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.

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Table of contents
page 697

JOURNAL

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ROYAL MICROSCOPICAL SOCIETY.

FEBRUARY 1891.

TRANSACTIONS OF THE SOCIETY.

I.—*Some Observations on the Various Forms of Human Spermatozoa.*

By R. L. Maddox, M.D., Hon. F.R.M.S.

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

Plate I.

In examining some recent slides of human spermatozoa, prepared in various ways, I was struck with the different appearances some reagents gave, and also by the abnormal forms to be found by careful study. It is for the purpose of noting some of these varieties that I venture to offer a few remarks, trusting they may be of interest.

There is considerable difficulty in so differentiating the parts that form these potent bodies without at the same time too freely disturbing their natural conditions.

The following methods out of many trials have appeared to be the most satisfactory. After diluting the sperm with the normal salt solution 0·75 per cent., it was very lightly smeared on the cover-

EXPLANATION OF PLATE I.

(The figures in the original drawings are variously coloured, but are here tinted to one shade; all except the last two × 3120.)

Fig. *a.*—A fairly normal spermatozoon.
" *b, c, d.*—With single, double, and treble vacuoles or light spaces.
" *e.*—The usually dark or denser portion reversed in position.
" *f.*—Head and filament united by a clear ring.
" *g.*—An abnormal head.
" *h.*—The filament embracing the head.
" *j.*—A spermatozoon seen somewhat obliquely.
" *k.*—Ditto ditto.
" *l.*—Head with two constrictions.
" *m.*—Two heads, both small, to one filament.
" *n.*—Two heads finally united in one filament.
" *o.*—Head with two clear spaces, filament tending to a separation.
" *p.*—Large head, filament tending to divide into three filaments.
" *q.*—A greatly contorted head.
" *r.*—Two heads to one filament × 810 } photo.
" *s.*—Two single heads with each two filaments × 750 } photo.

glass and dried without heat. The material was then covered with a weak solution of the ordinary iodine and potassic iodide solution mixed with rather less than an equal part of a saturated solution of potassic acetate, and the cover mounted in the same, without washing. This gave the organisms a very delicate greenish, or bluish-green, or grey tint, which showed the relations of the plasm in the heads or ovoid bodies very clearly, without, as far as I could judge, displacement, enlargement, or shrinkage of any moment. Unfortunately, such mounts do not keep well. It is from such a cover preparation the drawings of a grey tint have been made; while the yellow-tinted figures have been drawn (in each case using the Wollaston camera lucida) from a cover-glass preparation made in the same way, but substituting a weak chrysoidine solution for the iodine and potassic acetate, and, after five minutes, draining closely by the aid of a point of blotting-paper, drying without heat, and mounting dry. Various other plans were tried, using ammonia chromate, iodine and potassic iodide, logwood, different anilin dyes, zinc chloride, gold and silver staining, tincture of perchloride of iron, tannin, &c. Some brought out points less indicated by others, as seen in various mountants.

It has been often stated, and doubted, that the spermatozoon was occasionally provided with two heads to one filament, or two filaments to one head. I shall endeavour to show that such statements are correct, and not due to error in observation, or optical disturbance of the image by such highly refracting bodies.*

I have been able to photograph the two heads to one filament, as seen in fig. *r*; and several examples of two filaments to one head are seen in fig. *s*.

Here, I think, there can be no question about the reality of these abnormal forms. As regards the variations in the shape and union of the heads, I have been chiefly obliged to rely on my pencil. From some of the figures it will be seen how the two tails may originate. There is in the part near to the head a considerable thickening, with indication of a commencing division, which if deepened would separate the parts, and if continued through the length of the thickened filament the result would be two filaments to one head. In the large head and filament fig. *p*, there were strong indications that the filament might be split even into three. After much wearying search, I was rewarded by finding a spermatozoon having an abnormally shaped head, with three distinct filaments. Whether such a division is perfected in the original cell or in the receptacle, the vesiculæ seminales, I can offer no opinion. As regards the origin of the two heads, it is difficult to suggest more than the possibility that elongation may occur in the head and neck with a constriction, such as eventually to produce the two heads. Something of the kind is seen in figs. *l* and *q*, but I prefer to suppose them to originate by two nuclei in

* See this Journal, vi. (1886) p. 581; 'Medical World,' iv. (1886) pp. 18–20.

the original cell adhering, and furnishing between them but one filament. I have not found more than two heads with one stalk, but these are sometimes so curiously placed that I have considered they should be classed with the abnormal forms. In two instances the two heads were seen united to a larger, irregularly shaped body (fig. *i*), which, as far as I could determine, appeared to be caused by the swollen agglutinated filaments of the original spirals. In few cases only had the very minute flagella (as originally discovered, I believe, by Mr. E. M. Nelson, and photographed by Mr. A. Pringle) remained adherent, as seen in fig. *i*. Sometimes the two heads may simply diverge, as in fig. *m*, or there may be for a little distance a short neck to each, as in fig. *n*. It has struck me as very singular that in one of the primary or initial elements necessary to the perfect evolution of the fecundated ovum there should be any sport or straying from the perfect form, especially in the highest mammalian. I am not aware that any similar deviation has been noticed in phanerogams; the only difference in the pollen-grains, as far as my knowledge extends, being a difference in size, although in evolved parts teratology is common.

I am aware that the products of a cell are liable to great variation, as in many pathological structures, but this scarcely removes the difficulty attendant on such a sport as has been noticed in the foregoing in an initial element. Naturally the question follows—has it finally any importance should it find an entrance and mingle with the contents of the female ovum? I think we can hardly doubt that it must have some definite influence for good or otherwise, though it may be impossible of proof. Does it furnish additional parts, or contribute to superabundant stimulation to growth? A facetious friend has suggested that two tails may be the origin of twins. This cannot be seriously entertained, as the head is also necessary for the proper evolution of the embryo, and this would not dispose of the two heads to one filament, nor of the case of triplets and more. Possibly it may give an extra impetus to the growth of the future product, or additional parts, or it may decay as useless. An answer in our present state of knowledge must remain conjectural, for we are yet ignorant how far there may be a dynamical preponderance of either the male or female initial energy, or whether both equally share in the generative impulse, and determine together the further activity of the resulting fusion—a fusion that determines inherited conformity in the final unit, a significant likeness, yet often marred in the fashioning.

By those who have not made a study of these potent motile bodies, the question may be asked, what is the general form and appearance? As seen without preparation and under a variety of methods of staining, the ovoid body or head appears as a mass of homogeneous plasm of considerable refrangibility; or, if granular, only so far as to cause a slight greyness on the transmission of light. The anterior end, with its minute filament, is generally paler than the rest of the mass, except in the centre, which may perhaps be partly due to the organism being slightly concave. It often presents a more or less perfectly vacuolated aspect at one or more places, and in any position in the head ; in one case it was noticed in the upper part of the tail filament, fig. *c*.

At such spots, according as they are focused on or into, they may appear bright or dark, thus often simulating the appearance of a nucleolus if the mass be taken as a nucleus in the original cell—Kölliker's view. Seen on the flat, the anterior edge is often extremely delicate, but on the sides and advancing towards the filament the boundary is well marked, and after reagents it often shows a double outline, which is continued into the neck. The plasm generally appears to have separated itself into two parts differing in density, the separation being marked by a cupped line, or rather giving rise to a cupped line, the position of which is not constant, the part near the neck being generally the greyest in tint, thus presenting much the aspect of an acorn in its cup. I could not find any distinct evidence that this cupped appearance was more than optical, and I think the proof lies in the fact that this denser or greyish-looking part becomes sometimes displaced and occupies the anterior end, leaving what would represent the cupped part a perfectly clear outline. This is shown in the fig. *e*. I am therefore, I regret to say, at variance with that excellent observer, Mr. E. M. Nelson.

The attachment of the head with the filament seems at one stage to be continuous, uniform, or jointless, but often at about a distance less or equal to the length of the head there is a difference in the tint—under different reagents from that given to the rest of the filament—and where this ends it often looks as if it were crossed by a line; and when the edges of the filament at this part are slightly enlarged, both above and below it, there is the aspect of a joint, and, even at that point, often a constriction.

How seldom, however, is the head seen separated from the filament at that point, and this seems to me to militate against the idea of a joint, though it very likely is the weak point for separation after entering the ovum. Again, if jointed at that point, we might expect the filament to be commonly bent there at a right angle; yet this is seldom seen. Often a raggedness or roughness of the edges is noticed at the upper part of the filament, the remnant of a nuclear membrane (?).

Tracing the boundary into the filament, beyond the so-called joint, I could detect no true double outline, the slender body presenting the aspect of a flattened, attenuated rod, of very different dimensions, nor under the most diversified treatment could I detect any axial thread or fibrillar division. In some of the preparations, especially in those gold-stained, six of the heads showed a dark minute point, simulating a nucleolus, but it was so rare when we might expect it to be constant, that I am very doubtful whether such a definite point may not be accidental, and due to the method precipitating a very minute portion of the plasm, or even to the adherence on the under surface of a stained granule of the accompanying secretion.

I do not see there would be anything contrary biologically to the existence of such a nucleolus, but its rarity seems to militate against its real or general existence, and the histological evidence yet requires to be placed either with or against the optical conclusions. Further observations, under a variety of conditions, are needed to decide this point, unless others can furnish more satisfactory proof than is known to the writer.

Unfortunately, I have not as yet been able to follow or confirm the description of the latest research on the structure of the human spermatozoon, as furnished in the pages of the October No. of the 'Annales de Micrographie,' by that careful observer, Mr. G. F. Dowdeswell.

Briefly, my friend describes and figures a kind of calix, or very delicate envelope, which partially embraces the head. This is stated to be best seen while the organism is slowly moving, and very rarely in stained and dried preparations. The existence of such an envelope adds considerable interest to the general study of these delicate generative bodies.

Since writing the above, Mr. Dowdeswell has kindly informed me that Dr. Heneage Gibbes considered the joint could always be produced by treatment with alcohol; yet, as aforestated, it is also to be found in some of the spermatozoa which have been treated in very different ways, and without alcohol. I suspect it is more or less indicative of greater maturity in the spermatozoon. Although the varied additional forms mentioned by Dr. E. Cutler, and noticed in a short paragraph in the Journal of the Society, vol. vi. p. 581, have not yet been seen, no doubt they can be found by further close examination. I am quite willing to accept his suggestion that they may sometimes cause teratological conditions in children. If "fecundation be regarded as the union of the nuclear substance of the maternal and paternal individuals," should there be a preponderance of the male element, must we not suppose it to carry some additional influence, whether towards heredity or teratology, which may evolve as a "firm friend or a deadly foe." Indeed, may not such a privileged power, fraught with a co-operative influence, originate in the resultant individual an exalted repetition of its own history, or give rise to such rejuvenescence as may restore what by misguidance may have been lost, or brought about by the disastrous storms of circumstance and faulty environment?

If tending to teratology only, perhaps some light might be thrown on the subject by a strict examination of the spermatozoa in those families where redundant parts recur through several generations.

It is to be hoped further research in the study of spermatogenesis may not only lift it out of its bewildering nomenclature, but also bring to light much that is still hidden, and of the highest interest.

II.—*The President's Address on some Doubtful Points in the Natural History of the Rotifera.*

By C. T. Hudson, LLD., F.R.S.

(*Annual Meeting*, 21*st January*, 1891.)

There is perhaps no position that so tickles our sense of humour as that of

> "the engineer
> Hoist with his own petard."

That the digger of a pit for another should fall into it himself, that the biter should be bit, and that the maker of a new law should himself be the first to incur its penalty, are cases that catch our fancy, with a sense of justice flavoured with fun: and so if I,

> "When caught myself, lie struggling in the snare,"

I must be content to be ranked with the "wicked who is snared by the work of his own hands," and must try to make the best of the position, even if it is one which lights up the faces of my audience with a good-natured smile at my own expense. For, two years ago, in my first address to the Royal Microscopical Society, unaware of the future presidential honours which awaited me, and thinking only of the admirable summary given to us, every two months, by our able Editor and staff, I rashly said that no President in future would be able to take, as an obvious subject for his address, an account of the world's microscopic work during the preceding year; but that he would be compelled to follow Dr. Dallinger's shining example, as best he might, and offer to the Society some of the results of his own researches.

But we should beware of making general statements; especially such as concern ourselves. Indeed it seems to me that the safest general statement, that can be made, is, "that nearly all general statements will prove to be untrue": and so, in this matter, scarcely had I committed myself to what seemed a self-evident proposition, than I became aware that it no longer covered my own case. For, on the one hand, I found myself suddenly forbidden to use the Microscope; and on the other, I had already in the 'Rotifera,' in its supplement, and in my first presidential address, said almost all that I had to say on my own subject. Being then unfortunately debarred from further research, and having already told you all that I *do* know about the *Rotifera*, what remains for me but to tell you what I do *not?* And such negative information is not entirely without precedent. "A history of events which have not happened" has been suggested as one that "might enlarge our general views of human affairs;" and even a chapter or two of it has been already written. Again, it has been urged that a list of "inventions not yet invented" might excite some fertile brains to supply our wants; and so perhaps a record of the main points in the natural history of the *Rotifera* which are yet obscure, may serve to point out to students whither they can profitably direct their course: just as the lions and elephants, on the old charts of Africa, were the sign-boards which marked out the spots, where there was good entertainment for man and maps.

Considering first the position which the class Rotifera holds in the Natural Kingdom, we find that it has been placed (apparently by common consent) in the limbo "Incertæ sedis"; so here at the outset we light upon a subject, that will give ample opportunity for research and study: for, while the humbler species of *Rotifera* pass by easy gradations into larva-like worms, which have almost lost the characteristic ciliary wreath and trophi, the higher species have, standing at a great distance beyond them, a true rotiferon, *Pedalion mirum,* so far advanced in its structure that it forms an order by itself; and, moreover, the gap between this order and the other three, which contain the rest of the 450 species of the *Rotifera*, is obviously too great to be real.

The forms, then, that link *Pedalion* to the others cannot be few; and are, indeed, dimly foreshadowed by the hollow stumps of *Asplanchna Ebbesbornii*, and by similar processes in several of the male *Asplanchnæ.* We have in the latter, as it were, the first rude sketch of a *Pedalion;* for though their lateral processes do not end in swimming fans, and appear to be of no use to the animal, yet they have muscular fibres passing freely along their cavities from end to end.

The male of *A. intermedia* has three such appendages, the female of *A. Ebbesbornii* has four, the male of *A. Sieboldii* has five, while that of *A. Ebbesbornii* has six. Increase the number of the muscular fibres, expand them into bands, attach them to the body-wall (as they pass the base of each process into the cavity of the trunk), and we shall then have limbs adapted for swimming, and wanting only the finish of the terminal fan to approximate to those of *Pedalion.* Indeed the female of *A. Ebbesbornii* looks just as if some species of *Pedalion* had had its limbs rounded off at the extremities, so as to rob them of their fans.

On the other side of *Pedalion,* between it and the *Arthropoda,* there lies Schmarda's *Hexarthra* which requires a special notice, as Eckstein and von Daday both consider the two animals to be identical. How they have come to such a conclusion I cannot imagine, unless they suppose that Schmarda had less power of observation than an ordinary child. For *Pedalion* is a conically shaped animal, with six limbs arranged all round the cone, parallel to its axis, and pointing from its base to its apex; how then is it possible for the merest tyro to draw those six limbs as radiating from a common base on the surface? If a half-opened black umbrella had white pieces of tape sewn outside, along its ribs, could there be any one capable of declaring that the white tape formed a star, with six rays issuing from the middle point of one of the umbrella's ribs? And yet it is a mistake, quite as bad as this, that Schmarda is supposed to have made; and that too, in the case of an animal, of which he had numerous examples, and whose true form could be easily seen under a low power. It is probable then that *Hexarthra* exists, and that the *Rotifera*, in this species, make a still nearer approach to the Nauplius larva of the *Arthropoda*. Of course, if the *Rotifera* do run up to the *Arthropoda* through *Pedalion* and *Hexarthra*, there must be other forms lying between the outposts of the two classes, with which we are unacquainted, and which it is possible that we may yet discover. Nor do I think that I am too sanguine in supposing, that some of these connecting links, on either side of *Pedalion*, may yet be extant. For the *Rotifera*, owing apparently to their extraordinary power of adapting themselves to varying circumstances, contain more than one long series of forms connecting species that, at first sight, seem hopelessly wide apart. Place *Trochosphæra*, *Stephanoceros*, and *Actinurus* side by side; could there be a more discrepant trio? And yet we possess many intermediate forms which link the three together.

