Cervus eldi* from Manipur, in which the foot is modified to enable the animals to live on marshy ground. The under surface of the pasterns, instead of being hairy as in the typical form, is horny and hardened, and is practically continuous with the hoof. In walking the foot is bent, and the under surface of the pastern is applied to the ground. This the author regards as a case of incipient reversion to the ancestral plantigrade mode of progression.

Cerebellum of Scyllium canicula. § — L. Edinger has studied the nerve-tracts and the minute structure of the cerebellum of the dog-fish, and finds that it is essentially only the end-place of the direct sensory tract from the spinal nerves, all other fibres entering it being of relatively slight importance.

Superbranchial Organ in Hypophthalmichthys.‖—G. A. Boulenger describes a remarkable organ in *H. molitrix* from China, which is

* Ann. Nat. Hist., xlvi. (1901) pp. 321–5.
† Knowledge, xxiv. (1901) pp. 223–5. ‡ Nature, lxiv. (1901) p. 257.
§ Arch. Mikr. Anat., lviii. (1901) pp. 661–78 (2 pls.).
‖ Ann. Nat. Hist., xlv. (1901) pp. 186–8 (1 fig.).

apparently the homologue of the "gill-snail" in *Heterotis* and various members of the family Characinidæ. In *Hypophthalmichthys* the organ is not spirally coiled, but is made up of four distinct parts, each attached to a gill-arch and each infolded. No suggestion as to function has as yet been made.

Life-history of Littoral Fishes.*—Prof. W. C. M'Intosh discusses the breeding-habits of such common fish as the shanny, gunnel, viviparous blenny, and so on, with the object of showing that, however the habits may differ, the number of adult individuals remains fairly constant, and that there must therefore in all cases be an enormous destruction of eggs and young larvæ. The paper also includes some notes on Annelids.

Biology and Ethology.†—E. Wasmann maintains that it is justifiable to use the term "Biology" for a scientific account of the habits, inter-relations, and conditions of life of organisms; and that there is not much reason to prefer the term "Ethology," still less Haeckel's "Oekologie." It seems to us a historical question, and our reading of the history is that "Biology" had originally a much wider significance from which there is no reason to depart. For "Biologie" in Wasmann's sense, the British term "Bionomics" seems adequate.

Tunicata.

Excretory Organs of Tunicates.‡—Wilhelm Dahlgrün has investigated these organs in a number of simple and colonial forms. The organs occur in their simplest form in the Botryllidæ, where they consist of a large number of isolated cells, oval in form, and containing brown granules. There are in addition somewhat similar cells in the blood, which take up zoochlorellæ from the blood, and live in symbiosis with them. In *Ciona intestinalis* the conditions are equally simple. In the sub-family Ascidiina the cells are collected together into a definite organ, and form numerous vesicles. The cells excrete a fluid which, within the cavity of the vesicle, is converted into a brown amorphous substance. In the most highly differentiated members of the family, crystalline rods also appear at the ends of the cells. In the Cynthiadæ the cavities of the vesicles contain numerous crystals produced by the lining cells, as well as concretions. The most elaborate form of excretory organ occurs in the Molgulidæ, the separate vesicles of the Cynthiadæ being here united into a large sac, containing crystals, concretions, and micro-organisms.

INVERTEBRATA.

Mollusca.

γ. Gastropoda.

Notes on Acmæa testudinalis.§—Prof. M. A. Willcox notes that the nephridium is, like that of *Patella*, a large sac, beset, especially in the anterior part, with numerous out-pocketings, enwrapping the viscera

* Ann. Nat. Hist., xlv. (1901) pp. 216–32 (1 pl.).
† Biol. Centralbl., xxi. (1901) pp. 391–400.
‡ Arch. Mikr. Anat., lviii. (1901) pp. 608–40 (2 pls.).
§ Zool. Anzeig., xxiv. pp. 623–4.

on the right side and behind, and sending forward on the left side a dorsal branch which extends to the pericardium. Between the ventral face of the viscera on the left side and the underlying muscle is a space whose interpretation is much disputed; the author is not prepared to say whether it is a hæmocœle or a cœlom. He announces the discovery of Haller's sub-radular organ in this limpet.

Conchometer.*—H. S. Conant describes a simple and apparently valuable instrument which he constructed to facilitate his study of variation in *Purpura lapillus*. It consists of two parts:—(1) a device for measuring angles at the ends of the shell, and (2) a device for measuring the long axis of the shell and the distance from the apex of the shell to the aperture. About 4000 measurements have been taken with the help of the conchometer; and so well did they correspond with theoretical considerations, that the writer believes the value of the instrument to have been proved.

New Pteropod.†—Harold Heath and M. H. Spaulding describe *Cymbuliopis vitrea* sp. n., a form which occurs occasionally in large shoals near the surface in Monterey Bay, California. It differs only in minor points from the two other known species of the genus.

δ. Lamellibranchiata.

Crystalline Style of Lamellibranchiata.‡—S. B. Mitra, as the result of a series of observations on this subject, has come to the conclusion that the enigmatic style of, e.g. *Anodon*, consists of an active amylolytic ferment, that it is secreted as a viscous liquid, probably by the hepato-pancreas, that it is stored up as a flexible solid in the cæcum, or in some cases in a compartment of the alimentary canal itself, that the end of it which projects into the stomach is slowly and gradually dissolved there, and, being mingled with particles of food material, converts the starchy portion into a reducible sugar. Its presence in the Lipocephala is to be associated with the absence of special salivary glands. The style is not a reserve of food, nor a product of excretion.

Arthropoda.

α. Insecta.

Development of Muscidæ.§—W. Noack has made a series of observations on the eggs of *Calliphora erythrocephala* and of species of *Lucilia*. He finds that yolk-cells may originate by immigration of nuclei from the posterior end of the blastoderm, or from nuclei left behind in the yolk before the formation of the blastoderm, both methods occurring in varying forms within the limits of the family. The germ-band consists, in its early stages of development, of three parts, the middle piece, the only part hitherto recognised, and an anterior and a posterior part, stretching respectively towards the anterior and the posterior poles. The middle piece forms the mesoderm only, and has nothing to do with

* Amer. Nat., xxxv. (1901) pp. 665–7 (1 fig.).
† Proc. Acad. Nat. Sci. Philadelphia, 1901, pp. 509–11 (1 fig.).
‡ Quart. Journ. Micr. Sci., xliv. (1901) pp. 591–602 (1 pl.).
§ Zeitschr. wiss. Zool., lxx. (1901) pp. 1–57 (5 pls. and 10 figs.).

the mid-gut, the primordium of which arises from the anterior and posterior ends of the germ-band. The median part, the mesodermic groove, grows forwards and backwards, forcing the anterior and posterior regions inwards, where they form the beginning of the endoderm; but mesoderm and endoderm are in origin separate structures, the relations between them described by other authors being produced secondarily by differential growth.

Sense-organs in Collembola.* — Karl Absolon, in the course of an account of new Collembola from Moravian caves, discusses various forms of antennal sense-organs. In *Tetrodontophora gigas*, the organ of the third antennal segment reaches its fullest development. It consists of seven outer and seven inner club-shaped projections, each being supplied by a fibre of the antennal nerve, and each protected by a bristle. In *Achorutes* and other genera, the third and fourth segments of the antennæ bear numerous thickened projections, apparently of olfactory nature, which are in origin modified bristles. In *Neanura* there is a very complicated organ on the fourth segment, consisting of three rounded projections, in the vicinity of which are sensory hairs, as well as olfactory clubs. In *Podura aquatica*, a similar organ occurs, but with only one sensory bristle and no olfactory clubs.

Determination of Sex in Silkmoth.† — C. Flammarion began in 1894, at the Observatory of Juvisy, a series of observations on the influence of different colours on plants and animals, and he communicates an account of some experiments with silkworms. His results lead him to think that the production of male moths is favoured most by coloured rays and by restricted food (or appetite).

Mosquitoes.‡—Dr. L. O. Howard has published a useful volume of studies on mosquitoes;—he tells how they live, how they carry disease, how they are classified, and how they may be destroyed.

Fire-fly's Light the Cheapest Form of Light.§—S. P. Langley and F. W. Very show, by their study of the radiation of the fire-fly (*Pyrophorus noctilucus*), that it is possible to produce light without heat other than that in the light itself, and that this is actually effected in the fire-fly in a manner much more economical than any human devices for light-production. "Nature produces this cheapest light at about one-four-hundredth part of the cost of the energy which is expended in the candle-flame, and at but an insignificant fraction of the cost of the electric flame or the most economical light which has yet been devised. . . . There seems to be no reason why we are forbidden to hope that we may yet discover a method (since such a one exists and is in use on the small scale) of obtaining an enormously greater result than we now do from our present ordinary means for producing light."

Supernumerary Wings in Pieris rapæ.‖ — G. W. Tannreuther describes this rare occurrence in a prepupa. The abnormal structure

* Zool. Anzeig., xxiv. (1901) pp. 575-85 (8 figs.).
† Comptes Rendus, cxxxiii. (1901) pp. 397-400.
‡ Mosquitoes, by L. O. Howard, New York, 1901, xv. and 241 pp., I pl., and 50 figs. § Smithsonian Misc. Collections, 1258 (1901) pp. 1-20 (3 pls).
‖ Zool. Anzeig., xxiv. (1901) pp. 620-2 (3 figs.).

occurred on each side, was nearly circular in outline, was attached like a wing, but showed no trace of veins and only a few minute tracheoles in its cavity. This case differs from almost all of those previously recorded, in being bilaterally symmetrical, and in the supernumerary being closely similar to the normal wing in its general outline.

Development of Coccidæ.* —L. Reh concludes that male Coccidæ have an indirect development, with at least two larval stages and one or two pupal stages, while the females undergo no metamorphosis at all.

β. Myriopoda.

Coxal Sacs of Diplopoda.† — K. W. Verhoeff notes that coxal sacs occur in Colobognatha (in all ?) from the third appendage almost to the last. In this respect, as in the simple limb-like gonopods and simple mouth-parts, the Colobognatha, such as *Heterozonium*, seem to represent the most primitive group among the Chilognatha.

Supposed Phosphorescence of Millipedes.‡—Prof. F. Ludwig notes that a species of *Scolioplanes* (family Geophilidæ) which he studied, secreted a luminous mucus capable of making contiguous objects luminous. The animals were not always luminous, and they came from wood traversed with "*Hallimasch*" mycele. He cites other instances of luminous millipedes, but is inclined to conclude that in the case of *Scolioplanes* and its relatives, the luminosity is not due to the animal, but to the luminous wood, i.e. to its content of luminous Mycomycetes and Photobacteria. Experiments for testing this are suggested.

Nest of Iulus.§—Dr. G. Rossi has made some interesting observations on *Iulus terrestris*, which secretes a silky substance drawn out in threads. This material is used in the construction of a nest in which the eggs are deposited. They are placed in damp earth in the vicinity of material useful for the nutrition of the larvæ.

γ. Protracheata.

New Species of Peripatus.‖ — Richard Evans describes two new species of *Peripatus*, obtained by himself in the Malay peninsula. He includes them, together with Horst's *P. sumatranus*, in a new genus *Eoperipatus*, as *E. weldoni* and *E. horsti*. When captured, the specimens ejected from the slime papillæ a sticky whitish secretion to a distance of fully eighteen inches. As in Horst's species, the feet have only two papillæ; the ventral organs in the adults are less degenerate than in most forms described; the outer blade of the jaws has two denticles on the inner side of the main tooth; the ova are large and full of yolk.

In a further paper,¶ the author describes as *Eoperipatus butleri* sp. n., a female specimen in the British Museum, obtained from the Larut Hills, Straits Settlements. It differs only in minor points from the other species of this genus.

* Allg. Zeitschr. Entomol., vi. (1901) pp. 51, 61, 85. See Zool. Centralbl, viii. (1901) pp. 652–3.
† Zool. Anzeig., xxiv. (1901) pp. 601–4.
‡ Centralbl. Bakt., vii. (1901) pp. 270–4.
§ Zool. Anzeig., xxiv. (1901) pp. 525–7.
‖ Quart. Journ. Micr. Sci., xliv. (1901) pp. 474–538 (6 pls.).
¶ Tom. cit., pp. 539–64 (1 pl.).

Development of Eoperipatus weldoni.* —Richard Evans finds that in this form the ova originate in the manner called exogenous by Willey, and not endogenously as in the species of the genus *Peripatus*. There is reason to believe that the process of overgrowth of the yolk takes place from the future ventral surface towards the dorsal, as in so many Arthropods. In early embryos a remarkable structure occurs in front of the somite usually described as the first, which the author interprets as a vestigial cerebral somite. In the development of the cœlom, *Eoperipatus* closely agrees with *Peripatus capensis*, as described by Sedgwick. The author finds that the germinal nuclei originate in the mesoderm, and not in the endoderm as described by Sedgwick. The male accessory glands are also in part mesodermal, and the cavity of their inner moiety cœlomic. In consequence, the salivary glands, the renal organs, the genital ducts, and the male accessory organs, must all be regarded as homologous structures, derived from the mesoblastic somites, and communicating with the exterior by means of a short invagination of the ectoderm. As in *P. capensis*, the eye develops from the brain.

Peripatopsis blainvillei.† —E. L. Bouvier has pursued his observations on this interesting American form, and finds that, in regard to the structure of the reproductive organs and the development, it seems to be transitional between the other American forms belonging to the genus *Peripatus* s. str. and the South African members of the genus *Peripatopsis*. A comparison of the eggs of the different genera shows that the characters of these are exceedingly variable in the group, and cannot be relied upon in establishing generic distinctions. The eggs are small and without the "embryonic annex" in *P. blainvillei*, and a comparison with other American forms leads the author to conclude that the existence of this organ in a highly differentiated condition is an archaic character, and not a mark of specialisation as has been supposed. He believes that the ancestral forms were viviparous, and that as an adaptation to this the embryonic annexes became developed, and formed the "placenta." In the more specialised forms the eggs increased in size as yolk was developed, and the placenta became functionless as the oviparous habit was acquired. The primitive viviparous habit was rendered necessary when the aquatic ancestors first became terrestrial.

δ. Arachnida.

Genus Tetranychus.‡ —Dr. Reinold v. Hanstein, in the course of a paper on this genus of mites, defines *T. althææ*, contrasting it with *T. telarius*, and, by following the life-history of the latter, definitely disproves the statement sometimes made that *Leptus autumnalis* is the larval form. In both the species mentioned there is only one stigma, placed in the middle line beneath the epistome. It communicates both with a thick-walled tracheal tube which divides into two ventral branches, and also with two anterior branches. In the life-history there occurs a six-legged larval stage, and two eight-legged nymph stages, three immovable chrysalis-stages being intercalated. No apoderma formation occurs

* Quart. Journ. Micr. Sci., xlv. (1901) pp. 41–88 (5 pls.).
† Comptes Rendus, cxxxiii. (1901) pp. 518–21.
‡ Zeitschr. wiss. Zool., lxx. (1901) pp. 58–108 (1 pl.).

in any stage of development. Immediately after the conclusion of the second eight-legged resting-stage, the female is ready for impregnation.

ε. Crustacea.

Experiments on Regeneration.*—H. Przibram has previously shown that regeneration occurs in *Palæmon* when appendages are cut off *distal* to the "preformed breakage-line"; he now shows that this is true when the cut is *proximal* to that line. Antennæ, antennules, caudal pieces, may be regenerated after complete excision; the regenerated antennule had an ear-sac, the caudal piece (of *Mysis*) an otocyst, and even the telson was re-grown in *Palæmon* and *Mysis*.

Appendages like walking-legs may (in *Portunus*, *Porcellana*, *Sicyonia*, &c.) replace maxillipedes, if the extirpation is proximal to the preformed breakage-line. But in these so-called "Richard's monstrosities," which Richard found in nature, the normal maxillipede form is restored after the third moult. They are stages in regeneration, not heteromorphoses.

In *Alphæus*, the removal of the larger *Schnalzschere* is followed by a change in its smaller vis-a-vis, the *Zwickschere*, which after several moults becomes a *Schnalzschere*! The appendage replacing the lost *Schnalzschere* is a *Zwickschere*. If the smaller one is removed, it is replaced by another of the same kind; if both are removed, they are both re-grown in their characteristic forms, but of equal size.

Variation in Fiddler Crab.†—R. M. Yerkes gives the "place-modes" for twelve measurements on the carapace and extremities of right- and left-handed specimens of *Gelasimus pugilator*. The means of this table of "place-modes" show that the right-handed animals are larger and less variable than the left-handed. Right- and left-handed animals occur in approximately equal numbers. Two "stages" appear to be represented by the individuals measured. Many of the curves are compound, and it is probable that in these one mode represents those individuals which have recently moulted, the other those which are almost ready for the process. All the measurements are larger on the side of the great chela. "The results of this study in variation seem to indicate that right- and left-handedness is not directly due to heredity, but is caused by certain slight variations which give one side of the body an advantage over the other."

Malacostraca from Mediterranean.‡—A. O. Walker describes some very striking results obtained by dredging off Cannes and Hyères, with a modified tow-net to which a stone was attached. Six excursions gave seventy-eight species, including five new species and two new records for the Mediterranean. Among the Schizopoda a form, doubtfully described as *Mysidopsis serraticauda* sp. n., but probably the type of a new genus, was found. Among Isopods a form described as *Hyssura spinicauda* sp. n. was taken, remarkable because the only species of the genus previously described was found in the North Atlantic at a depth of 1450 fathoms. The Munnidæ included a single female of *Pleurocope*

* Arch. Entwickmech., xi. (1901) pp. 321–45 (4 pls.). See Zool. Centralbl., viii. (1901) pp. 619–21.
† Proc. Amer. Acad., xxxvi. (1901) pp. 417–42 (3 figs. and 5 tables).
‡ Journ Linn. Soc. (Zool.), xlv. (1901) pp. 290–306 (1 pl.).

dasyura g. et sp. n., while among the Amphipods *Leucothoë spinicarpa* sp. n. occurred.

Fresh-water Palæmonidæ from Madagascar.* — H. Coutière has studied a collection of these Crustacea, comprising fourteen species, of which three are new. The interest of the collection lies in the wide distribution of the species included in it, most of them being found in the Malay Archipelago, in Africa, and various parts of the Pacific, as well as in Madagascar. These facts the author believes can only be explained on the supposition that the species of *Palæmon* were primitively littoral forms which have become gradually adapted to life in fresh water. This view is confirmed by the fact that the same species sometimes occurs in brackish lagoons and in fresh water. This is even more marked in the species of *Leander*, while in the interesting case of *Palæmonetes varians*, where there is the same plasticity, the development is direct in fresh water and indirect in salt. There is reason to believe that the acquisition of the fresh-water habitat is recent in the species of *Palæmon*; and the fact that the larvæ of certain species are able to tolerate salt water increases the chances of distribution of these species. The paper includes a discussion of the minute characters of the genus *Palæmon*.

Ostracoda from the Bismarck Archipelago.† — Dr. W. Vávra describes a small collection made by Dahl, including *Pontoparta rara* g. et sp. n. The new genus resembles *Candona* as regards the shell, and *Cypria* and *Cyclocypris* as regards the structure of the limbs; it is peculiar in possessing two bristles on the posterior border of the furca.

Annulata.

Cœlomic Fluid in Acanthodrilids.‡ — W. Blaxland Benham finds that in *Octochætus multiporus* and allied species, the cœlomic fluid is creamy-white, and contains a large number of cellular elements. Four different kinds of elements are recognisable, the amœbocytes, the eleocytes, the *lamprocytes*, the *linocytes*, the last being the rarest and the lamprocytes the most abundant. The amœbocytes are of two types, depending on the characters of the granules and the pseudopodia. In the eleocytes (Rosa), numerous clear colourless globules of oil are present. These elements are undoubtedly closely related to the lamprocytes, which are cells containing a clear colourless vacuole with an included highly refringent granule. The special character of the linocyte is the presence of a coiled thread, the cells recalling the thread-containing cells described by Goodrich in *Vermiculus*.

Eggs of Allolobophora fœtida.§—Katharine Foot and Ella Church Strobell publish a fresh series of photographs of these eggs, which have been taken with a view to settling certain disputed points in connection with yolk-nuclei and polar rings. The preparations confirm the authors in their view that a part of the yolk-nucleus persists, and contributes to the formation of the polar rings. They also show that

* Ann. Sci. Nat. (Zool.), xii. (1900) pp. 249–342 (5 pls.).
† Arch. Naturgesch., lxvi. (1901) pp. 179–86 (2 pls.).
‡ Quart. Journ. Micr. Sci., xliv. (1901) pp. 565–90 (1 pl.).
§ Journ. Morph., xvii. (1901) pp. 517–54 (5 figs.).

the archoplasm (yolk-nucleus) is a specific substance, but the authors were not able to come to any decision as to its origin, whether cytoplasmic or nuclear.

Regeneration of the Nervous System of Lumbricidæ.* — H. W. Rand has made a very detailed study of this, with especial reference to the centrosome of the nerve-cells. There is usually present in the nerve-cells of Lumbricidæ a centred system, consisting of centrosome and radiations. A centred system like that found in nerve-cells of normal worms is found in the regenerated nerve-cells; and its chief centre, or centrosome, is the centrosome of the last mitosis in the history of the cell. That the function of this centred system is mechanical seems very probable. The author also describes the occurrence of centrosome and radiations in some resting cells of recently regenerated epidermis; and gives a full account of the minute structure of the nerve-cells both normal and regenerated.

Habits of Earthworms.†—Dr. K. Bretscher brings forward evidence to show (1) that earthworms normally shift about from place to place to secure food and mates; (2) that there is no definite relation between the burrowing and burying operations and the form of the body in different kinds; and (3) that there is still much need for precise observations on the processes of reproduction, e.g. as to the mucous bonds during copulation which are sometimes present and sometimes absent.

Incomplete Duplication of Parts in Nereis virens.‡—C. W. Prentiss describes a case of incomplete duplication of parts and apparent "regulation" in *Nereis virens* Sars, the specimen being a sexually mature male. From his study of this interesting case, he concludes (1) that a single metamere of a Polychæte may give rise to a complete or partial duplication of the main axis of the body; (2) that the production of such abnormalities is in all probability due to traumatic stimulus in a post-embryonic stage; and (3) that the supernumerary, and in some cases useless, parts thus formed may be gradually suppressed by regulative changes which take place in the formative segment and tend to restore it to the normal.

Cocoon of Hirudo.§ — B. Sukatschoff returns to this subject, and points out that the substance of the cocoon is certainly not chitin, that it consists of an albuminoid, very probably near allied to keratin.

Nematohelminthes.

Method of Infection with Uncinaria duodenalis.‖ — Dr. A. Looss has been able to prove in a most satisfactory way that this parasite is capable of reaching the alimentary canal in the human subject by active movements through the skin, no less than by passive infection through the mouth. His suspicions were first aroused by finding that, after some months' work with ripe larvæ, he himself was strongly

* Bull. Mus. Harvard, xxxvii. (1901) pp. 85–164 (8 pls.).
† Biol. Centralbl., xxi. (1901) pp. 538–50 (3 figs.).
‡ Amer. Nat., xxxv. (1901) pp. 563–74 (6 figs.).
§ Zool. Anzeig., xxiv. (1901) pp. 604–8. Cf. this Journal, 1899, p. 578.
‖ Centralbl. Bakt., 1te Abt., xxix. (1901) pp. 733–9 (1 pl.).

infected by the parasite, in spite of precautions which made it seem impossible that the infection could have taken place *per os*. He noticed next that if a drop of water containing living larvæ was by chance spilt upon the skin, e.g. between two fingers, there resulted a burning sensation, and a noticeable reddening of the surface. Microscopic examination showed the presence on the affected surface of some dried or shrunken larvæ, but also of numerous cast coats of larvæ. The next experiment was to place a drop of larvæ-containing water on the skin of a patient about to undergo amputation of a limb. This was done on a carefully cleaned area of the skin, about an hour before the time fixed for the operation. Immediately after the operation, the area of skin treated was removed from the severed limb, fixed, hardened, and ultimately sectioned. It showed some larvæ in the act of penetration, and other very numerous specimens which had completely penetrated the skin, and lay in the hair-follicles. In all cases entrance took place through the chink between the hairs and their follicles, the follicles sometimes containing numerous larvæ. The proof of the possibility of cutaneous infection is thus decisive. The author is further of opinion that it probably plays a much more important part in the life-history of the parasite than infection with food or drink. The larvæ do not float in water, and could only be swallowed with sediment, while cutaneous infection by means of contaminated mud helps to explain the frequency of the parasite amongst Egyptian agriculturists, and the occurrence of epidemics of it among brick-makers, railway navvies, and so on. Washing the hands in 90 p.c. alcohol acted as a complete preventive to infection.

Platyhelminthes.

Regeneration in Leptoplana atomata.* — E. Schultz has made experiments on this Polyclad, which he cut across near the pharynx. No regeneration of the anterior part occurred, but only of the posterior half. The epithelium grows over the surface of the wound, the muscular layer is retarded in its growth, and thus it comes about that during the period of regeneration the epithelium and parenchyma are in direct contact at the posterior end. After the restoration of gonads, &c., muscle-cells begin to be insinuated beneath the epithelium.

The nervous system is re-established wholly from ectoderm; the whole of the male copulatory apparatus is also of ectodermal origin, as in ontogeny (Lang); the same is true of the uterus, which is also ectodermal in ontogeny (Graff). The new gonads arise in the mesenchyme, as in Triclads, not as diverticula from the gut as Lang described. On the anterior end of the excised posterior part, the margins of the wound close in in such a way that the median anterior point, from which regeneration should especially proceed, comes to lie internally, shut off from the outer world by parenchyma, muscular tissue, and ectoderm. The author goes on from this to explain why the anterior end is not regenerated.

Revision of Species of Allocreadium Lss.† — Th. Odhner makes a contribution to the systematisation of the chaotic genus *Distomum* by a

* Zool. Anzeig., xxiv. (1901) pp. 527–9.
† Zool. Jahrb., xiv. (1901) pp. 483–520 (1 pl.).

careful diagnosis (and a useful key) of nine species of *Allocreadium*—Distomid parasites of marine fishes.

New Trematoda from the Labridæ.*—Dr. A. Looss describes various new flukes from these fish, the most striking being a form which, together with Olsson's *Distomum viviparum*, he places in a new genus as *Zoogonus mirus* g. et sp. n. As indicated in the name, the most striking character is the viviparous habit, the egg-shell being absent, and the young developing free in the uterus as ciliated miracidia of large size (length 0·13 mm.). These at one stage of development are enveloped in a cellular investment, similar to that found beneath the shell in other Trematode embryos. This is lost at a later stage, and the miracidia become naked.

Avian Trematoda.†—M. Braun publishes a revision of the flukes found in Birds. Twenty-four species of *Distomum* are discussed, synonyms, type species, hosts, and specific characters being all given. The second part of the paper contains descriptions of a number of new species, found by the author chiefly in birds from Brazil.

New Tape-worm in Man.‡—Dr. O. von Linstow describes *Tænia asiatica* sp. n., from Aschabad in Asiatic Russia. In the structure of its uterus and other genital organs the new form belongs to the *Davainea* type; it is certainly distinct from any of the (8) species of *Tænia* hitherto recorded in man.

Bothriocephalus histiophorus sp. n. § — A. E. Shipley describes under this name a tape-worm obtained from the intestine of the sword-fish, *Histiophorus* sp. The scolex is unarmed, and there is no neck. It would appear that the eggs leave the ripe proglottides within the body of the host, and do not remain within these until they break off. There is no receptaculum seminis, and the uterine pore is not median as in most species of the genus.

Position of Nerve-cord in Abothrium rectangulum. ‖ — Dr. Al. Mrázek figures and describes sections of this tape-worm to show the position of the longitudinal nerve-ends. He finds that their relation to the genital organs is very variable, for they are sometimes dorsal to the cirrus-sac and vagina, and sometimes ventral. An interesting case is shown in a proglottis with double genitalia, for here the longitudinal nerve at one side is dorsal and at the other ventral to the organs.

Development in Cestoda.¶ — G. Saint-Remy has studied the early development in two tape-worms of the horse, *Anoplocephala plicata* and *A. mammillana*, in which the developmental processes prove to be similar in all essentials. In the young eggs the proportionately small egg-cell lies at the side of the yolk-mass. Later, this yolk-mass divides into two parts and becomes gradually absorbed, while the egg-cell gives rise to three sets of cells, or rather to three sets of nuclei, for cell-

* Centralbl. Bakt., 1te Abt., xxix. (1901) pp. 398–405, 437–42 (6 figs.).
† Tom. cit., pp. 560–8, 941–8. ‡ Tom. cit., pp. 982–5 (5 figs.).
§ Proc. Camb. Phil. Soc., xi. (1901) pp. 209–13 (1 pl.).
‖ Centralbl. Bakt., 1te Abt., xxix. (1901) pp. 569–71 (3 figs.).
¶ Arch. Parasitol., iii. (1900) pp. 292–315 (1 pl.). See also tom. cit., pp. 739–40.

boundaries are not apparent. Twenty-five nuclei with their unsegmented protoplasm constitute the true embryo or oncosphere. The nuclei stain deeply, and are all alike, whereas in Bothriocephalidæ and Cystotæniæ the oncosphere consists of two kinds of cell, large and small. Three or four cells with very large nuclei form the inner embryonic membrane, and correspond to the mantle-cells of Bothriocephalidæ. Finally, two cells with large nuclei constitute the outer embryonic membrane, corresponding to the single membrane of the Bothriocephalidæ.

Larva of Caryophyllæus mutabilis.*—Dr. Al. Mrázek has found, in the anterior region of *Tubifex*, a Cestode larva, which he believes is certainly that of this form, and not of *Archigetes*. The evidence chiefly relied upon is the size (5 mm.)—much greater than that of *Archigetes*; the existence of the remarkable cell-strands, described by Will in the adult; the condition of the reproductive organs; and the structure of the head. As in *Archigetes*, an embryonic appendage (tail) is present. In regard to the central cell-strands of *Caryophyllæus*, the author is of opinion that these represent a remnant of the primitive digestive organs.

New British Nemertea.†—R. C. Punnett describes *Micrella rufa* g. et sp. n., and *Oxypolia beaumontiana* g. et sp. n., both found at Plymouth. The abbreviated generic diagnoses are as follows:—*Micrella*, body elongated and slender, without side folds and with caudal appendage. Rhynchocœlom to posterior end, and with pockets in œsophageal region. Proboscis two-layered, and with muscle crosses. Excretory system with long duct and a single pair of openings at the posterior end. No neurochord cells. Side organ present just behind excretory pore. The genus is thus seen to be very primitive, the most primitive of the known genera of Lineidæ. In *Oxypolia* the body is short and stout, and the proboscis pore ventral. There is a circular ciliated groove round the head just in front of the mouth, and the rhynchocœlom reaches to the end of the body. The excretory system has many ducts, and the cerebral organs are small and not surrounded by blood-lacunæ. The proboscis has three muscle layers, but is without muscle crosses. The genus appears to occupy an intermediate position between *Valencinia* and *Eupolia*.

Callinera bürgeri.‡—D. Bergendal gives a full description of this aberrant Palæonemertean, which must be included in Bürger's Protonemertini. Its most important peculiarities, all discussed in detail, may be summarised:—(1) the pointed head, not marked off from the body, with a subterminal proboscis aperture, and the mouth opening just behind the brain; (2) the absence of special cerebral organs and the presence of contractile lateral organs; (3) the strong development of the brain, especially of the dorsal ganglia, whose fibrillar nuclei, widely extended, lie directly on the *Grundschicht*, and the shortness of the ventral cerebral commissure; (4) the development, restricted to the head, of a strong nervous layer; (5) the unpaired œsophageal nerve; (6) the

* Centralbl. Bakt., 1te Abt., xxix. (1901) pp. 485–91 (3 figs.).

† Quart. Journ. Micr. Sci., xliv. (1901) pp. 547–64 (2 pls.).

‡ Lunds Univ. Arsskft., xxxvi. (1900) pp. 1–47 and vii. (2 pls. and 25 figs.); and xxxvii. (1901) pp. 49–118.

thinness of the *Grundschicht* and its very constant and regular swellings outside the nerve-strands; (7) the four bundles of longitudinal muscles and the annular muscle in the fore-gut region of the proboscis; (8) the great strength and peculiar shape of the posterior end of the proboscis sheath; and (9) the position of the blood-vessels above the gut in the anterior fore-gut region. The form described must be ranked as representative of a new sub-family (Callinereæ) of M'Intosh's Carinellidæ, that is, as very distinct from, though allied to, *Carinina* and *Carinella*.

Incertæ Sedis.

Structure of Polyzoa.* — Karl Schulz has examined the minute structure of *Membranipora membranacea* and some other forms, with special reference to the excretory organs. The author re-describes the excretory apparatus in *Pedicellina*, giving the histology in detail, and emphasising the homology with the protonephridia of Annelids. In Phytactolæmata among Ectoproctous forms, the dilated unpaired region of the forked canal contains excretory cells, in which the products are stored throughout life. The canal cannot be regarded as the homologue of the segmental organs of Annelids. In Gymnolæmata there is no definite excretory organ, the intertentacular organ is merely the oviduct. In *Membranipora*, the excretory function is performed by the free mesenchyme cells of the body-cavity, probably also by the cells of the mesodermic epithelium of the tentacles.