The persistence of such links gives us, I think, good ground for hoping that the missing forms, between *Pedalion* and the other *Rotifera*, may yet exist; and (whatever may be thought about *Hexarthra*) possibly some too between *Pedalion* and the *Arthropoda*. At any rate it is worth while to try to find them; and, if so, where can we search with the best prospect of success? It is hardly likely that their natural homes are in Europe, or the United States; for, if they were, they could hardly have escaped the sharp eyes there, that are ever prying for novelties; it is in the tropical and semi-tropical countries that we must conduct our search. Their lakes, tanks, flooded rice-fields, swamps, and irrigation-canals—all sweltering under the sun, and abounding in minute vegetation—have surely a wealth of new microscopic creatures yet in store for us. I only know of four observers, who have had the good fortune to explore these almost virgin fields of research, and each has found at least one prize. Dr. Semper discovered the female of *Trochosphæra æquatorialis* in the flooded rice-fields of Manila; Dr. Schmarda *Hexarthra*, in the irrigation canals of Egypt; Surgeon Gunson Thorpe, R.N., the male of *Trochosphæra æquatorialis*, near Brisbane; and Mr. Whitelegge, at Sydney, that curious social Melicertan *Lacinularia pedunculata*; which, anchored by its long thread of intertwined stems to the leaves of *Myriophyllum*, floats on the surface of shallow pools, "like acacia blossoms that have fallen into the water from the trees above."

Pedalion, too, which has given rise to this question, itself would seem to suggest the same answer. For it is a very rare creature, and does not thrive in our ponds, dying out after the first or second year. The only spot where it seems more at home is in the warm water lily-tank in the Duke of Westminster's conservatory at Eaton. This inclines me to think that it may be a sub-tropical species, whose ephippial eggs are occasionally wafted to England; especially as it has been found in great abundance, by Surgeon Thorpe, on a rocky island off the coast of Queensland.

But unfortunately those of our friends, who are spending the prime of their lives near the Equator, are necessarily too busy with more important matters to give up their time and thoughts to such researches; yet I think that there is a way in which they might effectively help us, without incurring much trouble or expense. If they would send us the hard earth pared from the surface bottom of dried up pools, it would most probably bring over, with it, ephippial eggs of tropical Rotifera; and, as these are constructed to bear a dormant condition for nine months or more, they would travel safely across the globe, and come to life in our aquaria at home. No doubt many such chance ventures would prove failures, but to hit the mark one must often throw many a stone. If we now turn from the unknown Rotifera that we wish to find, to the unknown points in those that we have found already, we shall be comforted by seeing that there is still an encouraging store of ignorance awaiting attack.

In the first place, there is much yet remaining to be discovered about the reproduction of the Rotifera. Although the diœcious character of the class as a whole has been established, yet it is a reproach to naturalists that so common an order as the *Bdelloida* should as yet have presented us with nothing but an unbroken succession of virgin mothers. There is nothing in the internal structure of any of the species to lead us to suspect that they are other than diœcious; all the organs are accounted for, and the female organs are precisely like those of the other orders, yet no one has seen the male. With such hardy creatures as Philodines, Rotifers, and *Adinetæ*—creatures to whom extremities of heat, cold, and drought are the ordinary incidents of life—nothing is easier than to keep an abundant stock all the year round: and so, one would think, to make sure of finding the male. Possibly the male and female fœtus resemble each other so much, as to be not easily distinguished when *in utero*: possibly, too, the males are rare, or very small, or live only for a very short period:—and it is possible that all these conditions may exist together. If so, it would be no wonder that they have as yet escaped mere random observation. But patient, persistent, daily search through small aquaria well stocked with these creatures, must lead at last to the discovery of the Bdelloid male.

But the search for a missing male is a light matter compared with that of settling the yet doubtful points in the reproduction of the Rotifera; points on which some of the best observers hold very different opinions.

It would be impossible for me to discuss this question within the limits of this paper, but I will endeavour to give a brief summary of the differing theories, and suggest experiments which might, I think, decide between them.

There are, as no doubt you are aware, three sorts of eggs among the Rotifera. Of these the ordinary, or "summer" eggs, have only a soft membranous covering; they are hatched soon after they are laid, and are of two sexes, distinguished from each other by both shape and size. The female eggs are large and distinctly oval; the male eggs are smaller and nearly spherical. The third sort of egg, or "ephippial" egg, has a double shell, often beset with spines, bosses, or prickles. It is sometimes termed a "winter" egg, but this is a misnomer, as it occurs at all times of the year.

Now there is no doubt of the continued production of female eggs by parthenogenesis in every family of the *Rotifera;* and indeed, among the *Bdelloida* no other mode of reproduction has as yet been seen: but concerning the origin of ephippial eggs there is no such agreement. Cohn thinks that they are the product of sexual intercourse; Huxley says that sexual intercourse gives rise to the ordinary soft-shelled eggs; Plate maintains that sexual intercourse has no effect in determining the sort of egg that is to be laid. Again, Plate declares that no female ever lays more than one sort of egg; while Balbiani, on the contrary, says that the same individual may first lay ordinary female eggs and then ephippial eggs.

It is not easy to steer one's way through such contending authorities; but before making the attempt, let us first separate the facts from the opinions.

(1) It is admitted on all hands that virgin females will produce virgin females, in unbroken succession, through many generations.

(2) Balbiani states that he has often observed, that a solitary female of *Notommata Werneckii*, inclosed in a gall of *Vaucheria*, has first laid ordinary female eggs, and then ephippial eggs: and that the laying of the latter was preceded by a gradual exhaustion of the vitality of the germ in the ordinary female egg, as shown by a great number of them remaining sterile; or, if the embryo were formed, by its dying without hatching, even after the eye-spot had become visible. Moreover, the males had nothing to do with the matter, as they were absent during the whole of the observations.

(3) Huxley has observed in *Lacinularia socialis* that the ephippial egg is formed out of several germs and their surrounding yolk; and I have myself watched the entire process of the formation of an ephippial egg in *Conochilus volvox*, and seen that it consisted of nearly two-thirds of the ovary, with many inclosed germs.

(4) Plate has tried many experiments in coupling females (that had already begun to lay eggs) with males; and in no case did sexual intercourse alter the kind of egg that the female had been in the habit of laying.

(5) In two cases Plate observed the results of coitus on a young

female, that had laid no eggs before intercourse with the male; and, in both cases, she laid ordinary female eggs.

(6) Plate has seen the hatching of two ephippial eggs of *Hydatina senta*, and Joliet one of *Melicerta ringens*, and in each case the ephippial egg produced one female.

It is probable then, from the statements above, that the ephippial egg is not due to the action of the male; but that it is the termination of that budding process, by which virgin females produce virgin females through many generations, and that it is resorted to when the vigour of the ovary begins to fail, so that a single germ is no longer able to produce a living animal. When this time arrives many germs are separated off to do the work for which one is usually sufficient, and so combine together to produce one embryo for the next year. The double egg-shell with its deep cells, and various knobs or spines, may be due to a surplusage of material in this joint-stock egg-making.*

Of the series, of which the ephippial egg is the end, it is probable that an ovary impregnated by the male is the beginning; but this point, as well as the doubts that yet linger about the above account, could surely be cleared up by patient experiment.

It would be easy, for instance, to isolate, as soon as it is hatched, a female of each succeeding generation of a *Hydatina senta*, and to see how many generations may be thus produced; and whether the series invariably ended in a female laying ephippial eggs. There should be, moreover, two such series; one commencing with a female impregnated before she had laid any eggs, the other with a virgin female. As *Hydatina senta* is a common, large, and very prolific Rotiferon, as well as one that may be easily fed with *Euglenæ*, &c., the experiment would not be very troublesome. Possibly, too, such experiments might throw some light on the causes that give rise to the laying of male eggs; about which at present we do not seem to know anything.

There are two other points in the reproduction of the *Rotifera* which are puzzling. The first occurs in *Rotifer vulgaris* and its allied forms. In these the eggs drop off the ovary into the perivisceral cavity, and are hatched within the animal; and the young rotifer seems to lie free in the cavity, for it can stretch itself to its whole length, or twist round and reverse its position without apparent hinderance from any inclosing membrane. In the act of birth it has been seen to pass through the cloacal aperture; and one observer noticed a young *Rotifer vulgaris* protrude its head, expand its wheels in the water, and then furl them and shrink back within the

* M. Joliet's observations on the hatching of the ephippial egg of *Melicerta ringens* (Comptes Rendus, xciii. (1881) p. 856) point in the same direction. For he noticed that the young female hatched from the ephippial egg had the perfect form of the adult *Melicerta*, and was therefore in an advanced stage of growth compared with the young hatched from the ordinary thin-shelled egg.

parent. But how it can do this is a puzzle. Neither ovary appears to have any connection with the cloaca, and the young rotifer seems to be in the body-cavity *outside* of the closed tube which passes from the cloacal outlet to the lower stomach. I have suggested* that the long thread which passes from the posterior end of the ovary towards the cloaca, may really be not a muscle, as is usually supposed, but the collapsed oviduct; and that when the ovum becomes detached and seems to fall into the perivisceral cavity, it does not really do so but simply stretches out over itself the delicate membrane investing the ovary; for the collapsed oviduct, which is a prolongation of this membrane, would at once yield to the slightest pressure, and accommodate itself to the increasing size first of the ovum, and afterwards of the embryo; while the extreme tenuity of the membrane may have caused it to escape notice when expanded over the young. However, this is only a guess; for I have never seen any such membrane, and the difficulty is still waiting for its explanation.

The next point is the frequent presence of spermatozoa in the perivisceral cavity. It is as perplexing to explain how they get into this cavity, as how young *Rotifer vulgaris* gets out of it. Coitus has been seen to take place in several species of *Rotifera*, and by various observers; and with the exception of Dr. Plate, all observers agree that it takes place at the cloaca, into which the oviduct opens. Neither the oviduct, nor the cloaca, is known to have an opening into the perivisceral cavity, and yet the spermatozoa in several species have been seen in that cavity, adhering to the outside of the ovary. How did they get there? †

There may, perhaps, be minute openings in the oviduct through which the spermatozoa can pass into the perivisceral cavity, but I

* 'Rotifera,' i. p. 103, footnote.

† Dr. Plate describes experiments in which he has seen several males (in number varying from two to eight) having intercourse at the same time with the same female. He describes them as firmly fastened by the penis to various parts of her body; and he asserts that the penis bores through the body-wall, anywhere, and ejects the spermatozoa, and the rod-like bodies which accompany them, into the body-cavity. Further on, however, he qualifies this statement by saying that he never could find any traces of an opening in the cuticle, at the spot where copulation appeared to have taken place; that the penis appeared to be glued on outwardly; and that finally he believed that it was the stiff bristles of the penis which penetrated the cuticle, and gave a passage to the spermatozoa.

It is not necessary to comment further on this strange theory than to say, that Gosse has seen intercourse take place at the cloaca in the case of *Brachionus pala*; M. E. F. Weber in that of *Diglena catellina*; and Mr. J. Hood, not only in *Floscularia ornata*, *Synchæta gyrina*, *Euchlanis triquetra*, and *Melicerta tubicolaria*, but also more than a score of times in *Hydatina senta* itself.

Mr. Hood further states, in the letter with which he has favoured me, that the female Rhizota (whose copulation he has often witnessed) "draw themselves up in their tubes, so as to bring the orifice of the cloaca above the upper edge." He also says that *Hydatina senta* copulates while clinging with her foot to some confervoid filament, but *Synchæta gyrina* copulates while swimming.

The duration of contact, according to Mr. Hood, is from forty seconds to two minutes in *Hydatina senta*, and three to three and a half minutes in *Floscularia ornata*.

know of no one who has seen such openings. Or it is possible that the spermatozoa may pass through the walls of the oviduct, just as white corpuscules pass through the walls of the capillaries. And though it is hardly likely that this should be their regular path, yet it is obvious that they are capable of penetrating the membrane, which covers the ovary and is prolonged into an oviduct, for they have been seen to attach themselves to the external surface of the ovary,* so that their contents must pass through the membrane to get at the germ.

There remains one more organ that is waiting for a skilful experimenter and observer, viz. the contractile vesicle with its lateral canals and vibratile tags. Various functions have been ascribed to this group of vessels. It has been described as a male sexual organ, as a respiratory organ, and as an excreting one. The last explanation is the one now usually given; but there are difficulties in the way of its complete acceptance which have not as yet been met.

The theory is that the lateral canals, aided by the vibratile tags, gradually fill the contractile vesicle with a secretion derived from the perivisceral fluid; and that the contractile vesicle, as soon as it has reached its full distention, discharges this fluid through the cloaca.

Now it can be readily demonstrated that the contractile vesicle does discharge its contents through the cloaca,† but it is not easy to credit that these contents consist solely of a secretion derived from the perivisceral fluid. For the contractile vesicle, owing to its rapid and continuous action, often discharges in a minute or two a quantity of fluid equal to that of the whole body. Take for instance the case of *Mastigocerca carinata*. Gosse observed that the discharge took place twenty-five times in a minute; and, as the volume of the vesicle is greater than one-tenth of the perivisceral fluid, it would follow that the creature renews the whole of its body-fluids at least twice in a minute. Is this likely? and, if it could be established as true, what could the perivisceral fluid be but mere water drawn from without? *Secretion*, at such a rate, seems impossible. What, too, shall we say of the great contractile vesicles of some of the *Asplanchnæ*, filling more than half of the body-cavity? Or of that of *Brachionus militaris*, expanding even to two-thirds? Is it probable that they are filled with a *secretion?*

Moreover, that practised observer Cohn declares, that he has seen particles of pigment first driven away by the rush of fluid from the contractile vesicle, and then carried by a return current, through the cloaca, right into the vesicle; while other particles, turned back by its contraction, were violently driven out again from the cloacal aperture.

* Dr. Cohn and myself have seen this in *Conochilus volvox*.

† By compressing a young *Asplanchna Ebbesbornii*, so as to check slightly the action of the contractile vesicle, I have caused partial contractions, each of which has been seen to send a plug of fluid down the oviduct to the cloaca. I have also successfully tried the same experiment on *Hydatina senta*.

I do not see how we can decline to accept such a precise statement, made as it is by an expert; and, if we admit its accuracy, how can we escape from the conclusion, that the fluid, which distends the contractile vesicle, is probably little else but water drawn in through the cloaca?

And, should this explanation prove to be correct, there would then be no difficulty concerning the quantity of fluid, so frequently expelled from the contractile vesicle. The lateral canals and vibratile tags might then be considered, as before, to form a secreting organ, whose secretion did indeed enter the vesicle, but was there so diluted, with water drawn up from the cloaca, that it in no way injured that water in its office of aerating the perivisceral fluid through the delicate wall of the vesicle.*

To sum up, then, I think that of the various explanations offered of this perplexing system of organs, the most probable one is that it is an excreto-respiratory one; the contractile vesicle performing the function of respiration, and the lateral canals that of secretion; and that these functions remain unaltered, whether the lateral canals are united to the vesicle or not. It is evident, however, that to place this explanation beyond doubt, Cohn's experiment should be repeated several times; *Trochosphæra* should be thoroughly re-examined; a record should be kept of the rate at which the vesicle contracts in various species; and an estimation made in such case of the ratio of its volume to that of the perivisceral fluid.

The study of such minute details, no doubt, is dry, and I am afraid that my recital of them has proved wearisome; but then natural history, to a large extent, *is* a study of minute details, which, indeed, must always be its sure foundation. And yet this study has its compensations; for while engaged in it, laying the foundations of such a work as man generally raises—solid perhaps, certainly formal, and probably heavy—I became aware of the silent growth, on the same foundation, of a palace of delight, into which I could enter at a wish, and leave the world behind me. Here could I roam through pleasant chambers, rejoicing in their treasures of memory—in their store of early fancies glittering in the light of happy youth—and in strange prizes, won in dear companionship, among all the charms of cliff, combe, sea, and sunshine. Here, too, were corridors of half-formed thoughts, stretching out into that enchanted region where a few grains of fact, like a drop or two of a compressed gas, expand into clouds of ideas, hazy, yet tinted with the hue of hope—clouds that

* Now the probability of this theory being true is strengthened by the case of *Trochosphæra æquatorialis.* For Semper distinctly states that in *Trochosphæra* the lateral canals are entirely detached from the contractile vesicle; and that, instead of terminating on its surface, they both pass below it to the cloaca, and open just at the cloacal aperture. With such an arrangement of the parts, it is hardly possible to suppose that the contractile vesicle is distended by fluid discharged from the canals. So here, too, we seem driven to the conclusion, that water drawn through the cloaca is the principal agent in the distention of the vesicle.

soften the hard features of modern science, and seem as if they would some day lift a little, and give glimpses of possible replies to the three eternal questions: "Where did we come from?" "Why are we here?" "Whither are we going?" Here, too, could I please myself with thoughts that rose unbidden as I reflected on what I had seen in the world beneath the waters. What happiness reigns there! What ease, grace, beauty, leisure and content! Watch these living specks as they glide through their forests of algæ; all "without hurry and care," as if their "span-long lives" really could endure for the thousand years that the old catch pines for. Here is no greedy jostling at the banquet that Nature has spread for them; no dread of each other; but a leisurely inspection of the field, that shows neither the pressure of hunger nor the dread of an enemy.

"To labour and to be content" (that "sweet life" of the son of Sirach)—to be equally ready for an enemy or a friend—to trust in themselves alone—to show a brave unconcern for the morrow—all these are the admirable points of a character almost universal among animals, and one that would lighten many a heart were it more common among men. That character is the direct result of the golden law, "If one will not work, neither let him eat;" a law whose stern kindness, unflinchingly applied, has produced whole nations of living creatures, without a pauper in their ranks, flushed with health, alert, resolute, self-reliant, and singularly happy.

Another thing that has struck me greatly is that "the struggle for existence" leaves them so much leisure, and such famous spirits. Even the Swift can find time to play. From early morning late into the twilight, it rushes through the air, crushing into a summer's day the emotions of a season's fox-hunting; and then, having "provided for those of its own house," it takes its ease in darting from sky to earth, at eighty miles an hour, shrieking with delight in a mad game of "catch-who-catch can."

During the late hard frost, all the hills where I live, were alive with toboganners—an unwonted sight in the south-west; but the rooks invented the game long ago. I have often watched them at Ilfracombe in the evening (when a strong north-wester was blowing) flying low above the town, from the Manor House trees, to the landward slopes above the tunnels. There, closing their ranks and sheltered by the slope, they rose, almost brushing the grass, till, at the very edge of the cliff they were caught by the wind, and hurled, in a whirl of wings, back to their rookery; whence after much fluttering and cawing, they again set out for the cliffs.

The slow toilsome approach, the mad return, the intoxication of headlong flight, and the spice of possible danger, are the same in both games; but the birds have the best of it; for no policeman ever wishes to interfere with their sport; and they can enjoy it if they please, nearly all the year round.

The *Rotifera* occasionally play; at least I think so. You may sometimes see, floating in the water of a live-trough, a tangle of what looks like spider's web. It is, I believe, a chance gathering of the threads spun by a swarm of the larger *Rotifera*. On one of these threads, I have sometimes seen a line of minute creatures (1/250 in. long) hanging on by their toes, and whirling round, one after another, like boys on an iron railing, or rather like professional athletes on a horizontal bar. It is hardly possible that they get their food in this way, for the pace is so great; besides, at other times, they flit about among the algæ with a decorum much more suitable to the important business of dining.

But why should I adduce further examples? Higher up in the scale, the games of animals are obvious to all; as are also, I think, their health, their leisure, and their happiness. Where they lead unhealthy and unhappy lives, I fear that man's brutality, or his injudicious kindness, are too often to blame.

All such speculations as these, however, lead to burning questions; for man is much too closely kin to the lower animals not to be conscious, that the laws, which affect their conduct, are but a rough sketch of those which affect his own. Still I may be permitted to say, without offence, that we have much to learn from our dumb brethren; and that we sometimes cut sorry figures compared with them. Indeed, we can only wince and be silent, when we read the caustic lines that sum up the discourse of Luath and Cæsar,—

> "Then up they gat, and shook their lugs,
> Rejoiced they werena *men* but *dogs*."

Of the outward condition of the brute creation, and of the happiness that falls to its lot, we can perhaps form an opinion that approximates to the truth, though even here the same facts receive widely different interpretations. But of the sensations and emotions of the humbler animals what *can* we know? Of the import to them of those phenomena, which make up our own familiar world, we cannot conjecture. We can but make feeble guesses at the causes of their actions; causes lost in one of the profoundest abysses with which our reason can attempt to cope. I have seen actions among the *Rotifera* that seemed to betoken the possession of memory, consiousness, and choice; but, without the means of testing the matter by experiment, it would be rash indeed to assert that they possess them. Still, what could *look* more rational than the following conduct in a *Floscularia campanulata?* It had stretched itself well out of its case, and, fully expanded, was drawing one victim after another down to the bottom of its coronal cup, when there slipped into the latter, almost filling it, a *Euplotes charon*—one of the oval, style-bearing Infusoria. Now the Floscule's habit, when it is disturbed, is to fold up its cup, draw it into its body, and dart back into its tube. It does this scores of times during the day, and a whole series of actions—the pressing of the lobes of the cup together, their proper folding, their withdrawal within the body, the contraction of the foot, and the consequent darting to the bottom of the tube—bring into play a number of various muscles. These are all practised to act together with the utmost precision and swiftness; and I never, except on this occasion, saw them act otherwise than in concert. But to have done so now would have been to have caused a struggle between the Floscule to get into its tube, and the *Euplotes* to get out of the Floscule's grip; in which the cup's delicate walls might have been much injured. So the latter did the only thing that there was to be done with safety. It slowly contracted its foot while *distending its coronal cup to the utmost;* and, making as it were a graceful curtsy, gave the *Euplotes* a free passage.

Here, then, was an unusual danger met promptly by the reversal of one of a group of related actions, which habit must have made almost inseparable. It *looked* as if the Floscule had consciously adopted this mode of escape from its awkward position; but, as Hamerton has well said, "the impossibility of knowing the real sensations of animals—and the sensations are the life—stands like an inaccessible and immovable rock right in the pathway of our studies. None of us can imagine the feelings of a tiger when his jaws are bathed in blood, and he tears the quivering flesh. The passion of the great flesh-eater is as completely unknown to civilised men, as the passion of the poet is to the tiger in the jungle. It is far more than merely a good appetite; it is an intense emotion."

The main difficulty in conceiving the mental state of animals is, that the moment we think of them as *human* we are lost. But the hopeless absurdity of trying to fancy how life looks and feels to a Floscule, is only a trifling instance of what meets us at every turn; our speculations constantly leading us to abysses in which thought does not so much lose itself, as expire.

Curiosity may tempt us to peer into the darkness; but if we wish

> "To take what passes in good part,
> And keep the hiccoughs from the heart,"

we must turn back to sunshine and our beautiful earth, existence on which is acceptable almost on any terms. It has delights for our senses, satisfaction for our affections; and, for our minds, a store of marvels which the longest life can never exhaust. For the softer consolations of hope, for dreams of the future, for the recovery of lost love, and the re-uniting of snapt heart-strings, we must step into the realm of Faith, clinging to our hopes, and declining "to lose *ourselves* while seeking for our primary cell."*

Sir Thomas Browne's advice is as good now as it was 250 years ago: "Desert not thy title to a divine particle. Have a glimpse of incomprehensibles, and thoughts of things, which thoughts but tenderly touch."

Science, though it has its own religion of wonder and reverence,

* 'Horæ Subsecivæ,' Dr. John Brown.

is in such matters hemmed in by barriers impassable by human reason ; and knows as little of first causes, as it does of last consequences. Yet from the drama of animal life we may learn wholesome lessons. Here Nature suffers us to guess at her wishes, from her acts ; and so judged, we may well say of her, that

"She too is no mean preacher."

For though her precepts are few, they are burnt into her pupils by her unvarying practice ; as, almost from birth to death, from the Primates to the Rotifers, she trains up her dumb children in the exercise of that splendid virtue—fearless Self-reliance.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

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

a. Embryology.†

Preservation and Accumulation of Cross-Infertility.‡—The Rev. J. T. Gulick regards physiological segregation as including all kinds of incompatibility between the male and female elements of different groups, however closely or however widely they may be separated; he urges that the importance of this principle in the origin and continuance of different groups cannot be exaggerated in the case of organisms whose fertilizing elements are fully distributed by wind or water; in those cases the segregate compatibility and cross incompatibility of the male and female elements may be the means by which the prevention of free crossing is secured, as well as the means by which the swamping effect of the crossing that occurs is prevented.

Experimental Studies on Ova.§—Prof. O. Hertwig discusses under this title a number of strange facts.

(1) *The effect of over-ripeness.*—At Trieste, in April 1887, the majority of the sea-urchins (*Echinus microtuberculatus* and *Strongylocentrotus lividus*) seem to have been in a pathological condition. The reproductive organs were over-ripe; the ova would not fertilize at all, or were more frequently susceptible to multiple fertilization, containing sometimes a score of sperm-nuclei; segmentation, if it did begin, was very abnormal. As Professor Hertwig does not believe in the possibility of unfavourable external conditions having a direct effect on the reproductive elements, he inclines to think that spawning had been

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

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

‡ Amer. Journal of Science, cxl. (1890) pp. 437-42.

§ Jenaische Zeitschr. f. Naturwiss., xxiv. (1890) pp. 268-313 (3 pls.).

somehow prevented, and that an injurious over-ripeness of both spermatozoa and ova, but especially of the latter, resulted.

(2) *The influence of cold on the reproductive elements.*—Ova of sea-urchins can survive a temperature of − 2° or − 3° C., but the changes which are associated with fertilization are much modified. Thus the vitelline membrane was imperfectly formed or suppressed, according to the duration of the refrigeration. The receptive prominence where the protoplasm of the ovum usually reacts to the stimulus of the penetrating spermatozoon was formed slightly or not at all. At the beginning of refrigeration normal fertilization might be observed, after half an hour polyspermy occurred, in the second hour no fertilization. More rapid than any other change was the disappearance of the usual radiate figures in the protoplasm of the ovum. The author then describes in detail the remarkable influences of lowered temperature on segmenting ova.

(3) *Staining living cell-substance with methyl-blue.*—Ova of *Strongylocentrotus lividus* placed for a short time in strong solutions of methyl-blue, or for a longer time in weak solutions, take up the pigment readily. The more they absorb, the more their future development is retarded. When returned to pure sea-water, they retain the colour for a while, and the pigment is observed at the bases of the ciliated cells in the blastula stage.

(4) *Parthenogenesis of Starfish.*—Prof. Hertwig was able to confirm Greeff's observation that ova of starfishes might begin to develope without fertilization. The ova of *Asterias glacialis* and also of *Astropecten* were sometimes seen to segment, usually in abnormal fashion, without any fertilization having occurred. In some cases the blastula stage was attained, and these blastula embryos were without any vitelline membrane, which is only formed when fertilization is effected. Though the observations on the formation of polar bodies in these parthenogenetic ova were not very conclusive, they seem to indicate that a second nuclear division, but no second extrusion takes place, a fact of obvious interest in connection with the theories as to the relation between the formation of polar bodies and parthenogenetic development.

Maturation of the Ovum of the Fowl.*—Prof. M. Holl begins his account with a description of the ova of the newly hatched chick which are not yet inclosed within follicles. He then sketches the origin of the *tunica adventitia* (or vitelline membrane), of the *membrana granulosa* (or follicular epithelium), and of the *membrana propria*, all of which arise from the stroma of the ovary. As maturation proceeds, the nucleus undergoes a series of changes:—it seems to move from the centre to the surface, thence inwards, and finally once more outwards, with slight changes of form meanwhile; the nuclear membrane disappears; so does the nucleolus; the chromatin substance, at first a fine network, becomes distributed in small granules, but collects again in six chromatin rods, whose appearance is probably to be associated with the formation of polar bodies. Considerable attention is paid to the remarkable yolk-nucleus which lies near the germinal vesicle, and to the peripheral increase of the yolk. The author then describes the appearance of the *zona radiata*, which he regards as a product of the cells of the *membrana*

* SB. K. Akad. Wiss. Wien, xcix. (1890) pp. 309–70 (1 pl.).

granulosa, and traces the subsequent changes that occur round the ripening ovum in the "vitelline membrane" and "follicular epithelium."

The Pressure within the Egg of the Fowl.*—Sig. L. Tarulli finds that internal varnishing of the air-chamber of the egg prevents development, except in the first stages. The pressure is much affected, and the respiration but a little. External varnishing of the air-chamber is also followed by disturbing results, but the pressure after being increased returns to the normal, through the use of the unvarnished region. When the air-chamber is filled with oil, and thus completely varnished internally, there are no traces of development. Varnishing the egg not only hinders respiration, but affects pressure and temperature. The air-chamber regulates pressure, the surface of evaporation regulates temperature. It is only when these two conditions are naturally fulfilled that respiration can remain normal.

Formation of a Double Embryo in the Hen's-egg.†—Prof. W. Baldwin Spencer describes an egg in which two clearly formed embryos were developed within the limits of one blastoderm. The two embryos are precisely similar to one another; each is in the stage at which the nervous system has the form of a tube, the anterior end of which is becoming swollen out to form the vesicles of the brain; at the posterior end the neural canal is still widely open. Apparently every stage may be met with between this complete reduplication and that in which one portion only of the body is doubled. Prof. Spencer points out that there are three ways in which this doubling may have been brought about. As in the case of *Lumbricus trapezoides* there may be division of the at first single and normal embryo, but that could hardly have happened here, as the surrounding areæ show no trace of division. Two distinct nuclei may have been inclosed abnormally within the protoplasmic material of one ovum; but then we should expect two blastoderms. The third chance is the most probable, namely that the very first division of the nucleus was abnormal, and its products may have been qualitatively and quantitatively precisely similar, and not, as we may suppose to be the case in normal division, slightly different. This explanation will suffice also for the case, recorded by Mr. A. H. S. Lucas,‡ of a partially double chick embryo; and in fact, all cases of incomplete division may be explained by it. In these abnormal segmentation, resulting in the production of two halves precisely similar, only takes place at a later stage, and so only affects certain cells (or their nuclei) which will give rise to certain organs of the body. The earlier in segmentation the abnormal division takes place, the larger is the part of the body affected.

Maturation of Amphibian Ova.§—Dr. O. Rossi has been studying the maturation of the ovum in *Triton* and *Rana*. He finds that the germinal vesicle undergoes preliminary modifications within the ovarian ova, and that the ova from the base of the oviduct show no trace of germinal vesicle as such. He believes that a complete dissolution, and

* Atti e Rend. Accad. Med. Chirurg. Perugia, ii. (1890) pp. 121–34.
† Proc. Roy. Soc. Victoria, ii. (1890) pp. 113–5 (1 fig.).
‡ T. c., pp. 111–2 (1 fig.).
§ Anat. Anzeig., v. (1890) pp. 142–3.

perhaps partial digestion, of the nucleus takes place as the ova leave the ovary, or as they pass through the uppermost part of the oviduct. We await further details.

The Formation of the Zona Pellucida.*—Prof. G. Paladino refers to what G. Retzius recently † maintained in regard to the connections between follicular cells and the ovarian ovum, and cites some passages from a work of his own ‡ published in 1887, in which he described the intercellular protoplasmic bridges between the ovarian ovum of the rabbit and the surrounding follicular cells. The result of this nutritive connection is a reticular layer around the ovum. It is thus, namely from the follicular cells, that the *zona pellucida* arises, and its variable appearance, its presence or absence, are readily explained. It is an accessory stratum of no constancy or intrinsic importance.

Fœtal Membranes of Chelonia.§—Dr. K. Mitsukuri has investigated the fœtal membranes in *Clemmys japonica* and *Trionyx japonicus.* Among the interesting discoveries which he has made, he has discovered that the extra-embryonic cavities of the two halves of the amnion are never united with one another over the dorsal region of the embryo. A connection between the amnion and the serous envelope separates them to the very end of development and may be called the sero-amniotic connection. As may be supposed it causes great peculiarities in the fœtal membranes, in later stages. The anterior and lateral folds which, starting from the head, have gradually extended backwards over the whole embryo, do not stop at the posterior end of the embryo but continue to grow backwards; there is thus produced a tube which extends backwards from the posterior end of the embryo and is almost as long as the embryo itself; it connects the amniotic sac with the exterior. It is possible that its function is to convey nutritious matter from the white yolk into the amniotic cavity.

At one spot a small mass of white persists for a long time; it seems to undergo some change in its chemical composition for it becomes much denser and is sticky. The membranes are often slightly indented to receive this mass, and into it a low thick process of the membranes is sent; the cells of the outer layer of the serous envelope in this process are peculiarly modified, and there can be no doubt that they absorb albuminous particles from the white. This seems to be a very primitive condition of the structure described by Duval as the placenta in Birds.

Formation of the Notochord in the Human Embryo.‖—Prof. J. Kollmann has been able to demonstrate the origin of the notochord in a human embryo 14–16 days old, consisting of 13 metameres, and measuring 2·5 mm. in length. He finds that it arises in the ordinary way as an axial differentiation of endoderm along the dorsal mid-line of the gut. Kollmann maintains that in the lower Vertebrates (*Amphioxus*, Selachia, Urodela, and probably in Teleosteans and Ganoids) the notochord arises from the endoderm alone, i.e. from the "chordal-entoblast,"

* Anat. Anzeig., v. (1890) pp. 254–9 (1 fig.).
† Verh. Anat. Ges., 1889, pp. 10–11.
‡ 'Ulteriori ricerche sulla distruzione e sul rinnovamento continuo del parenchimo ovarico,' Napoli, 1887, 230 pp. and 9 pls.
§ Anat. Anzeig., v. (1890) pp. 510–9 (12 figs.).
‖ T. c., pp. 308–21 (3 figs.).

but that in mammals and probably in Sauropsida the mesoderm shares to some extent in making it. His present investigation shows that in man the notochord has certainly its main foundation in the endoderm.