Rotatoria.

North American Rotatoria.†—Prof. H. S. Jennings gives a synopsis with diagnostic tables of North American Rotifers (240 species) which are much the same as those of Europe. The system employed by Hudson and Gosse is followed, but with some reservations; and certain divisions are introduced which are not given in the famous monograph, such as the general division into Digonata (with two ovaries) and Monogonata (with one ovary). Certain families, e.g. Apsilidæ, Plœsomadæ, Gastropodidæ, and Anapodidæ, are added to those given by Hudson and Gosse.

Echinoderma.

Natural History of Starfish.‡—Dr. A. D. Mead has studied *Asterias forbesii* and *A. vulgaris*, and discusses their distribution, locomotor powers, migration, feeding habits, reproduction, development, and regeneration.

A common rate of movement is 6 in. per minute, but there is no evidence that they travel far. Especially when young they are very voracious,—in six days one ate 50 clams. They feed on oysters, mussels, clams, oyster-drills, barnacles, worms, or even smaller starfish. The answer which Schiemenz gave to the question, "How does a starfish open an oyster?" is confirmed. Although some ripe starfishes may be found almost at any time, there is in Narragansett Bay a short spawning season beginning about the second week in June and continuing for two

* Arch. Naturgesch., lxvii. (1901) pp. 115–44 (1 pl.).
† Amer. Nat., xxxv. (1901) pp. 724–77 (9 pls.).
‡ Bull. U.S. Fish Commission for 1899 (published 1900), pp. 203–24 (4 pls.).

or three weeks. The rate of growth depends largely upon the amount of food; in four months from the time of setting some had grown to a size of 2–$2\frac{1}{8}$ in. from mouth to tip of arm; but others had not attained that size in a year. With good opportunities a starfish becomes sexually mature in less than a year. Regeneration of arms is frequent, but the author did not find in the natural haunts any instance of the regeneration of the disc, though this may occur in the aquarium. If a starfish be torn apart and thrown overboard by the fisherman, it is unlikely that the parts will survive and regenerate.

Oral Skeleton of Ophiuroids.*—Prof. O. zur Strassen agrees in a general way with Ludwig's interpretation of the jaw apparatus—the lateral mouth-shields and the bipartite mouth-corner pieces—but these belong to the second and third segment, not to a first and second. The halves of the vertebræ of the second (Ludwig's first) segment do not form peristomial pieces—which are quite apart—but either degenerate or remain as small rudiments in the corner of the mouth. The same is true of the vertebral primordia of the true first or innermost segment. But the important result of this sort of discussion, which is not very easily followed, is that, if the author is right, the oral skeleton of Ophiuroids is very different from that of Asteroids, in which the skeleton comes from the two innermost segments, and the first ambulacralia are often in a position similar to that of the peristomial plates in Ophiuroids. In short, the supposed close relationship of Ophiuroids and Asteroids is not supported by a detailed study of the mouth.

Regeneration in Antedon rosacea.†—H. Przibram has made many experiments as to regeneration and transplantation. The "disc" can regenerate only in the direction of the anus; it may be transplanted with success to another animal; the whole disc may be re-grown, or all the arms; a half can grow into a whole; and so on. There seem to be some limitations, however; for regeneration does not occur if the central nervous system be destroyed.

Antarctic Holothurians.‡—Edgard Hérouard gives a preliminary account of the Holothurians of the Belgian Antarctic Expedition. Their chief interest is that they include Elasipodes taken from depths of only 410–460 metres, and also larvæ of the same family. Among the new forms is *Rhipidothuria racovitzai* g. et sp. n., the genus being intermediate between *Parelpidia* and *Scotoplanes*; *Peniagone vignoni* sp. n.; and some other forms. Two larval Elasipodes were taken, one with four pairs of ambulacral feet, and the other with three, both possessing a large ovoid dorsal vesicle, which was pedunculated, and probably contained the visceral mass. In all probability these larvæ belonged to the sub-family Elpidiineæ, and the vesicle gives rise ultimately to the characteristic dorsal veil of the members of that sub-family.

Cœlentera.

Scissiparity in Hydrozoa.§—Armand Billard points out that this occurs oftener than has been imagined. It has been observed by von

* Zool. Anzeig., xxiv. (1901) pp. 609–20 (4 pls.).
† Arch. Entwickmech., xi. (1901) pp. 321–45 (4 pls.). See Zool. Centralbl., viii (1901) pp. 619–21.
‡ Arch. Zool. Expér., ix. (1901) pp. 39–48.
§ Comptes Rendus, cxxxiii. (1901) pp. 441–3.

Kölliker in a medusoid (*Stomobrachium mirabile*), by Allman in a hydroid (perhaps a species of *Obelia*) which he called *Schizocladium mirabile*, and by Murbach in a free hydroid—*Hippolytus peregrinus*. Billard has found scissiparity in *Obelia flabellata* Hincks, *O. geniculata* L., *Leptoscyphus tenuis* Allman, and *Campanularia angulata* Hincks. This mode of multiplication secures rapid propagation in the species of *Obelia* and *Campanularia* above-mentioned.

Asexual Reproduction in Hydrozoa.*—Armand Billard gives the name of *Stolonisation* to a method of reproduction found in littoral Hydroids, notably in the species of *Obelia*. In it the hydroclades, or certain branches of the colony, are converted into stolons, which spread rapidly over the surface, and give rise to buds from which new colonies develop. This method of reproduction occurs usually in shallow-water forms, and is replaced in deep-water species by "scissiparity."

Variations in Hydromedusæ.†—C. W. Hargitt reports on some of his studies, especially on species of *Pennaria* and *Gonionemus*. The medusoid of *Pennaria* seems to be degenerating; in many specimens the marginal canal is wholly atrophied, and in some cases the radials have been more or less suppressed. Sometimes the medusoids are not liberated. Of 500 specimens of *Gonionemus* only 15 showed abnormal or unusual genital features, but there was considerable variation in both the number and arrangement of the tentacles. There was most marked variation in the radial canals, from one with two to several with six. Threes and fives were also found.

Limnocodium sowerbii at Lyon.‡ — C. Vaney and A. Conte report that, in June 1901, a large number of medusoids appeared in the Victoria Regia tank at Lyon, and that these were identified as the *Limnocodium sowerbii* described by Allman and Ray Lankester from a similar tank at Regent's Park, London. They figure and describe the nematocysts and the spermatozoa, and in so doing add a little to previous accounts of this interesting fresh-water medusoid.

Post-Embryonic Development of Aurelia aurita.§—O. Friedemann has endeavoured to come to some decision regarding those points in the development of *Aurelia* which have been disputed for a score of years. (*a*) The author could not verify what Goette described in the 8-tentacled Scyphistoma—an ectodermic gullet. (*b*) The four gastric pouches appear in entire independence of the gullet. (*c*) The tentacles increase in the series 4, 8, 16, 24; forms with 12 or 20 are intermediate phases. (*d*) There is no lumen or funnel in the septal muscle. (*e*) There is a funnel, however, though it does not arise at the time or place described by Goette. For Goette's term *Septaltrichter* the author proposes to substitute the term *Peristomtrichter*, since the organ neither lies in the muscle nor gives origin to the subgenital cavity, but merely represents a transitory ectodermic proliferation from the peristome into the tæniola.

Attachment of Young Sea-Anemones to an Adult.‖—Dr. F. Immermann describes specimens of a species of *Epiactis* (probably *E. prolifera*),

* Comptes Rendus, cxxxiii. (1901) pp. 521–4.
† Proc. Amer. Ass. Adv. Sci., 49th Meeting, 1900, pp. 203–6.
‡ Zool. Anzeig., xxiv. (1901) pp. 533–4 (2 figs.). § Tom. cit., pp. 567–8.
‖ Zool. Jahrb., xiv. (1901) pp. 558–64 (1 pl.).

from Doflein's collection on the Californian coast, in which young forms of various sizes occurred irregularly attached to the outer wall of the adults with their bases surrounded by a slight rampart of ectoderm. The habit may be correlated with the occurrence of cold currents from the deep water. In any case, it seems to be a new mode of protective association between the young sea-anemones and the adults.

Protozoa.

New Infusoria.* — R. Florentin describes *Loxophyllum verrucosum* sp. n. and *Strombidium elegans* sp. n. from salt ponds in Lorraine. The first is nearly allied to *L. fasciola*—which was absent from the ponds studied—but differs in the arrangement of the trichocysts and some other points. The new *Strombidium* is especially characterised by its locomotor apparatus, which consists of about twelve finely-fringed projections ("membranelles"), forming an anterior collar. The paper also includes a brief discussion of the fauna of saline lakes in general.

Division of Hypotrichous Infusoria.† — Dr. Hans Wallengren has investigated the question of the extent to which the regenerative process takes place during transverse division in these Infusoria. He finds that in both daughter-cells the whole of the cilia, including all the forms of so-called bristles, are renewed, as well as at least a considerable portion of the old follicle. In the posterior daughter-cell the peristome is entirely renewed; the anterior daughter-cell retains the original peristome, but it also is largely renewed in all cases, and in e.g. *Holosticha rubra*, is wholly replaced by a new structure, the old being completely absorbed. In no case is there a throwing-off of any part of the body, but always absorption. The total renewal of the cilia is justified by the fact that the mother-organs are not adapted to the needs of the new cells in size or position. The regenerative processes during division serve also to repair accidental injuries.

Drepanidium in Snakes.‡ — Dr. Adolph Lutz has found in the blood of various snakes at San Paulo, Sporozoa which he believes all belong to a new species, which he provisionally describes as *Drepanidium serpentium*. The organisms occur in the following forms:—within the red blood-corpuscles of circulating blood, as microzoites and macrozoites; in the blood-capillaries of such organs as liver, lung, kidney, as free sporonts; in little clusters in the same organs as macrosporozoite-cysts and microsporozoite-cysts, these cysts having apparently arisen from encysted sporonts. Though macrozoites and microzoites present respectively the characters of female and male elements, yet no evidence of a process of conjugation was discovered. Further, there was much evidence to show that the microzoites, no less than the macrozoites, are capable, after encystation, of producing fresh individuals without any sexual process. The process of infection of other snakes also remains obscure.

Hæmatozoa of Frog and Tortoises.§ — Popovici A. Bâznosano finds, in the red blood-corpuscles of *Rana esculenta*:—(1) Labbé's *Cytamœba*

* Ann. Sci. Nat. (Zool.), xii. (1900) pp. 343–63 (1 pl.).
† Zool. Jahrb., xv. (1901) pp. 1–58 (1 pl. and 28 figs.).
‡ Centralbl. Bakt., 1te Abt., xxix. (1901) pp. 390–8 (1 pl.).
§ Bull. Soc. Sci. Bucarest, x. (1901) pp. 329–35 (12 figs.).

bacterifera, an amœboid form with commensal bacteria; it is mobile in character, and displaces the nucleus of the corpuscle; (2) Laveran's *Bacillus krusei*, with vacuoles full of bacilli; it is immobile, and does not displace the nucleus. He has not been able to find *Lankesterella* or *Drepanidium*, so common in countries where it has been studied.

In *Cistudo europæa* he found almost all the red blood-corpuscles infected with Danilewsky's *Hæmogregarina stepanowi*. In *Testudo ibera* he found a form which was not referable to either of the two Hæmosporidia reported to occur in Reptiles, namely *Caryolysus* and *Hæmogregarina*. One of the peculiarities of this new form is that its nucleus is at one of the extremities. A phenomenon like conjugation was observed.

Development of Polycystid Gregarines.*—L. Léger and O. Dubosq refer to the fact that until recently the development of Polycystid Sporozoa was held to include an intracellular stage. They were led to oppose this general statement by finding no intracellular stage in the life-history of *Pyxinia möbuszi* and *Diplocystis major*. Extending their observations to types of the three great groups of Polycystids—Actinocephalidæ, Dactylophoridæ, and Clepsidrinidæ, they find no evidence of an intracellular stage. Thus the Polycystids differ notably from the intestinal Monocystids (e.g. *Selenidium* and *Monocystis ascidiæ*), whose young stages are passed within epithelial cells.

Exciting Cause of Vaccinia and Variola.†—Dr. M. Funck concludes, from his observations and experiments, that the effect of vaccine depends on a protozoon, apparently a sporozoon which exists in the lymphatic system. This cell-parasite was first seen and examined by L. Pfeiffer in 1887, and it is designated *Sporidium vaccinale*. In the pustules of variola a morphologically similar protozoon exists. *Sporidium vaccinale* produces in calves the characteristic symptoms of vaccinia, and imparts to animals a lasting immunity to vaccinia. From the author's researches it appears that variola and vaccinia are apparently two identical affections, and that eventually lymph will be able to be prepared under more favourable conditions as regards efficiency and sterility.

* Comptes Rendus, cxxxiii. (1901) pp. 439–41.

† Centralbl. Bakt., 1te Abt., xxix. (1901) pp. 921–40 (2 pls.).

BOTANY.

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

a. Anatomy.

(1) Cell-Structure and Protoplasm.

Fibrillar Structure of Protoplasm.* —B. Němec describes in detail the various circumstances in which a fibrillar structure may be detected in the protoplasm of plants. It occurs most commonly in nuclear and cell-division, usually before the actual division, and disappearing after it is completed. The nucleus may put out fibriform appendages, reaching to the parietal utricle. Those connected with the transmission of irritation usually make their appearance as homogeneous slightly stainable threads, enclosed in a more strongly stainable sheath, and run from one parietal utricle to another. The sheath of these fibrils corresponds to the entire substance of the kinoplasm fibres; except in the case of *Blechnum boreale*, where the fibrils have an isolated course in some of the cells.

The author utters a caution against drawing too close an analogy between the irritation-conducting fibrils and the nerve-system of animals. That the former are not continuous is not a final argument against their function of transmitting irritation. The demonstration of this continuity is often a matter of extreme difficulty.

The structure of these fibrils is not uniform. In some plants—*Lonchitis pubescens*, *Calla palustris*—they have, when young, more or less of a reticulate character. A good subject for their study is the adventitious roots of *Aspidium decussatum*. The bundles are readily seen in the large plerom-cells; the fibrils themselves are strongly refringent, and appear to form a network here and there. The finest branches of the fibrils are to be seen at the ends of the cells; and it is here that the granular degradation first takes place. They become changed into granular masses composed of numerous spherical bodies. In the roots the fibrils occur in the growing apex, and connect the perceptive zone with the motor cells.

The author is unable to accept Haberlandt's criticism † as in any way weakening his argument that the fibrils act as transmitters of irritation.

Centrosomes in the Pollen-mother-cells of Lilium longiflorum.‡—S. Yamanouchi confirms Guignard's statement §, in opposition to that of other observers, of the presence of centrosomes or centrosome-like bodies in the cells of the higher plants, the object examined being the pollen-mother-cells of *Lilium longiflorum*.

In the resting nuclei no structures of this kind were observed; they

* Biol. Centralbl., xxi. (1901) pp. 529–38. † See *infra*, p. 667

‡ Beih. z. Bot. Centralbl., x. (1901) pp. 301 4 (1 pl.).

§ Cf. this Journal, 1899, p. 290.

were first seen in that stage of the first division of the mother-cells when the nuclear membrane was still present, but twelve chromosomes had already been differentiated. A strongly stainable centrosome lies on each side of the nucleus, and on one of them the beautifully developed aster (*Strahlensonne*) was seen as it partially forced itself towards the interior of the nucleus; while round the other one only a number of minute granules could be detected. In the mother-aster stage this was repeatedly seen, sometimes at only one, sometimes at both ends of the nuclear spindle; or two centrosomes were often visible at the same end of the spindle, doubtless resulting from the division of one.

On the second division of the mother-pollen-cells, in addition to the nucleus found in the knot, a centrosome was observed, sometimes of the ordinary form, sometimes hour-glass shaped; in the latter case probably in the act of division. Both in the mother-aster and in the diaster stage centrosomes are present at the two ends of the spindle. As soon as four primordia of pollen-cells could be detected, the centrosomes were no longer visible. In the place of one or two centrosomes, it was not uncommon for the pole of the spindle to include a number of small granules.

Influence of External Conditions on the Streaming of Protoplasm.* —According to E. Josing, the influence of light on the streaming of protoplasm is greatly affected by the external conditions. If objects which display this streaming readily—leaves of *Elodea*, *Vallisneria*, or *Alisma*, hairs of *Tradescantia* or *Heracleum*, internodes of *Chara*, &c.—are placed in pure water, the streaming is scarcely affected if they are deprived of light. The case is very different if they are placed in dilute ether. In the light, the streaming is then even more rapid than in pure water; but if deprived of light the movement is at once arrested, to be again resumed when restored to the light. Light which has passed through a solution of ammonium-copper-oxide acts in this respect the same as darkness; red light the same as white light. The removal of carbon dioxide from the atmosphere produces the same effect as placing in ether or chloroform.

Cytology of Erythronium.† — J. H. Schaffner continues his study of the life-history and cytology of *Erythronium* (*albidum* and *americanum*), which he compares with that of *Lilium*.‡ In the germinating pollen-tube the pollen-tube nucleus takes a very light stain, and is comparatively small, while the generative nucleus is large, and is surrounded by dense-staining protoplasm. In the archesporial cell the chromatin network is very distinct; after the formation of the spirem the nucleus and the chromosomes grow to a large size. Some of the nuclei of *Erythronium* are of enormous size; those in the walls of the ovule are usually from 15 to 20 μ in diameter, and the large reduction-nucleus often measures from 40 to 50 μ. No figures were seen in the entire study which could be interpreted as a synapsis stage; and the author maintains that what is usually called synapsis is a mere artifact. The

* Pringsheim's Jahrb. f. wiss. Bot., xxxvi. (1901) pp. 197–228.
† Bot. Gazette, xxxi. (1901) pp. 369–87 (6 pls.). Cf. this Journal, 1900, p. 605.
‡ Cf. this Journal, 1897, p. 552.

division of the reduction-nucleus gives rise to the first two cells of the gametophyte; the daughter-nuclei go into a resting stage, and form a network from which a new spirem is developed. The chromosomes are distinctly V and U-shaped.

Permeability of the Walls of Tracheids for Atmospheric Air.*—P. Claussen discusses this subject from a mathematical point of view, and, notwithstanding the great difficulties of the problem, from the possible occurrence of very minute fissures, comes to the conclusion that moist tracheid-walls are more permeable than dry ones for atmospheric air. Rarefaction of the air can exist only for a short time in the water-conducting elements after the cessation of suction (root-pressure). The density of this rarefied air varies between 0·5 and 0·9 atmospheres.

Fixation of Metals by the Cell-wall.†—H. Devaux finds that all metals with strong basic properties—potassium, sodium, lithium, calcium, strontium, barium, iron, nickel, cobalt, cadmium, copper, lead, silver—are absorbed in appreciable quantities by the cell-wall, even from very dilute solutions, especially by the soft tissues. Gold, platinum, chromium, were not absorbed, and mercury scarcely. With zinc, manganese, magnesium, and aluminium, sufficiently delicate reactions have not been discovered. A metal fixed in this way may be replaced by another metal presented in the form of a saline solution.

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

Albuminoids of the Seeds of Leguminosæ.‡—According to K. Weiss, the phosphorus which is an invariable accompaniment of albumen in plants depends partly on the presence of lecithin, partly on that of nuclein. Globulin is split up by various agencies into albuminates containing phosphorus or into casein and hetero-albumose. Vegetable globulins must be regarded as saline compounds of inorganic bases and an acid albumen, which, when freed from the base, splits up into casein and hetero-albumose. In the same way, vegetable albumins are saline compounds of bases and an acid albumen, which, when freed from the base, forms casein. Inorganic bases play therefore an important part in the albuminoid processes. The globulins of the seeds of Leguminosæ are indefinite mixtures of proteids closely resembling one another. They belong to a homologous series beginning with hetero-albumose and passing, through the globulins, into albumose.

Yellow Colouring Matters of Leaves.§—C. A. Schunck has made further spectroscopic observations on the yellow colouring matters which accompany chlorophyll in the leaves of plants. His conclusion is that chrysophyll (the orange xanthophyll of Sorby) pre-exists in the leaf, and is not formed spontaneously from one of the other colouring matters, and that it is one, if not the chief, constituent of the xanthophyll group of yellow colouring matters which accompany chlorophyll. In one point he revises his previous conclusion, and now believes that the four-

* Flora, lxxxviii. (1901) pp. 422–69 (9 figs.).

† Comptes Rendus, cxxxiii. (1901) pp. 58–60.

‡ Ueb. d. Eiweissstoffe d. Leguminosen-Samen, München, 1899, 36 pp. See Bot. Centralbl., lxxxvii. (1901) p. 13.

§ Proc. Roy. Soc., lxviii. (1901) pp. 474–80 (2 pls.). Cf. this Journal, 1899, p. 611.

banded spectrum exhibited by the crude solution of the xanthophylls does not represent a single colouring matter (xanthophyll), but is due to a mixture of colouring matters, the chief constituent of which is chrysophyll. The observations were made on leaves of *Ficus carica* and *F. repens*.

Endosperm and Milk of the Cocoa-nut.* — J. E. Kirkwood and W. J. Gies give the following general statement of the composition of the endosperm and milk of the cocoa-nut. The milk is composed of 95·3 p.c. water and 4·7 p.c. solids. Of the latter 88·5 p.c. is organic, 11·5 p.c. inorganic. The average composition of the endosperm is:– water 46 p.c., solid matter 54 p.c.; of the latter 98·1 p.c. is organic, 1·9 p.c. inorganic. The organic matter consists mainly of oil and cellulose; there is some soluble carbohydrate; a small proportion of globulin and proteose; only a very small quantity of albumin; no peptons. The fresh endosperm contains 0·75 p.c. of nitrogen, or 4·7 p.c. of albuminoid.

Solanine in Tobacco-Seeds.†—From a series of experiments made on a cultivated variety of *Nicotiana Tabacum* and on *N. macrophylla*, J. Starke disputes the statement of Albo that the alkaloid solanine occurs in the seeds. He also confirms the assertion of other botanists that neither does nicotine occur in the seeds themselves.

Barium in Plants.‡ — R. Homberger finds barium carbonate as a constant constituent of the ash of the copper-beech, occurring probably in the plant in the form of sulphate. The amount varied between 0·57 and 1·20 p.c. of the ash.

Zinc in Plants.§—L. Labaud has found zinc in very small quantities in the ash of plants growing in a soil containing a considerable amount of the salts of this metal. From 100 grm. of the air-dried material, about 0·25 grm. of zinc oxide, or 0·2 grm. of metallic zinc, were obtained.

(3) Structure of Tissues.

Stomatiferous Cavities in the Leaves of Ficus.‖—In three species of *Ficus*—*F. kallicarpa*, *punctata*, and *excavata* (and probably they occur in other species also)—Dr. G. Bargagli-Petrucci finds peculiar cavities on the under side of the leaves. In the first and second named species the cavity opens on the surface of the leaf by a short circular or elliptical aperture, and it is clothed internally by long unicellular hairs. In the third species there are no such hairs, and the communication of the cavity with the exterior is long and greatly curved. The cystoliths do not always occupy the same position in respect to these cavities. The cavities are abundantly supplied with stomates, and their purpose appears to be the protection of these organs, in order to maintain a uniformity in transpiration.

* Proc. Amer. Ass. Adv. Sci., 49th Meeting, New York, 1900, pp. 275–6.

† Bull. Classe Sci. Acad. R. Belge, 1901, pp. 379–83.

‡ Landwirthsch. Vers.-Stat., li. (1899) p. 473. See Bot. Centralbl., lxxxvii. (1901) p. 12.

§ Zeit. Nahr-Genussm., iv. (1901) pp. 489–92. See Journ. Chem. Soc., 1901, Abstr. ii. p. 467.

‖ Nuov. Giorn. Bot. Ital., viii. (1901) pp. 491–8 (4 figs.).

Production of Gummy Thyllæ.*—In *Ailanthus glandulosa*, L. Mangin finds an excretion of gum and the production of gummy thyllæ, even in trees which are in a healthy condition, and which have not in any way been injured. They appear to result from a diminution of pressure, produced during a certain period of the year, of the air in the trunk. The cause of their frequency in injured or unhealthy trees is probably a rarefaction of the air in the vessels, resulting from an insufficient production of rootlets and a consequent diminution of the required current of water to the leaves.

Persistence of Leaf-traces.† — Sir W. T. Thiselton-Dyer records several examples, in recent and fossil plants belonging to the Coniferæ, of the leaf-traces being continued to the leaves, where they are more or less persistent, through several successive zones of wood. All the recent instances observed belong to *Araucaria*.

Apex of the Axis in the Flower of Gamopetalæ.‡ — L. Vidal discusses the question whether, in the Gamopetalæ, the axis takes part in the constitution of the pistil or merely acts as a support to the carpellary leaves. While the axis may assume very different forms in members of the same family, the author concludes that, in the majority of the Gamopetalæ, it takes a more or less important part in the formation of the gynæceum. In the most highly developed orders, the Compositæ and Dipsacaceæ, the summit of the axis has usurped the function of the carpel, the true carpel being reduced to nothing but the style.

Bark of Robinia Pseudacacia.§ — Pierre É. F. Perrédès gives a minute account of the structure of the bark of the locust-tree or false acacia.

Dr. F. B. Power ‖ contributes an examination of the contents of the bark. The toxic principle—robin or robinin—appears to be a true proteid, probably belonging to the class of nucleo-proteids. It differs from both albumoses and globulins in being soluble in water. It is apparently an enzyme closely related to myrosin. Its chemical reactions and its physiological action are described in detail.

Formation of Annual Rings in Tropical Trees.¶ — A. Ursprung has investigated the phenomena of periodicity in eight species of trees natives of the Seychelles. He finds that, although there is in most cases a connection between the periodicity of the formation of leaves and flowers, and that of the increase in girth of the stem ; yet there are instances of tropical trees which are deciduous and bloom periodically, but are without annual rings in the wood ; and on the other hand, there are species which are evergreen, and bloom all the year round, and yet form annual rings. The periodicity in the energy of the cambium

* Comptes Rendus, cxxxiii. (1901) pp. 305–7.

† Ann. of Bot., xv. (1901) pp. 423–5 (1 pl.).

‡ Rech. s. l. sommet de l'axe d. l. flore d. Gamopétales, Grenoble, 115 pp., 4 pls., and 18 figs. See Bot. Centralbl., lxxxvii. (1901) p. 93.

§ Anatomy of the Bark of Robinia Pseudacacia, London, 11 pp. and 4 pls.

‖ Chemistry of the Bark of Robinia Pseudacacia, London, 23 pp.

¶ Beitr. z. Anat. u. Jahresringbildung tropischer Holzarten, Basel, 1900, 81 pp. See Bot. Ztg., lix. (1901) 2te Abt., p. 229.

depends on internal causes, although influenced by adaptation to climatic conditions.

Conducting Apparatus of Nyctagineæ.*—F. Gidon has studied the structure and development of the conducting apparatus in the stem and leaf in this order, and differs in several points from the conclusions of Van Tieghem. The peripheral zone which gives birth to the so-called supernumerary bundles is not a secondary generating zone; it constitutes in reality the procambium, which formed earlier the more deeply placed bundles, and the apparent movement of which towards the surface is due to the thickness of the non-vascular tissues which it produces towards the interior, especially in the medullary rays. A pericycle is always wanting. It is frequently replaced by a pseudo-pericycle, the origin of which is complex; it frequently arises from the procambium or liber. Several other points of structure are noted in the stem and leaves. The mesophyll may be entirely of a palisade character.

(4) Structure of Organs.

Fruit of the Scrophulariaceæ.†—A. Weberbauer gives an account of the varieties in the anatomical structure and mode of opening in the fruit of the Scrophulariaceæ, including the Selagineæ. A large number are described in detail and classified. The capsule exhibits, in the majority of the genera, the same kinds of imbibition movements that are found in other families. They open with drought and close with moisture. The opening is usually brought about by a movement or bending outwards of the valves, less often by a bending inwards. There are occasionally contrivances for assisting the transport of the fruit or of the seeds by animals.

Structure of Seeds.‡—F. H. Billings has investigated the development and structure of the seed of a large number of plants chiefly belonging to the Gamopetalæ (18 orders, 40 genera, 70 species), and finds but few characters that can be used for purposes of general classification. With the exception of the Primulaceæ and Plumbagineæ, there is only a single integument in the Gamopetalæ examined. When the integument attains a considerable thickness, as is the case in all the orders examined except the Oxalideæ, Geraniaceæ, and Plumbagineæ, it serves as a storing tissue for food-material. After impregnation the integument increases in thickness, either from increase in size only of the cells, or from increase in both size and number. The synergids disappear, in almost all cases, soon after impregnation; the antipodals are absorbed in the endosperm, taking no part in its formation.

Where haustoria occur, they may often be characteristic even of particular species. Their greatest activity is during the early stages of the development of the seed. They contain one or more nuclei, originating from the endosperm, except in the case of *Calendula*.

Suckers of Sequoia sempervirens.§—Suckers are of vary rare occurrence in Gymnosperms. Prof. G. J. Peirce describes those in *Sequoia*

* Mém. Soc. Linn. Normandie, xx. (1900) pp. 1–120 (6 pls.). See Bull. Soc. Bot. France, vii. (1900) p. 472.

† Beih. z. Bot. Centralbl., x. (1901) pp. 393–457 (1 pl.). Cf. this Journal, 1898, p. 319.

‡ Flora, lxxxviii. (1901) pp. 253–318 (100 figs.).

§ Proc. California Acad. Sci., ii. (1901) pp. 83–106 (1 pl.).

sempervirens. It is not unusual for these suckers to be entirely destitute of chlorophyll, and the author attributes this phenomenon to the fact tha the leaves form, and attain nearly or quite their full size, when the warmth is not sufficient for the formation of chromoplasts and chlorophyll. If a sucker is once white, it always remains so. The leaves on the colourless suckers are marked by the entire absence of palisade parenchyme.

Theory of Phyllotaxis.—Prof. S. Schwendener * replies at length to Winkler's attack on his theory of contact as explaining the phenomena of phyllotaxis. He maintains that in nearly all the cases brought forward by Winkler there is actual contact; exceptions occurring, however, in the spikes of *Zea Mays*, and in the 3-angled Cacteæ.

To this H. Winkler † rejoins, and disputes Schwendener's statement that the relative size of primordia is nearly constant for the equivalent organs of a shoot.

The individual facts on which the two disputants support their respective theories cannot be cited here in detail.

Unfolding of Leaves. ‡ — G. Hinze has studied the laws which regulate the unfolding of leaves in the bud, with reference to their position in venation and the protection of the young leaves against excessive radiation. They are arranged on this basis under a number of different types; and numerous examples are described in detail under each type.

"Fore-runner Point" of Leaves. § — Prof. K. Goebel explains the purpose of the "fore-runner point" (*Vorläufer-Spitze*) which is characteristic of the leaves of many Monocotyledons, by the theory that, from its hollow cylindrical structure, it conveys oxygen from the atmospheric air to the lower parts of the leaf, and assists therefore in the development of the bud, serving, at the same time, for the promotion of respiration.

Anatomy of Caryophyllaceæ and Primulaceæ.‖ — W. Meyer calls attention to the resemblance in anatomical characters of the cæspitose species belonging to these widely separated natural orders, as an example of the influence which conditions of soil and climate may have on the anatomieal structure of plants, resulting in a wide departure from the typical structure.

β. Physiology.

(1) Reproduction and Embryology.

Double Fertilisation in Maize. ¶ — After a *resumé* of the results obtained by other observers on the phenomenon of double fertilisation, L. Guignard gives an account of observations of his own, in which he claims to have actually observed the process for the first time in the

* SB. Preuss. Akad. Berlin, xxv. (1901) pp. 556–69 (5 figs.). Cf. this Journal, *ante*, p. 429. † Bot. Ztg., lix. (1901) 2te Abt., pp. 280–4 (1 fig.).
‡ Beih. z. Bot. Centralbl., x. (1901) pp. 224–56 (1 pl.).
§ Flora, lxxxviii. (1901) pp. 470–2 (2 figs.). Cf. this Journal, 1900, p. 346.
‖ Beitr. z. vergleich. Anat. d. Caryophyllaceæ u. Primulaceæ, Hildesheim, 1899, 74 pp. See Bot. Centralbl., lxxxvii. (1901) p. 205.
¶ Journ. de Bot. (Morot), xv. (1901) pp. 37–50. Cf. this Journal, *ante*, p. 57.

case of a hybrid maize. Before impregnation the two polar nuclei, which display no difference the one from the other, both lie in contact with the oosphere, being about double the size of the nucleus, and containing but little chromatin. One of the two male nuclei was seen to fuse with the nucleus of the oosphere, the other with the two polar nuclei; but the process takes place with so great a rapidity that it is extremely difficult to observe. The division of the polar nuclei also takes place with great rapidity; but one of the synergids persists for a time after impregnation. The author was never able to observe the actual fusion of the two polar nuclei.

M. Guignard criticises unfavourably Weber's theory that the nucleus of the embryo-sac may, in some cases, divide parthenogenetically in order to form the endosperm.

Embryology of Nelumbium.*—H. L. Lyon has studied the embryology of this genus of Nymphæaceæ, and concludes, from the resemblance of the development of the embryo to that of *Pistia*, and other considerations, that the order should be removed from the Dicotyledones, and placed among the Monocotyledones, in the series Helobiæ.