Development of Vessels and Blood in the Embryonic Liver.*—Dr. P. Kuborn finds that the formation and the increase of the giant-cells in the embryonic liver of sheep are due to the extension of the vascular plexus. Nucleated prolongations grow out from the endothelial cells forming the walls of the vessels, increase the vascular channels, and give rise in so doing to giant-cells. The giant-cells form the walls of vascular cavities, also hyaline cells which become red blood-corpuscles (erythroblasts of Löwit), and part of the liquid in which these float. But when the embryos have attained a length of 3–4 cm., the process becomes more complicated, for within the giant-cells and beside the red cells which continue to be formed there, special hæmatid cells ("hématies") appear. These are developed in the protoplasm of the giant-cell as little spherical corpuscles, impregnated with hæmoglobin. They become more and more distinct from the cell-substance in which they arise, are eventually liberated, and join the colourless and red cells in the vascular cavity.

Relation of Mesonephros to the Pronephros and Supra-renal Bodies.†—Dr. R. Semon has investigated this problem in embryos of *Ichthyophis glutinosus.* (1) The pronephros has a Malpighian body as well as the mesonephros; and though a segmental constriction of this body is not demonstrable, there are some hints of segmental structure. (2) The pronephric Malpighian body is a diverticulum of the body-cavity; those of the mesonephros are also secondarily constricted cœlomic diverticula. (3) The mesonephric canals with their Malpighian bodies represent the second (dorso-lateral) generation of the pronephros and its Malpighian body. (4) The non-nervous (inter-renal) portion of the supra-renal bodies is nothing more than the distal portion of the Malpighian body of the pronephros, which has undergone great modifications—degeneration of the glomerulus and of the efferent canals, besides loss of the lumen. (5) The reproductive organ also lies in a diverticulum which was constricted off in the formation of the Malpighian body of the pronephros. The testicular network and the vasa efferentia in the male, the so-called medullary strands in the female, are anastomosing cavities derived from the original diverticulum. At first there was a connection with the Malpighian body of the pronephros, but after this was modified to form the inter-renal portion of the supra-renal body, the connection was with the Malpighian body of the mesonephros, itself a derivative of the pronephros. Sometimes, indeed, both connections persist.

Development of Urinogenital Apparatus of Crocodiles and Chelonians.‡—Prof. R. Wiedersheim finds in Crocodiles and Chelonians undoubted signs of a pronephros. Rather late in development it undergoes degeneration and consists only of a few glandular canaliculi which open by ciliated nephrostomes into the most anterior part of the cœlom. On either side, and near the pronephros there is a large vascular coil

* Anat. Anzeig., v. (1890) pp. 277–82. † T. c., pp. 455–82 (8 figs.).
‡ Arch. f. Mikr. Anat., xxxvi. (1890) pp. 410–68 (3 pls.).

(glomus) covered by cœlomic epithelium, projecting freely into the peritoneal cavity and turned towards the mesentery. Neither of these parts gives any signs of segmental origin. The glomus is multilobate but single, though it extends over more than four segments; it does not completely disappear till the Müllerian duct opens into the cloaca. It is probable that the glomus, and, with it, the whole system of pronephros, extended, in the primitive Reptiles, through the whole cœlom. The pro- and archi-nephros pass into one another without any distinct boundaries between them. A pronephric duct which later becomes the archinephric is distinctly developed, as in other Vertebrates, but it could not be decided from which germinal layer this duct arose. In the anterior region of the excretory organ there are numerous nephrostomes provided with ciliated epithelium, which are, in the earlier embryonic stages, arranged in an altogether segmental manner. In opposition to other Reptiles the Crocodiles and Tortoises have these organs fully developed and in active function for some time. This means that the embryonic renal system of these two groups of Reptiles is an important link between the renal system of other Sauropsida and Mammals on the one hand and that of the Anamnia (and especially Selachians and Amphibians) on the other. It also affords a proof that in primitive Reptiles the renal glands must, all their life long, have been connected with the cœlom.

In the ontogeny of the renal gland of Crocodilia and Chelonia we can follow the whole series of stages which gradually free it completely from the cœlom; all the three kinds of nephrostome are merely modifications of one and the same arrangement, and with the "glomus" and "glomerulus" may be looked at from the same morphological and physiological point of view, that is, their permanent connection with the cœlom. The same is true of the permanent kidneys (metanephros), which arise indirectly from the same rudiment, and are not to be regarded as anything else than a posterior and more lately developed portion of the primitive kidney.

The Müllerian duct of Crocodiles and Chelonians has as little to do with the pronephric duct, in its development, as in any other Vertebrate animal.

Development of the Reproductive System.*—Prof. J. Janošik's investigation of the early development of the reproductive organs in mammals has led him to conclude that if all were developed the result would be hermaphrodite organs, with internal testes and ovaries surrounding them. The same is true for the fowl and probably for other birds. The cells from which spermatozoa arise are descendants of those which are due to the primary proliferation of the germinal epithelium; the cells from which ova are formed are ontogenetically younger.

Structure of Nervous Cells.†—Dr. A. Coggi protests against drawing hasty conclusions about structure from artificially prepared specimens. He deals especially with some theoretical conclusions which Sig. Magini drew from his study of the electric lobes of *Torpedo*, These are not confirmed by the investigation of the living cells. Thus the karyoplasma does not always contract in the direction of the nervous

* SB. K. K. Akad. Wiss. Wien, xcix. (1890) pp. 260–88 (1 pl.).
† Atti R. Accad. Lincei—Rend., vi. (1890) pp. 236–8.

prolongation of the cell, but may contract in any direction according to the stimulus, and the position of the nucleus is variable.

Morphology of Blood-corpuscles.*—Mr. C. S. Minot distinguishes the blood-corpuscles of Vertebrates as red cells, white cells, and plastids; the last name is applied to the non-nucleated corpuscles of adult Mammals which are completely new elements, peculiar to the class, and not derived either from white or red corpuscles; they were first described by Schäfer, whose results have lately been confirmed by Kuborn. Their essential characteristic is that they arise intracellularly and by differentiation of the protoplasm of the vessel-forming cells.

The red cells have three chief forms, the primitive of which does not, perhaps, persist in any adult Vertebrate; the second form obtains in the Ichthyopsida, and the third in the Sauropsida. The author distinguishes (*a*) blood with single cells; that is the first stage in all Vertebrates, when the blood contains only red cells with a small quantity of protoplasm; (*b*) blood with two kinds of cells, red and white; the red cells have either a large, coarsely granulated nucleus as in the Ichthyopsida, or a small darkly staining nucleus as in Sauropsida and embryonic Mammals; and (*c*) plastid blood, without red cells but with white cells and red plastids; this is found only in adult Mammals.

B. INVERTEBRATA.

Parasites of Mola rotunda.†—Prof. Leidy reports a great number and variety of parasites from this Sunfish. Chief among them was the large Lernean, *Penella filosa*, which hung in great clusters from the root of the dorsal and other fins; they were from five to nearly seven inches long and had one to three inches buried in the flesh of the fish. To many of these were appended the barnacle, *Conchoderma virgatum*, and they were also more or less profusely covered with colonies of the Hydroid Polyp *Eucope parasitica*. The other Crustacean parasites were *Cecrops Latreillii*, *Læmargus muricatus*, and *Dinematura serrata*.

Gliding on the skin was the circular Trematode *Tristomum Rudolphianum*, and in the intestine was *Distomum pedocotyle* which appears to be new; the body is cylindrical, narrowest in front, with vertical bothria larger than the mouth and projecting in advance to an extent equal to the body. The soft, yellow liver of the fishes was throughout pervaded with the tape-worm *Anthocephalus elongatus*.

Mollusca.

α. Cephalopoda.

Notes on Cephalopods.‡—Dr. A. Appellöf commences with a description of a new genus of Œgopsida, which he calls *Chthenopteryx*; its fins consist of a series of muscular filaments, which are connected at their base by an extremely thin and transparent membrane. The apparatus for closing the mantle consists of a cartilaginous piece placed on either side of the base of the funnel, and having in the middle an extremely delicate groove; a cartilaginous ridge corresponding to this

* Anat. Anzeig., v. (1890) pp. 601–4.
† Proc. Acad. Philadelphia, 1890, pp. 281–2.
‡ Bergens Museums Aarsberetning for 1889 (1890) No. iii., 34 pp. and 1 pl..

groove is to be found on the inner side of the mantle. There are only two pairs of adductors of the funnel. The optic orifice is pyriform in shape. The single species, *C. fimbriatus*, has been found in the Mediterranean. This new genus has some remarkable peculiarities, but may be placed with the Ommatostrephidæ.

The author has had the opportunity of examining various specimens of *Veranya sicula*. In its chief characters this species agrees with most of the other Œgopsida, but there are some points which may be peculiar to it; such are the presence of two commissures between the visceral nerves, which have not been reported in any other Decapod; the position of the heart is rather octopod than decapod in character; in the feeble development of its musculature *Veranya* approaches the Cranchiidæ and Chiroteuthidæ.

Some observations are offered on *Loligo Alessandrini* of Vérany, which Dr. Appellöf places with *Calliteuthis;* the liver was seen to consist of one mass, which indicated its double nature by a shallow groove. The accessory is much more spacious than the true stomach, and has a distinct spiral twist. The heart is elongated in the transverse direction of the body, and is so curved that the tip from which the cephalic aorta arises looks forwards; the posterior aorta arises in the hinder margin of the heart; the efferent duct of the ink-bag is very short. *Calliteuthis reversa* Verrill is now for the first time recorded from the Mediterranean; it is a species of wide distribution, as it has been found on the North Atlantic coast of America and in New Zealand and Japan.

γ. Gastropoda.

List of Opisthobranchiate Mollusca of Plymouth.* — Mr. W. Garstang gives a complete list of the Opisthobranchiate Mollusca hitherto found at Plymouth; fifty-four species are, in all, recorded. With regard to the colour-changes in *Aplysia punctata*, which M. Vayssière attributes to the nature of the bottoms upon which they are found, the author remarks that the living *Aplysia* whose colour-changes he observed was kept under the same conditions for two months. The characters of the radula are discussed in great detail. All the known specimens of *Lomanotus* appear to belong to *L. genei*, notwithstanding the fact that some six specific names have been applied to them. Mr. Garstang gives a quantity of interesting information regarding many of the species which he catalogues.

Nervous System of Parmophorus australis.† — M. L. Boutan finds that three sets of nerves are given off from the ventral nervous mass of *Parmophorus;* from the lower surface nerves go to the foot only; from the sides others pass to the lower mantle, and between these there are nerves which pass directly to the mantle. It may, therefore, be justly concluded that the ventral nervous mass is both a pedal and a pallial centre. The author combats the views of those who regard *Fissurella* and *Parmophorus* as intermediate between the Lamellibranchiata on the one hand and *Chiton* and even worms on the other; the apparent symmetry of the adult is an acquired character, and the farther back we

* Journ. Marine Biol. Assoc., i. (1890) pp. 399–457 (2 pls.).
† Arch. Zool. Expér. et Gén., viii. (1890) pp. xliv.–viii.

trace the history of development the more do we find the primitive want of symmetry, while the larva is like that of normal Gastropods. It must not, however, be supposed that *Fissurella* and the allied forms are highly organized Gastropods; while they have become more differentiated in the symmetry of various organs, they have preserved indubitable signs of inferiority.

It may be concluded that the lower mantle or epipodium is of the same nature as the mantle, since the nerves which are supplied to it arise from the same parts of the centre as the nerves of the mantle. It may also be concluded that the two first ganglia of the asymmetrical centre are not limited to the upper part of the nerve-chain which furnished the nerves for the mantle and epipodium. If this be so, the groove which marks out two distinct and parallel parts in the nervous mass is not, as B. Haller supposes, an unimportant groove, but is of high morphological interest, as it indicates the point of union of the pedal and pallial centres. As the nervous system of *Fissurella* is very like that of *Parmophorus*, the conclusions may be applied to the former which are drawn from the latter.

That there is an ontogenetic and phylogenetic relation between *Parmophorus*, *Haliotis*, and *Fissurella*, is shown by the presence in the last of two nerve-rings in the mantle, which replace the pallial anastomoses seen in the two first.

The presence of the vestige of a coiled shell in the young of *Parmophorus* and *Fissurella* show that there is no affinity between these molluscs and the Lamellibranchs or the Chitons.

Nervous System of Cypræa.*—M. E. L. Bouvier, in consequence of some criticisms made by Dr. B. Haller in his recent memoir on *Cypræa*,† has re-examined the nervous system in *Cypræa arabica*. M. Bouvier has not been able to find the terminal ganglion in the first branchial nerve which has been described by his critic, but he has been able to trace the nerve itself and see it innervate the mantle; the nerve is quite large, and can be seen without any dissection. Similar answers are made to sundry other criticisms, and some few new details are added.

Development of a Solenogaster.‡—M. G. Pruvot has been able to follow out the development of a recently described species of *Dondersia*—*D. banyulensis*. The eggs are deposited a few at a time, and are covered with a delicate shell. Segmentation is unequal from the first; at the 8-stage there is one large blastomere at the nutrient pole, and seven small and equal blastomeres at the formative. Periods of repose alternate with periods of division. After twenty-four hours there appears a median corona of vibratile cilia, while two ciliated areæ appear at the cephalic pole and the point of invagination respectively. The embryo elongates and becomes divided by two annular constrictions into three segments. The cephalic segment is formed of two rows of ciliated cells; some of the cilia become longer than the rest, and one finally becomes much larger, and forms the terminal flagellum. The second segment or velum is formed of a single layer of cells, which have a single row of cilia: these grow and form the ciliated corona, the chief organ of

* Zool. Anzeig., xiii. (1890) pp. 717–20. † See this Journal, 1890, p. 704.
‡ Comptes Rendus, cxi. (1890) pp. 689–92.

locomotion. The third or pallial segment is formed of two rows of cells which are entirely covered by fine cilia. In a larva of 100 hours three imbricated spicules are to be seen on either side of the ventral line, still inclosed in their mother-cells. The spicules increase in number. The conical body elongates rapidly and becomes curved on its ventral surface, while the mantle is gradually reduced, and the embryo falls to the bottom, as the ciliated corona is unable longer to support it in the fluid.

Only one of the author's embryos passed safely through the critical period of metamorphosis, which is on the seventh day. This change consists in the casting off of almost the whole of the external envelope of the larva, that is to say, of the cells of the velum and the two rows that form the pallial lobes. Seven dorsal calcareous and slightly imbricated plates were observed in the surviving embryo.

Till the time of metamorphosis the larva has no mouth, and the endoderm forms a solid mass flanked on either side by solid rows of mesoderm, the origin of which has not yet been made out.

To sum up, the mode of segmentation is almost identical with that of *Dentalium* and certain Lamellibranchs; the mouthless larva, formed of three segments, has no known analogue, except among the Brachiopoda; the loss of the greater part of the ectoderm has been noted in *Polygordius*, and the tegumentary investment of the young Solenogastrid closely recalls that of young Chitons.

δ. Lamellibranchiata.

Primitive Structure of Kidney of Lamellibranchs.*—Dr. P. Pelseneer points out that it is the generally received doctrine that the structure of the renal organ of Lamellibranchs does not ally them to the lowest, but to the more highly developed representatives of the Prosobranchiata. This statement, however, is made on the results of the investigation of very specialized forms. When the more archaic representatives of the group, such as the Nuculidæ or Solenomyidæ, are dissected, a very different arrangement is found to obtain. In them each kidney forms a sac which is folded on itself in such a way as to have its two ends more or less approximated and directed forwards; one of these opens into the pericardium, and the other to the exterior. In no Protobranch does the sac extend as far backwards as the posterior adductor, and it does not communicate with its fellow. As to structure, the kidney has no internal fold or lamella, and no ramifications; it is an absolutely simple sac, with a large lumen. Its inner wall is formed by a uniform epithelial investment, extending from one extremity to the other, and having all its cells similar and secretory. This fact shows that, in the more specialized Lamellibranchiata, the terminal or postero-anterior branch of the kidney had not, as Rankin supposed, a primitively efferent function, but was originally secretory, like the whole of the gland. The arrangement which obtains in the Najidæ, for example, when the secretory formation falls on the antero-posterior branch, is a specialization.

From the point of view of structure there is a great resemblance between the protobranch Lamellibranchiata and the Fissurellidæ, for the

* Comptes Rendus, cxi. (1890) pp. 583-4.

renal organs of *Solenomya* and *Fissurella* are much more similar to one another than are those of the former and most Lamellibranchs, or of the latter and most Gastropods. The resemblance between the excretory organ of the Protobranchiata and that of the more primitive Rhipidoglossata is made still more complete by the fact that in the former (*Nucula*, *Leda*, *Yoldia*, *Solenomya*) the gonads open into the kidneys as in the Fissurellidæ, Haliotidæ, &c.; an arrangement known in only three of the higher Lamellibranchs.

Molluscoida.

a. Tunicata.

Origin of Test-cells of Ascidians.*—Dr. T. H. Morgan, who has examined various forms, describes especially the history of the test-cells in *Cynthia ocellata* and *Clavellina* sp. In the former the test-cells arise from follicular cells of the egg, which take up a more internal position; at the stage when the follicular cells are thus migrating two main sources of error may arise:—if the section passes near one end of the egg, when the convexity of the surface is so great relatively to the plane of the section that two or more layers of the nuclei of the follicle may appear in the same section; or an error may arise if the microtome knife does not cut the egg cleanly, but turns over part of the follicular zone. The author refers so constantly to his figures that we cannot trace with him the various stages in development. In later stages the test-cells do not seem materially to change either in number, size, or structure, but the follicular cells continue to increase in size and become much vacuolated. In young ova the follicular cells were found from surface views to have irregular outlines, and in general appearance to resemble peritoneal epithelial cells. Dr. Morgan's results agree essentially with those of Van Beneden and Julin, and are diametrically opposed to those of Davidoff.

β. Bryozoa.

Cyclatella annelidicola.†—M. H. Prouho gives an account of this organism. It was first seen by MM. Van Beneden and Hesse on the integument of a *Clymene*, and was by them regarded as a Tristomid, though its resemblance to a *Loxosoma* was noticed. Leuckart believed it to be a Bryozoon, and with him Nitsche agreed, while Schmidt upheld its Trematod character, though Van Beneden was converted by the arguments of Leuckart.

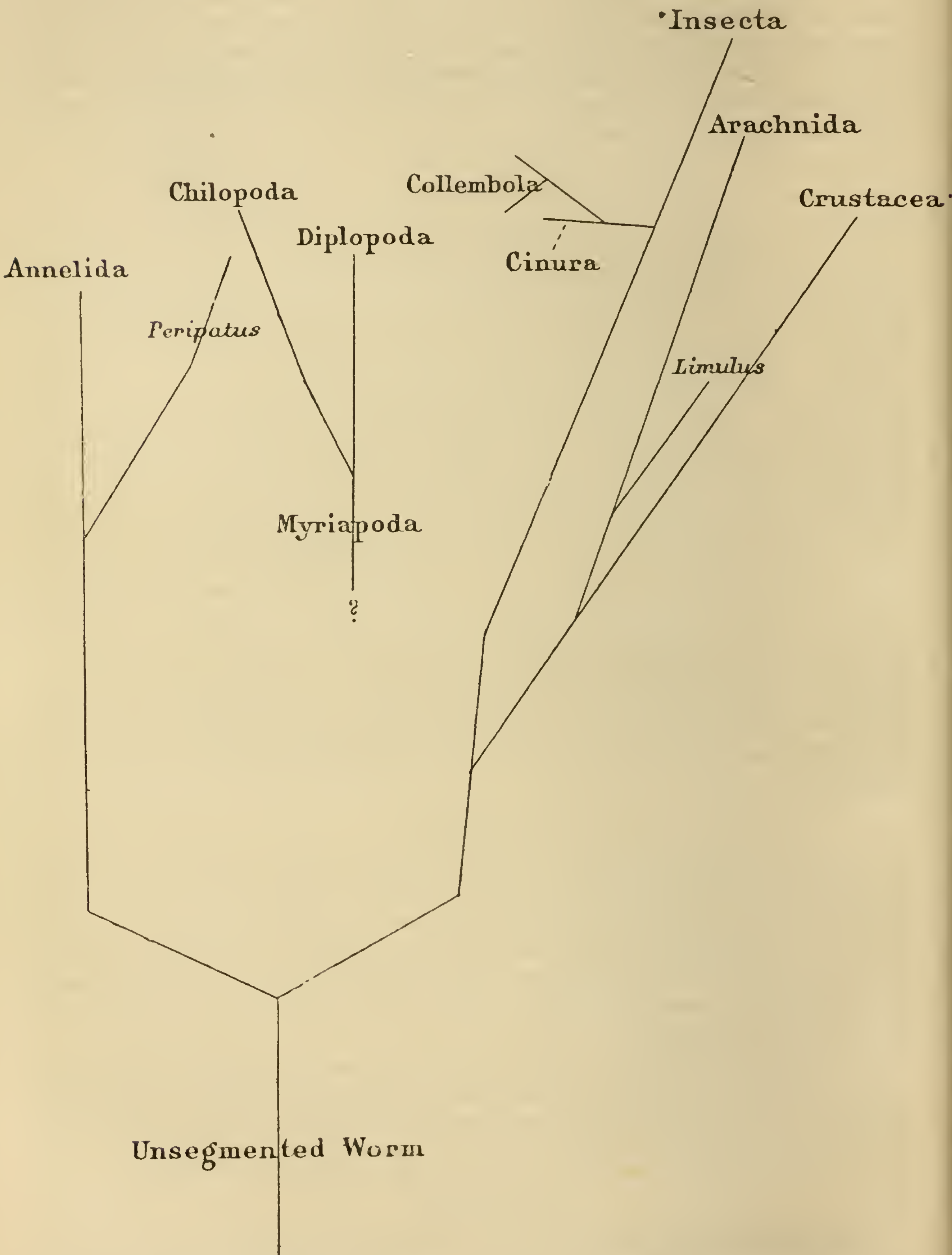
M. Prouho cannot doubt that it is a *Loxosoma*, although specifically different from any species yet described as belonging to that genus. It has the two lobes of the calyx greatly developed, and the other characters, none of more than specific value, are enumerated and discussed.

Arthropoda.

Relationships of Arthropods.‡—Prof. H. T. Fernald discusses the relationships of Arthropods. He commences with an account of the

* Journal of Morphology, iv. (1890) pp. 195–204 (1 pl.).
† Comptes Rendus, cxi. (1890) pp. 799–801.
‡ Stud. Biol. Lab. Johns Hopkins Univ., iv. (1890) pp. 432–513 (3 pls.).

anatomy of *Anurida maritima*, and has some notes on *Lepisma saccharina*. The probable characters of the ancestors of Insects are judged from the



evidence given by Palæontology, Anatomy, and Embryology, and the following summary is given of the characters of the "archentomon":—

Segmented, bilaterally symmetrical, divided (perhaps slightly) into head, thorax, and abdomen. On each thoracic and abdominal (?) segment a pair of jointed legs; two pairs of wings (perhaps only dorsal lobes); a pair of antennæ and a pair of eyes; gnathites (three pairs) formed for biting. Body covered by a somewhat chitinous layer resting on a cellular one; alimentary tract straight, with its terminal portions lined by chitin; into its anterior end opened the ducts of a pair of secretory glands, and into its posterior portion several thread-like hollow tubes. Respiration effected by tracheæ. The circulatory system consisted of a dorsal vessel, narrowed in the thoracic region, and the nervous of a double supra-œsophageal ganglion, œsophageal cords, subœsophageal ganglion, and a segmentally placed series of ventral ganglia, joined by commissural bands. A fat-body at least partly occupied the body-cavity. Sexual organs paired, opening to the exterior by a median duct. Sexes distinct; animal terrestrial.

From the archentomon two or several trunks developed; one trunk divided into two limbs, one of which became the Cinura, which are only slightly modified from their ancestor; the other limb would represent the Collembola, and send branches in various directions. The other main trunk or trunks develope rapidly and in different directions, and represent the different groups of the higher Insects.

The Arachnida, Myriopods, and *Peripatus* are discussed, and the conclusion is come to that the first of those has no close relationships with the others or with the Hexapoda. The Crustacea seem to be separated from all except the Arachnida.

The author offers the phylogenetic diagram reproduced on the preceding page.

Experimental Researches on Locomotion of Arthropods.*—M. J. Demoor remarks that no observer has yet explained the theory of the production of the double step in Arthropods. The observation of the oscillations of the body and of the displacements of the centre of gravity has been greatly neglected.

He finds that the mechanical hexapod system of Insects is that of the double tripod, with alternate movements. Each tripod is formed by the anterior and posterior legs of one side, and the median leg of the other. The anterior leg is a traction lever, the posterior pushes, the middle supports. Oscillations take place in the horizontal, vertical antero-posterior, and vertical transverse planes. The terrestrial progression of walking Insects is always walking, in the physiological sense of the word.

The Arachnida are octopods; the four middle levers, which are essentially supporting, form on the ground a basis of support triangular in form. The anterior limbs draw, the posterior push. The first and last limbs of one side act simultaneously. Of the Crustacea, some species walk forwards, and some laterally. In the former the hexapod or octopod mode of locomotion is entirely similar to that of Insects or Arachnids. In the latter the limbs are indifferently organs of traction or propulsion. No anatomical differentiation nor any functional constancy characterizes the different appendages; the mechanical system is octopod; there is no regularity in the alternation of the limbs of either side.

In all walking Arthropods which M. Demoor has examined the centre

* Comptes Rendus, cxi. (1890) pp. 839–40.

of gravity leaves the base of support at each step, so that the general definition of walking applies to the locomotion of these organisms. There is a causal relation between the lateral walking of some Crustacea, and the globular form, the insertion of the limbs far from the axis, and the general conformation of these creatures. The physiology of movement of Crabs confirms the theoretical data, and requires a median insertion and a functional horizontality of the limbs. The foot of Crustaceans is defective as a walking organ, owing to the articulation of the carpopodite with the ischiopodite; this articulation is necessary for the production of the functional horizontality of the limb. The octopod walk of Scorpions is less perfect than hexapod progression, which in Insects is, from a mechanical point of view, very perfect.

Is the Ommatidium a Hair-bearing Sense-bud? *—In answer to this question Prof. W. Patten states that he has come to the conclusion that the convex eye of Arthropods is a group of hair-bearing sense-buds. He finds hair-like pseudocones over the cone-cells of *Belostoma*, *Tabanus* and *Vespa*, and he considers his suspicion that the ommatidia are modified hair-bearing organs is fully confirmed by the fact that, in the young pupæ of *Vespa*, the first corneal cuticula is actually provided with hair-like spines unquestionably formed by the hardening of the outer ends of the pseudocones. This spine-bearing cornea is soon shed, and a facetted one formed; each facet, which is, in the main, the product of two newly formed cornea-forming cells, often contains, in its centre, the remnants of an ommatidial spine. If the ommatidia are hair-bearing sense-buds, we ought to find some resemblance between isolated hair-cells and retinophoræ and isolated hair-cells acting as rudimentary ommatidia. This seems to be really the case, for the isolated hair-cells of *Vespa* are beyond all question double cells, and they contain a coiled canal which the author believes to be continuous with a nerve-tube. After the first pupal moult the larger component cell forms a long protoplasmic process which is finally converted into one of the bristles so abundant near the eyes. These double hair-cells resemble the retinophoræ of Molluscs and Arthropods in their axial nerve-canals, the imperfect union of their twisted component cells, and in the position, size, and colour of their nuclei. Moreover, hair-cells have been found between the ommatidia in the convex eyes of *Aphis*, *Vespa*, and *Belostoma*, and in all cases the cells were surrounded by a layer of pigment, so that they bore a striking resemblance to very simple ommatidia, and probably functioned as such.

The author does not think it necessary to assume, as is usually done, that the adult ancestors of animals with vesicular eyes had eyes in progressive stages of invagination. He thinks we may safely assume that primitive sense-organs, ganglia, &c., have been formed, phylogenetically, by the telescoping of individual epithelial cells; this process, when repeated ontogenetically, gives rise to invaginations, for invagination probably occurs only in compound sense-organs, and then as an incidental result of the rapid inwandering of ganglion-cells, which, causing an enlargement of the inner surface of the sensory layer, gives rise to a warping of the whole organ.

* Anat. Anzeig., v. (1890) pp. 353–9 (4 figs.).

α. Insecta.

Metamerism of Insect's Body.*—M. A. Lameere has a preliminary notice of the results of his study of the development of *Phyllodromia germanica.* He supports the view of Savigny that the order of buccal appendages is, mandibles, maxillæ, labium, against that of Meinert who puts the labium first and the mandibles last. Only four pairs of enterocœlic cavities are developed in that part of the embryo which goes to form the head; one does not correspond to the eyes, but the first bears the antennæ, and the succeeding the three buccal appendages. There is, in addition, an unpaired anterior cavity which corresponds to the labrum, and represents the medio-ventral chamber which causes the bilateral symmetry of Cœlenterates. M. Lameere is led to the conclusion that there are no preoral appendages in Insects, and that, from every point of view, the antennæ correspond to the cheliceræ of Arachnids and the antennulæ of Crustacea. In an early stage all the abdominal segments carry appendages, but the first and last only persist; the latter forms the cerci of the adult, the former becomes of considerable size, and then undergoes an enlargement at its free end, becomes detached and falls into the amnion. As there are ten segments in the embryonic abdomen, three in the thorax and four in the head, the whole number of somites in an insect's body is seventeen.

Hooked Joint of Insects.†—Herr A. Oehler has a memoir on the hooked joint of the feet of Insects. He considers that the hooks ought to be regarded as setæ modified for definite objects. The joint, in structure and function, belongs to one of two chief types; there is a two-hooked tarsal joint with or without organs of attachment, or it is one-hooked. The former is divisible into three subtypes: (*a*) with an unpaired median fixing lobule, (*b*) with two outer lateral fixing lobes, (*c*) with two fixing lobes below the hooks; the latter chief type is either a climbing or a clasping foot. The amount of movement possessed by the hooks is limited, and what there is, is effected by means of an elastic membrane and the exterior plate. The "extensor sole," which is always present in Insects with an unpaired median fixing organ, is to be regarded as a modification of the extensor seta. The extensor plate is an organ peculiar to Insects. The fixing organs are modified outgrowths of the integument. The tarsal margin is adapted to the function of the hooked joint. In ectoparasitic flies the fixing lobes are well developed. The so-called pressure-plate of Dahl is only a movably articulated skeletal supporting plate for the median fixing lobule.

Live Oak Caterpillar.‡—Writing in 'Zoe,' Mr. H. H. Behr points out how this species (*Phryganidia californica*) is indirectly protected by the English sparrow; some years ago it was thought to be a great prize by entomologists, but has lately become more common. Though four generations would arise in one summer, the live oaks on which they lived were not endangered, for various insectivorous birds, and especially a species of titmouse, ate the eggs and the caterpillars. But the sparrow,

* Bull. Soc. Belge de Micr., xvii. (1890) pp. 2–9.
† Arch. f. Naturgesch., lvi. (1890) pp. 221–62 (2 pls.).
‡ Amer. Natural., xxiv. (1890) pp. 685–6.

when introduced, drove away the titmouse, and now the leaves of the live oak disappear four times a summer, some trees succumbing and others surviving.

Adhesive Organs on the Tarsal Joints of Coleoptera.* — Prof. P. Pero has made a detailed study of the microscopic organs of adhesion which are found on the tarsal joints of Coleoptera, especially in the lower families of this order. In Longicorn beetles, Curculionidæ, and Chrysomelidæ they are very well developed, and the author believes them to be efficient. Their evolution he explains by natural selection. But in Carabidæ and Cantharidæ (*Idrocanthari*) they are usually restricted to the first pair of legs in the males only, and have been interpreted by Camerano as evolved by sexual selection, and by Zimmermacher as organs for copulatory adhesion. These interpretations are denied by Prof. Pero, who maintains that in the families mentioned the structures are rudimentary organs entailed on the males only.

Blood of Meloe and Function of Cantharidine in Biology of Vesicating Coleoptera.†—M. L. Cuénot confirms the view of Leydig that the fluid ejected by a vesicating coleopterous Insect when it shams death is blood; this escapes in somewhat viscous yellow drops from the tibio-tarsal articulations. Magretti and Beauregard are therefore wrong in regarding the fluid as a special excretion. The chemical constitution of this blood is much the same as that of caterpillars; it has cantharidine dissolved in it, and the function of this compound is undoubtedly a defensive one. It is excessively disagreeable to other Insects.

Tongues of British Hymenoptera Anthophila.‡—Mr. E. Saunders gives descriptions and figures of the tongues of British anthophilous Hymenoptera. In all the genera the cibarial apparatus is arranged on the same general plan as in *Apis*, the structure of which was described by Mr. T. J. Briant; but it varies considerably in details, both as to the shape and the relative proportions of its component parts. After a general description the details of the different genera are described. Mr. Saunders states that "it is to the beautiful preparations of Mr. Enock that all the merit of this paper is due."