The vascular bundles are closed, and are irregularly placed through the stem.

The embryo-sac is ovoid at its micropylar end, and tapers down to a narrow attenuation which extends deeply into the nucellus; as the embryo-sac matures, the nucellar tissue directly in contact with it begins to break down. There also appears, in the antipodal region, a club-shaped cellular structure which obliterates the lower portion of the sac. The embryo goes through four stages,—the spherical, the "monocotyledonous," the "dicotyledonous," and the mature stage. In the spherical stage the young embryo becomes surrounded by endosperm-nuclei, between which thin cell-walls are very early apparent. There is no evident suspensor. The single cotyledon makes its appearance as a crescent-shaped mound of tissue round the rear of the embryo, its wings extending forward even with the plumule. In the third stage the cotyledon becomes bilobed through the localisation of growth at the foci, each lobe growing rapidly downward outside the endosperm. The lobes of the cotyledon are not separate structures, but have a common tissue at the base of the embryo. The structure of the ripe seed conforms more closely to the monocotyledonous than to the dicotyledonous type.

Embryo-sac of Delphinium.†—In *Delphinium exaltatum*, Louise B Dunn finds in the embryo-sac at maturity the normal seven cells; the oosphere and the synergids being, however, indistinguishable from one another. There is a well-defined endosperm-nucleus, and, at the chalazal end three very large and apparently active antipodals. These, as far as is known, do not disappear, but persist even in the oldest seeds without any trace of degeneration.

Embryology of the Caprifoliaceæ.‡—In *Viburnum prunifolium*, according to Nellie P. Hewins, the ovules of two of the locules of the

* Minnesota Bot. Studies, 1901, pp. 643–55 (3 pls.).
† Proc. Amer. Ass. Adv. Sci., 49th Meeting, New York, 1900, p. 284.
‡ Tom. cit., pp. 280–1.

tricarpellary ovary become early aborted, while the single ovule of the remaining locule develops normally. The embryo-sacs of the abortive ovules develop, but undergo changes correlated with their loss of function. The polar nuclei of the embryo-sacs of the functional ovule fuse before flowering; three antipodals are prominent, but soon disintegrate. The nucellar tissue, small in amount, disappears as the embryo-sac develops. The endosperm develops rapidly, and is surrounded by the integument; integumental cells infringing on the endosperm constitute a tapete which does not disintegrate.

Fertilisation of Salisburia.*—S. Ikeno supplements Hirasé's observations on the mode of impregnation of *Salisburia adiantifolia* (*Gingko biloba*). One only of the antherozoids from the pollen-tube is absorbed into the oosphere, the other perishing. The process of development of the nucleus of the oosphere is in complete accordance with that observed in *Cycas* and *Pinus*. The two conjugating nuclei are very unequal in size, the difference being even greater than has previously been observed in Gymnosperms; the female has quite ten times the volume of the male nucleus. As in other Gymnosperms, the small male nucleus slowly penetrates the female nucleus, the fusion of the substance of the two nuclei taking place very gradually.

Ovule and Embryo of Potamogeton.†—G. M. Holferty describes the structure and development of the ovule and embryo in *Potamogeton natans*. There is no wide departure from the normal. The embryo-sac is much more deeply seated than in many other plants, occupying the centre of the nucellus, and being surrounded on all sides by a mass of tissue from 5–8 cells in depth. The archespore consists of a single hypodermal cell, which divides into an outer or tapetal cell and an inner cell, the primary sporogenous cell or megaspore. There appear to be four potential megaspores. The antipodals are of short duration. The polar nuclei do not meet in the centre of the sac, but always nearer the antipodal end. The suspensor consists of a single cell, which is remarkably large and vesicular.

Endotropic Course of the Pollen-tube.‡ — After a short *resumé* of recent observations on the chalazogamic mode of impregnation in Angiosperms, especially those on *Alchemilla*, Dr. B. Longo disputes the explanation which has been given of chalazogamy, that it is due to the incapacity of the pollen-tube to grow across a cavity. Experiments on the artificial production of pollen-tubes induce him to believe that the explanation must be sought in chemotactic phenomena;—that the porogamic or chalazogamic course of the pollen-tube is determined by the presence of special chemotactic substances which are developed, in the one case within the tissues, in the other case outside of them.

Pollen-tube of Pinus.§—Miss M. C. Ferguson has investigated the development of the pollen-tube and the division of the generative

* Ann. Sci. Nat. (Bot.), xiii. (1901) pp. 305–16 (2 pls.). Cf. this Journal, 1896, p. 328.

† Bot. Gazette, xxxi. (1901) pp. 339–46 (2 pls. and 1 fig.). Cf. this Journal, 1898, p. 323.

‡ Atti R. Accad. Lincei, x. 2° Sem. (1901) pp. 50–4. Cf. this Journal, *ante*, pp. 431–3.

§ Ann. of Bot., xv. (1901) pp. 193–223 (3 pls.).

nucleus in certain pines, and finds the phenomena to agree in essential points in the species examined, viz.—*Pinus Strobus*, *P. austriaca*, *P. rigida*, *P. montana* var. *uncinata*, and *P. resinosa*.

In these species a period of about 13 months elapses between pollination and impregnation. The pollen-grain germinates very soon after pollination, and the vegetative nucleus immediately passes into the pollen-tube. In *P. Strobus* and *austriaca* the division of the antheridial cell takes place before the beginning of winter. During the first season the tube grows very slowly; it may be broad and irregular in outline, or it may branch freely. Shortly before impregnation the generative cell, followed by the pedicel-cell, moves into the pollen-tube; the pedicel-cell soon passes the generative cell, and takes up a position near the generative nucleus. The generative cell is never limited by a well-defined cell-wall; it consists, at the time of its division, of an irregular protoplasmic body, in the upper part of which lies the nucleus. In the division of the generative nucleus the spindle is extra-nuclear and unipolar in origin. This division takes place a little more than a year after pollination, and from a week to ten days before impregnation. Two sperm-cells are never formed; but the two sperm-nuclei, very unequal in size, remain surrounded by a common mass of protoplasm; they rapidly attain their full size, the larger one being always in advance. At the time when the sperm-nuclei come into contact, or nearly so, the pollen-tube has penetrated but little, if at all, beyond the nucellar tissue of the first year's growth; it now begins to elongate, and its downward course through the new nucellar tissue is very rapid. When just above the oosphere, the apex of the pollen-tube is filled with cytoplasm. The vegetative nucleus lies in the upper part of this cytoplasm, and near it is seen the pedicel-cell, still in contact with the lower portion of the cytoplasm which surrounds the sperm-nuclei. No individualised centrosome was observed.

A copious bibliography is appended.

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

Vitality of Seeds. * — H. H. Dixon finds that seeds of a number of different plants will resist very high temperatures if they are first air-dried. The most resistant seed experimented on was that of *Medicago sativa*; after exposure of one hour to 110° C., and then of one hour to 121° C., 10 p.c. of the seeds germinated. With other seeds the maximum temperature resisted was from 100° to 110° C. In all cases exposure to a very high temperature resulted in a retardation of germination and extremely slow growth afterwards, the plants being frequently weakly. With regard to the action of poisons on seeds, some seem to be able to withstand it, while others do not. The power of some seeds to resist poisons does not appear to be due to the quiescent state or stability of the protoplasm, but to the imperviousness of the seed-coat.

Influence of the Solar Rays on the Germination of Seeds.†— According to T. Tammes, the direct rays of the sun, which have such a

* Nature, lxiv. (1901) pp. 256–7. Cf. this Journal, 1900, p. 302.

† Landwirthsch. Jahrb., xxix. (1900) pp. 467–82. See Bot. Centralbl., lxxxvii. (1901) p. 14.

destructive effect on bacteria, have no influence, one way or the other, on the germinating power of the seeds of the higher plants, even after long exposure. The experiments were made on *Oryza sativa*, *Helianthus annuus*, *Erodium cicutarium*, *Datura Stramonium*, *Allium fistulosum*, *Erythræa centaurium*, *Nicotiana rustica*, and *Vicia Faba*.

Ripening of Shoots of the Vine.*—F. Kövessi gives further details of his observations on various species of *Vitis*. He adopts as a general statement the conclusion that ripening consists, from an anatomical point of view, in a development and differentiation of the tissues of the plant subsequent to the formation of the bark, a browning of the cortex, development of the xylem and phloem rings, reduction of the pith, thickening of the cell-walls, and increase in the amount of starch. The proportion of water in the branches is also greatly reduced, enabling them to resist a greater intensity of cold. The favourable conditions for ripening are strong light, a high temperature, and a small amount of moisture in the air.

Parasitism of Buckleya.†—S. Kusano publishes an account of the parasitism of *Buckleya Quadriala*, belonging to the Santalaceæ. The haustoria appear to attack the roots of almost any plant. As a result of the attack the activity of the cambium of the host-root seems to be much increased. The same organ of the parasite can apparently maintain its activity during fifteen years, and probably longer.

Periodicity in the Growth of the Root. ‡ — J. Hammerle has investigated the phenomena connected with the periodicity in the formation of roots, especially in the sycamore (*Acer pseudo-platanus*). He finds there are two annual periods of growth when the root increases in length and produces new lateral roots, viz. in the spring and the autumn. From January to March is a period of entire rest. Similar results were obtained with *Quercus*, *Salix*, and *Corylus*, but not with *Fagus*.

Periodic Growth in the Potato. § — Prof. C. MacMillan states that there is a rhythmic increase of growth in the potato-tuber, with maxima once or twice, or oftener, in 24 hours, followed by minima, when growth nearly or quite ceases.

Movement of Water in Plants.‖—K. Fuchs gives further evidence in favour of the already accepted theory that a cell the active contents of which are not homogeneous must absorb water from one side and give it out on the other, in other words must act as a pump; thus confirming the theory already enunciated by Pfeffer.

Transpiration and the Resistance of Stems. ¶ — A series of experiments by C. C. Curtis lead him to the following general conclusions. By means of pressure tests a definite measure of the resistance of a given length of stem to the transpiration current may be obtained, and

* Rev. Gén. de Bot. (Bonnier), xiii. (1901) pp. 193–211, 251–64, 307–25 (7 pls. and 3 figs.). Cf. this Journal, *ante*, p. 302.

† Bot. Mag. Tokyo. xv. (1901) pp. 42–6. See Bot. Gazette, xxxi. (1901) p. 440.

‡ Beitr. z. wiss. Bot. (Fünfstück), iv. Abt. 2. See Bot. Ztg., lix. (1901) p. 230.

§ Bull. Minn. Acad. Nat. Sci., iii. (1901) pp. 355–62. See Bot. Gazette, xxxi. (1901) p. 439.

‖ Beih. z. Bot. Centralbl., x. (1901) pp. 305–8 (3 figs.).

¶ Bull. Torrey Bot. Club, xxviii. (1901) pp. 335–48.

the work actually performed by the plant can be computed. The resistance overcome by the transpiration current is often much higher than can be measured by the suction of the transpiring shoot, and is subject to extensive variations in different species and among plants of the same species. Various parts of a stem differ widely in the resistance offered, and there is consequently no ratio in the rate of transmission of a stem under pressure and the length of stem.

(3) Irritability.

Conduction of Irritation in Plants.*—B. Němec gives a *resumé* of his previous communications on this subject, and gives further evidence of his discovery † of fibrils through which he believes that the irritation is conducted, though positive evidence of this connection is still wanting. As methods for observing the structure of these fibrils, he recommends the following:—Fixing in picric-glacial-acetic-acid-sulphuric acid, and staining by paracarmine; also fixing in chrom-acetic acid or Flemming's solution, staining by gentian-violet and orange-G, and differentiating in oil of cloves. Even in living objects he has detected them by slow killing in methylen-blue before the disorganisation of the fibrils.

These fibrils have a definite sheath, and are imbedded in a special protoplasmic layer. The sheath is regarded as a prolongation of the parietal utricle, and readily breaks up into nucleole-like granules. Transverse fibrils were found in certain cells, but not in bundles. The protoplasmic strands composed of these fibrils are always in direct connection with the nucleus, often dividing and enclosing the nucleus. Němec's observations were largely "traumatropic," i.e. were made on the transmission of the irritation in wounded bulbs of the onion.

G. Haberlandt,‡ while admitting the careful nature of Němec's observations, and confirming them to a certain extent, considers that further evidence is required before it can be set down as established that these fibrillar structures are the sole or the chief agent for the transmission of irritation in plants. There are many examples of a conduction of irritation through organs in which no fibrillar structure has been detected:—glands on the leaf of *Aldrovanda vesiculosa*, tendrils of *Cucurbita Pepo*, sensitive stamens of *Opuntia vulgaris*, &c.

Phenomena of Tactic Sensitiveness.§—W. Rothert describes in great detail the results of a long series of observations on the sensitiveness of vegetable organisms to contact-irritation. Among the more important are the following:—

In addition to the examples already known—*Polyphagus Euglenæ* and *Chytridium vorax*—positive phototaxis (or, as the author prefers to call it, *prosphototaxis*) was observed in another colourless micro-organism, a species of *Bodo*.

The term "chemo-kinetic sensitiveness," or *chemokinesis*, is applied by the author to an arrest or an incitement to movement caused by

* Die Reizleitung u. d. reizleitenden Structuren b. d. Pflanzen, Jena, 1901, 153 pp., 3 pls., and 10 figs. See Bot. Ztg., lix. (1901) Abt. ii. p. 148; also Nature, lxiv. (1901) p. 371.

† Cf. this Journal, *ante*, p. 437.

‡ Biol. Centralbl., xxi. (1901) pp. 369–79.

§ Flora, lxxxviii. (1901) pp. 371–421.

chemical substances. An example is afforded by the swarm-spores of *Saprolegnia*, which soon come to rest under the influence of chemical irritation (chemotaxis), but, when not under this influence, continue their motion for a longer time. *Apaerotaxis* is the term given to a repugnance to oxygen, an instance of which is adduced in a species of *Amylobacter*. The same organism and *Bacillus Solmsii* exhibit *proschemotaxis* (positive chemotaxis) towards ether.

The chemotactic sensitiveness of an organism towards different chemical substances appears to depend on different properties of the protoplasm. While in the chemotactic movement of spermatozoids, the capillary opening exercises a directing influence on their motion; bacteria, on the other hand, display simply a swarming movement round the opening. A distinction is drawn between *strophic* and *apobatic* chemotaxis, the motion consisting in the former case of a twisting, in the latter of a repulsive movement. *Osmotaxis* is distinguished from chemotaxis in that it is induced, not by the chemical composition, but by the osmotic property of the medium.

Finally, the author calls attention to the inconstancy or fickleness of the tactic sensitiveness of micro-organisms. They appear to be most sensitive when first operated upon, and gradually to lose this sensitiveness, possibly from long cultivation diminishing the struggle for existence.

Senso-motory Apparatus of the Tendrils of Cucurbitaceæ.*—Prof. A. Borzì has studied the anatomy of the senso-motory apparatus in tendrils, which he finds to be uniform in its main features throughout the Cucurbitaceæ. The activity of the tendril cannot be accounted for by variations in the ordinary processes of growth; they must be attributed to a special activity of the protoplasm.

The phenomena may be regarded as extending over three phases:—(1) Attachment to the support by means of the free extremity, and its circumnutation in space; (2) coiling round the support by the apical portion; (3) definite attachment of the whole of the tendril to the support. In the first phase the apex is composed of a resistant somewhat horny refringent substance, with a very strongly thickened cuticle. The hooked form of the apex, caused by a slight difference in the growth of the two sides, serves to assist the attachment to the support; the motion being the result of the negative geotropism of the branch, and of the circumnutation of its apex. During the second phase, the sensitive properties of the tendril come strongly into play; these are confined to its inner or concave side. During this phase all the epidermal protoplasts of a tendril (except those of the basal portion) must be regarded as sense-organs, and are furnished with strongly contractile threads of protoplasm which are the motory organs. Every sensory cell possesses a number of very short protoplasmic papillæ, which constitute a tactile body. In the third phase, the tendril has acquired a somewhat woody consistency and great elasticity. It becomes closely attached to the support.

The permanence of the position induced by the elasticity of the protoplasmic threads, and the sensitive phenomena in general, are

* Atti R. Accad. Lincei, x. (1901) pp. 395–400.

greatly assisted by a structure which the author calls, after its discoverer, "Bianconi's plate" (*lamina del Bianconi*), common to most tendrils, including all the Cucurbitaceæ. It consists of a plexus of sclerenchymatous fibres near the fibrovascular bundles, on the side towards the concave face of the organ.

Motile Cushions of Robinia and Porlieria.*—E. Pantanelli describes in detail the structure of the motile cushions in the leaves of *Robinia pseudacacia* and *Porlieria hygrometrica*. With regard to both the primary and the secondary cushions, he states that, in both the upper and the lower half of the cushion, the expansive force increases as the night advances, diminishing again with the increase of light in the morning. The maximum expansive force in the night, and the minimum expansive force in the day-time, account for the nyctitropic movements of the leaves and leaflets in these species.

Sensitive Style of Arctotis.†—M. von Minden describes the phenomena connected with the sensitive style of two species of *Arctotis* (Compositæ, Cynareæ), *A. aspera* and *calendulacea*, from South Africa. The pollen is pushed out by the growth of the style, but the very strong proterandry renders self-pollination impossible. The elongation of the style and the opening of the five corolla-lobes take place with very great rapidity. The style is sensitive on all sides, and bends in any direction at an angle of 45°, either as a response to mechanical irritation, or spontaneously under the influence of sunlight. When fully carried out, this curvature of the style brings the stigma into contact with the receptacle. Subsequently the style again contracts, so that it and the stigma are almost entirely enclosed within the dried-up anther-tube. The author assigns as the purpose of this irritability the facilitating of cross-pollination by flies.

Geotropism of Stems.‡—Pursuing his investigations on this subject (chiefly on *Lupinus albus*), E. B. Copeland states that, in nearly all the plants observed, the sharpest geotropic curve occurs above the middle of the hypocotyl. In the base of the hypocotyl the downward curve occurs only in a zone not separated from the root-tip by any mature tissue; the geotropic response is evidently to a stimulus received at the root-tip. The structure of stems does not demand that the geotropic response they execute shall be negative, and the root-structure is not essential to the positive response; the more characteristic feature in both organs is the perception. The cotyledon of many Monocotyledons elongates at the base and is positively geotropic.

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

Appearance and Disappearance of Phosphorus-Compounds.§—The observations of L. Iwanoff on the appearance and disappearance of compounds of phosphorus in plants are in general accordance with those of Schimper. The distribution of phosphorus in plants is very wide; it

* Atti r. Ist. Bot. Univ. Pavia, vii. (1901). See Nuov. Giorn. Bot. Ital., viii. 1901) p. 524.
† Flora, lxxxviii. (1901) pp. 238–42.
‡ Bot. Gazette, xxxi. (1901) pp. 410–22 (3 figs.). Cf. this Journal, 1900, p. 695.
§ Pringsheim's Jahrb. f. wiss. Bot., xxxvi. (1901) pp. 355–79.

is always found abundantly in the colourless parenchyme of the cortex and of the pith, both in the branches and in the root. In the mesophyll and epiderm of the leaf it occurs only in traces; in the leaves it is found almost exclusively in the vascular bundles or their sheaths. In bleached leaves phosphorus occurs also abundantly in the colourless mesophyll. It is found, although in small quantities, in ripe seeds, and in all parts of the flower with the exception of the pollen. The source of the phosphorus is the organic compounds of phosphorus in the soil, which are converted by the plant into phosphates; and this takes place in the seedling plant rather than in the cotyledons. The assimilation of phosphates takes place chiefly in the leaves. Among the lower plants phosphorus was found in *Atrichum*, *Funaria*, *Marchantia*, *Spirogyra*, *Cladophora*, *Nostoc*, and *Phormidium*; in the Hymenomycetes only in the stipes.

Influence of Injury to the Tissues on the Production of Proteids.*— By cutting up, and otherwise injuring, onion bulbs, A. Hettlinger shows that the wounding of the tissues of plants has a tendency to increase the amount of proteid substances in the plant.

Germination of Phœnix canariensis.†—E. Bourquelot and H. Hérissey find, during the germination of the seeds of this palm, a soluble ferment capable of hydrolysing the mannoses of the endosperm, with production of mannose. This ferment penetrates into the endosperm, at least into those portions of it which are in contact with the cotyledon. The mannose is used up as it is formed.

Enzymes of Bacteria and Moulds.‡—Prof. C. Eijkmann divides microbic enzymes into four classes, viz. those which split up casein, hæmolytic, amylolytic or diastatic, and fat-splitting or lipases. Contrary to the usually accepted notion, the author finds that enzymes which are colloid bodies are diffusible through colloids. This holds true not only for maltase and for microbic enzymes, but also for enzymes of animal origin. Thus, if carmin-fibrin be enclosed in agar and immersed in gastric juice, it is digested; while the result is negative if a control experiment be made with hydrochloric acid. The penetration of ptyalin is provable in a similar way. If a drop of saliva be placed on a starch-agar plate, the medium in the vicinity is soon cleared up. That the starch is decomposed can be proved by the aid of dilute iodine solution. The experiment also succeeds even when the drop of saliva is separated from the starchy layer by a starch-free agar layer. When a little gelatin solution is placed on an agar plate, it is soon absorbed, provided that a suitable temperature be maintained.

The presence of the caseases was demonstrated on a medium composed of buttermilk and agar. Blood-agar was used for the hæmolytic experiments, and starch-agar for the amylases. For the lipases a thin layer of tallow was spread on the bottom of a Petri capsule, and upon this a layer of agar. The experiments with lipases showed that the fat underwent saponification, a calcium-soap being first formed. The calcium was afterwards replaced by sodium, and finally by ammonium.

* Rev. Gén. de Bot. (Bonnier), xiii. (1901) pp. 248–50.
† Comptes Rendus, cxxxiii. (1901) pp. 302–4.
‡ Centralbl. Bakt., 1[te] Abt., xxix. (1901) pp. 841–8.

Hence a product was finally attained which had much resemblance to adipocere. With regard to the enzymes which decompose casein, and those which liquefy gelatin, the opinion is expressed that they are probably identical. The hæmolytic enzyme is not identical with trypsin, and it is not improbable that the tryptic enzymes secreted by different micro-organisms are different.

Respiration of Plants.*—K. Purjewicz has studied the value of the quotient $\frac{CO_2}{O_2}$ in the case of *Aspergillus niger*, with various nutrient media, and has come to the following general conclusions. The value of the fraction is greater, the larger the proportion of oxygen in the nutrient substance; with the carbohydrates it is, as a general rule, smaller the higher the molecular weight. With dextrose and saccharose the quotient rises as the concentration is increased up to an optimum (10 p.c.), decreasing again when the concentration is further increased. With the exception of tartaric acid, all the substances experimented on yielded a relatively smaller amount of carbon dioxide in physiological oxidation than in combustion.

Intramolecular Respiration and Production of Alcohol by Seeds placed in water.† — A series of experiments by E. Godlewski and F. Polzeniusz on the germination of peas lead to the conclusion that the chemical processes are, in the main, identical with fermentation, the main product being alcohol and carbon dioxide, others only in inconsiderable quantities. Not only the reserve-substances of seeds, but carbohydrates absorbed from without, can be fermented in the seeds as they are by the yeast-fungus, cane-sugar being in the first place inverted. The quantity of alcohol thus produced may amount to as much as 22 p.c. of the original dry weight of the seed. Asparagin is not one of the products of intramolecular respiration. It would appear, however, that the chemical processes concerned in the respiration of seeds are not uniform for all plants, but vary according to circumstances.

Influence of the Alkaloids on Respiration.‡ — N. Morkowine gives the details of a series of experiments on the influence of different alkaloids on the respiration of *Vicia Faba*. The disengagement of CO_2 was found uniformly to increase under the influence of alkaloids, i.e. oxidation is accelerated but not the decomposition of oxidised substances. When the action commences, the value of the proportion $\frac{CO_2}{O}$ is below the normal; it then rises considerably, but never reaches unity; always remaining above the normal with concentrated solutions, but scarcely above it with dilute solutions. With regard to their toxic influence on the vegetable cell, the alkaloids experimented on may be arranged in the following series:—quinine, cinchonine, caffeine, morphine, cocaine, strychnine, atropine, antipyrine, brucine, codeine, pilocarpine. Of all the materials used, the most poisonous was chlorhydrate of quinine.

* Schriften d. Naturf.-Ges. Kiew, xvii. (1899) (Russian). See Bot. Centralbl., lxxxvii. (1901) p. 141.

† Bull. Internat. Acad. Sci. Cracovie, 1901, pp. 227–76 (1 fig.) (German). Cf. this Journal, *ante*, p. 558.

‡ Rev. Gén. de Bot. (Bonnier), xiii. (1901) pp. 109–26, 177–92, 212–26, 265–75.

γ. General.

Ant-Gardens.*—E. Ule has made some interesting observations on the ant-gardens which abound on many woody plants in the Amazon region. They are commonly spherical, and about the size of a walnut. Several species of ants appear to collect the seeds of a number of plants and sow them in these nests, covering up the seedlings with humus when they begin to germinate. In the structure of these "ant-epiphytes," the roots and foliage display characters which especially adapt them for the situation in which they grow, and promote the protection of the ants in their nests. Quite a number of these epiphytes were found by Ule as denizens of the ant-gardens, and nowhere else. These comprised 3 species of Araceæ, 5 of Bromeliaceæ, 5 of Gesneraceæ, 1 of Moraceæ, 2 of Piperaceæ, and 1 of Cactaceæ.

Contrivances for Distribution in Plants.†—M. Kronfeld discusses the various ways in which seeds or fruits are distributed,—by a floating apparatus, by the elasticity of the walls of the carpels, by adhering to the fur of animals, &c., devoting the present instalment to a detailed description of the contrivances for assisting carriage by the wind (anemocarps). The minute seeds of epiphytic Orchids are dispersed by means of hygroscopic hairs. The twisted ovary, which afterwards becomes straight, is a further assistance. In a very large number of plants—Primulaceæ, Labiatæ, Asperifolieæ, *Plantago*, &c.—the wind shakes the seeds out of the dry persistent calyx; and this is the case with one genus of Compositæ, *Lapsana*, in which the calyx is almost entirely obsolete. The seeds of *Typha* possess special contrivances for dispersion, not only by the wind, but also by water and by animals.

Osmotic Pressure as a Defence against Cold.‡—M. d'Arsonval attributes the exemption of living plants from destruction by severe cold to the very high osmotic pressure within the cell, which, as is well known, prevents water from freezing. Beer-yeast, the pyocyanic bacillus, and various pathogenic microbes, may retain their vitality even after having been subjected, during several weeks, to the temperature of liquid air. It has been shown that the pressure within the cells of certain mould-fungi may exceed 160 atmospheres; and it is possible, the author suggests, that within micro-organisms it may amount to thousands of atmospheres.

B. CRYPTOGAMIA.

Phyllotaxis in Musci and Florideæ.§—In certain genera of Mosses—*Dicranum*, *Aulacomnion*, *Polytrichum*—H. Seckt has established the law that each new segment of the apical cell is so formed that the inner wall of the n^{th} segment is nearly parallel to the inner wall of the n–3^{rd} segment. The anodic encroachment (*Vorgreifen*) of the newly formed membrane cannot therefore be original, but must be the result of a subsequent displacement. The same is stated by the author to be the case,

* Engler's Bot. Jahrb., xxx. (1901) Beibl. 68, pp. 45–52 (1 pl.).
† Stud. üb. d. Verbreitungsmittel d. Pflanzen, Th. i. Windfrüchtler, Leipzig, 1900 (5 figs.). See Bot. Centralbl., lxxxvii. (1901) p. 58.
‡ Comptes Rendus, cxxxiii. (1901) pp. 84–6.
§ Beih. z. Bot. Centralbl., x. (1901) pp. 257–78 (2 pls.).

contrary to the assertion of previous observers, also in certain Florideæ —*Polysiphonia*, *Rhodomela*. Where, therefore, a spiral phyllotaxis occurs in the Florideæ, it must be the result of the contact which occurs in the apical region.

Phylogeny of the Green Algæ and Archegoniatæ.* — K. Bohlin proposes the following scheme for the relationships of the Green Algæ and Archegoniatæ.

The Chlorophyceæ are descended from the Flagellata; their isogonids or zoospores are embryonal forms of the greatest phylogenetic importance. The spermatozoids and the zoogonids have the same number of cilia and the same systematic value. A second character of great importance is the pigment and the product of assimilation of the chromatophore. The pigments soluble in alcohol are of the greatest systematic value; while those soluble in water (phycoerythrin and phycocyan), while determining the colour of the plant, do not influence the product of assimilation. On these principles the green algæ may be classed under three groups, parallel to the Phæophyceæ, viz.:—

(1) *Heterocontæ*:—Product of assimilation oil; two unequal flagella. Descended from the Chloromonadineæ.

(2) *Chlorophyceæ*:—Product of assimilation starch. Descended from several unknown or extinct types of green Flagellata.

(3) *Glaucophyceæ*:—Blue-green like the Cyanophyceæ; but provided with a nucleus and producing starch as the product of assimilation. Descended from the Cryptomonadineæ.

The Vaucheriaceæ are detached from the Siphoneæ and placed among the Heterocontæ, with a probable descent from *Vacuolaria*, on account of their agreement in the product of assimilation and in the structure of the spermatozoids; while the starch-forming Siphoneæ belong to Chlorophyceæ. It is doubtful whether the yellow-brown unicellular Algæ at present known (*Entodesmis*, *Phæococcus*), belong to the Phæophyceæ or to the Glaucophyceæ.

The Archegoniatæ are probably derived from the starch-producing Chlorophyceæ, but not in one line of descent. The ciliation of the spermatozoids shows that there must have been at least three lines, which have developed into the Bryophyta, the Lycopodineæ, and the remaining Pteridophyta.

Cryptogamia Vascularia.

Root of Vascular Cryptogams.†—G. Chauveaud has made the following observations.

In Equisetaceæ the separation of the cortex and the stele takes place, not merely before the separation of the external cortex; it precedes all other septation, even the appearance of the radial longitudinal septa which divide each of the three external segments into several cells. The cortical or stelic elements, instead of being at first superposed on the transverse plane, alternate with one another. The cortical segments, eight or more in number, are arranged in a single layer, surrounding

* Utkast. till d. gröna Algernas o. Arkegoniaternas Fylogeni, Upsala, 1901. See Bot. Ztg., lix. (1901) 2te Abt. p. 234.

† Comptes Rendus, cxxxiii. (1901) pp. 54–5.

the stelic cells, which number only three. These three stelic cells afterwards divide to produce the sieve-tubes, the vessels, and the conjunctive of the definite stele; but no pericyclic region can at any time be distinguished.

In the root of *Azolla* there is a pericyclic layer outside the two xylem-bundles, each of which is composed of two vessels. The outer of these vessels undergoes differentiation before the sieve-tubes,—a speciality of this root.

In Ferns, the first layer detached at the periphery of the stele regarded as the pericycle, gives rise to the first sieve-tubes. Some of these cells divide by a tangential septum, and the inner daughter-cells develop into sieve-tubes, while the outer daughter-cells gradually acquire the dimensions of the undivided pericyclic cells. Additional sieve-tubes are afterwards differentiated directly within the undivided pericyclic cells; they are situated on the same arc as the first sieve-tubes; so that the two kinds of sieve-tube cannot afterwards be distinguished.

Sporange and Inflorescence of Selaginella.* — According to Prof. K. Goebel, the impregnation of the female by the male organs on the same spike in *Selaginella* is rendered difficult by their relative position; by the proterogyny of the sexual organs; by the violent expulsion of the megaspores when ripe; and by the unequal rapidity of germination of the two kinds of spore from the same spike. The two kinds of sporange open in the same way, viz. by two valves which become detached, by lateral fissures, from the basal boat-shaped portion; but, in the megasporange, the mechanism for the expulsion of the spores renders the structure of the wall the most complicated that occurs in Pteridophytes. In no other genus of Pteridophytes is there a mechanism for the mechanical expulsion of spores.

The inflorescence (*Blüthenstand*) presents the only example of a dorsiventral arrangement in these organs that occurs in Pteridophytes; it is in *Selaginella* the most common arrangement of the vegetative organs.

Imperfect Sporanges in Pteridophyta.† — Prof. F. O. Bower discusses the question whether the imperfect sporanges found in certain Vascular Cryptogams are vestigial. The instances cited occur especially in many species of *Lycopodium*, though illustrations are given from other genera and from fossil plants. A discussion of the phenomena of development leads the author to the conclusion that the imperfect sporanges at the base of the strobile are vestigial organs, and are not indicative of an upward evolution, leading in the race to the complete sporange. In *Lycopodium* there appears to be a zone of reproductive activity, limited below by phylogenetically evanescent or vestigial parts, above by phylogenetically nascent or supernumerary parts.

Anatomy of the Schizæaceæ.‡—The following is given as a summary of the more important results derived from an examination by L. A. Boodle of the structure of a number of species of Schizæaceæ belonging to the genera *Lygodium*, *Schizæa*, *Anemia*, and *Mohria*.

* Flora, lxxxviii. (1901) pp. 209–28 (16 figs.).
† Ann. of Bot., xv. (1901) pp. 225–67. ‡ Tom. cit., pp. 359–421 (3 pls.).

The sieve-tubes of the Hymenophyllaceæ and Schizæaceæ do not appear to form callus; but in other respects (perhaps excepting *Schizæa*) agree structurally with the sieve-tubes of other ferns. Silica-nodules occur in the cavities of parenchyme-cells in some species of *Lygodium* and *Anemia*. The fibres in the petiolar bundle of some species of *Lygodium*, *Schizæa*, and *Anemia* are to be regarded as modified sieve-tubes. Those of *Trichomanes Prieurii*, on the other hand, appear to be formed either all from parenchyme or some from parenchyme and some from sieve-tubes. The species of *Lygodium* are very uniform in structure, and possess a solid stele; *Schizæa* has a medullated stele; while dialystelic structure is found in *Mohria* and some species of *Anemia*, solenostelic structure in others. The "seedling" [sporeling, ED.] of *Lygodium* does not suggest reduction from a more complicated type. In the "seedling" of *Anemia* the solid stele is converted into a dialystelic one by gradations similar in type to those found in *Pteris*. The protoxylem belonging to the stem in Schizæaceæ is scattered, does not include spiral elements, and is differentiated mostly with no relation to the leaf-traces. The petiole possesses a single bundle. The roots appear to be diarch throughout.

Muscineæ.

Anatomy of the Leucobryaceæ.*—From the anatomical characters of the leaves, J. Cardot classifies the genera of Leucobryaceæ in four sections, viz.:—(1) Leucobryeæ; leaf-vein without a bundle of stereid cells; chlorocysts (chlorophyll-cells) tetragonal on transverse section, in a single row along the entire length of the vein (*Leucobryum*, *Ochrobryum*, *Schistomitrium*, *Cladopodanthus*. (2) Leucophaneæ; leaf-vein with a bundle of stereid cells in the middle, chlorocysts tetragonal on transverse section, in a single row through the entire length of the vein (*Leucophanes*). (3) Octoblephareæ; leaf-nerve without a bundle of stereid cells, chlorocysts triangular on transverse section, in a single row through the entire length of the vein (*Cardotia*, *Octoblepharum*). (4) Arthrocormeæ; leaf-vein without a bundle of stereid cells, chlorocysts irregularly arranged in three rows, at least in the upper part of the vein (*Arthrocormus*, *Exodictyon*). The author regards the whole of that portion of the leaf which consists of several layers as a vein; the lamina including only the marginal portion of the leaf which is only a few cells in width. The vein may consist of the same number of layers of cells throughout (usually three), or the number of rows may gradually diminish towards the apex.

Algæ.

Melobesieæ.†—M. Foslie gives a monograph of the species hitherto known of this section of the Corallinaceæ. The characters used for discriminating the genera and sub-genera are mostly derived from the reproductive rather than from the vegetative organs. The genera are ten in number, viz.:—*Archæolithothamnion* (Rothpl.) Fosl. (13 sp.),

* Mém. couron. par l'Acad. Sci. Cherbourg, 1900, 84 pp. and 19 pls. See Bot. Centralbl., lxxxvii. (1901) p. 167.

† Kgl. norsk. Vidensk. Skrift., 1900, No. 5, pp. 1–22. See Bot. Centralbl., lxxxvii. (1901) p. 49. Cf. this Journal, 1897, p. 417.

Phymatolithon Fosl. (3 sp.), *Clathromorphum* Fosl. (4 sp.), *Lithothamnion* Phil. emend. (64 sp.), *Chætolithon* Fosl. (1 sp.), *Goniolithon* Fosl. (13 sp.), *Lithophyllum* Phil. emend. (44 sp.), *Melobesia* Lamour emend. (11 sp.), *Dermatolithon* Fosl. (5 sp.), *Choreonema* Schm. (1 sp.).

Ulva latissima and its relation to the Pollution of Sea-Water.*—From observations made on the growth of this sea-weed in Belfast Lough, where it is extremely abundant, and on cultures, Prof. Letts and J. Hawthorne conclude that the sewage-like stench is largely due to the sulphuretted hydrogen given off by its fermentation. The decaying sea-weed appears to be attacked by two micro-organisms in succession; the first is a spore-forming bacillus, the product of fermentation consisting mainly of propionic acid derived from the decomposition of the albuminoids; the second producing ultimately sulphuretted hydrogen from the reduction of sulphates. The *Ulva* flourishes in polluted water, and is generally, when present in large quantities, a sign of the presence of sewage. By its capacity of producing sulphuretted hydrogen, it enormously increases the evil. It has a remarkable power of absorbing nitrogen from polluted sea-water in the form both of ammonia and of nitrates.

Dictyosiphon.†—Dr. S. Murbeck gives an account of this genus of Phæosporeæ. The growth of the "hairs" is fully described and figured; also the formation of pits, and the consequent enlargement of the surface of the thallus. The occurrence of "hyphæ" in the thallus is noted in the case of *D. fœniculaceus.* This species is epiphytic on *Chordaria*, the two plants showing a close intermingling at the point of junction.

Classification of Desmidiaceæ.‡ — Prof. C. E. Bessey proposes the arrangement of the American genera of desmids under three tribes, viz. the Desmidieæ, Arthrodieæ, and Cosmarieæ. The Desmidieæ are characterised by having the cells in unbranched filaments, and comprise the genera *Gonatozygon*, *Genicularia*, *Gymnozygon*, *Phymatodocis*, *Hyalotheca*, *Desmidium*, *Sphærozosma*, and *Onychonema*. In the Arthrodieæ the cells are solitary and elongated, and not at all, or but moderately, constricted; the genera are *Entospira*, *Mesotænium*, *Penium*, *Arthrodia* (*Closterium* Nitzsch), *Tetmemorus*, *Docidium*, and *Pleurotænium*. In the Cosmarieæ the cells are solitary, broad, and deeply constricted; they include the genera *Cosmarium*, *Pleurotæniopsis*, *Cosmocladium*, *Arthrodesmus*, *Euastrum*, *Micrasterias*, *Xanthidium*, and *Staurastrum*.

Structure of Diatoms.§—F. Keeley states that, in a certain group of species of *Aulacodiscus*—*A. oreganus*, *Rogersii*, *Janischii*, &c.—we have a structure differing essentially from that of other diatoms. The typical honeycomb cellular structure is marked by the unusual character of the external plate, which differs from that of other diatoms in having the finer secondary structure between, rather than over, the large cells of the middle plate. *A. oreganus* is one of the few diatoms that show bright colours with central transmitted light.

* Proc. Roy. Soc. Edinburgh, xxiii. (1901) pp. 268–94 (3 pls.).

† Vidensk. Skrift., Mathem.-naturv. Klasse, No. 7. 1900. See Journ. Bot., xxxix. (1901) p. 251.

‡ Trans. American Micros. Soc., xxii. (1901) pp. 89–96 (1 pl.).

§ Proc. Acad. Nat. Sci. Philadelphia, 1901, pp. 321–3.

Ægagropila.*—Lorenz v Liburnau has investigated the conditions under which the organism known as *Ægagropila Sauteri* is formed in the Zeller See and elsewhere. The hollow balls are unquestionably simply a mode of growth, dependent on external conditions, of a species of *Cladophora*. The special condition favourable to the formation of the balls appears to be a nearly uniform illumination on all sides, which can occur only in shallow water, where they are constantly rolled about by the waves. The formation of these balls is the only character by which *Ægagropila Sauteri* can be distinguished from the polymorphic *Cladophora glomerata* or from *C. muscoides*.

Transplantation and Structure of Protoplasm in Bryopsis.†—S. Prowasek has made further study of the phenomena connected with the transplantation of a portion of the structure in *Bryopsis plumosa*. He states that—excluding the phenomena of conjugation—a complete fusion of two masses of protoplasm does not take place. The movement of the protoplasm in *Bryopsis* is, correctly speaking, a movement neither of rotation nor of circulation, but a simple streaming. It usually begins at the apical end of the pinna or portion of a stem, and runs down all sides to the base; only rarely were counter-streamings observed. Light plays a large part in the life of *Bryopsis*; in the dark it loses its characteristic form and assumes a filiform woolly character. The elongated chlorophyll-bodies have an obscurely mesh-like structure; they often contain two or three pyrenoids, but usually divide independently of their position.

Acicularia and Acetabulum.‡—M. A. Howe gives a very full description of the rare and beautiful species *Acicularia Schenkii*. Described at first as a species of *Acetabularia*, the author now identifies it generically with the fossil *Acicularia Pavantina*.

Thermal Alga.§—An alga already known as *Protococcus vulcanicus* and *Pleurococcus sulphurarius* is described by G. A. Galdieri from the hot sulphur-springs of Pozzuoli. It consists of a single spherical cell 3–12 μ in diameter, of a blue-green colour. The chromatophore completely clothes the inner surface of the cell-wall. The cell-sap contains a number of colourless, strongly refringent pyrenoids [? Ed.], which are in constant active motion. No nucleus or cilia could be detected.

Fungi.

Sexuality of Fungi.‖—F. Oltmanns sums up the results of all recent observations of importance on this subject, and concludes that the evidence is in favour of De Bary's view of a true sexuality rather than of the opposing view of Brefeld. This is especially the case with the Ascomycetes, and points to a closer affinity of this class of Fungi with the Florideæ than has generally been admitted. It is not, however, necessary to assume that all organs which were originally of a sexual character have retained that function, as with the "spermatia" of lichens.

* Verhandl. k. k. Zool.-bot. Gesell. Wien, li. (1901) pp. 363–8. Cf. this Journal, 1900, p. 92.
† Biol. Centralbl., xxi. (1901) pp. 283–91 (13 figs.).
‡ Bull. Torrey Bot. Club, xxviii. (1901) pp. 321–34 (2 pls.).
§ Rend. Accad. Sci. fis. e mat. Napoli, v. pp. 160–4. See Bot. Centralbl., lxxxvii. (1901) p. 84.
‖ Biol. Centralbl., xxi. (1901) pp. 433–42 (5 figs.).

Phycomycetes and Ascomycetes.* — A. Möller gives a detailed account of the Brazilian Phycomycetes and Ascomycetes. Among the many interesting points, the following may be especially noted.

Among the Phycomycetes, *Empusa Muscæ* and *Conidiobolus utriculosus* are as abundant as with us. The life-history of *Basidiobolus Ranarum* is especially followed out. The genera *Dimargaris*, *Dispira*, *Coemansia*, *Martensella*, *Syncephalis*, and *Piptocephalis*, must be removed from the Zygomycetes and placed at the end of the Entomophthoraceæ. In the Oomycetes there are three series:—the 1st including the genera *Pythium*, *Phytophthora*, and *Peronospora;* the 2nd begins with *Monoblepharis*, and leads, through *Basidiobolus*, to *Conidiobolus;* the 3rd includes *Calvocephalis*, *Syncephalis*, *Piptocephalis*, and others. Most of the Phycomycetes are cosmopolitan; *Choanophora americana* sp. n. is described.

The various theories with regard to the sexuality of the Fungi are discussed at length. The author does not consider either Harper's or Dangeard's conclusions as at present beyond the region of controversy.

Among the Hypocreaceæ the form of the ascospore must be taken as the first factor in classification rather than the differentiation of the stroma.

Nearly all the Didymoporæ are parasitic on other fungi, and possess conids and chlamydospores. Several new species of *Hypocrea* and of other genera are described, and the following new genera:—*Mycocitrus aurantium* g. et sp. n. forms large red spherical stromata ($\frac{1}{2}$ lb. in weight) on bamboos. Similar large stromata are formed on the bamboo by *Peloronectria vinosa* g. et sp. n., belonging to the Phragmosporæ; its spores are 4-celled.

The Scolecosporæ are especially abundant in the Tropics. *Mycomalus bambusinus* g. et sp. n. also forms spherical stromata on bamboos; *Ascopolyporus* g. n. has a stroma resembling in form that of a pleurocarpous *Polyporus*. The genus *Cordyceps* is especially abundant in the Tropics, and many new species are described.

Among Sphæriaceæ we have, in the Xylarieæ, *Trachyxylaria* g. n., with free peritheces; *Entonæma* g. n., with soft, gelatinous, hollow, black receptacle, and unicellular dark-brown spores; and *Henningsinia* g. n., with receptacle of extraordinary hardness, resembling a button.

Among the Discomycetes 2 new genera are described:—The mycele of *Phycoascus tremellosus* g. et sp. n. forms a kind of loosely felted hypothallus. The apothece of *Peltigeromyces microsporus* g. et sp. n. forms discs 3 cm. in diameter, with rolled up lobes and branches at the margin.

Biology and Cytology of Pythium ultimum sp. n.† — Dr. A. H. Trow describes this new species of fungus, distinguished from the other species of *Pythium* by the absence of zoospores, found on rotten cress-seedlings. It is a pure saprophyte, and can be cultivated on animal or vegetable media. On potatoes an aerial mycele is freely formed, which remains sterile for weeks. An aquatic mycele is produced on house-flies

* Schimper's Bot. Mittheil. a. d. Tropen, Heft ix. (1901) 319 pp. and 11 pls. See Bot. Centralbl., lxxxvi. (1901) p. 133.

† Ann. of Bot., xv. (1901) pp. 269–312 (2 pls.).

and on cabbage immersed in water. The conids and oosperms invariably produce germ-tubes. The mycele, conids, oogones, and antherids are multinucleate, the oosphere and the ripe oosperm uninucleate, and the young oosperm binucleate. The nuclei multiply in the mycele and sexual organs by indirect division. No nuclear fusions take place other than those of the male and female nuclei in fertilisation. The number of chromosomes is considerable, certainly 6 or more. The oogone receives 12 or more nuclei, the antherid 3 or more. These invariably divide once, so that the number of nuclei is doubled. The supernumerary nuclei in the oogone pass into the periplasm; one only remains behind, and occupies the centre of the ovum-cell. No similar differentiation takes place in the antherid. The fertilisation-tube penetrates the wall of the oogone, passes through the periplasm, and penetrates deeply into the ovum-cell. One male nucleus passes down, and enters the ovum-cell. The oosphere clothes itself with a delicate cell-wall, and proceeds to digest and absorb the periplasm. The male and female nuclei do not fuse until a thick oosperm-wall has been produced. As the oosperm ripens, a reserve globule is formed in the centre of the oosperm, and the fusion-nucleus is forced to one side. No epispore is developed.

New Chytridiaceæ.*—E. de Wildeman describes the following new or little-known species of parasitic Chytridiaceæ:—*Olpidium Stigeoclonii* sp. n., within the cells of *Stigeoclonium*; *Rhizophidium Schrœteri* sp. n., in the plankton of the Lake of Zurich, especially on *Asterionella gracillima*; *R. Vaucheriæ* sp. n., and *R. multiporum* sp. n., within the oogones of *Vaucheria sessilis*; *Olpidium tumæfaciens* sp. n., on the rhizoids of an alga probably belonging to the Florideæ.

Germination of the Spores of Penicillium.†—Further experiments by P. Lesage on the germination of the spores of *Penicillium glaucum* in moist air, bring him to the conclusion that it depends less on the absolute quantity of aqueous vapour in the air than on its hygrometric condition.

Aspergillus.‡—C. Wehmer discusses this genus of Fungi under the following heads:—mycele, conidiophore, fructification, cultivation, influence of temperature, light, and oxygen, pigment, variability, sensitiveness to toxic substances, classification. Herr Wehmer maintains his previous arrangement of the species into 4 groups, distinguished by the colour of the young conid-masses, viz. green, blackish, white, and brown-yellow. The number of clearly distinct species described is 102. A copious bibliography is appended.

Biology of the Erysipheæ.§—Dr. F. W. Neger finds, in other genera of Erysipheæ, contrivances similar to those which he has described in the case of *Phyllactinia*, for anchoring the perithece to the substratum by means of mucilaginous rows of cells or other modes of attachment. This occurs in *Sphærotheca* and *Erysiphe*. In most of the other genera, on the contrary—*Podosphæra*, *Microsphæra*, *Uncinula*, &c.—the perithece

* Mém. Herb. Boissier, 1900, No. 15. See Bot. Centralbl., lxxxvii. (1901) p. 166.

† Comptes Rendus, cxxxiii. (1901) pp. 174–6. Cf. this Journal, 1896, p. 338.

‡ Mém. Soc. Phys. et Nat.-Hist. Genève, xxxiii. (1901) 153 pp. and 5 pls. Cf. this Journal, 1890, p. 235.

§ Flora, lxxxviii. (1901) pp. 333–70 (3 pls.). Cf. this Journal, 1900, p. 494; *ante*, p. 72.

becomes detached by the shrinking of its basal cells, and the appendages then serve to bring about its attachment to a secondary substratum. The author regards the genus *Sphærotheca*, with its single ascus and appendage, and the absence of a differentiation of the wall of the perithece into an upper and under side, as the ancestral type of the order. From this is derived *Erysiphe*, characterised by numerous asci and a usually simple appendage; the other genera exhibiting greater complexity of structure.

With regard to the structure of the perithece, the Erysipheæ may be classified under two heads :—(A) Peritheces not falling off spontaneously, usually attached to the mycele by the appendages (*Sphærotheca*, *Erysiphe*, *Uncinula circinata* ?); (B) Peritheces falling off when ripe. These latter are again classified under two subdivisions :—(1) Detachment caused by the shrinking of the base of the perithece (*Podosphæra*, *Trichocladia*, *Microsphæra*, *Uncinula* section Microsphæroidea, and section Euuncinula except *U. circinata*); (2) Detachment of the perithece by the pressure of the appendages against the substratum (*Phyllactinia*).

Arsenic Fungi.*—B. Gosio has paid special attention to the group of Fungi which have the property of decomposing compounds of arsenic, with production of the peculiar garlic-like odour of arsenious acid. Of these *Penicillium brevicaule* was specially studied. Independently of its production of volatile compounds of arsenic, this fungus is pathogenic to rabbits, producing pneumonia. The author discusses the use of this fungus as a test for arsenic, in the production of the garlic-like odour. As a nutrient material, potato is preferable to bread. It produces alcoholic fermentation, and inverts starch.

Coprophilous Fungi.†—G. Massee and E. S. Salmon describe a number of new species belonging to the Ascomycetes saprophytic on the excrements of a variety of different animals (mammalia and birds); also two new genera, viz. :—

Pleuroascus g. n. (Perisporiaceæ). Perithecia subiculo intexto pannoso distincto v. confluente insidentia, atra, astoma, membranaceo-carbonacea, fragilia, contextu parenchymatico, appendicibus pluribus hyalinis arcte spiraliter convolutis instructa; ascis globosis, minutis, numerosissimis, mox diffluentibus, in hyphis ramosis pleurogenis; sporis minutis, fuligineis, globosis.

Spumatoria g. n. (Sphæriaceæ). Perithecia subglobosa, semi-immersa, demum superficialia, membranacea, in rostrum longum cylindraceum apice fimbriatum plus minus dilatatum attenuata; ascis tenuibus, evanescentibus, octosporis, sporis didymis, hyalinis; demum in spuma mucilaginosa ex ore rostri ejectis; paraphysibus indistinctis.

The majority of coprophilous fungi occur on the excrement of herbivorous animals, and they are propagated by the spores passing through their bodies rather than by the wind; as a rule any one species of fungus is not confined to the excrement of a single animal. In species of *Ascobolus*, *Ryparobius*, *Saccobolus*, *Sordaria*, and *Thelebolus*, the spores are ejected at maturity in an agglutinated mass, often to a considerable distance. This ejection occurs equally in bright sunshine and in darkness. The sudden shooting-out of the spores appears to depend on the

* Il Policlinico, 1900, No. 10. See Bot. Centralbl., lxxxvii. (1901) p. 131.
† Ann. of Bot., xv. (1901) pp. 313–57 (2 pls.).

absorption of moisture by the mucus and consequent increase of volume.

New Genera of Fungi.*—In a collection of fungi made by M. A. Chevalier, in Senegal and the western Soudan, N. Patouillard and P. Hariot describe a new genus of "Fungi imperfecti," *Ocularіopsis*, with the following diagnosis:—Biophyta; hyphæ steriles repentes, fertiles adscendentes, simplices, septatæ, apice conidiophoro; conidia acrogena, solitaria, simplicia, hyalina, subclaviformia.

The following new genera of Fungi from Japan are described by P. Hennings.†

Hydnofomes (near *Hydnochætes*). Lignosus, durus, apus, perennis, e stratis annosis crusta rigida obductus, sulcatus; hymenium inferum, aculeatum, aculeis lignosis, fasciculatis, setulosis; basidia 4-sterigmatibus; sporæ ellipsoideæ, hyalinæ.

Shiraia (near *Mattirolia*). Stromata carnosa-lignescentia, tuberiformia, dein rimosa; perithecia subglobosa, magna, stromata omnino immersa, ostiolis haud prominulis; asci cylindraceo-clavati, 8-spori, paraphysati; sporæ oblongo fusiformes, pluriseptatæ, muriformes, hyalino-fuscidulæ.

Coccoidea (Dothideaceæ). Stromata membranaceo-subcarbonacea, disciformi-pulvinata, superficialia, medio substipitato-affixa, atra: perithecia immersa, globulosa, punctato-ostiolata; asci 8-spori, paraphysati; sporæ ellipsoideæ, continuæ, hyalinæ.

Kusanoa (near *Molleriella* and *Cookella*). Stromata superficialia, intus dense loculigera, loculis monascis; asci ovoidei, 8-spori, aparaphysati; sporæ subclavatæ, 3-septatæ, coloratæ.

In a monograph of the North American species of Tylostomaceæ (Gastromycetes) V. S. White ‡ describes several new species of *Tylostoma*; also a new genus *Dictyocephalos*, with the following diagnosis:—Plants with the irregularly rupturing peridium closely attached to the solid stem; volva cup-like, persistent at the base of the stem; gleba composed of a mesh-like irregular tissue, in which the capillitium threads are imbedded.

Formation of Spores in Taphrina.§—S. Ikeno describes the mode of formation of the ascospores within the ascus of *Taphrina Johansoni*, belonging to the Exoascaceæ, which presents several peculiarities.

A fusion of two nuclei takes place in the young ascus; the resulting body has at first the appearance of an ordinary nucleus, consisting of a ground-substance, and a massive structure which the author regards as a chromatin-body. On the inner side of the nuclear wall are chromosome-like bodies or rods, probably fragments which have broken off from the chromatin-body. As the young ascus increases in size, the nuclear membrane is absorbed, and the ground-substance is taken up by the cytoplasm. The nucleus, which now consists of nothing but a chromatin-body, breaks up, the fragments becoming dispersed through the cytoplasm, which has now become distinctly reticulate. The cytoplasm collects round the fragments of chromatin; and these balls of cytoplasm

* Journ. de Bot. (Morot), xiv. (1900) p. 246.
† Engler's Jahrb., xxviii. (1900) p. 259 *et seq.* See Bot. Centralbl., lxxxvii. (1901) p. 86.
‡ Bull. Torrey Bot. Club, xxviii. (1901) p. 111.
§ Flora, lxxxviii. (1901) pp. 229–37 (1 pl.).

are usually enclosed in vacuoles. The ascospores appear to be formed by a process of budding.

The mode of formation of the spores in *Taphrina* is therefore very different from that which prevails in the Phycomycetes, presenting a greater resemblance to that in typical Ascomycetes. The author infers that the typical Ascomycetes are derived genetically from the Exoascaceæ, but not the Exoascaceæ from the Phycomycetes.

Parasitic Fungi. — E. Boudier * describes a new species of *Exobasidium* which he names *E. Brevieri*, parasitic on *Athyrium filix-femina*.

Prof. A. Zimmermann † describes the following fungi parasitic on cultivated plants in the Tropics:—*Trametes Theæ* sp. n. on *Thea viridis*, *Beniophora Coffeæ* sp. n. on *Coffea arabica*, *Hypochnus Gardeniæ* sp. n. on *Gardenia florida*, *Corticium javanicum* sp. n. on *Coffea arabica* and *liberica* and other plants, *Nectria coffeicola* sp. n. on *Coffea arabica* and *Theobroma Cacao*, *N. striatospora* sp. n. on *Theobroma Cacao*, *Calonectria Meliæ* sp. n. on *Melia arguta*, *C. Coffeæ* sp. n. on *Coffea arabica*, *C. cremea* sp. n. on *Theobroma Cacao*, *Molleriella Sirih* sp. n. on *Piper betle*, *Protomyces Theæ* sp. n. on roots of *Thea*, *Phytophthora* sp. on *Myristica fragrans*, *Chætodiplodia Coffeæ* sp. n. on *Coffea liberica*, *Colletotrichum incarnatum* sp. n. on *Coffea liberica*, *Periconia Coffeæ* sp. n., and *Stilbum Coffeæ* sp. n. on *Coffea arabica*, *Sporocybe minuta* sp. n. on rotten wood of *Coffea arabica*, *Graphium Coffeæ* sp. n. on dead twigs of *Coffea arabica*, *Necator decretus* on *Coffea arabica* and *liberica*.

The cause of the rust of *Chrysanthemum indicum* is described by E. Roze ‡ as a new species of *Puccinia*, under the name *P. Chrysanthemi* sp. n.

A disease which attacks the vineyards in the Caucasus, and which has hitherto been confounded with other parasites of the vine, is now distinguished by L. Montemartini and R. Farneti § as a new species, and is named *Physalospora Woroninii* sp. n.

E. M. Wilcox ‖ has investigated a rhizomorphic root-rot of fruit-trees which does great damage to the peach, cherry, and apple-trees in the south-western United States. The fungus also infests oak-trees, and is described as a new species, *Clitocybe parasitica* sp. n.

A disease of the mulberry, which especially attacks young seedlings, causing arrest of growth and subsequent decay, is described by G. Briosi and R. Farneti ¶ under the name *Phoma pyriformis* sp. n.

Dr. U. Brizi ** has found a new fungus parasitic on the fruit of *Diospyros Kaki*, which he names *Botrytis Diospyri* sp. n.

Prof. J. C. Arthur and E. W. D. Holway †† give a detailed account of the rusts which infest the various species of *Viola* in the United States. They refer them to three species, *Æcidium pedatum* (*Cæoma pedatum* Schw.), *Puccinia Violæ* (very common), and *P. effusa*.

* Bull. Soc. Mycol. France, xvi. (1900). See Bull. Soc. Bot. France, vii. (1901) p. 453.
† Centralbl. Bakt., vii. (1901) pp. 101–6, 139–47 (24 figs.).
‡ Bull. Soc. Mycol. France, xvi. p. 88. See Bull. Soc. Bot. France, vii. (1901) p. 455.
§ Atti R. Ist. Bot. Univ. Pavia, 1900, 14 pp. and 1 pl. See Bull. Soc. Bot. France, vii. (1901) p. 475.
‖ Bull. 49 Oklahoma Agric. Exp. Stat., 1900, 32 pp. and 11 pls. See Bot. Gazette, xxxi. (1901) p. 441.
¶ Atti R. Accad. Lincei (Rend.), x. (1901) pp. 61–4.
** Tom. cit., pp. 75–9.
†† Minnesota Bot. Studies, 1901. pp. 631–41.

Origin and Development of the Apothece of Lichens.*—Dr. E. Baur discusses the question of the sexuality of the higher Ascomycetes, describing especially the carpogone of *Parmelia Acetabulum*, *Pertusaria communis*, and *Pyrenula nitida*. He gives a list of those genera of lichens in which a typical archegone with an ascogone and trichogyne have hitherto been detected with certainty. He supports the view of Harper † that a process of impregnation does take place in many lichens; but that the so-called "spermatia" are not the male sexual organs; they are, at least in many lichens, pycnospores, the germination of which can be artificially induced.

Chinese Yeast.—A fresh examination of the organisms connected with the fermentation of Chinese yeast, used in making the "ragi" of Java, have led C. Wehmer ‡ to the following conclusions. The chief agents in the process of saccharification are *Rhizopus Oryzæ*, *Chlamydomucor Oryzæ*, and, to a less extent, *Mucor Rouxii*. The latter species, as also *M. javanicus* (including *M. dubius*), also produce active fermentation, which is not the case with *Chlamydomucor* or *Rhizopus*. *Rhizopus Oryzæ* is probably a form of the very polymorphic *R. nigricans*. In *Mucor Rouxii*, *javanicus*, and *dubius*, the cells contain a light golden-yellow or orange-yellow pigment, which does not penetrate the cell-walls; while in *Chlamydomucor* the membrane is often coloured, yellow oil-drops not having been observed.

T. Chrzaszcz § describes, under the name *Mucor Cambodja* sp. n., a new technical fungus found in rice-meal cakes in Java, possessing fermenting properties. It is a well-marked species presenting some of the characters of *Rhizopus*, especially in the well-developed mycele.

Fungus-slime of Trees.—Dr. W. Holtz ‖ discusses the fungus-forms which enter into the composition of the slime on living trees, especially the oak, and describes in detail the structure and life-history of *Endomyces Magnusii*. His general conclusions differ considerably from those of Ludwig.¶ He does not find in any case the presence of parasitic fungi which bring about the destruction of the cortical tissue; there being no evidence of the penetration of the hyphæ into living cells of the cortex, the bast, or the cambium. The organisms found in the slime are harmless guests, living on the sap exuded from the tree. He agrees with Hansen in considering the oidium-form not as belonging genetically to *Endomyces Magnusii*, but as an independent organism, the *Oidium Ludwigii* of Hansen.

The only bacterial organisms found with certainty in the slime are *Leuconostoc Lagerheimii* and *Micrococcus dendroporthos*.

Prof. F. Ludwig ** adds a further note on the brown slime caused by *Torula monilioides*; on the association of *Endomyces* and *Leuconostoc* in the slime of the oak; and on the "musk-slime" caused by the *Fusarium* form of *Nectria aquæductum*.

* Flora, lxxxviii. (1901) pp. 319–32 (pls.).
† Cf. this Journal, *ante*, p. 69.
‡ Centralbl. Bakt., 2te Abt., vii. (1901) pp. 313–26 (1 pl.).
§ Tom. cit., pp. 326–38 (2 pls.).
‖ Centralbl. Bakt., 2te Abt., vii. (1901) pp. 113–28, 179–89, 229–38, 274–81, 338–50 (2 pls. and 6 figs.).
¶ Cf. this Journal, 1894, p. 604.
** Tom. cit., pp. 350–2.

Agglutination of Yeast.*—Dr. A. Macfadyen has found that yeast-juice (zymase) has the property of agglutinating yeast-cells when injected into animals. The blood-serum of rabbits gave the best results. Zymase thus appears to possess the power of producing agglutinins in the animal body which have a specific reaction on the yeasts in question.

Place of the Parasite of Tuberculosis among Fungi.†—St. Droba states that the exciting cause of tuberculosis grows on artificial media as a mycele with long thick stolons and short thin rhizoids. In the filaments there are no septa, but strongly refracting granules of a fatty nature. In some phases conids or sporophores were present. Zygospores, which exhibited all the stages of development from junction ot the sexual cells to their complete formation, were observed. The stylospores, which were of frequent occurrence, presented themselves as spherical bodies on short filaments. The parasite of tuberculosis therefore belongs to the Zygomycetes, and forms a new genus of the Chætocladiaceæ.

Sterigmatocystis candida Saccardo.‡—R. Pound found *Sterigmatocystis candida* Sacc. in the human ear, and gives the following description of this new human parasite. Fertile hyphæ hyaline or whitish, rather narrow, 150–200 by 10 μ; vesicle globose, 30–35 μ; basids clavate, 30 by $7\frac{1}{2}$ μ, noticeably obtuse and flattened at the top, bearing three filiform sterigmata 10–15 μ long; conids globose, not exceeding 2 μ.

Microsporium Audouini.§—P. Vuillemin has cultivated this parasitic fungus on human hair, and has determined that the *Microsporium Audouini* Mal. is not identical with the original *M. Audouini* Gruby, but belongs even to a different genus, *Cercosphæra*. On the other hand, the species first described by Sabouraud as *M. Audouini*, but subsequently referred to a different genus, *Marteniella*, is identical with Gruby's *Microsporium Audouini*, or is at least closely related to it.

Protophyta.

a. Schizophyceæ.

Eremosphæra viridis.‖—G. T. Moore disputes the statements of previous observers with regard to the alleged polymorphism of this alga. After cultivation for over two years in nutrient solutions and on agar-agar, it showed no disposition to pass into any other form, maintaining its characters as an independent genus. The only mode of multiplication is by simple fission into two or four daughter-cells.

Cell-structure of Phycochromaceæ (Cyanophyceæ).¶—An exhaustive study of several types of the blue-green algæ has led R. Hegler to the following general conclusions.

* Centralbl. Bakt., 1te Abt., xxx. (1901) p. 368.
† Bull. Internat. Acad. Sci. Cracovie, 1901, pp. 309–11.
‡ Trans. Amer. Micr. Soc., xxii. (1901) pp. 81–8 (1 pl.).
§ Bull. Soc. Mycol. France, xvii. (1900) p. 96. See Bot. Centralbl., lxxxvii. (1901) p. 3.
‖ Proc. Amer. Ass. Adv. Sci., 49th Meeting, New York, 1900, pp. 278–9.
¶ Pringsheim's Jahrb. f. wiss. Bot., xxxvi. (1901) pp. 229–354 (2 pls. and 5 figs.).