Life-history of Lyda.§—Dr. K. Eckstein describes the life-history of this wasp whose larvæ often do so much damage in pine forests. In early summer the females of *L. pratensis* lay their eggs on the tips of the pine needles, usually not more than one on a double leaf. The hatched larva spins a loose web, and there are usually several of these on one twig. The inmates devour the leaves, but without abandoning their shelter, which they renew as they move from leaf to leaf. After several moults they lose their power of spinning, and the colour, hitherto bright, becomes ochreous or dull green. They fall to the ground, and soon bury themselves 10–12 cm. in the earth. There they lie quiescent, slightly shrivelled, but with leathery skin and abundant adipose tissue. They do not pupate, but remain dormant for two years. The whole

* Atti Soc. Ital. Sci. Nat., xxxii. (1889) pp. 17–64 (4 pls.).
† Bull. Soc. Zool. France, xv. (1890) pp. 126–8.
‡ Journ. Linn. Soc., xxiii. (1890) pp. 410–31 (8 pls.).
§ Zool. Jahrb., v. (1890) pp. 425–36 (1 pl.).

life-history—of *L. pratensis* and *L. hypotrophica* at least—thus occupies three years.

Halteres of Diptera.*—Herr E. Weinland has a long and detailed paper on the "balancers" of Diptera. The balancer is modified from a hindwing and has in its interior canals, which correspond to the veins of a wing; it is of no use as an organ of flight. It is capable of a large number of various movements which are rendered possible by a second joint which is to be found at its base, and in which the proper thoracic muscles take no part. It can bring about differences in the direction of the flight of an Insect in the vertical plane; if the balancers act unequally there is a change in direction.

The sensory organs formed of variously constructed papillæ which are found at the base of the halteres are the means by which movements are perceived. The movement of the organs when the insect is not flying has for its object the preservation of the equilibrium of the body.

A new Cecidomyia.†—Dr. F. Thomas describes the life of *Cecidomyia pseudococcus* sp. n., which has this special interest, that the larva is not errant, but keeps to one position on the leaf of *Salix caprea* and yet forms no gall. The absence of a gall may be due to some constitutional peculiarity of the species, e. g. in its secretion, but it is more probably an illustration of the general fact that galls are formed only on leaves which are still growing, for this species is too slow in developing to be able to attack the young willow leaves.

Herr E. H. Rübsaamen ‡ gives a careful description of the pupa and imago of this new species.

Host of Hypoderma lineata.§—Prof. F. Brauer publishes the discovery which the late Dr. A. Handlirsch made of the host of *Hypoderma lineata* Villers. He explains how the insect was traced to cattle, contrasts it with *H. bovis*, and gives some interesting information about the habits of these pests. It seems that the larva of *H. bovis* found in the skin of cattle is not strictly the first stage, but that there is a preliminary larval form *in ovo* before deposition is effected.

Terminal Segment of Male Hemiptera.‖—Dr. D. Sharp describes this in twenty-nine species. It forms a chamber widely open externally and contains the following structures:—(1) the part of the male organs through which pass the membranous structures connected with the ejaculatory duct; (2) the termination of the alimentary canal which is free and very mobile, and forms a sort of tail; (3) some accessory pieces of appendages, a lateral on each side and an inferior single piece. The differences in species systematically allied are extraordinarily great, but no variation was observed within the same species. "The æsthetic aspect of the arrangement in many of the higher species is very remarkable," but Dr. Sharp does not attach any special biological importance to it. The structures are not in any way modified for clasping; they protect sensitive parts from pressure, exclude parasites, direct the move-

* Zeitschr. f. Wiss Zool., li. (1890) pp. 55–160 (5 pls.).
† Verh. K. K. Zool.-Bot. Ges., xl. (1890) pp. 301–6.
‡ T. c., pp. 307–10 (1 pl. shared by the two papers).
§ Verh. K. K. Zool.-Bot. Ges., xl. (1890) pp. 509–16 (3 cuts).
‖ Trans. Entomol. Soc. Lond. (1890) pp. 399–427 (3 pls.).

ment of the true intromittent organs, and probably alter the pressure on the ejaculatory canal.

Spermatogenesis in Locustidæ.*—M. A. Sabatier has studied the development of the spermatozoa in *Locusta viridissima*, *Decticus albifrons*, and *D. griseus*. He finds that a vesicle becomes formed in the protoplasm, and that it is placed near the caudal pole; he calls it the protoplasmic vesicle. This vesicle grows and elongates and its walls become invested internally with chromophilous granules. When it is fusiform in shape and takes stains freely it forms what has been regarded as the head of the spermatozoon. The grains of nuclein in the nucleus become vesicular and form a group of vesicles which fuse, lose their affinity for the nuclear stains, and form an anchor-shaped head-covering. The degeneration of the nucleus *qua* nucleus is, therefore, one of the principal characters in the spermatogenesis of the Locustidæ. The protoplasm of the cell elongates in the form of a tail, in the axis of which appears a filament which forms the tail of the spermatozoon.

γ. Prototracheata.

New Species of Peripatus from Victoria.—Mr. A. Dendy writes to us to say that he regards *Peripatus insignis* mentioned in our note † as a good species, and as distinct from the specimens which, after some trouble, he recognized as examples of *P. leuckarti*. Several specimens of *P. insignis* have been found at Macedon.

δ. Arachnida.

Structure of Nerve-centres of Limulus.‡—M. H. Viallanes describes the minute structure of the nerve-centres of the King-Crab. The protocerebrum is composed of relatively small fibrous nodules and is partially invested by a cortex of large unipolar cells. The nerve for the compound eye is not directly connected with the corresponding cerebral lobe, but intermediately and by a structure which is comparable in its essential points to the optic lobe of Insects and Crustaceans. With each of the protocerebral lobes there is connected an organ which, from its anatomical relations and histological structure, may be compared to the pedunculated body of Insects. In *Limulus* this pedunculated body is arborescent in form, its upper extremity dividing dichotomously into a large number of branches. These last, which end in truncated extremities, are entirely invested by a thick cortex of small cells; they are very poor in protoplasm, stain deeply, give off very fine fibrils, and, in a word, are exactly comparable to the elements which form the cellular investment of the similar body in Insects. The pedunculated body of *Limulus* is extraordinarily developed, and is larger than in any known Arthropod, for it forms at least 99/100 of the total mass of the brain.

The hinder brain is composed of a pair of nervous masses which give origin to the nerves of the cheliceræ, and are connected with one another by a transverse peri-œsophageal commissure. This latter is invested by a very resistant fibrous sheath. The lateral parts of the

* Comptes Rendus, cxi. (1890) pp. 797–9. † See this Journal, 1890, p. 453.
‡ Comptes Rendus, cxi. (1890) pp. 831–3.

nerve-collar are formed by five pairs of ganglionic centres which innervate the five pairs of foot-jaws. The hinder part of the nerve-collar is formed by the very close fusion of two pairs of ganglionic centres, the second of which innervates the operculum.

ε. Crustacea.

Amœboid Cells in Crab's Blood.* — Prof. G. Cattaneo describes the granular and hyaline cells in the blood of *Carcinus mænas*. The two kinds of cells are simply different physiological states of the same set of elements. The normal form is that with localized polar or bipolar pseudopodia, but this may degenerate into a radiating amœboid phase, or the amœboid cells may unite abnormally in plasmodia. The various phases are compared with those of Myxomycetes. With some difficulty Cattaneo was able to demonstrate that the cells may absorb particles in phagocytic fashion. He describes their behaviour in water, when undergoing desiccation, in relation to oxygen, carbonic acid, and chemical reagents, and his results are like those of Graber and Frommann. A ciliated Infusorian, *Anophrys maggii*, is sometimes an abundant parasite in the blood.

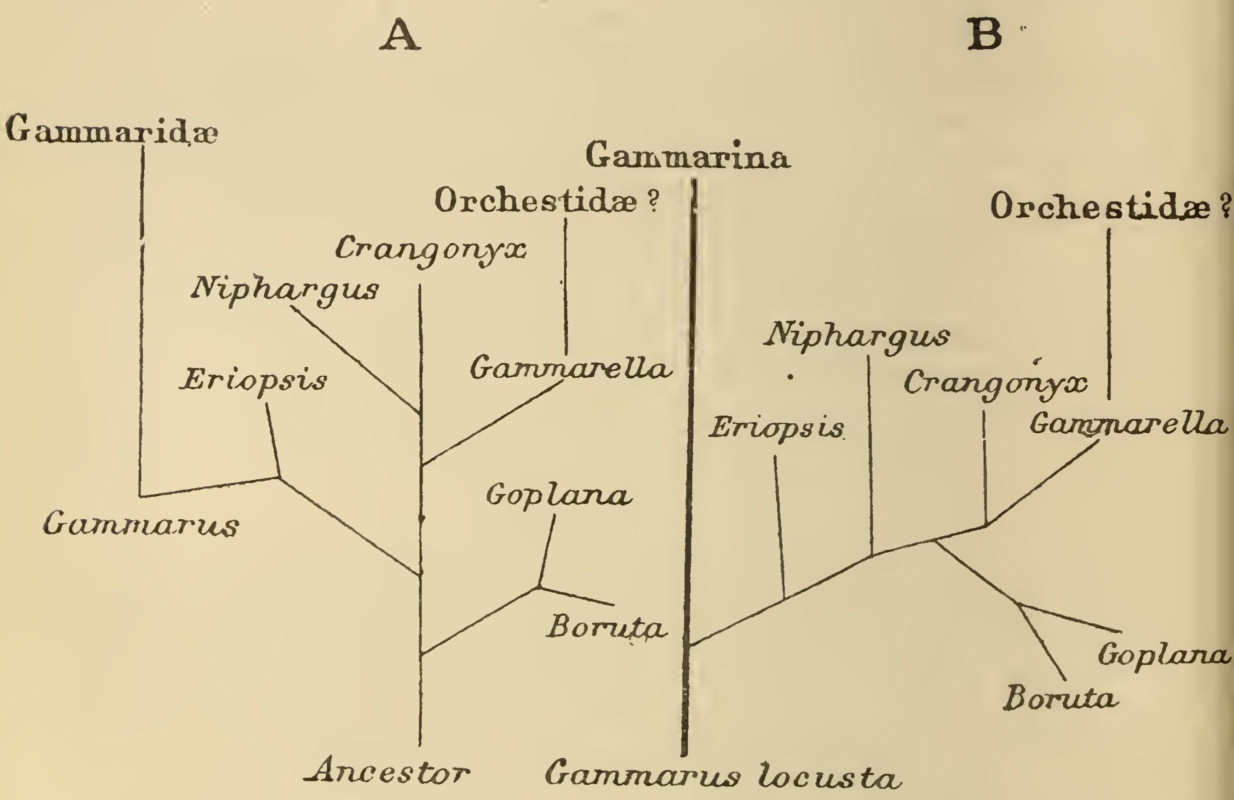
Excretory Apparatus of Palinurus, Gebia, and Crangon.†—M. P. Marchal, in continuation ‡ of his studies on the excretory apparatus of Crustacea, describes those of *Palinurus vulgaris* and *Crangon vulgaris*. With regard to the internal structure of the organ in *Gebia* we may note that there is a sacculus with a central cavity from which are given off numerous ramifications which pass into the reticulated tissue of the surrounding labyrinth; this tissue is very dense and the glandular lacunæ in it are extremely numerous. The clear portion is formed by a less dense glandular reticulum, and the spaces become progressively larger near the excretory tubercle, with the orifice of which one space communicates by means of a fine canaliculus. *Crangon* has, like *Palæmon*, a large unpaired bladder lying above the stomach; it has numerous lobes which make their way between the different organs. In a preceding notice the author spoke of the mobile piece which carries the excretory orifice in *Maia* as representing the excretory tubercle of the Macrura, but he is now convinced that it corresponds to the whole joint which carries this tubercle. In other words, it is the homologue of the first joint of the antennæ of the Macrura.

Palæmonetes varians.§—Mr. W. F. R. Weldon has examined nearly a thousand specimens of *Palæmonetes varians* at Plymouth, and finds a considerable amount of variation in the characters of the rostrum. There is at Plymouth a race which approximates in its habits to the races of Southern Europe, but in its development, at least, completely resembles those northern forms from which it is probably descended.

Three Subterranean Gammaridæ.‖ — Dr. A. Wzesniowski has published a German translation of his Polish essay on these Amphipods,

* Atti Soc. Ital. Sci. Nat., xxxi. (1889) pp. 231-66 (1 pl.).
† Comptes Rendus, cxi. (1890) pp. 580-2. ‡ See this Journal, 1890, p. 719.
§ Journ. Marine Biol. Assoc., i. (1890) pp. 459-61.
‖ Zeitschr. f. Wiss. Zool., l. (1890) pp. 600-724 (6 pls.).

in which he discusses their characters in the greatest detail. We have only space for the conclusions which he summarizes in two phylogenetic tables; he thinks it almost certain that the primitive ancestor was marine.



Sexual Dimorphism of Copepoda Ascidiicola.* — M. E. Canu points out that there are very considerable differences between the sexes in these Crustacea; the males have rarely been observed, and when they have they have ordinarily been described as distinct species. It is necessary to follow the various stages before defining species. He gives a special account of *Enterocola fulgens*, which is often found on *Polyclinum succineum*.

Test-gland of Freshwater Copepoda.†—M. J. Richard has a preliminary notice of his researches on the so-called test-gland of Copepods, in which he makes some additions to the knowledge acquired for us by Prof. Claus. He has examined the organ in a number of forms.

Polar Bodies of Balanus.‡—Dr. B. Solger states that he has lately been able to observe the formation of both polar globules in a large number of eggs of *Balanus improvisus*. During the process of constriction of the second the first lay on the outer surface of the egg-membrane. An ovarian lamella was fixed in chrom-acetic acid and cut into a series of sections. After staining with hæmatoxylin a large number of eggs exhibited, near the blunt pole, a well-marked spindle, which on account of its size, appeared to be the first. Further details are given, and it is

* Comptes Rendus, cxi. (1890) pp. 757–9.
† Bull. Soc. Zool., xv. (1890) pp. 113–8.
‡ Zool. Anzeig., xiii. (1890) pp. 607–9.

stated by the author that his observations agree very well with those of Nusbaum on *Pollicipes*, a genus of Lepadidæ which, in the opinion of Gerstaecker, is most nearly allied to the Balanidæ.

Vermes.

α. Annelida.

Epithelial Fibrillar Tissue of Annelids.*—M. E. Jourdan justly remarks that one often meets in Invertebrates with tissues which it is very difficult to refer to the types which we have been in the habit of observing in the organs of higher animals. The Annelids are particularly remarkable from this point of view, and the subcuticular epithelial layer often presents appearances which differ from those of ordinary epithelia.

In the proboscis of Glycerids the author has observed an epithelial layer which is represented by irregularly arranged nuclei set in the midst of a stroma of small fibres. These fibrils are easily distinguished from the muscular fibres of the contractile sheaths of the proboscis; nor can they be regarded as connective tissue. The only possible interpretation is that the fibres are nervous, although it is, *à priori*, difficult to suppose that they have a nervous function. It is probable that the stellate connective tissue described by Claparède in tubicolous Annelids belongs to the same group.

Chætopterus.†—M. J. Joyeux-Laffuie has prepared a monograph of this genus, the new points in which he summarizes in a somewhat novel fashion. The cephalic and buccal segments are distinct; there are eleven segments in the superior region of the body; the twelfth and thirteenth segments are characterized by the possession of pediculate suckers, ventral in position and of assistance in enabling the animal to adhere to the inner wall of its tube; the number of segments of the lower half is discussed, and the structure of the integuments described. It is well known that the mucus of *Chætopterus* is luminous, but the author finds that the contents of the glands, so long as they are contained in the cellular envelope, are not so. The diverticula of the general body-cavity are described, and additions are made to our knowledge of the musculature. The nerve-ganglia and the commissures that unite them with the nerves given off from them are described in great detail. The only sensory organs are the tactile and optic.

After dealing with the organs in order M. Joyeux-Laffuie describes the commensals of the worm, and states that the Bryozoon which he called *Delagia chætopteri* should be known by the older name of *Hypophorella expansa*. The only properly known species of the genus is *C. variopedatus*.

A new Alciopid.‡—Dr. C. Apstein describes *Vanadis fasciata* sp. n., a new Alciopid found during the cruise of the 'Galathea' in the North Pacific. It differs from the other numerous species of *Vanadis* chiefly in the abundance, irregular distribution, and large size of the

* Comptes Rendus, cxi. (1890) pp. 825–6.
† Arch. Zool. Expér. et Gén., viii. (1890) pp. 245–60 (6 pls.).
‡ Zool. Jahrb., v. (1890) pp. 543–5 (1 pl.).

"black glands," as also in the characters of the antennary-cirri and parapodia.

The Work of Earthworms on the African Coast.—The 'Kew Bulletin' * of October last contains a report by Mr. Alvan Millson, the Assistant Colonial Secretary of Lagos, on Yorubaland, the native territory adjacent to Lagos. After describing the wasteful system of cultivation employed by the natives and the wonderful rapidity with which the soil recovers from it, he says the mystery is solved in a simple and unexpected manner during the dry season. The whole surface of the ground beneath the grass is seen to be covered by rows of cylindrical worm-casts. These vary in height from 1/4 in. to 3 in., and exist in astonishing numbers. It is in many places impossible to press a finger upon the ground without touching one. For scores of square miles they cover the surface of the soil, closely packed, upright, and burned by the sun into rigid rolls of hardened clay. The rains ultimately break them down into a fine powder, rich in plant-food and lending itself easily to the hoe of the farmer. On digging down the soil is found to be drilled in all directions by a countless multitude of worm-drills, while from 13 in. to 2 ft. in depth the worms are found in great numbers in the moist subsoil. Having carefully removed the worm-casts of one season from two separate square feet of land at a considerable distance from one another, and chosen at random, Mr. Millson found the weight to be 10¾ lb., in a thoroughly dry state. This gives a mean of over 5 lb. per square foot and a total of not less than 62,233 tons of subsoil brought to the surface on each square mile of cultivable land in the Yoruba country every year. This work goes on unceasingly year after year, and to the untiring labours of its earthworms this part of West Africa owes the livelihood of its people. Where the worms do not work the Yoruba knows that it is useless to make his farm. Estimating one square yard of dry earth by 2 ft. deep as weighing half a ton, there is an annual movement of earth per square yard of the depth of 2 ft., amounting to not less than 45 lb. From this it appears that every particle of earth in each ton of soil to the depth of 2 ft. is brought to the surface once in twenty-seven years. It seems more than probable that the comparative freedom of this part of West Africa from dangerous malarial fevers is due, in part at least, to the work of earthworms in ventilating and constantly bringing to the surface the soil in which the malarial germs live and breed. From specimens which Mr. Millson has sent home it appears the worm belongs to a new species of the genus *Siphonogaster*.

Trigaster and Benhamia.†—Dr. W. B. Benham has altered his conclusion that *Benhamia* of Michaelsen is synonymous with *Trigaster* Benham. They are, perhaps, both subgenera of *Acanthodrilus*, with which (and with *Deinodrilus*) they have in common the following characters—The nephridia are in the form of a network; there are two pairs of coiled cylindrical prostates in somites xvii. and xix., and there are two pairs of spermathecæ. In *Trigaster* the clitellum is exceedingly long and extends over somites xiii.–xl.; in *Benhamia* it

* 'Bulletin of Miscellaneous Information,' 1890, pp. 243–4.
† Ann. and Mag. Nat. Hist., vi. (1890) pp. 414–7.

occupies at most eight somites; in the latter there are two, and in the former three gizzards; *Trigaster* has no calciferous glands, its spermathecæ are globular and without appendages; there are no penial setæ and no dorsal pores. *Benhamia*, on the other hand, has calciferous glands, the spermathecæ are ovoid, and have appendices to their narrowed ducts; there are penial setæ in special sacs, and some species, at any rate, have dorsal pores. Only one species of *Trigaster* is known, but there are already eight of *Benhamia*.

Heliodrilus.*—Mr. F. E. Beddard has a preliminary notice of a new genus of Eudrilidæ, which he calls *Heliodrilus;* it has some resemblance to the lately described genus *Hyperiodrilus*, and, like it, it comes from Lagos, West Africa. There are six gizzards—one to a somite—at the junction of the œsophagus with the intestine.

Development of Leeches.†—Dr. R. S. Bergh has a preliminary notice of the results of his investigations on the formation of layers in the germ-stripes of Leeches. In *Clepsine* the cell-rows are formed in the same way as in the earthworm; of the four more superficially placed rows of cells, those which lie nearest the median line (I.) go to form the ventral chain, and may consequently be called, with Whitman, the neural row; the three more lateral rows (II.–IV.) form the layer of circular muscles, and may, therefore, be called collectively the outer muscular plates; they have no relation to the formation of the nephridia. The deeper cell-row forms the so-called mesoderm, whence arise the blood-vessels, longitudinal muscles, loops of the nephridia, &c.

Matters are more complicated in the Leeches with jaws, for, as is well known, the primitive epidermis is lost and replaced by a new and permanent one. This new epidermis consists of the descendants of the three lateral primitive cells; in these, cell-divisions take place in various planes, and not only from before backwards, but also from right to left. In this way the germ-stripes increase in length and breadth, but do not give rise to any new layers. There are, however, other cell-divisions, which pass obliquely to the surface; by these divisions some cells become separated from the superficial layer. These multiply, extend in length transversely to the longitudinal direction of the germ-stripe, and so form the circular musculature; the superficial layer of the primitive cell-rows II.–IV. continue to grow and give rise to the permanent epidermis. The row (I.) nearest the median line here again forms the ventral chain; it thickens and fuses with its fellow of the opposite side; at first in a segmental manner in those regions which correspond to the later ganglionic parts. In the commissural parts they remain for some time distinct, and as the permanent epidermis is not yet formed, and there is no "mesoderm," there is at this stage a step-ladder-like appearance. So far as the author can see, some cells of the primitive nerve-cell-plexus take part in forming the ventral chain.

The looped parts of the nephridia are formed from derivatives of the more deeply placed cell-row, but the epithelium of the contractile terminal bladders are invaginations of the permanent epidermis; the nephridia of the earthworm have nothing homologous to these terminal bladders.

* Zool. Anzeig., xiii. (1890) pp. 627–9.

† T. c., pp. 658–60.

American Terrestrial Leech.*—Mr. S. A. Forbes calls attention to a hitherto unnoticed species of terrestrial leech occurring commonly in Illinois, where it is found in moist earth. When first found it was regarded by Prof. Verrill as identical with his *Semiscolex grandis*, but is certainly distinct from it, and may be called *S. terrestris* sp. n. We may suggest that this hybrid generic name be altered to *Hemiscolex*. Contracted spirit specimens have a length of 7 in., are 3/4 in. wide, and 3/8 in. deep. The colour is sooty drab varying to plumbeous black, and rather lighter beneath; a well-defined darker median longitudinal stripe is almost invariably present. There is no external trace of segmental papillæ. In all there are one hundred and four annuli. The eyes are ten in number; the male sexual orifice is on the twenty-eighth entire annulus, in the female on the thirty-third. The three maxillæ are rudimentary, and have an ill-defined armature of teeth. The only known food of this leech consists of earthworms of various genera, and these it swallows entire. Like the earthworm, this creature probably penetrates to considerable depths during the dry weather of mid-summer.

Anatomy of Sipunculus Gouldi.†—Mr. E. A. Andrews gives a full account of the anatomy of *Sipunculus Gouldi*, which agrees closely with that of *S. nudus*; it is also sufficiently similar to that of *Phymosoma* as to indicate the fundamental identity of the two genera in all but secondary characters. The body-wall of *S. Gouldi* has, however, a less specialized epidermis than the other Sipunculid, while its glandular bodies are essentially identical with those of *Phymosoma*. The peculiar arrangement of the gland-cells described by Andreæ in *S. nudus* seems, to the author, to be due to poor preservation.

The tentacle-like processes about the mouth may be regarded as branchiæ physiologically, if not, also, morphologically, for a rapid circulation of corpuscles takes place in them; the dorsal blood-sac is not merely a reservoir for blood in introversion, but must also serve as a conveyor of respiratory gases to the liquid of the body-cavity, and furnish an important aid to the thick body-wall. The position of the cilia on the concave oral surfaces and their arrangement along radiating oral grooves suggest that the branchiæ also serve as means for bringing currents of water (and food) into the mouth. The statement that the cilia are on the outside surface seems to be an error due to the study of invaginated specimens, in which the positions of the branchial surfaces are apparently inverted.

The author has been able to demonstrate the presence of a nerve-plexus in the walls of the digestive tract; this is continuous with that of the body-wall at the anus. The digestive tract is divided into more numerous regions than have been hitherto recognized. The structure of the ciliated groove of the intestine suggests a secretory function, and at the same time a use as a conduit from one region to another.

The author has already ‡ described the structure of the reproductive organs, and he thinks that the arrangement which obtains may be taken

* Amer. Natural., xxiv. (1890) pp. 646–9.
† Studies Biol. Lab. Johns Hopkins Univ., iv. (1890) pp. 389–430 (4 pls.).
‡ See this Journal, 1889, p. 518.

as characteristic of Sipunculids; a review of the opinions and statements of earlier investigators into the subject is now given.

Mr. Andrews sees nothing in the adult Sipunculid that may not be explained on the assumption of lost metamerism; even the genital organs suggest a derivation from those of the Polychæta, with which they very closely agree in structure and fate; their attachment to the posterior side of a septum may now be indicated by their attachment to the retractors.

β. Nemathelminthes.

Nematodes of Mammalian Lungs and Lung Disease.*—Herr A. Mueller has, in a convenient manner, brought together and added to our knowledge of round worms infecting the lungs of Mammals. Twenty-five species of mammals are known to be so infected, among which are Man, the Dog, the Fox, the Hare and Rabbit, the Pig and Ox; sheep suffer most from these parasites, the most common of which is *Strongylus filaria*, which is found in eight species of Ruminants. Great care has been given to the description of the species of *Strongylus*.

Allantonema and Diplogaster.†—Dr. v. Linstow remarks that he can add another to the several cases which prove that a division into free-living and parasitic Nematodes does not accord with known facts. He has received some specimens of *Tomicus typographus*, which had in its body-cavity a large *Allantonema;* the larvæ are very active, and make their way into the intestine whence they escape on to the back of the beetle, where they live between the elytra and wings, or between the wings and the surface of the body. Passing thence into damp earth, they become sexually developed Nematodes in ten days. They move about actively. There are six setæ, 0·005 mm. long in the head, and internally to them are six shorter setæ, which surround the mouth. The male is 0·84 mm. long, and 0·021 mm. broad; the female is 1·03–0·97 mm. by 0·029 mm. If one were to find these Nematodes without knowing whence they came, they would be placed in the genus *Diplogaster*, and the author proposes for this new species the name of *Allantonema diplogaster*. On returning to the beetle they pass into the hermaphrodite stage.

γ. Platyhelminthes.

Enantia spinifera.‡—Prof. L. v. Graff describes *Enantia spinifera* as the representative of a new family—Enantiidæ—of Polyclads, which may be thus defined:—Body oval, smooth, without sucker or tentacles. Mouth near the anterior end, immediately behind the brain. Pharynx bell-shaped, directed forwards. There is no anterior median branch of the enteron, and the enteric branches anastomose. Male reproductive apparatus simple, with a muscular seminal vesicle directed forwards, placed directly behind the pharyngeal pouch, and opening there. Female reproductive apparatus opens a short distance behind the male, and has

* Deutsch. Zeitschr. f. Thiermed. u. Vergl. Path., xv. (1889) pp. 261–321 (4 pls.). See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 706–8.

† Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 488–93 (6 figs.).

‡ Mittheil. Naturwiss. Ver f. Steiermark, xxvi. (1890) pp. 1–16 (1 pl.).

a well-developed bursa (accessory vesicle). Four optic aggregations in the cerebral area, but no eyes on the margin of the body.

This form, which is distinguished from all known species by the presence of marginal chitinous spines, was found at Trieste, and was noticed but not fully described by the author thirteen years ago. The largest of the eight specimens found measured 25 by 12 mm., but the thickness of the body is only 0·5 mm. The spines lie rather on the periphery of the dorsal surface than on the margin of the body; they are absent from the anterior fourth, but are closely packed on the rest; some are smaller than the rest and will obviously replace them; the largest spines are found on the last third of the body, and project not more than 0·25 from the surface. The youngest are simple hollow processes, almost transparent, and with a dermal papilla projecting into them, almost to their tip; a basal plate becomes developed which is striated parallel to the long diameter of the spine; as they grow the plates take on an oval form, and the colour gets darker and darker. The spines appear to be organs for defence and for seizing prey. Brief notes are given on the other organs, but there are no histological details.

Mode of Feeding in Flukes.* — M. A. Railliet reports that some sheep, which had died from rot, were injected with a blue colouring matter previous to dissection at the Veterinary School at Alfort; the flukes in the liver of one of these were carefully examined and were found to be themselves injected, the ramifications being stained blue. On teasing, it was easy to see that the contents of the intestine were formed of coloured plaster. At the same time it must be noted that there was not the least trace of the injection in the lumen of the bile-ducts. M. Railliet thinks that this discovery settles the disputed question of the mode of feeding of Flukes. He cannot doubt that the Flukes were occupied in sucking the vessels when the injection was driven in, and it may be justly supposed that these parasites are in the habit, under ordinary circumstances, of feeding on the blood of their host.

M. R. Blanchard † points out that this observation may explain the presence of erratic flukes in the blood-vessels; when they gain an entrance they are carried along by the current, are stopped in a capillary, and give rise to a tumour.

Nature of Monostoma leporis.‡—M. A. Railliet has been able to convince himself that the so-called *Monostoma leporis*, described by Kuhn as a Trematode, is a pisiform *Cysticercus;* two years before Kuhn, Rudolphi described a *Cysticercus leporis variabilis*.

Distribution of Gyrocotyle.§—Sig. F. S. Monticelli believes that *Gyrocotyle* is a parasite peculiar to the Chimæridæ, that *Chimæra* and *Callorhynchus* each harbour a species, and that the parasites have intermediate hosts in bivalves (*Mactra*, &c.) eaten by the Chimæridæ.

Ova and Embryos of Temnocephala chilensis.||—Sig. F. S. Monticelli states that the ova of *Temnocephala chilensis* are fastened at either

* Bull. Soc. Zool. France, xv. (1890) pp. 90–1.
† T. c., pp. 91–2.
‡ T. c., pp. 132–3.
§ Atti Soc. Ital. Sci. Nat., xxxii. (1890) pp. 327–9.
|| T. c. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 500–1.

end by a yellowish filament, 1·5 mm. long. Its substance is fibrous and it is also distinguished by its appearance from the shell-substance of the egg, to which the filaments are fixed by a finely granular mass. These filaments appear to be secreted by well-developed dermal glands, which are placed near the genital orifice. The embryos enclosed in the eggs are, save for the difference in size and the development of the reproductive organs, exactly like the adults.

Anatomy of Distomum fabaceum.*—Mr. J. M. Stedman has some notes on the anatomy of this Trematode, which was found in the large intestine of a Manatee; the author's account is purely descriptive.

External Differences in Species of Nematobothrium.†—M. R. Moniez reports that a large number of specimens of a new species of *Nematobothrium*—which he calls *N. Guernei*—were found on fifty-three specimens of *Thynnus alalonga* dredged during the voyage of the Prince of Monaco's yacht 'Hirondelle.' The specimens were from 0·3 to 0·5 metre long. At first sight, it was difficult to say whether the parasite was a Trematode or a Nematode. Nor did the investigation of the internal structure enable the author to at once determine the question. At the anterior end of the body and at the point ordinarily occupied by the mouth there are two genital orifices, very distinct from one another and placed one above the other, as is the case in many Cestodes. The male apparatus is formed of a penial pouch, and is continued by a sperm-duct into two immense testicular tubes; the oviduct is extremely long and folded several times along the whole length of the body, and it is continued into an ovary which presents the same peculiarity.

Near the hinder extremity is the orifice of the water-vascular apparatus, which is continuous with a tube of thick walls, very wide, and extending without any ramifications as far as the anterior part of the body. These are the only organs which the author has as yet been able to make out. But very large nerve-cells, like those already noticed in Trematodes, have been frequently seen in the tissues. The specimens found in the gills were in the form of cysts containing two individuals which were very delicate anteriorly but greatly swollen in the remaining part of their body; their structure, however, shows they belong to the same species as the others; the polymorphism appears to be due to the difference in the difficulty of development, according to the spot at which the embryos are fixed.