The cell is in all cases enclosed in a distinct cell-membrane; naked protoplasts do not occur in the Schizophyceæ; a cell-membrane is present even in the hormogones. The gelatinous envelope and the sheath both take part in the formation of this membrane. Both the sheath and the cell-membrane are marked by their strong resistancy to chemical reagents, resembling in this respect the cuticle of the higher plants; but in optical and chemical properties they have nothing to do with the cuticle; they are chiefly composed of chitin. The cell-wall of the heterocysts is, however, always composed of cellulose.

The protoplast of all Schizophyceæ is differentiated into a peripheral layer which contains the pigment, and a colourless central portion. The pigment is usually present in the form of very minute granular bodies; each particle contains both chlorophyll and phycocyan [in the Phycochromaceæ]; they must be regarded as chromatophores, and the author terms them *cyanoplasts.* The cells of the Schizophyceæ contain no starch or starch-like substance, but glycogen has frequently been detected; this substance is the first recognisable product of assimilation in the Cyanophyceæ.

The peripheral layer of protoplasm which contains the cyanoplasts encloses two different substances, proteid-crystalloids and mucilage-vacuoles. The proteid-crystalloids occur most largely in the heterocysts and spores, being often entirely wanting in the vegetative cells of rapidly growing filaments. Neither of these substances has any relations to a nucleole.

The central colourless portion of the cell of the Phycochromaceæ is a true nucleus. The cell invariably contains a single nucleus, with the exception of the heterocysts, in which it degenerates at an early period. The form depends largely on the dimensions of the cell. In resting cells it consists of a slightly stainable ground-substance, in which are imbedded small granules, identical with the chromatin granules of the higher plants. These nuclei are distinguished from those of the higher plants by the absence of nucleoles and of a stainable nuclear membrane. They are, however, sharply differentiated from the cytoplasm. In the process of division the polar separation of the chromatic substance and the development of a chromatic figure agree, in all important points, with the karyokinetic process of division of the ordinary vegetable or animal nucleus.

Nostoc punctiforme.*—Pursuing his investigations on the power of this organism to assimilate in the dark, R. Bouilhac states that glucose may be replaced, as the nutrient material, by saccharose, maltose, or starch, but not by levulose. The substances which serve for the development of the plant are those which easily give rise to glucose by hydrolysis, produced probably by the bacteria which accompany it, or by the *Nostoc* itself.

β. Schizomycetes.

Structure of Bacteria.†—Prof. K. Nakanishi, by adopting a special method of staining, found that all bacteria, when in the fresh condition,

* Comptes Rendus, cxxxiii. (1901) pp. 55–7. Cf. this Journal, 1898, p. 574.
† Centralbl. Bakt., 1[te] Abt., xxx. (1901) pp. 97–110. 145–58, 193–201, 225–32, (5 pls. and 38 figs.). Cf. this Journal, 1900, p. 525.

are stainable in a very short time. The staining is not diffuse but delicate and differential, and shows that all bacteria in their early stages are short uninuclear cells. The bacterial cell-membrane presents itself under the Microscope as a thin smooth structureless sheath. In some species there exists, immediately external to this, a mucous investment, which is to be regarded not as part of the cell proper, but as an excretion product therefrom. The chief part of the bacterial cell consists of cytoplasm, differentiable into an outer deeply staining layer or ectoplasm and a less or not stainable endoplasm. The nucleus forms the centre of the cell, and, though usually round or oval, may be very irregular in shape. In the spore-forming bacteria it is smaller and less regular than in the non-sporing.

Cell-division takes place just as in the cells of higher plants and animals, and is preceded by nuclear fission, the constriction of the cytoplasm following immediately. In this way new members are developed, and these become separated or may remain adherent. In the latter case polynuclear rodlets or filaments arise. The isodiametric cells of a bacterium which is to develop into a rodlet are easily distinguishable from true spheroidal bacteria, by the delicate constitution of the investing membrane and the easy demonstrability of the nucleus. The wedge-forms of the bacilli of the diphtheria group are mostly uninuclear cells, the long rodlets and clubs being composite ones. When in a good condition of nutrition the structural details of the vibrios of the cholera group and also spirilla are complicated and indistinct, but in the atrophic condition they present a typical cell-structure and are uninuclear cells.

When spores develop in a bacterial cell, the cytoplasm in the vicinity of an axially placed nucleus clears up and assumes an oval shape. This spot increases in size, and assumes chromatophilous properties, and finally, by the formation of a membrane, becomes highly refractive and difficult to stain. Spore-formation practically consists of an intracellular incapsulation of the nucleus and of the thickened perinuclear cytoplasm. The spore always possesses a centrally placed nucleus, and in some bacteria the spore-membrane is clearly double. The spore-plasma is homogeneous, but before germination becomes differentiated into ecto- and endoplasm. In some bacteria the rupture of the spore-membrane at germination is equatorial and in others polar.

Albumen-forming Bacteria.*—Dr. Gerlach and Dr. Vogel obtained seven species of albumen-forming bacteria from garden earth and stable manure. The general characters of these bacteria are as follows. All are short motile rodlets which stain with the usual anilin dyes. They do not form spores. They grow on all the ordinary media; they rapidly liquefy gelatin, and do not form gas in the presence of grape-sugar or nitrate. They thrive in liquid media which contain, besides the requisite mineral substances, grape-sugar, glycerin, straw, lactic-acid-salts, &c., as sources of carbon and saltpetre, ammonia-salts or urea as source of nitrogen. When the non-nitrogenous and the nitrogenous nutrient substances are absent, no noteworthy growth takes place. Hence the albumen-forming bacteria have not the capacity to utilise the carbonic acid or the nitrogen of the air. On the other hand, they all have the power

* Centralbl. Bakt., 2te Abt., vii. (1901) pp. 609–23.

of transforming the nitrogen contained in the nitrogenous compounds into albumen.

They do not thrive under strictly anaerobic conditions. All the seven kinds coagulate milk, some within 48 hours, others less quickly. Several form a greenish fluorescing pigment on agar and gelatin. Some darken the surface of potato, while others form thereon a yellow shining deposit. Some form a surface scum on liquid media. Details are given of the experiments on which the general conclusions are founded.

Branching of Bacteria.*—Prof. A. Meyer records observations on and experiments with *Bacillus cohærens* made for the purpose of testing the vexed question of the branching of bacteria. He concludes that the species of the genera *Bacillus* and *Bacterium*, and also very likely of the genus *Spirillum*, have inherited from their ancestors a potentiality to branching. The formation of branches occurs however only rarely, and then in a rudimentary manner. It takes place as a rule when the species is young, in a stage of the development of the species in which apparently the formation of the branched mycele in the ancestors of the bacteria arose. These retrograde formations are called forth by special external exciting causes, and apparently act by prolonging the youthful stage of the species; but about the exact nature of the momenta nothing accurate is known.

Oligonitrophilous Microbes and the Genus Azotobacter.† — By *oligonitrophilous*, Prof. M. W. Beijerinck understands those micro-organisms which, in free competition with the rest of the microbic world, develop in nutrient media to which no nitrogenous compounds have been intentionally added, or from which no special care has been taken to remove the last traces of such compounds. They are able to make use of the free atmospheric nitrogen and adapt it to their own nutrition. There are two principal series, one developing in the light at the cost of atmospheric carbonic acid and being coloured green by chromophyll; the other developing in the dark and being devoid of colour. After describing observations and experiments relative to the oligonitrophilism of the Cyanophyceæ, he passes on to oligonitrophilous bacteria, of which there is one genus *Azotobacter* and two species, *A. chroococcum* and *A. agilis*. Azotobacteria exist as large diplococci or short rodlets, 4–6 μ about, but may be shorter or much longer. Their contents are hyaline, they sometimes including a vacuole, and their mucous wall is of variable thickness. When young they are motile. The flagella are polar and about the same length as the bacteria. They do not form spores. They are capable of growing in media containing suitable carbon compounds but very little nitrogen, the nitrogen being assimilated from the air. Pure cultures grow on the most different media, but best on those which contain very little nitrogen. The temperature optimum is not far from 28° C.

A. chroococcum forms a membranous scum when tap-water with 2 p.c. mannite and 0·02 p.c. K_2HPO_4 is infected with garden earth. Only a few of the youngest are motile, most of the rodlets being at rest. Young membranes answer to the description given under the genus, while

* Centralbl. Bakt., 1te Abt., xxx. (1901) pp. 49–60 (2 pls.).
† Op. cit., 2te Abt., vii. (1901) pp. 561–82 (1 pl. and 6 figs.).

older ones consist of cocci of very variable size, which are grouped in Sarcina-packets and possess mucous walls. They are often brown or black. This species oxidises numerous carbon compounds with the formation of carbonic acid and water. It is macro-aerophilous.

A. agilis was found in Delft canal water. It has polar cilia and is very motile. These bacteria are large and transparent, resembling small Monads. They have a well-marked wall, protoplasm, nucleus, granules, and vacuoles. They grow well on various media, and especially well on tap-water agar with 2 p.c. glucose and 0·02 p.c. K_2HPO_4. With salts of organic acids they can produce a green or red diffusible pigment. Gelatin is not liquefied.

Influence of Microbes on the Development of Tadpoles.*—Mdme. O. Metchnikoff has endeavoured to solve the much debated questions whether microbes are or are not indispensable to animal nutrition and development, and what part non-pathogenic microbes play in the intestinal canal. Tadpoles were obtained under aseptic conditions and fed on sterilised bread. Of 80 tadpoles, 31 died in a day or two; in 42 cases the cultures therefrom gave evidence of bacterial contamination, and only seven remained sterile. None of the 80 survived longer than 79 days. Five out of the seven sterile cultures lived for 63 days or longer, while only seven out of the 42 reached this age. The non-sterile became considerably larger and heavier than the sterile tadpoles, the maximum weight and size of the latter corresponding to the minimum of the former. From this the authoress concludes that microbes are necessary to the life and development of tadpoles.

Ripening of Cheese and the Rôle of Micro-organisms in the Process.†—F. C. Harrison, after recounting the results of previous observers from F. Cohn in 1875, states that the three following facts seem well supported by good evidence and by trustworthy experiments. (1) The enormous number of lactic acid bacteria in hard cheese, and the very small numbers of liquefying or digesting bacteria. (2) The existence of galactose, a natural enzyme inherent in fresh milk. (3) The ability of rennet to cause the change of non-soluble nitrogenous products to soluble ones.

Assuming that these facts are proved, the ripening of cheese may be said to be caused by the digestive action of rennet on the insoluble nitrogenous matter of the cheese, in the presence of acid formed by the lactic acid bacteria. The large amount of acidity also prevents or inhibits the growth of other and perhaps undesirable species of bacteria. As far as Canadian Cheddar cheese is concerned, the presence of galactose appears to be of little importance.

Photo-bacteria as a Reagent in the Investigation of the Chlorophyll Function.‡—Prof. M. W. Beijerinck finds that photo-bacteria can be used to show when the chlorophyll of leaves is functioning; for if leaves in contact with a culture of photo-bacteria are excluded from any source of oxygen, the bacteria will only phosphoresce when the chlorophyll is functioning.

* Ann. Inst. Pasteur, xv. (1901) pp. 631–4.

† Trans. Canadian Inst., vii. (1901) pp. 103–34. Cf. this Journal, *ante*, p. 196.

‡ Proc. K. Akad. Wetensch. Amsterdam, iv. (1901) pp. 45–9. See Journ. Chem. Soc., lxxx. (1901) Abstr. ii. p. 523.

Bacterial Disease of the Potato.*—G. Delacroix describes a bacterial disease affecting the potato in western and central France. The same disease, according to Johnson, is prevalent in Ireland. All soils are liable, but especially those which possess little lime. The bacterium is identified as *Bacillus Solanacearum* E. F. Smith. It appears to gain entrance through wounds made by insects, &c., on the subterranean parts of the stem. From the wound entrance the microbes spread upwards and downwards, chiefly through the vessels. The destruction of the plants is hastened by the attacks of numerous other parasitic fungi.

Bacillus putrefaciens sp. n., a new Parasite on Plants. † — After a general account of the action of fungus parasites on plants, both external and internal, M. J. Ray describes, under this name, a new bacterial parasite which attacks wheat, oat, lupin, haricot, sunflower, radish, and mustard. Cultivated on potato, carrot, bouillon of haricot or lupin, it forms a thick grey mucus, tending towards rose-colour; on bouillon it forms a large quantity of diastase. It is very destructive to vegetable tissues.

Spore-formation of Anthrax under Anaerobic Conditions. — Dr. A. Klett's ‡ experiments were made with the object of ascertaining the effect of atmospheres of nitrogen and hydrogen, and his results showed that spore-formation was independent of the presence of oxygen. Spores were formed freely in the nitrogen atmosphere, sparely in that of hydrogen. Hence oxygen is not a necessity, but every gas exerts a specific influence.

Dr. E. Jacobitz § finds, in opposition to Klett, that when anthrax is cultivated in an atmosphere of nitrogen spores are not formed, at any rate when agar is used as the nutrient medium.

Denitrification.—According to O. Lemmermann,‖ the functions of the denitrifying bacteria, of which 23 varieties are known, are controlled by the absence or presence of suitable carbonaceous matter and oxygen when the conditions are in other respects normal. The results of experiments indicate that in practice denitrification has not the importance which has been ascribed to it.

G. Ampola and C. Ulpiani ¶ describe experiments showing that if the soil fulfils the conditions necessary for denitrification, that is, if it contains bacteria, nitrate, and assimilable organic material, the nitrate is completely reduced to free nitrogen. Hence stable manure and sodium nitrate should not be applied simultaneously, but the former should be allowed to reach its full maturity on the soil before the latter is added. They also found that calcium nitrate was a better manure than sodium nitrate; that it offers far greater resistance to denitrifying micro-organisms than the sodium salt; and that the question of denitrification

* Comptes Rendus, cxxxiii. (1901) pp. 417–9.
† Rev. Gén. de Bot. (Bonnier), xiii. (1901) pp. 145–51.
‡ Zeitschr. f. Hygiene, xxxv. (1900) pp. 420–38.
§ Centralbl. Bakt., 1te Abt., xxx. (1901) pp. 232–9.
‖ Bied. Centr., xxx. (1901) pp. 368–9.
¶ Gazzetta, xxxi. (1901) i. pp. 185–221. See Journ. Chem. Soc., lxxx. (1901) Abstr. ii. p. 524.

must be divided into two distinct parts according as the fermentation takes place in connection with sodium nitrate or with calcium nitrate, which is the final product of nitrification.

Negative Chemiotaxis of Leucocytes.* — A. Zilberberg and J. Zeliony record observations as to the negative chemiotaxis of the leucocytes of rabbits when infected with pure cultures of fowl-cholera. They found there was an absence of phagocytosis when virulent cultures were used, and almost none when the microbes were somewhat less virulent. When phagocytosis occurs, it is probably due to the presence of non-virulent bacteria among the virulent ones, for the rabbit leucocytes never incorporate virulent fowl-cholera bacteria. The absence of phagocytosis is not due to poisoning of the leucocytes, but to their negative chemiotactic sensibility; for the same leucocytes preserve their power of ingesting non-virulent microbes even when the animal is in a moribund condition, as was shown by injecting non-virulent bacteria some eight minutes before death.

Agglutinating Substance.†—F. C. Harrison conducted experiments to find out if the agglutinating substance was present only in the external layers of the microbe, and if the phenomenon of agglutination was a kind of coagulation of the substance dissolved or not dissolved in an ambient medium. In order to carry out the condition, it was necessary to dissolve the external layers and yet leave the inner portion of the microbes intact. Three series of experiments are recorded for which immune horse-serum, pyocyanase, and *B. typhi* were used. The results showed that the agglutinating substance exists entirely in the outer layers of the bacilli, and that the nuclear portion is incapable of giving the reaction, and therefore endorse Nicolle's hypothesis that "agglutination consists in the coagulation and the coalescence of the external layers of the agglutinable microbes under the influence of the agglutinating serum." But in view of the author's experiments, he would insert "dissolved or not dissolved" between the words "external layers."

Importance of Inorganic Salts and Organic Crystalloids in the Agglutination of Bacteria.‡—Dr. E. Friedberger states that agglutination does not occur when the suspension fluids are totally devoid of crystalloid substances. Of these substances the most effective are the inorganic salts, and even these are of different degrees of activity. The rapidity of the occurrence of agglutination in dialysed cultures is dependent on the saline contents of the suspension fluid, and in bacterial emulsions on the presence of sodium chloride. The action of the salts is not a chemical one.

Presence of Typhoid Bacilli in Sputum. § — P. Edel examined the sputum of eleven cases of typhoid, and in one which was complicated with pneumonia found on three occasions typhoid bacilli in the expectoration.

* Ann. Inst. Pasteur, xv. (1901) pp. 615–30 (1 pl.).
† Centralbl. Bakt., 1te Abt., xxx. (1901) pp. 115–8. ‡ Tom. cit., pp. 336–47.
§ Festschr. d. Med., 1901, No. 14. See Centralbl. Bakt., 1te Abt., xxix. (1901) p. 911.

New Species of Ascobacillus.*—Prof. J. M. Moreno found in canal water a new species of *Ascobacillus*, *A. aquatilis*. On gelatin plates at room temperature, or at 21°, lemon-coloured colonies 1–3 mm. in diameter appear in 48 hours. The colonies are zooglœa masses, consisting of bacteria in shape varying from cocci to bacilli. The bacilli are 2 μ long and 0·6 μ thick. The zooglœa masses stain yellow with iodine, and resist decoloration by Gram's method, as also do the bacilli. The organism was cultivated also on agar, litmus-lactose-agar, lactose-agar, blood-serum, potato, bouillon, and pepton-water. Milk was slowly coagulated. *A. aquatilis* grows at room-temperature, at 21°, and at 37°; it is strictly aerobic, and is not pathogenic to animals.

Bacteriology of Acute Articular Rheumatism. † — Meyer isolated from the tonsils of five cases of typical acute rheumatism a streptococcus which grew best on blood-agar. Injections of the cultures produced the characteristic phenomena of acute rheumatism.

Bacillus isolated from the Blood of Syphilides. ‡ — De Lille and Jullien report the successful isolation of a characteristic bacillus from the blood of syphilitics. The cultures were made on blood-plasma separated from the serum and in the fluid obtained from blisters. From these sub-cultures were made on the ordinary media. The bacillus is polymorphic. It is pathogenic to guinea-pigs, producing locally an indurated ulcer with swelling of the nearest lymphatic glands. The blood of syphilides added to a three days old culture agglutinates the bacilli.

Colon Bacillus of Hamster. § — Prof. B. Galli-Valerio describes a disease of the hamster which was characterised by emaciation and extreme fatty degeneration of the liver. From the liver, spleen, and blood was isolated a short thick-set bacillus with rounded ends. It was motile and adorned with polar flagella. The short cells were 2–3 μ long, but the bacillus grew into filaments which were sometimes 60–70 μ in length. It was easily stained, but not by Gram's method. On gelatin two kinds of colonies developed, the superficial being flattish with a thicker central portion or nucleus, while the deep colonies were spherical with a yellowish central nucleus. The medium was not liquefied. It was cultivated also successfully on agar, potato, carrot, and peptonised bouillon. The growth on potato was white. Milk was coagulated in about four days. Lactose bouillon and glucose bouillon were fermented, but did not give the indol reaction. Bouillon cultures with typhoid serum were agglutinated. Inoculation experiments on rabbits, guinea-pigs, fowls, and hamsters failed, but were successful on mice.

Bacterium coli gallinarum.‖—Dr. R. Rahnor examined the dejecta of fowls, and found the first motions were free from fungi. Bacteria began to appear in the course of the second day. Numerous kinds were isolated, the most persistent being *B. coli gallinarum*. The characters of this microbe are as follows:—A rodlet 2–4 μ long by 0·3–0·5 μ broad,

* Centralbl. Bakt., 1te Abt., xxx. (1901) pp. 111–4.
† Deutsche Med. Wochenschr., Feb 2, 1901. See Brit. Med. Journ., 1901, Epit. 151.
‡ Acad. Med. Paris, July 2, 1901. See Brit. Med. Journ., 1901, Epit. 150.
§ Centralbl. Bakt., 1te Abt., xxx. (1901) pp. 273–6 (2 figs.).
‖ Tom. cit., pp. 239–41.

with rounded ends; frequently in pairs and occasionally in chains. On gelatin the growth is grey or yellowish. On agar the colonies are raised and greyish white. Bouillon becomes turbid with a moderate amount of sediment. Milk is quickly coagulated. In grape-sugar bouillon there is copious formation of CO_2. On potato the growth is luxuriant and of a brownish-yellow colour. In pepton there is copious production of H_2S, and a positive nitroso-indol reaction. It is actively motile, and does not stain by Gram's method.

Streptothrix from the Pathogenic Action of Bacillus Pseudo-tuberculosis Murium.*—Dorothy M. Reed, who has studied the spontaneous and experimental aspects of the pseudo-tuberculosis in animals, concludes that several different bacteria are engaged in the process, but that rodents are specially liable to such forms of tuberculosis. The bacillus described by Kutscher, and the one previously isolated by Welch, are identical. Experimental production of the natural disease in mice can be accomplished by injections of pure cultures of the bacilli, but the only certain methods are inoculation into the pleural and peritoneal cavities. The pseudo-tubercles consist essentially of colonies of bacteria, and to a small extent only of proliferated and emigrated body-cells. The propriety of the denomination pseudo-tuberculosis is therefore open to question. The bacilli occur in the form of simple and of branching rods. The branching is observed in growths in the animal body and in those in artificial cultures. The bacillus closely resembles culturally and morphologically the Klebs-Loeffler bacillus. The colonies on serous membranes have a rough resemblance to Actinomyces *Drusen*.

Pseudotetanus Bacillus.†—J. B. Bain isolated from a blank cartridge wound a bacillus which had much resemblance to *B. tetani*, and like it was an essential anaerobe. The organism is a bacillus with rounded ends, and produces a spore at one pole. The spores were most abundant in blood-serum cultures. The bacillus possesses numerous flagella, but no movements were observed. It was cultivated successfully on blood-serum and glucose-agar and in bouillon. Its length is very variable, and its average thickness $0 \cdot 5\ \mu$. It is decolorised by Gram's method, is not pathogenic to guinea-pigs, and does not liquefy gelatin.

Pseudopneumococcus.‡—O. Richardson describes an organism which has been met with four times in pneumonic lungs. Though having many resemblances to pneumococcus, it differs therefrom in the following particulars. The capsules persist in cultures; on blood-serum the colonies are much larger than those of pneumococcus cultivated under the same conditions, and are entirely different in character. They may become confluent, and form a mucus-like scum, which the colonies of pneumococcus never do. In glucose-agar stab cultures the growths are quite unlike, and on gelatin at room temperature the development of the pseudococcus is almost luxuriant and that of pneumococcus scanty.

Micrococcus zymogenes.§—Dr. N. M. Harris and Dr. W. T. Longcope record five instances of the occurrence of *M. zymogenes*. The de-

* Johns Hopkins Hosp. Rep., ix. (1900) pp. 525–41 (1 pl.).
† Journ. Boston Soc. Med. Sci., v. (1901) pp. 506–10 (2 pls.).
‡ Tom. cit., pp. 499–505 (2 pls.).
§ Centralbl. Bakt., 1te Abt., xxx. (1901) pp. 353–6. Cf. this Journal, 1899, p. 320.

scription of the original discoverers, MacCallum and Hastings, is confirmed.

Bacillus mortiferus.*—N. Harris isolated from an abscess of the liver a pleomorphic bacterium which is designated *Bacillus mortiferus*. It is not motile, is decolorised by Gram's method, does not liquefy gelatin. In all media it gives a strong fæcal odour, and forms gas in glucose media (CO_2, H, H_2S). Lesions similar to those found in the human being were reproduced in rabbits and guinea-pigs.

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Strassburg, 1900, 30 pp.

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Stuttgart, 1900, 8vo, xvi. and 318 pp.

RIST, E.—**Synopsis of New Methods and New Results in the Bacteriology of Gangrenous and Fœtid Suppurations.**
Centralbl. Bakt., 1te Abt., XXX. (1901) pp. 287–305.

* Journ. Boston Soc. Med. Sci., v. (1901) pp. 376–8.

MICROSCOPY.

A. Instruments, Accessories, &c.*

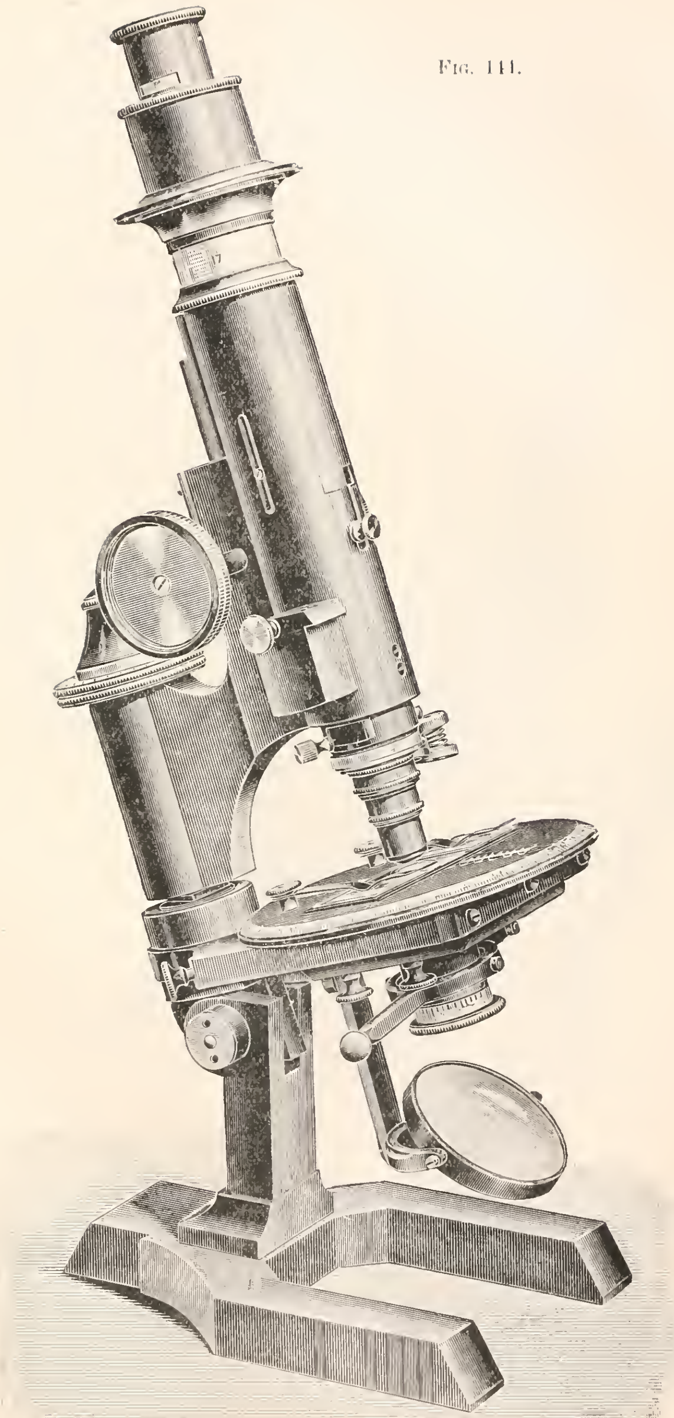
(1) Stands.

Seibert's New Microscope for Crystallography and Petrography.—In this large model (fig. 144), simplicity of construction, economy in cost, and suitability of purpose, have been especially kept in view. The stand is hinged for inclination and clamped by a small lever. The coarse adjustment is by rack-and-pinion, and the fine by a micrometer screw, whose head is graduated for thickness measurements. The draw-out tube has millimetre graduations. The circular object-stage (diameter 105 mm.) is rotary, graduated, and provided with a vernier and centering screws. The stage is marked with two perpendicular radii for orienting the object, and the illumination is by plane and concave mirrors. There are two analysers. One is applied above the ocular, and has graduations and a vernier. The other can be inserted into the tube directly over the objective; the consequent change in the focal length of the objective is compensated by a long focus lens on the top of the prism, so that, after the insertion of the analyser, no new adjustment of the objective is required. The prisms of the analysers have right-angled end planes, and give a very large field. The polariser is placed in a small sleeve under the stage, and has a lever arrangement for adjustment of height. The rotation of the nicol is controlled by a screw working in a groove. Over the polariser is a doublet condenser for axial images. A Bertrand lens can be used for magnifying the axial images, and for this purpose is inserted from above into the tube as far as the diaphragm of the draw-tube. The oculars are specially constructed for polarisation work. A screw engages in a notch in the tube, so fixing the direction of the cross threads, and this direction is made visible by a stroke on the outer rim of the mount. Other strokes mark the angles of 45°. The illustration shows a spring attachment of the objective. This arrangement, which is not peculiar to this particular class of instrument, gives accurate adjustment combined with easy and rapid facility of exchange.

Beck's London Microscope.—Fig. 145 represents this instrument, which was exhibited at the meeting of the Society held on October 15th. It has inclining joint, first-class fine and coarse adjustments, a divided draw-tube, removable mechanical stage, giving 2-in. horizontal and 1-in. vertical movements, with finder divisions, rack-and-pinion focussing substage, ebonite top stage, double mirror, and is absolutely rigid. The back leg of the base slides in, the side legs close up, the stage and mechanical stage both remove and pack in the bottom of the leather case, and the triple nose-piece swings round.

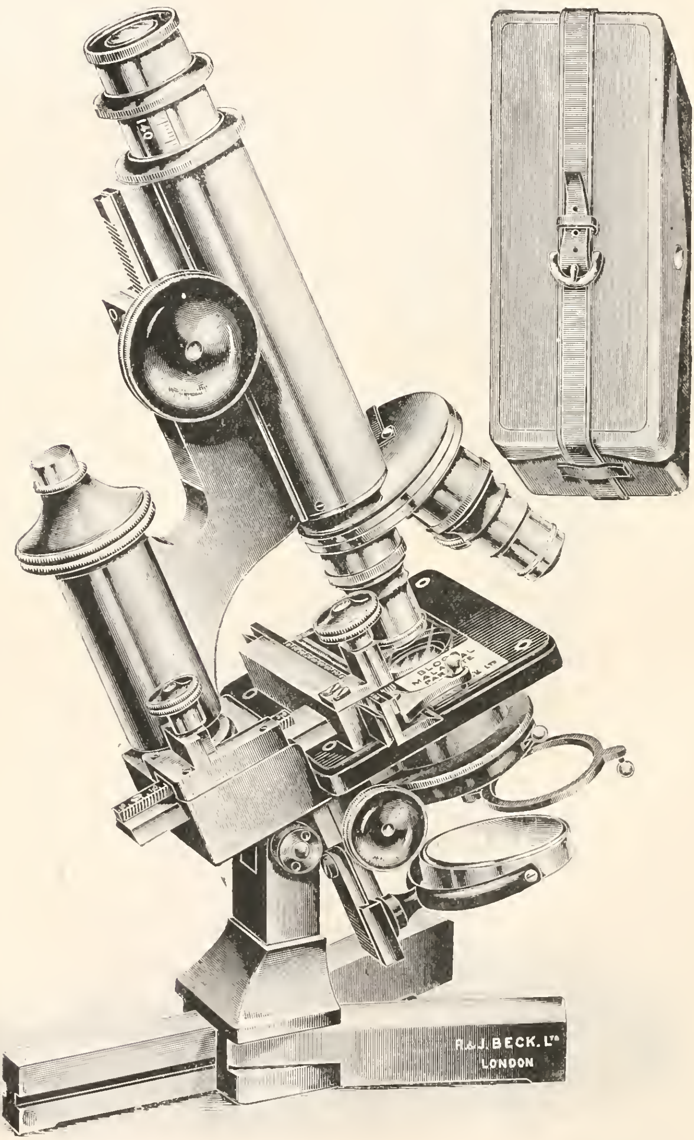
* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

Fig. 141.



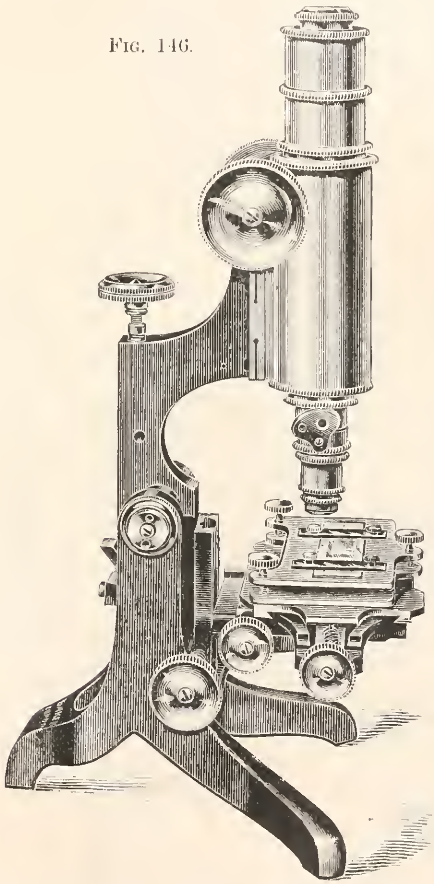
The special advantage of this instrument is its great portability, when packed into its comparatively small leather case, as shown in the illustration, measuring about $2\frac{1}{4}$ by $4\frac{1}{2}$ by $9\frac{1}{2}$ in.

Fig. 145.



Baker's Engineering Microscope.—This Microscope (fig. 146) has been specially designed for the examination and photography of metals, and is adapted for the examination of opaque objects only. It has diagonal rack-and-pinion coarse, and micrometer screw and lever fine adjustments, but no means of substage illumination, and no stage aperture. Illumination of the object is effected, when using low powers'

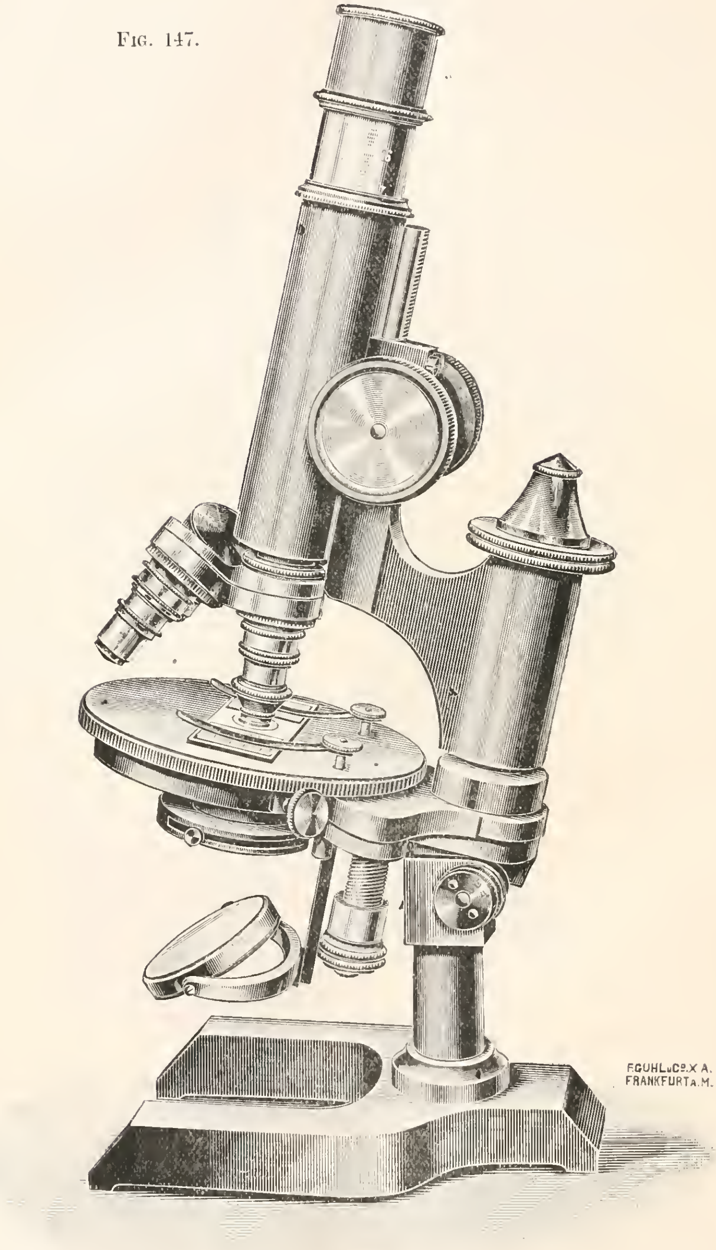
FIG. 146.



by diffused daylight or artificial light; when using the higher powers, by means of a vertical illuminator, with diaphragms for regulating the amount of illumination. The stage is provided with levelling screws.

Seibert's New Microscope, No. 5 A. — This is a new instrument (fig. 147) of medium size, intended for scientists of all grades who wish to carry out exact work with the best objectives and auxiliary apparatus. The stand is sold at a very low price. The pillar is jointed for inclina-

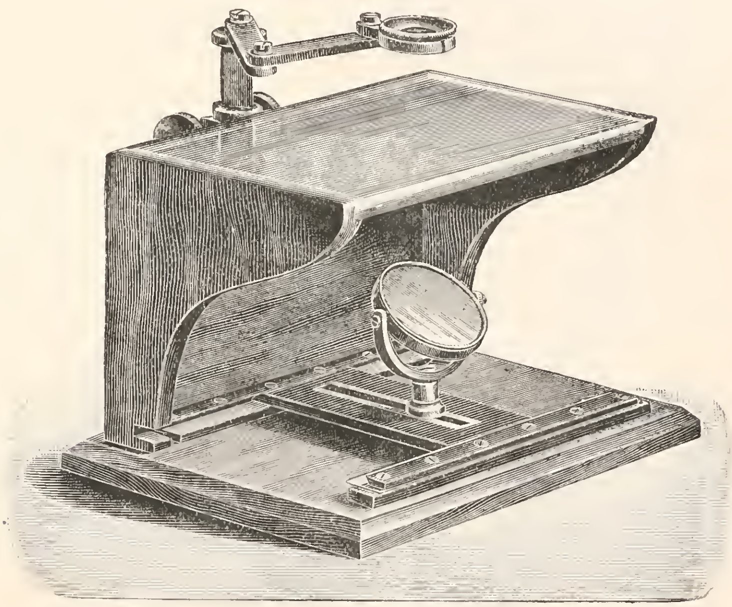
Fig. 147.



tion. The coarse adjustment is by rack-and-pinion, and the fine by micrometer screw. The circular rotating stage is fitted with centering screws. The draw-tube is graduated. The instrument has an Abbe's illuminating apparatus and iris diaphragm, which can be focussed by means of a screw-head under the stage. When the condenser is sufficiently screwed down, further rotation puts it aside. Under the iris is a slotted ring for receiving a coloured glass disc.

Seibert's Preparation Microscope.—This instrument (fig. 148) is mainly intended for the preliminary inspection and sampling of large objects. The stage is of glass, 18 by 12 cm. The adjustment is by

FIG. 148.

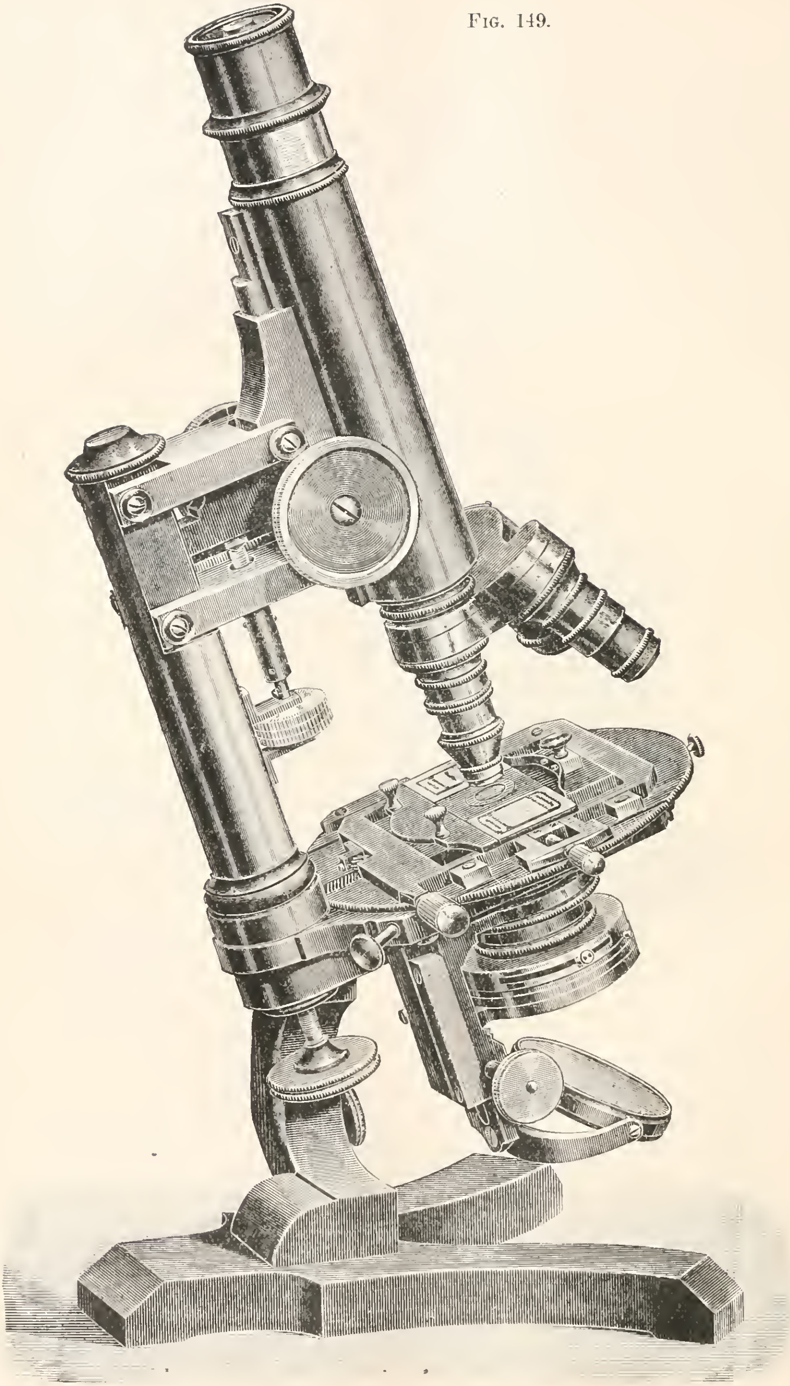


rack-and-pinion. By means of a three-jointed arm the loup can be easily arranged for exploring every part of the object. The mirror is movable, and can be pushed in all horizontal directions.

Micrometer Screws and Fine Adjustments as applied to Modern Stands.*—Prof. G. Marpmann introduces his article with some historical remarks. He attributes the modern stand to Vincent Chevalier, further developed by his son Charles and his nephew Arthur. These Chevalier stands go back to 1824, and reach their highest perfection in Strauss' grand Microscope of 1834, which has stage and substage, mirror, coarse and fine adjustments, as in the instruments of to-day. The chief difference lies in the shape of the pillar, which in the old stands is half round and with modern ones prismatic. In all the pillar is firmly

* Zeitschr. angew. Mikr., vii. (1901) pp. 33–8 (2 figs.).

Fig. 149.



connected with the stage, and the movable parts and tube depend on the pillar. The disadvantage common to all these models is that the micrometric movement, after a time, gets worn, and the fine adjustment no longer works with accuracy. A second disadvantage is in the position of the micrometer screw, which ought to be placed vertically below the stage. This arrangement was actually adopted by the Parisian firm of Trécourt, Bouquet, and Oberhäuser in 1830; and Oberhäuser, after his separation from his partners, introduced the same arrangement in all his instruments between 1847 and 1857. The only Continental firm which makes larger stands with the micrometer below the stage, as the author thinks it should be, is that of W. and H. Seibert, of Wetzlar.

Fig. 150.

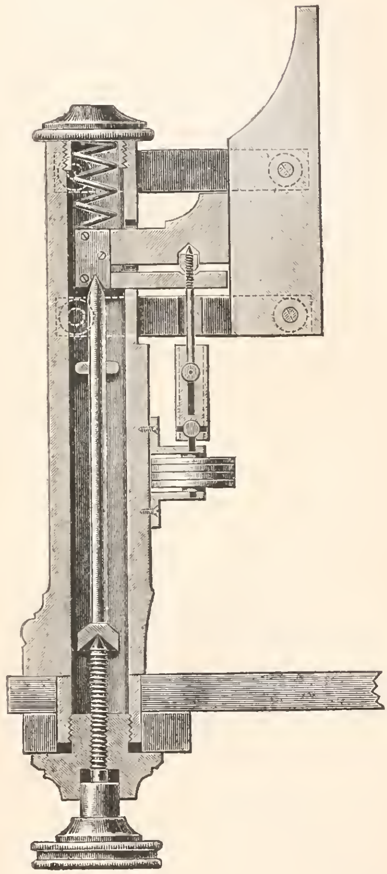


Fig. 149 shows Seibert's large model with three adjustments. The coarser adjustment is by rack-and-pinion; the fine, with parallelogram movement, is under the stage; the third adjustment is an extremely slow motion for delicate observations with the highest powers. Fig. 150 shows the two fine adjustments. The least fine of these is a micrometer screw, and its action securely moves the whole pillar and tube on the foot; its rotation about ten times as coarse as that of the third adjustment.

(2) Eye-pieces and Objectives.

Kreidl's New Stereoscopic Loup * (fig. 151).—The four totally reflecting planes m, m', n, n' of the four prisms P, P′, p, p' act as mirrors, by means of which the rays $o\,c$ and $o\,c'$, coming from the point o of the object, are reflected after their passage through the achromatic magnifying lenses $a\,b\,c$, $a'\,b\,c'$. After two reflections these rays emerge parallel or nearly so. An object at o, the common focus of the two central rays, is magnified to the right eye in the direction $A'\,o'$, and to the left eye in the direction $A\,o$. The angle enclosed by the two

* Zeitschr. wiss. Mikr., xviii. (1901) pp. 10–4 (1 fig.).

optical axes of the achromatic lenses is approximately equal to the angle between rays diverging to the eyes from a point at the distance

Fig. 151.

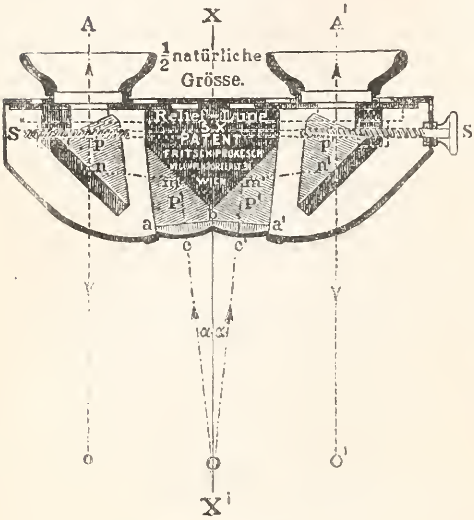


Fig. 152.

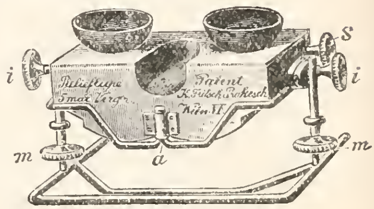


Fig. 153.

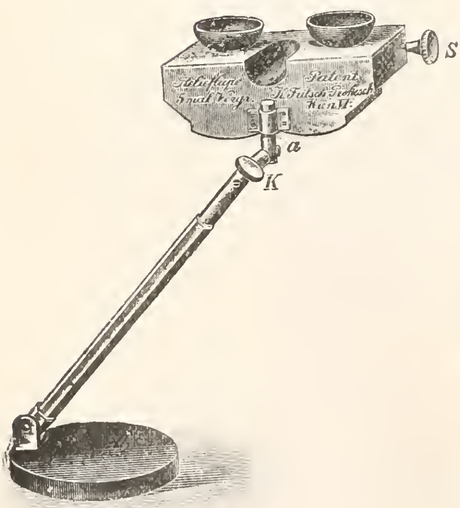
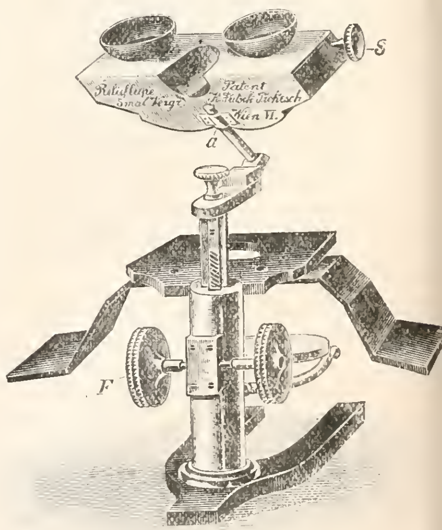


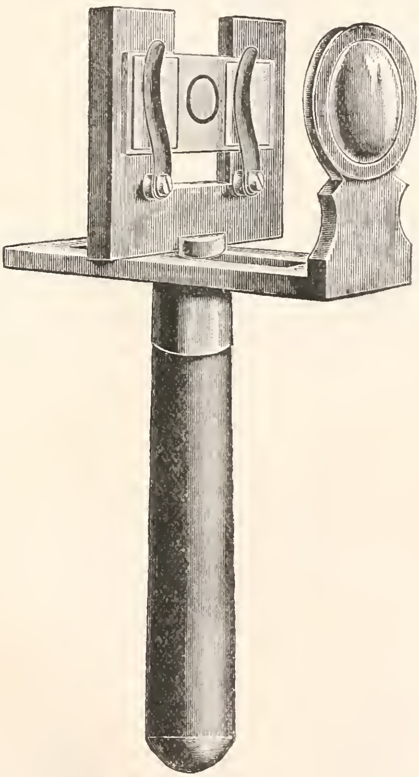
Fig. 154.



of normal distinct vision. The screw S S′ allows the emergent rays to be accommodated to the distance between the observer's pupils. This last peculiarity and the device of the two inclined lenses constitute the chief novelties of the instrument.

The loup may be mounted in various ways. In fig. 152 it is fitted on a simple frame, and this forms a pocket instrument. In fig. 153 it is seen on a simple stand; and in fig. 154 it is arranged for more elaborate work. The figures of these mountings seem to explain themselves so clearly that detailed description is not necessary. The instrument is manufactured by Fritsch of Vienna.

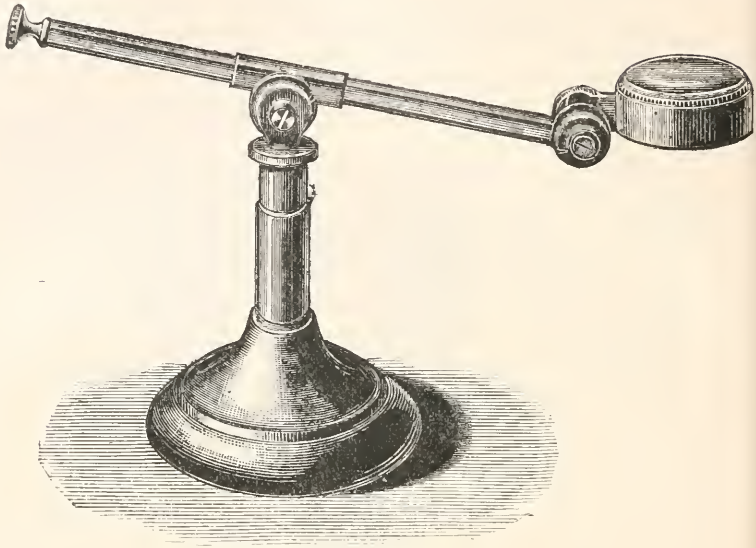
FIG. 155.



Seibert's New Demonstration Loup. — In this apparatus (fig. 155) the loup is set in a right-angled carrier, whose base is pierced by a rectangular slot. In this slot slides a screw, which serves as the tongue of the object-carrier. When the focus has been found by sliding the object-carrier into the proper position, the whole is tightened up by rotation of the wooden handle.

Seibert's Loup Stand.—In this apparatus (fig. 156), which is upon Fritsch's model, the pillar allows an elevation of the whole stand as well as a rotation of the loup arm. This arm can, by a push-motion through a clamping sleeve, be lengthened or shortened. The hinging of the loup permits its adjustment in all positions.

Fig. 156.



(3) Illuminating and other Apparatus.

Seibert's Illuminating Apparatus.—This apparatus (fig. 157) is of simple character and of special construction. The condenser has an aperture of 1·10. By the opening and closing of the iris-diaphragm the central illumination may be graduated as required. The oblique illumination is obtained by the adjustment of a mirror.

Fig. 157.

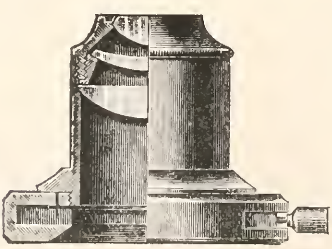
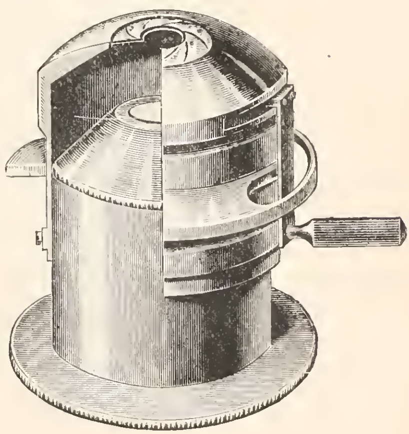


Fig. 158.

Watson's Universal Condenser.—The object of Messrs. W. Watson and Sons is to produce a condenser as suitable for low and medium as for high-power objectives. The apparatus (fig. 158) has a total aperture of 0·98, and if the exact thickness of slip for which the condenser is corrected be used, its total aperture is aplanatic. A special feature is that the field-lens is not so limited in size as to interfere with the quick work necessary for histological and diagnostic purposes, as it is $\frac{9}{10}$ in. in diameter. The front lens mount has been so shaped as to obviate, as far as possible, any obstruction of the mechanical stage. The back lens, which does the correcting, is a triple one, and is the system adopted by Messrs. Watson in their series of holoscopic objectives and oil-immersion condenser. The carrier is the same as that used for the Abbe illuminator, and will interchange with it. It has iris diaphragm and rotating cell for coloured glasses, black patch stops, &c.

Seibert's Cylinder Iris Diaphragm. — This (fig. 159) is intended as a substitute for the ordinary diaphragm stop of the Abbe illuminating apparatus, and consists of an iris with domed steel plates. It is fitted in the upper part of the sleeve collar of the condenser system, and during the use of the latter is out of action. When its use is required, the condenser is screwed out, and the iris brought to the desired aperture by pushing a lateral knob. The position of this stop is exactly the same as that of Abbe's diaphragm, and the plates, when completely closed, touch the object-slide.

Fig. 159.



Weinschenk's Guide to the Use of the Polarising Microscope. — This book deserves a fuller notice than that given to it in the Bibliographical list.* It claims to be a condensed general treatment of the subject. Special commercial and technical applications of polarisation are unnoticed. The main divisions of the book are :—The Polarising Microscope in general ; the adjustment of the Polarising Microscope ; observations with ordinary light ; observations with parallel polarised light ; observations with converging polarised light ; twin images and optical anomalies ; Appendix—Auxiliary Apparatus. The chapters are illustrated with a large number of explanatory diagrams. There are also representations of a great many forms of polarising apparatus collected mainly from the catalogues of Nachet, Seibert, Voight and Hochgesang, and Zeiss.

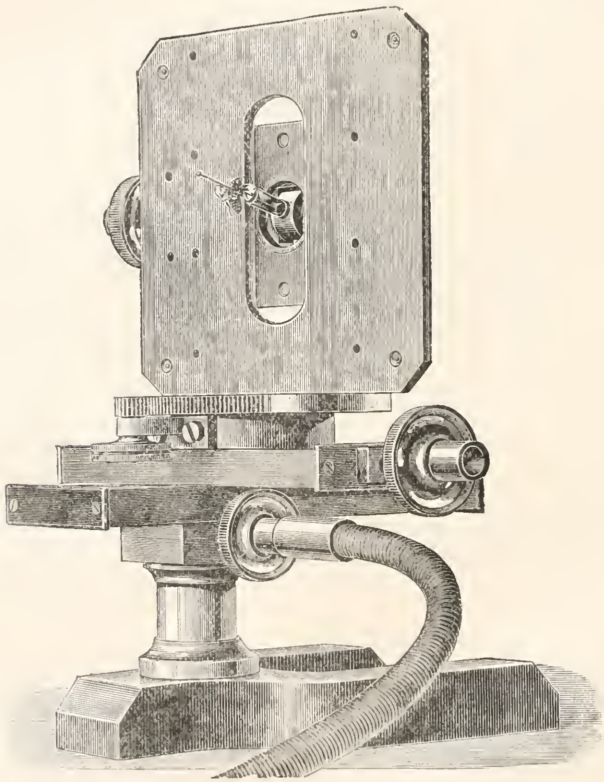
(4) Photomicrography.

Wandolleck's New Object-holder for Photomicrography.† — The intention of this apparatus is to facilitate the photography of solid objects. On a horse-shoe Microscope foot of the usual shape and size (fig. 160) a small vertical pillar carries, by means of a dove-tailed wedge,

* Cf. this Journal, *ante*, p. 587.
† Zeitschr. wiss. Mikr., xviii. (1901) pp. 1–9 (2 figs.).

a sliding-piece actuated by rack-and-pinion. Another sliding-piece is at right angles to this, and carries a cylindrical plug, which in its turn is connected to the toothed cylindrical disc on which the vertical stage stands. This stage is perforated by a rectangular notch with semicircular ends, and the object-slide, itself circularly perforated, carries the actual holder, and is operated by a rack-and-pinion. As each of the parts is capable of independent movement, the object-holder can receive

Fig. 160.

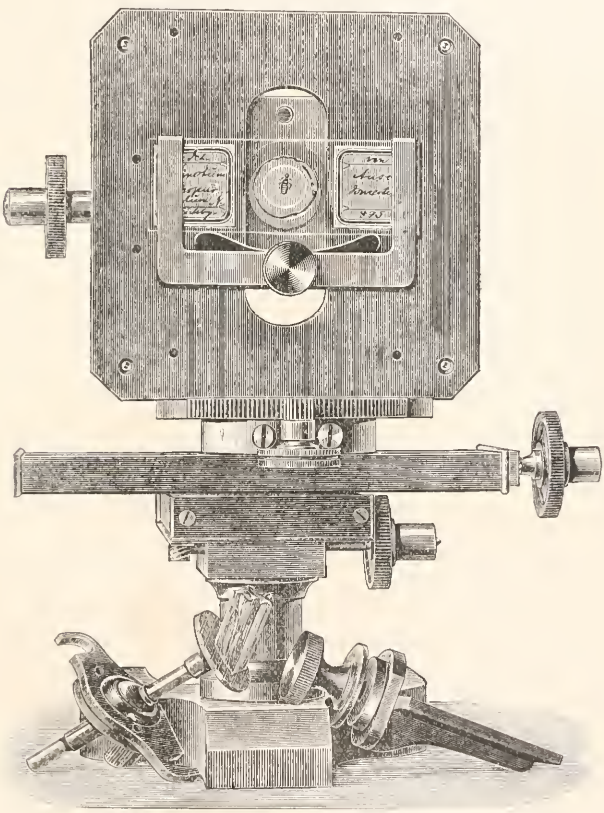


at least six different adjustments. The object is set on a small glass tube fitting into a suitable hole in a kind of wheel, and this arrangement removes it from the region of shadows. The teeth on the circular base permit of the quadrantal vertical rotation of the object-table.* The apparatus may be used for photography of transparent objects, as in fig. 161.

* A photograph of *Dædalochila avara* has been submitted to us as a specimen of the capabilities of Dr. Wandolleck's arrangement, and it seems very good.—[Ed.]

Methods of Producing Enlargements and Lantern Slides of Microscopic Objects for Class Demonstrations.*—The method practised by J. Aspinwall is the result of an attempt to produce photomicrographs of considerable magnification, and yet of great depth of focus, while using lenses of high resolving power. Use an objective of medium power, say a $\frac{1}{4}$ in., making the negative of a diameter of $1\frac{1}{2}$–2 in. In a lantern-slide camera enlarge from one-half to three-quarters of the

Fig. 161.



central area of the negative to twice its diameter on a Paget lantern-slide plate. By another enlargement from this positive a negative of any diameter can be secured. The enlarging lens must be well stopped down. In making the original negative use an objective without the ocular, and, instead of the substage condenser of high angle, an ordinary objective, say, of 1 in. focus, with a beam of light at a very low angle.

* Trans. Amer. Micr. Soc., xxii. (1901) pp. 41–7.

For making the lantern-slide the Paget plate gives the best results, and the warmer tones of brown, purple, and red are superior to black and white effects. Proper matting is of the greatest importance; the mat should be capable of being cut to suit the subject, e.g. the Boston. The developer is made up as follows:—Hydrochinon 100 grm., sodium sulphate 400 grm., sodium carbonate 400 grm., water 20 oz. The dilution of the developer is made as follows. (1) for black tone: developer 1 oz., water 2 oz., 10 p.c. solution of bromide 1–2 drops; exposure 20 seconds. (2) For brown tone: developer 1 oz., water 4 oz., bromide 5–8 drops; exposure $1\frac{1}{2}$–2 minutes. (3) For red tone: developer 1 oz., water 8 oz., bromide 15–25 drops; exposure 5–15 minutes. (4) For purple tone: over-exposure and No. 2 dilution. The temperature of the developer should be from 70° to 80°. In making slides the best results are obtained by using a reducing and enlarging camera in preference to making slides by contact with the negative. When the section is well differentiated, the following procedure is advised:—A lantern-slide is made with the reddest tone obtainable. After fixing and washing, but before the slide is dry, it is toned in a gold-bath made as follows: (1) sulphocyanide of ammonium 200 grains, water 32 oz., carbonate of soda 2 grains; (2) chloride of gold 15 grains, water 1 oz. Add 4 drops of No. 2 to 2 oz. of No. 1, and immerse the red slide long enough to permit the gold to attack the lighter deposit of silver in the film. The temperature of the gold-bath should be from 72° to 76°. After fixing the Paget plate, swab it over with a tuft of cotton immersed in a solution of ferricyanide of potash of the colour of very pale sherry.

For making the enlargement a rather weak negative is used. Parallel light is obtained by means of an arc lamp and a condenser so arranged that the arc is at its focus. Only the central portion of the condenser is used. The finest medium focus, double series, view lens is used for projection, and it is well stopped down, say, to F.–16. A paper made by Eastman is tacked to a board absolutely at right angles to the axis of the projection beam, and enough time is given to ensure the obtaining of every detail of the image. Developing is done in adurol, one portion of developer to about 30 of water, and bromide added according to the character of the image required. Then wash, and place in a weak solution of hypo, with a saturated solution of chrome-alum added in the proportion of 1 to 20. A very weak solution of formalin may be used after the print has been partially washed upon removal of the hypo solution. Wash thoroughly, and hang up to dry. Adurol gives a brownish tone just off a black, and imparts life to the image.

In making enlargements from a negative with clear glass surrounding the microscopic image, the light of the arc lamp should be cut off from the surrounding area by backing the negative with dense yellow paper cut to the requisite size. The size of the image on the negative should be reduced by allowing the paper to lap down upon the image. This gives a clear cut edge to the circle when enlarged upon the bromide paper.

B. Technique.*

(1) Collecting Objects, including Culture Processes.

New Apparatus for Cultivating Anaerobes. † — Dr. Herman has devised an apparatus for anaerobic cultivation which works very satisfactorily and is easily manipulated. It consists of twin flasks connected by a tube. Each flask has also a separate neck into which fits a caoutchouc stopper. In one flask is placed the medium, in the other the pyrogallate solution.

Glucoproteins as Cultivation Media for Micro-organisms. ‡ — C. Lepierre states that nearly all microbes, pathogenic or not, grow perfectly well in liquid media in which the nitrogen is exclusively furnished by the α-glucoproteins. The composition of the media used is as follows:—Water 100 grm.; glucoprotein (from C_6 to C_{11}) 1·5–2 grm., used alone or with the addition of 2–3 grm. of glycerin, glucose, or saccharose; chloride of sodium 0·5 grm.; sulphate of magnesium 0·5 grm.; glycerophosphate of calcium 0·2–0·3 grm.; bicarbonate of potassium 0·1–0·2 grm. In these media 22 pathogenic and 23 saprophytic fungi were successfully cultivated. Some microbes exhibited a preference for certain glucoproteins; e.g. anthrax, plague, tetanus grew well on media in C_8 and C_9, while tubercle preferred those in C_{10} and C_{11}.

Method for Rapid Solution of Gelatin and Agar in the Preparation of Nutrient Media.§—Dr. J. W. H. Eyre, in the course of some observations on the standardisation of nutrient media, mentioned the following method which he had recently adopted for the more rapid solution of gelatin and agar in the preparation of the nutrient media rendered solid by the addition of these substances, and which, although still in the trial stage, can be strongly recommended. The method is better explained by describing the preparation of an actual batch of 1000 ccm. of 2 p.c. agar.

500 grm. of lean beef, finely minced, were added to 1000 ccm. of distilled water in a 3-litre flask, which was placed in a water-bath, and the temperature of its contents raised to and kept at 45° C. for 20 minutes; then rapidly raised to 100° C., and maintained there for 10 minutes. The mixture was then filtered, and the filtrate found to amount to 650 ccm. 10 grm. of pepton, 5 grm. of salt, and 20 grm. of powdered agar were weighed out, mixed, and made into a thick paste with 150 ccm. distilled water, then added to the 650 ccm. of *Fleischwasser* in the flask, which was returned to the water-bath. By the side of this was arranged a 10-litre tin can (with copper bottom, such as is used in the preparation of distilled water), filled with boiling water, and fitted with a long safety tube and a delivery tube, bent twice at right angles, sufficiently long to reach to the bottom of the interior of the flask. 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.

† Bull. Acad. Roy. Méd. de Belgique, xv. (1901) pp. 259–63 (3 figs.).

‡ Comptes Rendus, cxxxiii. (1901) pp. 113–6.

§ Brit. Med. Journ., 1901, ii. pp. 788–91.

water in the can was kept vigorously boiling, and steam at 100° C consequently bubbling through the medium mass for 25 minutes, by which time complete solution of the agar had been effected. (If one had been preparing 10 p.c. or 12 p.c. gelatin instead of agar, bubbling the steam through for a period of 10 minutes would have been ample.) The medium mass was then rapidly cooled to 15° C. in a normal measuring flask, and found to amount to 900 ccm. A further 100 ccm. of distilled water was then added, the medium melted up, titrated, and controlled, and the reaction estimated as being + 20. Dekanormal soda solution 0·95 ccm. was therefore added to produce a reaction of + 10 in the 950 ccm. of medium remaining in the flask, and the medium egged, steamed, filtered, tubed, and sterilised in the usual way. The reaction of the finished medium was finally estimated as + 10.

Cultivation of Amœbæ.* — H. Zaubitzer obtained amœbæ from straw infusion where they were in symbiosis with a bacterium. Cultivations were made from the sporocyst stage at 15°–20° C. The most suitable of the liquid media tried were 1 p.c. Heyden-water and 2·5 p.c. somatose solution; of the solid, 1 p.c. Heyden-agar and 2·5 p.c. somatose-agar. Fucus crispus was much less favourable. Examinations were made in hanging drops, after staining with methylen-blue and eosin, and after Delafield's hæmatoxylin and methylen-blue. Pure cultures, free from bacteria destroyed with 20 p.c. soda solution, were not obtained.

Acid Media for Cultivating Tubercle Bacilli.† — G. Jochmann finds that media which are prepared with meat-water possess a favourable degree of acidity. Media which are naturally alkaline or neutral should be first tested for the neutral point with litmus, and then acidulated with 1 p.c. lactic acid; 10 drops to 50 ccm., or about 10 ccm. 1 p.c. lactic acid to 1 litre of medium.

Culture of Gonococcus.—Dr. H. H. Young ‡ records the successful cultivation of *Gonococcus* from cases of arthritis, abscess, cystitis, pyonephrosis, and peritonitis. The medium used was hydrocele-agar. The sterile fluid obtained aseptically may be kept for use in stoppered bottles. Agar slants are autoclaved for 5 minutes, and then put into water-bath at 55°. Hydrocele fluid is then poured into a tube in the proportion of a little more than one to two.

M. Wassermann § made successful cultivations of *Gonococcus* from vegetations of the aortic valves on human blood-agar.

Dr. N. M. Harris and Dr. W. H. Dabney ‖ report a case of endocarditis from which the *Gonococcus* was successfully cultivated.

Insects as Living Substratum for Cultivating Infectious Diseases of Man and Animals.¶—C. von Holub states that he has used insects as cultivation media for the past two years, and has found them an

* Arch. f. Hygiene, 1901, No. 2. See Centralbl. Bakt., 1te Abt., xxx (1901). p. 311.

† Hygien. Rundschau, 1901, No. 1. See Centralbl. Bakt., 1te Abt., xxix. (1901) p. 958.

‡ Johns Hopkins Hosp. Rep., ix. (1900) pp. 677–707.

§ Münch. Med. Wochenschr., 1901, No. 8. See Centralbl. Bakt., 1te Abt., xxix. (1901) p. 913.

‖ Johns Hopkins Hosp. Bull., xii. (1901) pp. 68–77.

¶ Centralbl. Bakt., 1te Abt., xxx. (1901) pp. 284–7.

excellent substratum for the bacillus of soft chancre, of syphilis, and other infective diseases of man and animals. The insects employed have been Orthoptera, Rhynchota, Hemiptera, Coleoptera, Lepidoptera, Diptera, Hymenoptera. The insects lived on the average for about 2 weeks. Inoculations were effected with a fine sharp sterilised needle in the heart, tracheal apertures, in the fat-bodies, between two thoracic segments as far from the digestive and reproductive organs as possible. The insects must be kept, especially in summer-time, in a moist atmosphere. Cultivated in insects the bacillus of soft chancre becomes shorter, gradually being transformed into cocci. It is also more difficult to stain than when obtained directly from a bubo. Although successful cultivations of syphilis were obtained, the results are not yet published.

(2) Preparing Objects.

Rapid Method for Making Slides of Amœbæ.* — M. A. Willcox removes amœbæ from detritus by means of a thin-walled dipper under a magnification of some 20 diameters. The amœba is then dropped on a slip, and, the excess of water having been removed, the animal is fixed with a drop of picric-alcohol (saturated solution of picric acid in 50 p.c. alcohol), after which it is dehydrated with alcohols of increasing strength. This done, the amœba is fixed to the slip with a droplet of very dilute collodion, after which the preparation is hardened in 80 p.c. alcohol. It may then be stained with borax-carmine, hæmatoxylin, &c. Amylic alcohol should be used for dehydration. If the specimen be large, supports may be necessary. Mount in balsam.

Preparation of Crystals as Microscopic Objects.† — S. E. Dowdy gives three principal methods for making preparations of crystals. The first consists of evaporating down a saturated solution of the salt until enough moisture has been driven off to enable the crystals to form rapidly on cooling. Make a saturated solution of the salt in distilled water, and deposit a drop with a pipette in the centre of a slide. Slope the slide to make a film, and remove superfluous fluid with blotting-paper. Hold the slide over a flame until a thin film of salt forms at the edges, then withdraw and allow to cool, and examine under Microscope. If satisfactory, mount in balsam. If the salt be insoluble in water, other suitable solvents are used. These evaporate without the aid of heat. Crystals formed from such solutions will probably require a different mounting medium, such as castor oil, or one in which they are not soluble. Another method is to dissolve gelatin or gum acacia in distilled water, and to add to this a few drops of a saturated aqueous solution of the salt. A drop of the warm mixture is then deposited on a slide, the superfluous fluid drained off, and the slide put aside to cool. Any salt soluble in water is suitable for this procedure.

The second principal method is by fusion. Place a small quantity, say of salicin, on the centre of a slide, and heat over the flame until it just fuses, withdraw before it chars, and allow it to cool gradually, and if successful mount in balsam. Crystals of fatty substances, such as spermaceti, paraffin, &c., are preparable in a similar way. When melted

* Journ. Applied Microscopy, iv. (1901) p. 1450.
† Pharm. Journ., lxvi. (1901) p. 198.

press on a cover-slip, the crystals forming as the mass cools. These crystals may be watched forming under the Microscope any number of times by simply warming the slide.

The third principal method is confined to those substances which are easily volatilised and crystallise on cooling. Some benzoic acid, say, is placed in a dry narrow test-tube, and heated over the flame until it volatilises. The tube is then inverted and made to stand on a slide. The crystals form on the part of the slide covered by the tube, and, if satisfactory, can be mounted in the usual way.

Modelling and Reconstruction Method.* — Florence R. Sabin's paper on the structure of the medulla, pons, and mid-brain of the new-born is preceded by a clear description of the wax-modelling and reconstruction method, which will be found very useful by those interested in this procedure.

Killing and Preserving Slugs.† — O. Goldfuss mentions the following procedures for killing slugs. The animals may be killed in the extended condition by placing them in a glass vessel filled with water, and capable of being hermetically closed by means of a glass plate. Twenty-four to thirty hours usually suffice, but the action is more rapid if a little carbolic acid be added to the water. Even better results are obtained by adding a few drops of kreolin or of lysol, or 2–5 parts of 5 p.c. cocaine. As a preservative, alcohol, when used alone, hardens too much; but 60–70 p.c. alcohol, with a certain percentage of glycerin, is a good preservative fluid. 3–5 p.c. formalin, to which about 5 p.c. of alcohol or some glycerin is added, will be found extremely useful.

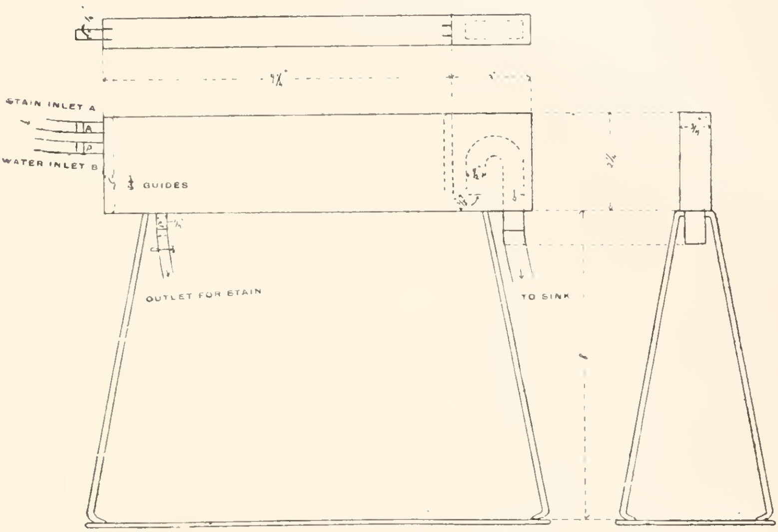
(4) Staining and Injecting.

Apparatus and Method for rapidly Staining large numbers of Sputum Specimens.‡ — B. R. Rickards designed the apparatus shown in fig. 162. It consists of a long narrow copper bath, mounted on legs which are inclined and terminate in a broad base weighted with lead to ensure stability. At one end near the top are two inlets; the upper one A for the admission of the stain, the lower one B for the water. In the bottom of the bath is a small outlet C for the stain, closed by means of a rubber tube and a pinch-cock. At the other end of the bath, partitioned off by a false wall, is a $\frac{1}{2}$ in. siphon, the inner end of which is left at least $\frac{3}{8}$ in. from the bottom, to prevent the effect of capillarity. The bottom of the bath is 8 in. above the base. The entire apparatus is nickel-plated. Instead of the ordinary slide, a piece of thin plate glass 9 by 3 in. is used. It is etched as shown in the diagram, fig. 163; the rough surface above the spacings is for writing the names of patients with a blue pencil. Several of these plates can be manipulated simultaneously. Carbol-fuchsin and Loeffler's methylen-blue are used for staining, and 3 p.c. HCl in 95 p.c. alcohol as the decoloriser. The technique is as follows. Carbol-fuchsin is admitted through A until the bath is about two-thirds full. The bath is then heated by means of a Bunsen's burner, and while the heating is in

* Johns Hopkins Hosp. Rep., ix. (1900) pp. 925–1045 (8 pls. and 45 figs.).
† Zeitschr. angew. Mikr., vii. (1901) pp 85–90.
‡ Journ. Boston Soc. Med. Sci., v. (1901) pp. 391–4 (2 figs.).

progress the specimens are smeared on the plate and dried. The plate is then placed in the bath. In about four minutes at 50° C. the specimens are stained, and then the fuchsin is withdrawn through C. Water is then admitted through B, and having been siphoned off

FIG. 162.



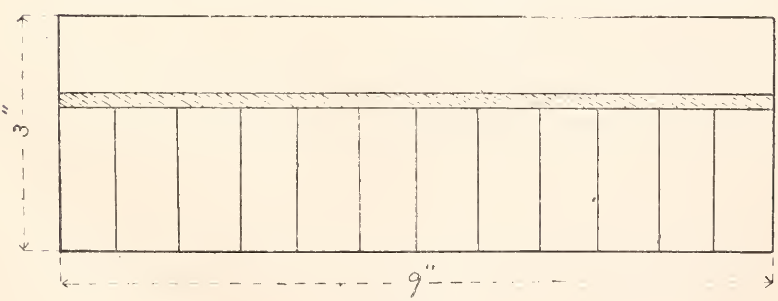


FIG. 163.

two or three times, the preparations are decolorised. The decolorising is performed in glass trays, and when finished, the plate is replaced in the bath and washed. It is then withdrawn, dried, stained with methylen-blue, and examined.

Ammonium Persulphate as a Decolorising Fluid for Staining Spores and Sputum.* — Dr. R. L. Pitfield recommends a solution of ammonium persulphate which acts by oxidation. To demonstrate spores

* Philadelphia Med. Journ., vii. (1901) p. 872.

the film is stained with carbol-fuchsin or with anilin-oil-gentian-violet or fuchsin. The cover-slip should lie in the boiling stain for at least one minute. Then wash, and run on the following solution:—Ammonium persulphate 5 grm.; alcohol 95 p.c., 50 ccm.; H_2O, 10 ccm. At the end of half a minute wash and counter-stain. The preparation will show red or violet spores and bacilli coloured with the contrast stain. Sputum may be stained by the foregoing method, but if pushed too far the tubercle bacilli may be decolorised.

New Staining Method.*—Dr. A. Spuler has devised the following procedure. Finely-powdered cochineal is boiled with distilled water, filtered, and evaporated nearly to dryness. Alcohol is then added, and the mixture filtered and evaporated down. The residue is dissolved in distilled water, and the solution filtered. Pieces of tissue which have been fixed in the usual way are immersed in this staining solution and incubated for 24 hours. On removal they are washed and then mordanted in dilute iron-alum solution. After having been thoroughly washed they are imbedded and sectioned. The sections present pictures like pen-and-ink drawings, the nuclei and cell contours being extremely well stained.

Modification of Gram's Method.†—Dr. C. Kisskalt shows that by using amyl-alcohol most bacteria can be stained by Gram's method, the exceptions being *Bacterium vulgare*, *Bacillus pyocyaneus*, and three vibrios, *V. choleræ*, *V. Metchnikovi*, and *V. albensis*. In all thirty-nine bacteria were tested, and the results are given in a table, at one end of which stands methyl-alcohol followed by ethyl, propyl, butyl, and amyl, in the order given.

Modification of Hoyer's Thionin Stain.‡—Dr. P. Hári's modification of Hoyer's staining for mucus is carried out in the following way. From the sections, which are all prepared from the celloidin method, all the celloidin must be completely removed by means of ether and ether-alcohol. The ether is extracted by treatment with absolute alcohol for 5 minutes. The sections are then washed in water for 3 minutes, after which they are immersed for 10–12 minutes in the sublimate solution used for fixing the material (sublimate 7, salt 0·5, water 100). The sections are next washed in absolute alcohol for about half a minute, and for a similar time in water, after which they are transferred to a freshly filtered 1 p.c. aqueous solution of thionin for 3–4 minutes. The over-stained sections are washed in water until the dye is no longer given off, and are then immersed in absolute alcohol for a similar object. The sections are then further decolorised in a mixture of equal parts of oil of cloves and carbol-xylol (acid carbol 1, xylol 2). In rather less than a minute the sections are placed on a slide and examined under a low power, to ascertain if the colour reaction has succeeded. As a rule the last process requires to be repeated twice or thrice. The desired effect is attained when the other tissue elements are blue and the mucus cells are red-violet. The carbol-xylol is removed by means of xylol.

* Deutsche Med. Wochenschr., xxvii. (1901) Beilage, p. 116.
† Centralbl. Bakt., 1te Abt., xxx. (1901) pp. 281–4.
‡ Arch. Mikr. Anat. u. Entwickl., lviii. (1901) pp. 678–85.

Simple and Rapid Method of Producing Romanowsky Staining of Blood-Films.*—Dr. W. B. Leishman prepares the stain in the following way. Solution A: A 1 p.c. solution of medicinal methylen-blue (Grübler) in distilled water is alkalised by the addition of 0·5 p.c. sodium carbonate. Solution B consists of a 0·1 p.c. solution of extra B A eosin (Grübler) in distilled water. Equal volumes of the two solutions are mixed in a large open vessel and allowed to stand for from 6–12 hours, being stirred from time to time with a glass rod. The precipitate is then collected on a filter, washed with distilled water, and the insoluble residue collected, dried, and powdered. The powder pigment is dissolved in methyl-alcohol in the proportion of 0·15 p.c., and the solution kept in stoppered glass bottles.

Three or four drops of the solution are deposited on a blood-film prepared in the usual way. In about ½ minute 6 or 8 drops of distilled water are added and allowed to mix with the staining solution. After allowing it to act for about 5 minutes, the stain is washed off with distilled water. The preparation may now be examined either wet or after drying without heat, and mounting in balsam.

Neutral Red for Detecting Bacillus coli in Water. — Dr. R. H. Makgill † concludes from his experiments that neutral red media afford a rapid and delicate test of the presence of *Bacillus coli* in water. By using varying quantities of water a rough estimate can be obtained of the number present, allowance being made for the influence of inhibiting organisms. Where a fair sample of water is examined, a negative result may be taken as evidence of the absence of *B. coli.* Further investigation is needed to decide whether or not a positive reaction always indicates the presence of *B. coli*; but the writer has not observed any case in which this bacillus was absent from a sample of water which gave a typical positive reaction.

Dr. W. G. Savage, ‡ who has also investigated the same subject, finds that a positive neutral red reaction obtained by the method adopted, while not absolutely diagnostic of *B. coli*, yet in the vast majority of cases points to the presence of that organism. A negative neutral red reaction does not certainly exclude *B. coli*, but renders its presence highly improbable. The test is readily applied, and is of great value in the routine examination of water.

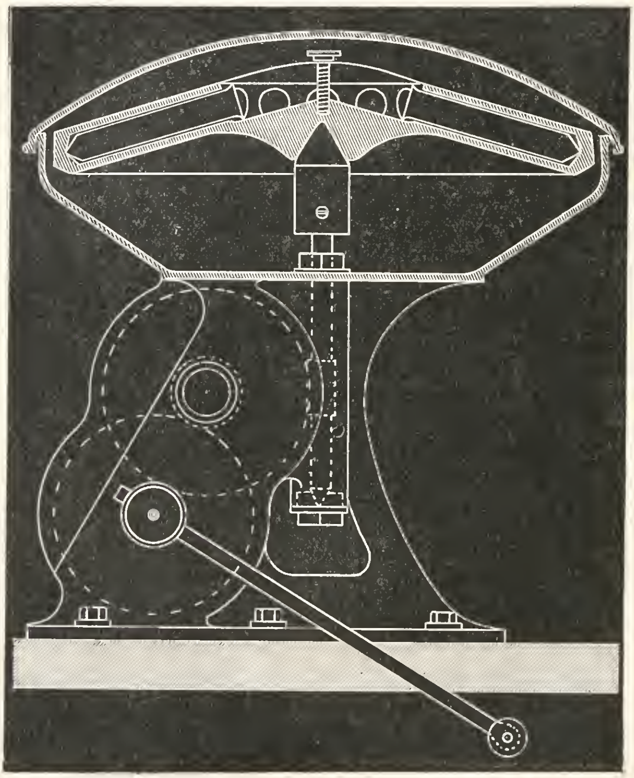
(6) Miscellaneous.

New Centrifuge for Bacteriological Work. § — Dr. J. W. H. Eyre has devised a machine (fig. 164) which is easy of manipulation and fulfils the following requirements. The tubes are of such capacity as will enable from 250–500 ccm. of milk to be manipulated at one time. It has a rate of 2500–3000 revolutions per minute. The gearing is so arranged that the requisite speed is obtained by 40 or 50 revolutions of the crank-handle per minute. The handle is provided with a special clutch, so that, on ceasing to turn, the machine is not stopped. The tube-bearing portion of the machine is a metal disc of sufficient weight to ensure good "flank" movement.

* Brit. Med. Journ, 1901, ii. pp. 757–8.
† Journ. Hygiene, i. (1901) pp. 430–6. ‡ Tom. cit., pp. 437–50.
§ Brit. Med. Journ., 1901, ii. pp. 773–4 (1 fig.).

The machine may be said to consist of three portions—the motion, the bearing spindle, and the disc. The motion is enclosed in a metal box, which is filled up with oil, so that the gearing wheels are running in a regular oil-bath. It consists of one pair of spur-wheels and a pair of screw-wheels, which transmit movement to the upright spindle through a smaller wheel, and the gearing is so arranged that one revolution of the driving wheel—corresponding, of course, to one revolution of the handle—is equivalent, in round numbers, to 50 revolutions

Fig. 164.



the bearing spindle, so that 40 turns of the handle per minute give a speed of about 2000 revolutions of the disc in the same time, and the labour involved in producing this speed is well within the powers of the ordinary laboratory boy.

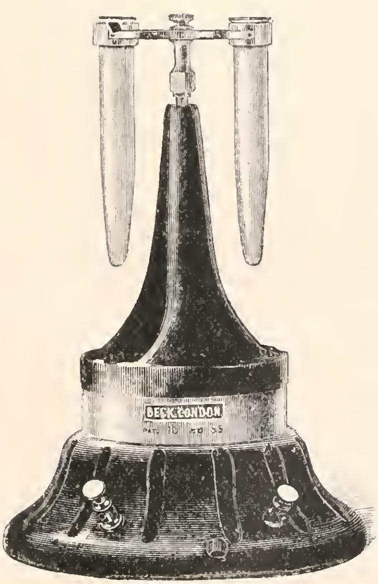
The handle is attached to the spindle of the driving wheel by means of a short screw with a quick thread, so that, on ceasing to turn the handle and holding it steady, two or three revolutions of the driving spindle completely unship the handle and leave it free in the hand.

The upright spindle is surmounted by a gun-metal cup containing a cone-shaped block of vulcanised rubber, renewable at will, upon which in turn rests the metal disc, carrying the centrifugal tubes. This disc is of cast steel, 14 in. in diameter, and weighing 50 lb., drilled to carry twelve stout glass tubes, $6\frac{1}{4}$ by $1\frac{1}{8}$ in. each, holding rather over 50 ccm. of milk. The disc, it will be noticed, is not *fastened* to the bearing spindle, it merely has a conical cup in the centre of its under surface, which receives the rubber cone that forms the head of the spindle, the friction clutch being quite sufficient to transmit the speed to the disc without the least diminution. This rubber head, on account of the amount of play it allows, serves a very important function, in that it renders the machine practically self-centering and automatic in its balancing. For instance, if only two tubes full of milk are placed in the machine, even in two contiguous holes, the machine can be run as rapidly and as smoothly as when the disc is either empty or completely filled with tubes.

The central aperture in the disc, through which the tubes are introduced, is closed by a copper cap which screws into the body of the disc, and the disc itself is enclosed in a copper basin, with a loose cover; both these details being introduced in order to lessen the air resistance the machine has to overcome.

Electric High-speed Centrifuge.—Fig. 165 represents this instrument, constructed by Messrs. R. and J. Beck (Ltd.), which was exhibited

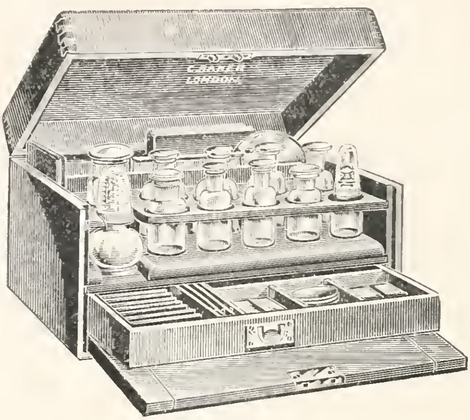
Fig. 165.



at the Meeting of the Society on October 15th. It may be made to run by an electric current at a very high rate of speed, regulated within certain limits by the interposition of different resistances.

Mounting Cabinet.—Messrs. C. Baker have provided a mounting cabinet (fig. 166), consisting of a strong well-finished mahogany case,

Fig. 166.



polished inside and out, $13\frac{1}{4}$ by $8\frac{3}{4}$ by $7\frac{1}{4}$ in., with hinged front, drawer, and lock and key, containing bottles of reagents, instruments, &c., of which a list is supplied in their Catalogue for 1902.

Combined Slide and Cover-glass Forceps.* — L. N. Boston has devised a forceps which can be used as a slide- and slip-holder. It is made of brass. The method of using the forceps is shown in the illustrations (figs. 167, 168).

Fig. 167.

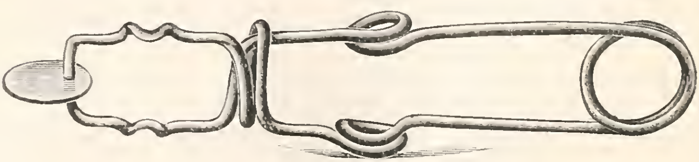


Fig. 168.

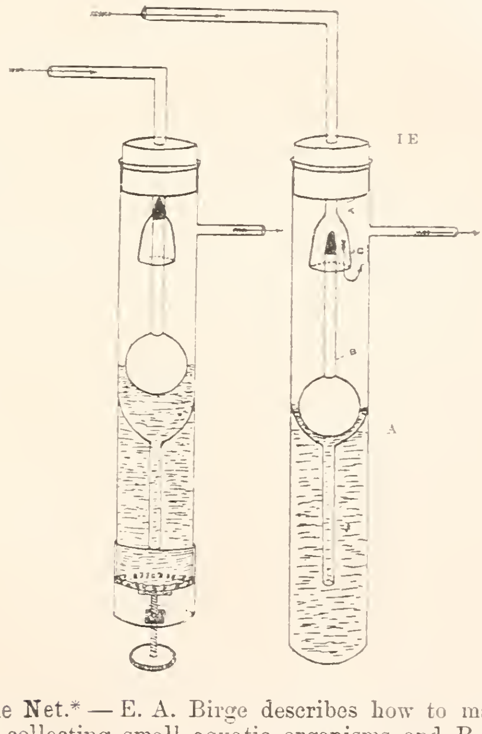
New Thermo-Regulator.†—T. Palmer describes a thermo-regulator (fig. 169) which gives satisfactory results with Jung's air steriliser.

* Journ. Applied Microscopy, iv. (1901) p. 1436 (2 figs.).

† Tom cit., p. 1449 (2 figs.).

I E is a rubber cork through which passes the tube T which terminates in a cup-shaped expansion C. B is a glass float, the upper end of which closes T when it rises, and drops into A when it descends. A is a cup with a tube dipping into the mercury. When the apparatus is in work, the heat causes the mercury to rise into the cup A, so that the float B ascends into the tube T, thus cutting off the gas supply. The form of the right-hand figure is serviceable for only one temperature, but by interposing a metal cap and screw (as shown in the left-hand figure) acting on a leather diaphragm, the apparatus may be regulated for any temperature.

Fig. 169.



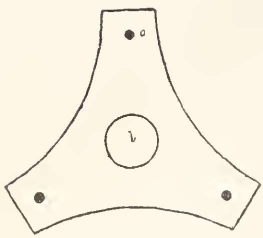
Birge's Cone Net.* — E. A. Birge describes how to make a cone-shaped net for collecting small aquatic organisms, and R. H. Wolcott describes some modifications which have served to render this apparatus more useful. For the details of the construction the original should be consulted.

Raising the Melting-point of Gelatin by means of Formalin.† — Dr. H. J. van't Hoff found that the addition of formalin raises the melting-point of gelatin. The addition of 1 to 1750 produces a gelatin which liquefies in a water-bath at 40°, while in the proportion of 1 to 500 (1 drop of 40 p.c. formalin to 10 grm. gelatin) the mass retains its solidity in boiling water.

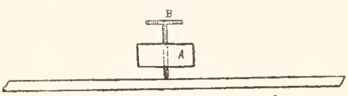
* Journ. Applied Microscopy, iv. (1901) pp. 1405–9 (7 figs.).
† Centralbl. Bakt., 1te Abt., xxx. (1901) p. 368.

Device for Levelling the Microscope.*—T. O. Reynolds shows the ingenious device (fig. 170) for levelling a Microscope when used for liquid preparations. The expense of a spirit-level may be saved by means of a glass slip on which are placed a few drops of water containing particles of opaque material. The apparatus is levelled by means of the three screws, and the desired position is indicated when currents are no longer perceptible.

Fig. 170.



Microscope Foot.
a. Threaded hole for leveling screw.
b Microscope pillar.



A. End view of microscope foot.
B. Milled head of leveling screw

Method for Demonstrating the Structure of Bacteria.†—In his researches on the structure of bacteria, Prof. K. Nakanishi adopted the same method which he found suitable for the demonstration of the malaria parasite. This method consists in making a film of the stain on a slide. A saturated aqueous solution of methylen-blue is deposited on a slide and allowed to dry. In this way a thin layer of pigment is formed. A droplet of blood is deposited on a cover-glass, and the latter on the staining film. Fluids containing bacteria are treated in a similar way. Bouillon cultures are the most suitable. Cultivations on solid media require to be suspended in some fluid in which the pigment is easily soluble. For methylen-blue, blood-serum, ascitic fluid, &c., may be used. The author, however, found that distilled water answered very well.

Klein's Method of Counting Bacteria, and some Applications thereof.‡—This method consists in mixing 0·1 to 1 ccm. of the fluid containing bacteria with the same quantity of staining fluid. After the lapse of a minute a portion is removed with a platinum loop of known size. A film smeared on a cover-slip is dried and mounted in the usual way. The number of bacteria in a cubic centimetre was calculated after counting 50 fields under the Microscope. For this purpose it is necessary to know how many fields go to 1 square centimetre of cover-glass.

F. H. Hehewerth made the number to be 5656. The author contrasts the results obtained by this method with Koch's plate method, and finds that Klein's procedure gives a greater number of organisms; this may be accounted for by the fact that when a preparation is stained after being fixed, a large number of bacteria are washed away. For fluids which contain few bacteria Klein's method is not to be recommended, and a perfect method of counting bacteria has yet to be devised.

The author employed the method for determining the duration of bacterial generations, and their increase in certain periods of time on different media and at different temperatures.

The author measured the size of bacteria, and found that the length and breadth were extremely variable even in quite fresh cultures.

By comparing the results of the Klein and Koch procedures, the

* Journ. Applied Microscopy, iv. (1901) p. 1458 (2 figs.).
† Centralbl. Bakt., 1te Abt., xxx. (1901) pp. 98–102.
‡ Op. cit., xxix. (1901) pp. 72–3 and 914.

number of bacteria in a culture which were no longer capable of development was easily determined.

Method for Distinguishing between different Kinds of Blood.* — Dr. Uhlenhuth's method promises to fill up a gap which has long been vacant in the technique of forensic medicine. Before dealing with human blood, the author experimented with the blood of cattle. At intervals of 6–8 days he injected 10 ccm. of defibrinated ox-blood into the peritoneal sac of rabbits—five times in all. Eighteen different blood-solutions were then tested in the following way:—The blood was diluted with water until the fluid was of a faint red hue (about 1 p.c.). The solution was filtered, and the filtrate mixed with an equal bulk of 1·6 per cent. salt solution. The accurate admixture is of great importance.

To about 2 ccm. of this blood-solution 6–8 drops of the serum of a rabbit previously treated with ox-blood were added. In such solutions an obvious and increasing cloudiness arose. All other blood solutions remained clear, as did also the untreated normal rabbit's blood.

The method was then extended to human blood. Rabbits were injected with human blood. A turbidity arose only in those solutions to which human blood was added. Only a trace of blood was necessary to bring about the reaction, and blood which had been dried on a board for four weeks produced a positive result.

Piorkowski's Method of Detecting Typhoid Bacilli.† — A. Peppler carefully tested Piorkowski's method for demonstrating the presence of typhoid bacilli, and arrived at the conclusion that, though of considerable merit, it was not always satisfactory; for a negative result does not disprove the presence of typhoid; and even if the colonies appear characteristic, there is no certainty that they may not be those of some other bacterium, so that further tests are necessary.

In the course of the investigation, a new bacterium, designated *Bacterium alcalifaciens*, was isolated by means of phenolphthalein-urine-gelatin, and this organism was employed to render urine alkaline in the preparation of the urine-gelatin.

Acid-free Cement.‡ — 250 grm. of powdered dammar resin are dissolved in 1 litre of petroleum ether in a spacious flask, and then $\frac{1}{4}$ litre of 10 p.c. NaHO are added. The mixture is well shaken and boiled for 10 minutes, and then, after having been allowed to settle, the perfectly acid-free ethereal solution is filtered off.

Iron and Phosphorus.§—J. E. Stead gives parts iii. and iv. of his researches. Part iii. deals with the constitution and microstructure of pig metals containing iron, carbon, and phosphorus. The author arrives at the following conclusions (*inter alia*):—(1) That with the aid of the Microscope it is possible to detect the phosphide eutectic in pig irons, even when the amount is as low as 0·03 per cent.; (2) that in white irons it is necessary to use the heat-tinting process to enable the cementite to be distinguished from the phosphide.

Part iv. deals with the diffusion of phosphide of iron in iron, and

* Deutsche Med. Wochenschr., xxvii. (1901) pp. 82–3.

† Inaug. Diss. Erlangen, 1901, 8vo, 77 pp. See Centralbl. Bakt., 1te Abt., xxix. (1901) pp. 879–81; Bot. Centrabl., lxxxvi. (1901) pp. 182–3. Cf. this Journal, 1900, p. 639.

‡ Zeitschr. angew. Mikr., vii. (1901) p. 102.

§ Metallographist, 1901, pp. 332–60 (2 figs.). Cf. this Journal, *ante*, p. 608.

the conclusions arrived at are :—(1) That the observations of Arnold and MacWilliam, proving that solid phosphide of iron does diffuse when in the solid state into solid iron, under certain conditions, have been fully confirmed ; (2) that if time is given, the quantity which will diffuse into iron is very considerable, amounting to what is equivalent to about 1 per cent. of phosphorus ; (3) that it still remains to be proved at what temperature diffusion commences. The paper includes valuable and elaborate appendices on eutectics, solid solutions, heat-tinting, and bibliography.

Clinical Pathology and Practical Morbid Histology.*—T. Strangeways Pigg's Manual of Clinical Pathology and Morbid Histology is a very practical and most useful little work ; and, though intended for the use of students of medicine, will be found of considerable assistance to other workers in bacteriology and histology. It includes methods for the examination of blood, sputum, diphtheria, ringworm, gonorrhœa, pus, bacteria, and urine. There is also a *resumé* of the procedures required in practical histology, in which the following stages are given with much clearness :—Fixing and hardening tissues, decalcification, imbedding in paraffin and celloidin, cutting sections on a freezing microtome or a Cambridge rocking microtome, and on a sliding microtome. Staining frozen sections with alum-carmine and with hæmatein. Staining paraffin and celloidin sections. Staining sections for fatty changes, for amyloid changes, for micro-organisms, for free iron ; of nervous tissue ; staining elastic tissue.

At the end is a list of 53 formulæ, which are in constant use in the laboratory. The paragraphs on the blood are preceded by two coloured plates showing normal and abnormal erythrocytes and leucocytes, with descriptions by Hon. G. Scott. This will be found extremely valuable to those interested in this special department.

Demonstrations of Microscopic Manipulation. — For the benefit of amateurs as yet unacquainted with the full resources of the instrument, Messrs. Baker (244 High Holborn) have set aside four afternoons in each month (except July, August, and September) for the demonstration of microscopic manipulation. These demonstrations will be given on the 1st and 3rd Friday, and the 2nd and 4th Tuesday in each month, from 3 p.m. to 6 p.m., the demonstration on each Tuesday being the same as that on the preceding Friday. These demonstrations will be entirely without charge ; full particulars are given in Messrs. Bakers' Catalogue for 1902.

Bibliography.

Praum—**Einfacher Apparat zur Entnahme von Wasserproben aus grösseren Tiefen.** *Centralbl. Bakt.*, 1te Abt., XXIX. (1901) pp. 994–6 (1 fig.).

Sauveur, A.—**The Progress of Metallography in 1900.**
[A very useful *resumé*, under the two heads : (i.) Preparation of samples of metals for microscopical examination ; (ii.) Development of the structure.] *Metallographist*, Oct. 1901, pp. 271–86 (5 figs.).

Tiemann, H. P.—**The Temperature Limits for the Separation of Graphite from Martensite in Pure Cast Iron.** *Metallographist*, Oct. 1901, pp. 313–32 (12 figs.).

* London, Strangeways and Sons, 1901, 2nd ed., 107 pp., 7 pls., and 6 figs.

PROCEEDINGS OF THE SOCIETY.

MEETING

HELD ON THE 16TH OF OCTOBER, 1901, AT 20 HANOVER SQUARE, W., W. CARRUTHERS, ESQ., F.R.S., PRESIDENT, IN THE CHAIR.

The Minutes of the Meeting of June 19th, 1901, 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 Society were voted to the donors.

	From
Board of Agriculture, Annual Report of Proceedings under the Diseases of Animals Acts for the year 1900. (8vo, London, 1901)	*The Board of Agriculture.*
Journal of the Board of Agriculture. Vol. viii. No. 2, Sept. 1901. (8vo, London, 1901)	*Ditto.*
Chamberlain, Chas. J., Methods in Plant Histology. (8vo, Chicago, 1901)	*The University of Chicago Press.*
Peragallo, H. and M., Les Diatomées Marines de France. Pt. ii. (8vo, Paris, n.d. (1901?))	*The Publisher.*
Wilkinson, J. J., The Pharynx of the Eristalis Larva. (8vo, Skipton, 1901)	*The Author.*
An old Microscope by Cary	*Mr. Chas. Lees Curties.*
Patent Graphic Telescope by Cornelius Varley	*Mr. Chas. F. Rousselet.*
Mikroskopers Arms	*Mr. A. Flatters*

Mr. C. L. Curties, for Messrs. C. Baker, exhibited a Portable Microscope made of magnalium. This alloy of manganese and aluminium, which is as light as aluminium, is much easier to work, and takes a very high polish.

The Microscope was on the model of the "Diagnostic," originally designed for Major Ronald Ross's investigation of malaria.

The weight of the Microscope is 14 oz.

He also exhibited the "Engineering" Microscope, intended for the examination of fractures and etchings on metal. A vertical illuminator with diaphragms is provided; and when the adjustments have been made with this apparatus, focussing can be done by rack-and-pinion attached to the stage, thus obviating the necessity of moving the body of the Microscope. Levelling screws are supplied to the mechanical stage to compensate for any want of parallelism between the faces of the blocks of metal under examination. The instrument is also provided with the usual diagonal rack coarse, and micrometer-screw fine adjustments, and is mounted on a solid tripod stand, with bracket for support when in horizontal position for photomicrographic work (see p. 697).

The President said that the travelling Microscope was an ideal one, as its extreme lightness and small compass into which it packed would add but little to the weight or the contents of a knapsack.

Mr. C. Beck exhibited a portable model of the "London Microscope," which was made to fold up in the smallest possible space, and packed into a leather case, containing also three objectives, two eye-pieces, and other useful accessories. The instrument was fitted with a good fine adjustment, and was of the first quality in every way. He also exhibited a modification of the ordinary centrifuge, made to run by an electric current at a very high rate of speed, which could be regulated within certain limits by the interposition of different resistances (see p. 694).

The President said that this portable Microscope was a great contrast to the other as regards weight, but it was a remarkably complete and compact instrument for holiday work.

The thanks of the Society were, on the motion of the President, cordially voted to Messrs. C. L. Curties and C. Beck for bringing these new instruments for exhibition.

The President said he had brought to the Meeting some specimens of the Mycetozoa, which he hoped would interest the Fellows of the Society. The Mycetozoa belong to a group of organisms which it was somewhat difficult to place, because at one stage of their life they seem to be animals, and at another they are true vegetables. The specimens belong to a species which has been recently described as *Badhamia foliicola* by Mr. Arthur Lister, F.R.S., in the *Journal of Botany*.* Their nearest affinities are with the Fungi. Like fungi they are not able to manufacture their food from inorganic materials, but obtain it from living or dead animals or plants, being either parasites or saprophytes. The spore of the Mycetozoa is a round body with a distinct cell-wall which has been separated in some cases into two layers. The cell-wall under chemical reagents gives the reaction of cellulose. When the spore begins to germinate, the wall is burst by the increasing size of the protoplasm, which pushes its way out of the sporange. For a short time it remains dormant, and then it begins to elongate into a pear-shaped form. From the apex is developed a flagellum; a nucleus and some vacuoles can be observed. Increasing in number by fission, many of the amœboids join together to form a plasmodium, which takes in its food just as an Amœba does. They might be found in this stage living upon dead wood and dead leaves from which they obtain their food. It is easy to cultivate these organisms; and if put into a damp chamber upon blotting-paper, they will begin to develop, and the plasmodium will in time spread itself over the blotting-paper. Afterwards sporanges are formed, either sessile or stalked, which usually contain a large number of fine threads intended to support the spores. When the sporange is ripe it bursts, and the dark coloured spores are scattered. He hoped the examination of these specimens might interest some Fellows in this curious group. This is the time of year when they are most abundant on decaying wood and on dead leaves. It is most interesting to watch

* Journ. of Bot., 1899, p. 145.

their growth and development in the house, which can be easily done, provided they are supplied with sufficient moisture. He had brought some leaves of grass on which there were numbers of sporanges, and would be pleased if Fellows would take specimens for experiment.

The thanks of the Meeting were voted to the President for his interesting account of the development of the Mycetozoa, and for the specimens brought for distribution.

The President called the special attention of the Fellows to the exhibits upon the table by Mr. C. L. Curties, consisting of a large number of mounted specimens of marine zoological objects which were not only admirably shown, but were accompanied by very full and interesting descriptions.

On the motion of the President the thanks of the Society were unanimously voted to Mr. Curties for this exhibition.

The President said the first paper on the Agenda was by Miss A. L. Smith, 'On the Fungi found on Germinating Farm Seeds.' He explained that part of the work in which they were engaged was the examination of farm seeds to ascertain their purity and their germinating power. For testing the germination the seeds were placed in thick porous porcelain saucers with glass covers, and these being placed in shallow water sufficient moisture reached the seeds to enable them to germinate. In the course of this work Miss Smith had found numerous species of fungi on the germinating seeds; 14 species were described, of which 5 were new to Britain, one belonging to a new genus. It was not proposed to read this paper, which described the species found, but it would appear in due course in the Journal with illustrations (see p. 613).

Dr. Hebb said they had also received another paper, being Part XII. of Mr. Millett's paper 'On the Foraminifera of the Malay Archipelago.' This paper, like those which preceded it, would be taken as read, and would appear in the December number of the Journal (see p. 619).

Dr. Hebb said that a letter had been received from Sir Dighton Probyn, intimating the pleasure of the King to continue his patronage of the Society. The letter was read to the Meeting, as follows:—

PRIVY PURSE OFFICE,
BUCKINGHAM PALACE,
28th June, 1901.

Sir,

I have the honour to inform you that I have submitted to the King your letter of the 19th instant, and, in reply, I am commanded to say that His Majesty is pleased to accede to the request contained in it to continue his patronage to the Royal Microscopical Society.

I am, Sir,
Your obedient servant,
D. M. PROBYN,
General Keeper of H.M.'s Privy Purse.

The President of the Royal Microscopical Society.

The President thought the Fellows would be much gratified by the contents of this communication, and suggested that its receipt should be acknowledged, a proposal which was heartily endorsed by the acclamation of those present.

Dr. Hebb said they had received from the Hon. Thomas Kirkman a quantity of porcupine quills for distribution amongst the Fellows, who would no doubt find them very useful for mounting minute objects.

Mr. J. J. Vezey moved that the cordial thanks of the Society be given to Miss Lorrain Smith for her paper, and also to the President for so kindly explaining its bearings.

The motion having been put to the Meeting, was unanimously carried.

Mr. C. Beck read a letter from Mr. Gordon with reference to a portion of his paper on the Abbe Diffraction Theory, and in correction of the statement therein made. This would be printed in the next number of the Journal, as an addendum to the paper which appeared in the Journal for August last (see p. 629).

The following Instruments, Objects, etc., were exhibited :—

The President :—Specimens of *Badhamia foliicola.*

Messrs. Chas. Baker :—Travelling Microscope made of Magnalium. The "Engineering" Microscope.

Messrs. R. and J. Beck (Ltd.) :—The "London" Microscope, Portable Model. Electric High-speed Centrifuge.

Mr. Chas. Lees Curties :—Mounted specimens of the following Marine Objects :—*Leucosolenia contorta* ; ditto with ova ; Mysis showing otocysts in tail ; Parasite of Wrasse ; Scorpion Shrimp (Cuma) ; Typical Copepod ; Zoëa, Porcelain Crab.

New Fellow.—The following gentleman was elected an *Ordinary* Fellow of the Society.

Mr. Leonard Sandall.

MEETING

HELD ON THE 20TH OF NOVEMBER, 1901, AT 20 HANOVER SQUARE, W. W. CARRUTHERS, ESQ., F.R.S., PRESIDENT, IN THE CHAIR.

The Minutes of the Meeting of 16th of October last were read and confirmed, and were signed by the Chairman.

The List of Donations to the Society (exclusive of exchanges and reprints), received since the last Meeting, was read as follows:—

	From
Carpenter, W. B., The Microscope and its Revelations, 8th edition, edited by Dr. Dallinger (8vo, London, 1901)	*The Rev. Dr. Dallinger.*
Gage, Simon Hy., The Microscope, 8th edition (8vo, Ithaca, 1901)	*The Author.*
Pigg, T. Strangeways, Clinical Pathology and Practical Morbid Histology, 2nd edition (8vo, London, 1901)	*The Publishers.*
Nelson, E. M., Opuscula Miscellanea—Reprints of papers read before the Royal Microscopical Society and the Quekett Microscopical Club	*The Author.*
A Microscope by Powell and Lealand, dated 1848 ..	*The Rev. Canon Carr; Mr. J. W. Gifford; Mr. Sidney T. Klein; Mr. A. D. Michael; Mr. Edward M. Nelson.*
A Microscope by Plössl et Cie., Wien	*The Rt. Hon. Sir Ford North.*
An old Microscope by Hugh Powell	*Messrs. Wm. Watson & Sons.*
An old Microscope by John Cuff	*Mr. C. Lees Curties.*

Descriptions of three of the Microscopes presented to the Society had been written by Mr. E. M. Nelson, and, in his absence, were read to the Meeting as under:—

(1) A Microscope by Messrs. Powell & Lealand, dated 1848, presented to the Royal Microscopical Society by the Rev. Canon Carr, J. W. Gifford, Sidney T. Klein, A. D. Michael, Edward M. Nelson.

Powell & Lealand's Microscope, dated 1848, signed "Powell & Lealand, 4 Seymour Place, Euston Square, London, 1848." This is historically an important, but not a very common, form of Powell's Microscopes. An account of it was first published in the *London Physiological Journal*, November 1843.*

This is the first instance where we have a Microscope hanging in a tripod in the same way that a kettle hangs from a tripod of sticks in a gipsy's encampment. The term "gipsy tripod" would by no means be a bad one to denote this form of Microscope-stand. This is also the first Microscope where the fine adjustment moves a nose-piece by

* A copy of this rare work, of which only five numbers were published, is in our Library.

means of a lever inside a bar movement. The screw which moves the lever is placed at the side of the bar. This must have been about the last Microscope made with the side screw, for it was in this year (1848) that the screw was placed vertically above the lever, where it has remained ever since (v. Quekett, 1st edition, 1848, p. 80, fig. 45).

It will be noticed that the lower part of the body where it joins the arm is conical. This is the last remnant of a design which had been in vogue for 100 years. Thus this instrument is dated 1848. Powell's Microscope of 1839 had a more pronounced cone. Messrs. Watson and Sons have most kindly presented an example of this interesting model to the Society to-night. The cone was still more pronounced in And. Pritchard's Microscope of 1832 (v. *Microscopic Cabinet*). The continuity is maintained by the following instruments:—

C. Gould's pocket Microscope, by Cary, *ante* 1828 (example presented by Mr. F. Gleadow in our Cabinet).

Jones' improved 1798 (example presented by Messrs. Watson and Sons in our Cabinet).

Adams, 1785 (example presented by Mr. J. M. Offord in our Cabinet).

Benj. Martin, 1776 (example presented by Dr. Dallinger in our Cabinet).

Adams, The Variable Microscope designed by a Nobleman, 1771.

Adams, New Universal Double Microscope, 1746. In this instrument the cone is very pronounced.

John Cuff, New constructed Double Microscope, slightly conical, 1744.

The 100 years are therefore more than completed.

(2) Microscope by Hugh Powell, presented by Messrs. Watson and Sons.

Date:—This Microscope must have been made prior to 1841, otherwise Mr. Lealand's name would have been coupled to that of Powell, because in that year Mr. Lealand joined the firm.

Stand:—A flat solid tripod with an upright pillar. The question is, Who was the inventor of the solid tripod? In old Microscopes the tripod always folded for packing. See Benj. Martin 1776, Adams 1785, Jones 1798, all in our Cabinet. The last of these folding flat tripod feet is figured in Pritchard's *Microscopic Illustrations*, 1838, illustrating Dr. Goring's Operative Aplanatic Engiscope. In the text (p. 93) Pritchard says, "I have lately made some of his (Dr. Goring's) instruments with a solid base, similar to my own, which are decidedly preferable." In the South Kensington Museum there is one of these Goring Microscopes mounted on a solid tripod foot. (Powell was the maker of Pritchard's Microscopes.) The upright pillar can be extended, and clamped with a pinching collar; the limb is attached to the pillar by a compass joint; this attachment is however peculiar, because it permits the body, stage, and mirror, in fact the whole Microscope, to be turned on one side. Microscopes having this kind of movement are figured in *Microscopic Illustrations*, pp. 88, 92, figs. 12 and 17. The body is held by a solid bar from which it can be unscrewed; a clamping nut is then loosed at the top and the bar rotated. The other end of the bar, which is made of much lighter metal, has a spring hole in it for the purpose of taking Wollaston doublets. The Microscope is therefore a "single and double," to use the terminology of that day.

The mirror has its pivots sprung. This kind of springing was first used by Powell in the stage forceps of a Microscope he made for Cornelius Varley in 1831.*

The rackwork coarse adjustment has a sprung pinion; this device was first used by Powell in the "Vial Microscope" which he made for C. Varley in 1833.†

The stage is very important; it is supported by brackets after the manner of Valentine's Microscope made by Andrew Ross in 1831. It has a Turrell stage (first made in 1833). It has also stage focussing by three wedges which are moved by a micrometer-screw having its head divided into 25 divisions, the movement being $\frac{1}{400}$ in. for one complete revolution of the micrometer-screw. This he described in the *Trans. Soc. of Arts*, vol. 50, pt. 2, p. 108, the plate being in vol. 49 (1833).

The stage has also a micrometer movement by means of a $\frac{1}{100}$ thread-screw, the head being divided into 100 parts, each part therefore being equal to $\frac{1}{10000}$ in. The second or "B" eye-piece has a cobweb across it, which can be focussed to the eye-lens or put out of focus when not required. The method of using the micrometer is therefore to place the object to be measured so that its image touches the cobweb in the eye-piece, and then by means of the graduated micrometer-head the object is moved across the cobweb, and its size directly determined. This kind of micrometer was designed by Fraunhofer and, a description will be found in Hannover on the Microscope (English translation, 1853, p. 67, fig. 12, pl. 1). This micrometer was one of the best in the days before the advent of accurately ruled glass micrometers, and before the introduction of the achromatic lens, when microscopic objects were some sizes larger than they are now.

The eye-pieces are capped, the tube being the same diameter as that of the body; the caps have a bayonet-joint catch. There is an achromatic substage condenser with rackwork focussing by means of a sprung pinion.

The presence of the condenser prevents the Microscope being dated earlier than 1839. We therefore know its age within the narrow limits of (1839–41).

(3) John Cuff's Microscope, presented by Curties. The date of its introduction was 1744. Cuff was an optician in Fleet Street. It was called A New Constructed Double Microscope, and is in this respect peculiar, because a great many instruments of that time were either single Microscopes, or double and singles. To translate this into present day terminology, for "double" read "compound," and for "single" read "simple." The box-foot of John Marshall (1704) is retained. In fact the whole instrument is a small and simplified edition of John Marshall's Microscope. It was a very good and popular Microscope, and was still made in 1798 by Jones, the successor to Adams. These instruments signed by Cuff must be rare, as Cuff disappears from the scene; for his Microscopes were copied by Adams in 1771, so that it is probable that

* Trans. Society of Arts, vol. 48, p. 332, pl. 4 (1831).

† Ibid., vol. 50, p. 158, pls. 5 and 6 (1834).

either Cuff was dead or that he had retired and sold his business to Adams. This, after the John Marshall, is historically one of the most important instruments in our collection, and I am happy to say that it is in almost new condition. Subsequently these Microscopes were fitted with a joint at the bottom of the pillar for inclination. Sometimes this foot was fastened to the bottom of a mahogany box, from which they got the name of "The Chest Compound Microscope." From this form of Microscope was evolved the instrument which had belonged to Sir David Brewster, which was made by Dollond and exhibited here. It is figured in the *Journal* of the R.M.S., 1898, p. 123, fig. 1.

The President asked the Society to thank the various donors of the gifts on the table:—Dr. Dallinger, Mr. Nelson, and others for valuable works for the Library; the Rt. Hon. Sir Ford North; the Rev. Canon Carr, Messrs. Nelson, Gifford, Klein, and Michael; Mr. C. L. Curties, and Messrs. Wm. Watson and Sons for important additions to the Society's collection of historical Microscopes; and he suggested that the Society should express their special gratitude to Mr. Nelson for the historical and critical account of some of the instruments now added to their collection. He regretted that the state of his health prevented Mr. Nelson being with them that evening. The thanks were unanimously voted by the Meeting.

The President called attention to an exhibition on the table arranged by Mr. Conrad Beck, to show, under six Microscopes, examples of Antipoints in illustration of the paper by Mr. Gordon read before the Society on the 19th of June last. The thanks of the Society were given to Mr. Beck.

Mr. C. Beck exhibited and described a new pattern Microscope embodying several new features and improvements. The substage was fitted with a rack-and-pinion coarse adjustment, and a lever and micrometer screw fine adjustment, with means of centering and of throwing out the diaphragm and substage condenser while the latter was actually in focus. The principal stage was circular, 5 in. in diameter, rotating, and graduated on the periphery, but having a removable mechanical stage with a travel of $2\frac{1}{2}$ in. by $1\frac{1}{2}$ in., and graduated as a finder. The main body was very short, but was fitted with two draw-tubes, one of which had a rack-and-pinion, enabling the tube to be extended, if required, to $11\frac{1}{2}$ in. The draw-tube was also made to take a photographic lens giving a very large angle of view. The body was also fitted with the new double fine adjustment designed by Mr. Ashe, the details of construction of which were further explained by a diagram on the board.

Mr. Beck said he should like also to say a few words in explanation of the exhibition of Antipoints to which the President had referred. These were extremely difficult things to show, on account of the trouble there was in obtaining points sufficiently small and sufficiently bright; and although some of those on the table showed very well in a darkened room and with strong illumination on the point, it was only possible to obtain a faint image with so much diffused light around them as there was under present circumstances. All the Microscopes were fitted with $\frac{1}{2}$-in. objectives, and the points in the case of the first two were produced by very small apertures in pieces of tin-foil, the others being light reflected from small mercury globules. Under the first Microscope the point of light was viewed with the ordinary aperture of the object-glass. The second had only a small aperture, and instead of seeing a copy of the point they got a large disc. The third had a slit aperture, and the image of every point was a slit with a series of diffraction images on either side. The fourth had a triangular aperture, and this showed a single point in the centre and a series of six star-like rays. The fifth had three small holes, the result being a series of images arranged round a central disc; and the sixth was viewed through a grating, and showed a small point image with two slit-like flanking images. The use of this demonstration was to illustrate how profoundly the images shown by the Microscope were influenced by the shape of the apertures through which minute objects were seen. With greater brilliancy of illumination many more diffraction images could be seen, outside those which were only faintly shown under present conditions.

The President said he was very glad that Mr. Beck had taken the opportunity of explaining more fully what was to be seen upon the table, as it would enable the exhibition to be more greatly appreciated. The fine adjustment of the Microscope he had shown them was extremely ingenious in its design, and would, no doubt, be found of great advantage in practice.

Mr. J. W. Gordon said he had listened with great interest to Mr. Beck's explanation of the demonstration he had prepared, but personally he was so extremely anxious to see the examples for himself—and had no doubt that many others also were equally desirous of doing so—that he had no idea of interposing any lengthened remarks of his own upon the subject. There was, however, one thing which struck him very specially in connection with it, and he should like to say just a word or two about that. There could be no doubt that the experiments would demonstrate the existence and appearance of the antipoint in each case, and the importance of this could not be over-estimated; but after all, it was clear that the results had been produced by very special apertures which it would not be possible to use in an ordinary instrument for ordinary working purposes. There was, however, another and equally important image which he should like to see, and that was the antipoint which was formed in the eye, and he hoped that some day Mr. Beck would be able to bring down a demonstration of that; for however interesting and instructive the study was of the antipoints which were formed by diaphragms, he thought it was a great deal more important for them to understand the nature and effects of the antipoints formed by the eye. The subject of the antipoint formed in the instrument had been examined very successfully, but the question of the antipoint in the eye had almost escaped the attention of those who had been engaged in that class of research.

The President expressed his sense of the value of Mr. Gordon's explanations. During Mr. Beck's interesting exposition of his exhibition he was in doubt whether the antipoint was entirely produced in the instrument, or partly in the eye. He thought Mr. Gordon's suggested investigations into the part the eye might play were important.

Mr. C. Beck thought that in the case of the instruments on the table the antipoint was certainly produced by the instrument, and that it was only when a very high ocular was used that it was produced by the eye.

Dr. G. P. Girdwood's paper 'On Stereomicrography' was read by Dr. Hebb, and was illustrated by a drawing on the board and by a specimen in a stereoscope handed round for inspection.

The President thought that the method described was ingenious, and the result successful. A vote of thanks was unanimously passed to Dr. Girdwood for his paper.

New Fellows :—Messrs. M. Anslow Alabone, J. W. Gordon, S. A. S. Metheny, and Joges. C. Ray were elected *Ordinary* Fellows of the Society.

The following Objects, Instruments, &c., were exhibited :—

Mr. Conrad Beck :—Exhibition of Antipoints. (1) A fine point of light viewed with a $\frac{1}{2}$-in. objective of ordinary aperture, showing *point* surrounded with faint diffraction circles. (2) A fine point of light viewed with a $\frac{1}{2}$-in. objective of very small aperture, showing *disc* of light and diffraction rings. (3) A fine point of light viewed with a $\frac{1}{2}$-in. objective with fine slit placed behind it, showing slit-shaped image with rows of slit-shaped images right and left. (4) A fine point of light viewed through a $\frac{1}{2}$-in. objective with a small triangular aperture placed behind it, showing small disc image with six radiating arms of diffraction images arranged like a star. (5) A fine point of light viewed through a $\frac{1}{2}$-in. objective with a diaphragm having three circular apertures arranged in the form of a triangle placed behind the objective, showing central disc surrounded by six small discs and again surrounded by twelve fainter small discs. (6) A fine point of light viewed through a grating which extended for the whole aperture of the $\frac{1}{2}$-in. objective, showing a punctiform central image and slit-shaped diffraction images on either side.

Messrs. R. and J. Beck (Ltd.) :—Two Microscopes fitted with Ashe's new Fine Adjustment.

Mr. C. Lees Curties :—An old Microscope by John Cuff.

Rev. Canon Carr, Messrs. J. W. Gifford, Sidney T. Klein, A. D. Michael, E. M. Nelson :—A Microscope by Powell and Lealand, dated 1848.

Prof. G. P. Girdwood :—A Stereoscopic Photomicrograph in illustration of his paper.

The Right Hon. Sir Ford North :—A Microscope made by Plössl et Cie., Wien.

Messrs. Wm. Watson and Sons :—An old Microscope by Hugh Powell.

INDEX OF NEW BIOLOGICAL TERMS, OR OLD TERMS WITH NEW MEANINGS, RECORDED IN THIS VOLUME.

α. ZOOLOGY.

β. BOTANY.

INDEX.

A.

B.

F.

I.

J.

L.

N.

Q.

R.

T.

W.

X.

Y.

LONDON: PRINTED BY WILLIAM CLOWES AND SONS, LIMITED,
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CONVERSION OF BRITISH AND METRIC MEASURES.

Computed by Mr. E. M. Nelson from the New Coefficient obtained by Order of the Board of Trade in 1896.

LINEAL.

Metric into British.

μ	in.
1	·000039
2	·000079
3	·000118
4	·000157
5	·000197
6	·000236
7	·000276
8	000315
9	·000354
10	·000394
11	·000433
12	·000472
13	·000512
14	·000551
15	·000591
16	·000630
17	·000669
18	·000709
19	·000748
20	·000787
21	·000827
22	·000866
23	·000906
24	·000945
25	·000984
26	·001024
27	·001063
28	·001102
29	·001142
30	·001181
31	·001220
32	·001260
33	·001299
34	·001339
35	·001378
36	·001417
37	·001457
38	·001496
39	·001535
40	·001575
41	·001614
42	·001654
43	·001693
44	·001732
45	·001772
46	·001811
47	·001850
48	·001890
49	·001929
50	·001969
60	·002362
70	·002756
80	·003150
90	·003543
100	·003937
200	·007874
300	·011811
400	·015748
500	·019685
600	·023622
700	·027559
800	·031496
900	·035433
1000 (= 1 mm.)	

mm.	in.
1	·039370
2	·078740
3	·118110
4	·157480
5	·196851
6	·236221
7	·275591
8	·314961
9	·354331
10	·393701
11	·433071
12	·472441
13	·511811
14	·551182
15	·590552
16	·629922
17	·669292
18	·708662
19	·748032
20	·787402
21	·826772
22	·866142
23	·905513
24	·944883
25	·984253
26	1·023623
27	1·062993
28	1·102363
29	1·141733
30	1·181103
31	1·220473
32	1·259844
33	1·299214
34	1·338584
35	1·377954
36	1·417324
37	1·456694
38	1·496064
39	1·535434
40	1·574805
41	1·614175
42	1·653545
43	1·692915
44	1·732285
45	1·771655
46	1·811025
47	1·850395
48	1·889765
49	1·929136
50	1·968506
51	2·007876
52	2·047246
53	2·086616
54	2·125986
55	2·165356

mm.	in.
56	2·204726
57	2 244096
58	2·283467
59	2·322837
60	2·362207
61	2·401577
62	2·440947
63	2·480317
64	2·519687
65	2·559057
66	2·598427
67	2·637798
68	2·677168
69	2·716538
70	2·755908
71	2·795278
72	2·834648
73	2·874018
74	2·913388
75	2·952758
76	2·992129
77	3·031499
78	3·070869
79	3·110239
80	3·149609
81	3·188979
82	3·228349
83	3·267719
84	3·307089
85	3·346460
86	3·385830
87	3·425200
88	3·464570
89	3·503940
90	3·543310
91	3·582680
92	3·622050
93	3·661420
94	3·700791
95	3·740161
96	3·779531
97	3·818901
98	3·858271
99	3·897641

dm.	in.
1	3·9370113
2	7·8740226
3	11·8110339
4	15·7480452
5	19·6850565
6	23·6220678
7	27·5590791
8	31·4960904
9	35·4331017

1 metre = 3·280842S ft.
= 1·09361426 yd.

British into Metric.

in.	mm.
1	25·399978
2	50·799956
3	76·199934
4	101·599912
5	126·999890
6	152·399868
7	177·799846
8	203·199824
9	228·599802
10	253·999780
11	279·399758
1 ft.	304·799736
1 yd.	914·399208

in.	mm.
$\frac{1}{2}$	12·699989
$\frac{1}{3}$	8·466659
$\frac{2}{3}$	16·933319
$\frac{1}{4}$	6·349994
$\frac{3}{4}$	19·049983
$\frac{1}{5}$	5·079996
$\frac{2}{5}$	10·159991
$\frac{3}{5}$	15·239987
$\frac{4}{5}$	20·319982
$\frac{1}{6}$	4·233330
$\frac{5}{6}$	21·166648
$\frac{1}{7}$	3·628568
$\frac{1}{8}$	3·174997
$\frac{3}{8}$	9·524992
$\frac{5}{8}$	15·874986
$\frac{7}{8}$	22·224980
$\frac{1}{9}$	2·822220
$\frac{1}{10}$	2·539998
$\frac{3}{10}$	7·619993
$\frac{7}{10}$	17·779985
$\frac{9}{10}$	22·859980
$\frac{1}{11}$	2·309089
$\frac{1}{12}$	2·116665
$\frac{5}{12}$	10·583324
$\frac{7}{12}$	14·816654
$\frac{11}{12}$	23·283313
$\frac{1}{13}$	1·953844
$\frac{1}{14}$	1·814284
$\frac{1}{15}$	1·693332
$\frac{1}{16}$	1·587499
$\frac{3}{16}$	4·762496
$\frac{5}{16}$	7·937493
$\frac{7}{16}$	11·112490
$\frac{9}{16}$	14·287487
$\frac{11}{16}$	17·462185
$\frac{13}{16}$	20·637482
$\frac{15}{16}$	23·812479
$\frac{1}{17}$	1·194116
$\frac{1}{18}$	1·411110
$\frac{1}{19}$	1·336841

in.	mm.
$\frac{1}{20}$	1·269999
$\frac{1}{21}$	1·209523
$\frac{1}{22}$	1·154544
$\frac{1}{23}$	1·104347
$\frac{1}{24}$	1·058332
$\frac{1}{25}$	1·015999
$\frac{1}{30}$	·846666
$\frac{1}{35}$	·725714
$\frac{1}{40}$	·634999
$\frac{1}{45}$	·564444
$\frac{1}{50}$	·508000
$\frac{1}{55}$	·461818
$\frac{1}{60}$	·423333
$\frac{1}{65}$	·390769
$\frac{1}{70}$	·362857
$\frac{1}{75}$	·338666
$\frac{1}{80}$	·317500
$\frac{1}{85}$	·298823
$\frac{1}{90}$	·282222
$\frac{1}{95}$	·267368
$\frac{1}{100}$	·254000
$\frac{1}{150}$	·169333
$\frac{1}{200}$	·127000
$\frac{1}{250}$	·101600
$\frac{1}{300}$	·084667
$\frac{1}{350}$	·072571
$\frac{1}{400}$	·063500
$\frac{1}{450}$	·056444
$\frac{1}{500}$	·050800
$\frac{1}{550}$	·046182
$\frac{1}{600}$	·042333
$\frac{1}{650}$	·039077
$\frac{1}{700}$	·036286
$\frac{1}{750}$	·033867
$\frac{1}{800}$	·031750
$\frac{1}{850}$	·029882
$\frac{1}{900}$	·028222
$\frac{1}{950}$	·026737

in.	μ
$\frac{1}{1000}$	25·399978
$\frac{1}{2000}$	12·699989
$\frac{1}{3000}$	8·466659
$\frac{1}{4000}$	6·349994
$\frac{1}{5000}$	5·079996
$\frac{1}{6000}$	4·233330
$\frac{1}{7000}$	3·628568
$\frac{1}{8000}$	3·174997
$\frac{1}{9000}$	2·822220
$\frac{1}{10000}$	2·539998
$\frac{1}{15000}$	1·693332
$\frac{1}{20000}$	1·269999
$\frac{1}{25000}$	1·015999

246.