Cysticercoids of Freshwater Crustacea.‡—Herr Al. Mrázek describes several cysticercoids with caudal appendages from freshwater Crustacea, and diminishes the number of species of *Tænia* whose intermediate hosts were unknown. Cysticercoids were obtained from 80 per cent. of examples of *Cyclops agilis* examined. They lie freely in the body-cavity. The body is lens-shaped, and 0·12–0·18 mm. in diameter; it is covered by a completely hyaline layer, and the subjacent cuticle has numerous pore-canaliculi; the rostellum has eight or nine hooks. The parasites are found in both males and females, and in the latter the

* Proc. Amer. Soc. Microscopists, xi. (1889) pp. 85–101 (3 pls.).
† Comptes Rendus, cxi. (1890) pp. 833–6.
‡ Verhandl. der Kgl. Ges. der Wiss. Prag, i. (1890) pp. 226–48 (1 pl.). See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 628–30.

gonads were degenerated. The hooks of the cysticercoid completely agree in form and size with those of *Tænia fasciata*, which lives in the intestine of domesticated and wild geese. Cysticercoids have also been found in Ostracoda—in *Cypris ovum* and *C. compressa;* as the infested animals lived for some time in captivity, the harmful influence of the parasite must be slight. These cysticercoids have hooks of the form and number of those of *Tænia coronula*, which has been found in the intestine of some species of Ducks. A new (third) species is now described from *Gammarus pulex*, but it is not yet known what its Vertebrate host is.

Generative Apparatus of Tænia Echinococcus.*—Herr R. v. Erlanger gives a description of the generative apparatus of *Tænia Echinococcus.* The female organs consist of the ovary, yolk-gland, shell-gland, and uterus, with their efferent ducts. All but the shell-gland open together into the atrium, which has a rounded or oval form, and consists of spindle-shaped cells. The yolk-gland is placed at the hinder end of the proglottis, and consist of two portions, one of which lies above the other. Each part is again divided into two lobes, and each lobe has an efferent duct which becomes united with its fellow. The ducts of the two chief parts unite at the median plane of the proglottis into a broad, unpaired yolk-duct, which passes forwards and opens into the ootyp. The separate follicles of the yolk-gland have a distinctly cellular wall. The yolk-cells are irregularly spherical or polyhedral in form. The unpaired ovary is derived from a paired one, has the form of a horse-shoe, with the concavity directed backwards, and lies in front of the shell-gland. The several lobules of the ovary possess walls which are formed by branched cells which are connected with one another by long processes and have the egg-cells between them, and contained, therefore, in a kind of follicle. The eggs have a large vesicular nucleus with nucleolus and chromatin framework, while their protoplasm stains intensely.

The oviduct commences with an ampulliform enlargement; its wall has a characteristic striated appearance, and consists of conical cells, placed on a homogeneous and pretty thick basal membrane; their axis is directed somewhat obliquely to that of the oviduct. The direction of this axis and the structure of the protoplasm is the cause of the striated appearance. The vagina, the lumen of which varies in width, has connected with it a large receptaculum seminis; beyond this the inner wall consists of a thick chitinous lamella, and is surrounded by a layer of strong circular muscles. The wall is, further on, provided with a large number of very fine, and probably chitinous hairs. The cuticle which covers the surface of the body bends round into the atrium and lines the inner wall of the vagina as far as the receptaculum.

The uterus has, likewise, a distinctly cellular wall; it extends forwards as far as the anterior boundary of the proglottis, where it lies dorsally to its axis; as it becomes filled with ova it becomes bulged out laterally, and at last fills up nearly the whole of the parenchyma. The uterus is never branched, but only bulged out laterally.

The testicular vesicles are from about forty to fifty in number, lie around the female organs, are scattered irregularly, and are most numerous in the most anterior and most posterior parts of the pro-

* Zeitschr. f. Wiss. Zool., l. (1890) pp. 555-9 (1 pl.).

glottis. Their fine efferent ducts, which have a distinct wall with much flattened cells, become united into two anterior and two posterior collecting ducts, which open into the hinder end of the vas deferens. This is a pretty thick and closely coiled tube which opens into the large penial (cirrus) sac, where it is prolonged into a spirally coiled cirrus. The neck of the pyriform sac and the terminal part of the vagina are surrounded by a common layer of strong circular muscles. The wall of the genital atrium as well as that of the cirrus is beset with hairs.

On the whole, it will be seen that the generative apparatus of *Tænia Echinococcus* does not essentially differ from that of other *Tæniæ*.

Tæniæ of Birds and others.*—Dr. v. Linstow has notes and descriptions of thirteen species, some of which are new. He first gives a detailed account of his species *Tænia puncta* fron *Corvus corone* and *C. nebula*. The pathological anatomy of *T. mediocanellata* is next discussed. *T. crassicollis* sp. n. was found in the intestine of *Sorex vulgaris*; the scolex is very large and broad, and the spindle-shaped rostellum is 0·22 mm. × 0·19 mm., and there are on it seventeen hooks 0·052 mm. long. *Diplostomum Cobitidis* sp. n. was found encapsuled and free in the body-cavity of *Cobitis barbatula*. *Echinorhynchus tæniæformis* sp. n. was found in the intestine of *Caranx* sp.; and *Spiropterina inflata* sp. n. lives attached to the gastric wall of *Scyllium immoratum*. *Filaria hyalina* and *Oxysoma tridentatum* are two new Nematodes, found respectively in the intestines of *Sorex vulgaris* and *Triton cristatus*. *Ascaris gracillima* sp. n. was found in an asexual stage in the intestines of *Cobitis barbatula*, *Phoxinus lævis*, and *Gastrosteus aculeatus*. A well-marked new species —*Trichosoma spinulosum*—was found in the cæcum of *Fuligula ferina*. In conclusion, there are some interesting notes on the Frog-parasite *Angiostomum nigrovenosum*.

Parasitic Origin of Pernicious Anæmia.†—M. A. Railliet finds that pernicious anæmia in man and animals may be caused by various parasites. The liver-parasites are *Distomum hepaticum* and *D. lanceolatum*, in the Sheep; *Coccidium oviforme*, in the Rabbit; *Echinococcus polymorphus*, in Man and Ruminants. The enteric parasites are various:—*Tæniæ*, in the Sheep and Rabbit; *Bothriocephalus latus*, in Man; *Ankylostoma duodenale*, in Man; *Dochmius trigonocephalus*, in Cats; the same and *D. stenocephalus*, in Hounds; *Sclerostoma hypostomum* and *S. tetracanthum*, in Horses; *Strongylus contortus* and *S. filicollis*, in Sheep and Oxen; *St. strigosus* and *St. retortæformis*, in Hares and Rabbits.

δ. Incertæ Sedis.

Morphological Significance of Organic Systems of Enteropneusta.‡ Prof. W. Schimkewitsch gives an abstract of two memoirs, written by himself in Russian, on the homology of various organs of the Enteropneusta, Echinodermata, and Chordata. He takes as his starting-point the stage in Echinoderm development which has been called by Semon the Pentactula. The proboscis of *Balanoglossus* is comparable to cephalic lobes, the cœlomic cavity of which is separated off from the archenteron

* Archiv f. Naturgesch., lvi. (1890) pp. 171–88 (1 pl.).

† Revue Génér. d. Sciences Pures et Appliq., i. (1890) pp. 294–9 (5 figs.). See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) p. 500.

‡ Anat. Anzeig., v. (1890) pp. 29–32.

as an unpaired diverticulum. In correlation with the excessive development of the cephalic lobes we have the preoral part of the enteron, which Bateson took for the notochord, especially well developed. As in *Balanoglossus*, so in *Amphioxus*, we find a pair of enteric outgrowths in the anterior part of the archenteron; the left one becomes, later on, connected with the external medium in both forms. Of the three outgrowths from the archenteron in Crinoids the unpaired one corresponds to the cephalic cœlom of the Enteropneusta, and is converted into the ambulacral ring.

According to Hatschek we have, in the embryo of *Amphioxus*, to do with two divisions of the cœlom (myocœl and splanchnocœl); in the Enteropneusta we find this division only in the collar-segment, where the myocœl (Bateson's perihæmal cavity) is very closely connected with the longitudinal musculature. The pulsating vesicle of *Tornaria* (Bateson's proboscis-gland) is nothing else than a division of the cœlom, and probably represents the myocœl of the proboscis-segment.

The vascular system of *B. Mereschkowskii* is formed by two trunks—a dorsal and a ventral—which lie between mesenteries, and probably pass into one another at either end of the body. This arrangement obtains in *Amphioxus* and *Synapta*, as well as in Annelids and Nemertines.

The anterior part of the enteron of *Balanoglossus* is divisible into a suprabranchial and a subœsophageal; the latter is reduced in *B. Mereschkowskii* to a groove, which is represented by the endostyle of Tunicates, the hypobranchial groove of *Amphioxus*, and the thyroid evagination of *Ammocœtes*. Notwithstanding various attempts to homologize other structures with them, the gill-clefts remain characteristic of the Chordata.

The gonads of Annelids, Nemertines, Enteropneusta, *Amphioxus*, and the hypothetical ancestors of Echinoderms, are formed on the same type, and it can scarcely be doubted that the genital orifices of Nemertines and Enteropneusta should be homologized with the ectodermal part of the segmental organs.

The nervous system of *Tornaria* seems to consist of the cephalic ganglion beneath the eyes, whereof no trace is left in the adult *Balanoglossus;* the nervous tube of this creature corresponds to that of the Chordata; the anterior neuropore corresponds to the ciliated pit of the *Amphioxus*-larva and the ciliated duct of the neural gland of Tunicates. In no way can the dorsal and ventral nerve-trunks of *Balanoglossus* be compared with the nerve-trunks of Holothurians.

All the Bilateria may be arranged in four groups, according to the structure of the nervous system:—

(1) Gastroneura—with a cephalic ganglion and two ventral trunks.

(2) Tetraneura (Mollusca)—with a cephalic ganglion, two ventral, and two lateral trunks.

(3) Cycloneura (Echinodermata)—with no cephalic ganglion, but with an œsophageal ring and five radial trunks.

(4) Notoneura (Enteropneusta and Chordata)—with no cephalic ganglion, but with a dorsally placed nerve-tube.

Fecundation of Hydatina senta.*—M. Maupas has been able to convince himself absolutely that the "winter eggs" of this Rotifer are

* Comptes Rendus, xci. (1890) pp. 310–2.

the fertilized eggs. Seven hundred and ninety-six females were, from their birth, kept isolated from males; none of these produced any but the so-called summer egg. One hundred and seventy-two females, opportunely placed with males, gave rise in eighty-four cases to fecundated eggs; the other eighty-eight produced female parthenogenetic eggs. All the copulations, therefore, were not fertilizing. The author thinks that, with a little more care, he might have obtained a larger number of fertilized eggs. The females should be fertilized six to eight hours after emergence; some have been fertilized immediately on leaving the egg. Copulation may happen frequently after eggs have been deposited, but no further fertilization of eggs occurs. The males are polygamous, or may be so. In a further communication * M. Maupas states that he has discovered that copulation has no effect on those specimens that are about to lay female eggs. Each egg seems to be predestined to form a male or a female at the time when it is differentiated and begins to grow in the maternal ovary. The author does not despair of finding the time and causes which determine this. In *Hydatina*, as in some Hymenoptera, there is established between arrhenotoky (parthenogenetic production of males) and fecundating karyogamy, a relation so necessary that the second is impossible without the first. It is very probable that this absolute connection between these two processes is commoner than we think, and that fresh researches will discover it in other parthenogenetic creatures. It was found by experiment that there is no advantage in cross-fertilization.

Distribution of Pedalion mirum.†—Dr. O. E. Imhof draws attention to various localities—Budapest, Galicia, Azores, North Italy, Germany, and others—in which this remarkable Rotifer has, in recent years, been found. The localities indicate that the creature lives in very varying conditions of existence.

New American Rotifer.‡—Dr. D. S. Kellicott describes a new species of the genus *Cephalosiphon*, which he calls *C. furcillatus*; the dorsal antenna is provided with two stout, down-curved claws, the use of which is not quite clear. The entire length of the animal is 1/120 in.

Echinodermata.

Enterocœlic Nervous System of Echinoderms.§—M. L. Cuénot describes a third system of nerves in Echinoderms. In the Asteroidea there is, on the aboral side of each arm, a strong muscular cord, which gives off branches in all directions, and functions chiefly as the antagonist of the muscles which unite the ambulacral pieces. When a section is made of the wall of the body in this region, it is seen that the muscular bands are completely on the internal face of this wall. They are invested by a rather thick layer (40 μ in *Asterias glacialis*), which is formed by a nerve-centre and the peritoneal epithelium. The nervous part is formed by fibrils, which take the same direction as the muscles, and inclose a rather large number of nerve-cells. The cells of the

* T. c., pp. 505–7.
† Zool. Anzeig., xiii. (1891) pp. 609–11.
‡ Proc. Amer. Soc. Microscopists, xi. (1890) pp. 32–3 (1 fig.).
§ Comptes Rendus, cxi. (1890) pp. 836–9.

peritoneal epithelium, which are set side by side in a single and very regular layer, are each prolonged into a delicate filament, which crosses the fibrillar layer perpendicularly, and passes on to be attached to the subjacent connective tissue. The histological constitution of this nervous layer is, therefore, identical with that of the ambulacral nervous system, save that the ectodermal cells of the latter are replaced in the former by enterocœlic cells.

The author states that he has recognized this enterocœlic nervous system in all his types—*Asterias glacialis* and *tenuispinis*, *Echinaster sepositus*, and *Astropecten aurantiacus*. He has not been able to detect any communication between this centre and the intra-epithelial superficial plexus, which extends between the ectodermic cells of the outer wall of the body.

He thinks that this new nervous system recalls in a singular manner that which is so well developed in Crinoids. If we make a transverse section of an arm of an *Asterias* or an *Antedon* we find exactly the same elements from the oral surface:—(1) Ectodermal nerve-band, continuous with the epithelium of the ambulacra, and, in *Asterias*, with the ectodermal investment of the body; (2) radial schizocœl-sinus, greatly developed in *Asterias*, more reduced, but certainly present in the Neocrinoidea; (3) the radial ambulacral canal; (4) a large cavity, the prolongation of the cœlom of the disc, simple in Asteroids, divided by septa into three cavities in Crinoids; (5) the aboral wall of the body, inclosing muscular fibres and nerve-cords, greatly developed in Crinoids. We know, moreover, that the axial nerves of Crinoids are of enterocœlic origin. The genital nerve-ring of Echinoids, discovered by Prouho in *Echinus acutus* and *Strongylocentrotus lividus*, and by the author in *Arbacia pustulosa* and *Echinodiscus biforis*, ought to be put in the same category. In Ophiurids the same part is represented by the aboral ring, which goes from the axial sinus to the genital organs; this has been found in *Ophiocoma scolopendrina*, *Ophiothrix fragilis*, and others. It seems certain that the genital nerve-ring of Echinoidea and Ophiuroidea, like the aboral cords of Crinoidea and Asteroidea, are of mesodermal origin, and are developed at the expense of the enterocœlic epithelium; this is one of the most interesting exceptions in the developmental history of the nerve-centres of Metazoa. No aboral nerve-centre has yet been seen in *Synapta* or *Holothuria*.

Echinodermata of Yucatan and Vera Cruz.* — Mr. J. E. Ives describes the Echinoderms collected from these regions. *Holothuria Heilprini* sp. n. is related to *H. atra*, but the calcareous deposits are arranged in heaps, which produces an appearance of granulation over the surface of the body; *H. Silamensis* is allied to the group which (in Thiel's classification) contains *H. marmorata*, and while it presents differences from all members of it, it may, like them, or some of them, belong to one very variable and widely distributed species. *H. nitida* sp. n. is also allied to *H. atra*. The new genus *Thyraster* is instituted for *Echinaster serpentarius*, as the skeleton consists of quadrilateral plates arranged in regular longitudinal series, and not, as in *Echinaster*, of small narrow imbricated plates united into an irregular network. This

* Proc. Acad. Nat. Sci. Philad., 1890, pp. 317–40 (1 pl.).

collection, like others which have preceded it, affords evidence of the limited habitat of many species of Holothurians.

Crinoids of Port Phillip.*—A Port Phillip Biological Survey Committee has been formed, and twenty-nine specimens of Crinoids were sent to Dr. P. H. Carpenter, who refers them to five species, one of which is probably new. *Antedon macronema* is for the first time recorded from this locality.

Anthozoa.

Rate of Growth of Corals.†—Prof. A. Agassiz has had the opportunity of examining some corals attached to a cable which has been laid down about seven years. *Orbicella annularis* grew to a thickness of 2½ in. in about seven years. *Manicina areolata* shows a rapid, and *Isophyllia dipsacea* a still more rapid rate of increase.

Corals of Tizard and Macclesfield Banks.‡—Mr. P. W. Bassett-Smith, R.N., has a report on the corals obtained by him when on board H.M.S. 'Rambler,' from the Tizard and Macclesfield Banks in the China Sea. One hundred and twenty-nine species of Madreporaria were obtained, and of the genus *Madrepora* there were as many as thirty-one species. Perhaps the most notable fact with regard to this collection is the number of species which have been found living at depths greater than 30 fathoms, which depth has until lately been supposed to be the limit of deep-building corals. Nineteen species have, however, been found between 31 and 45 fathoms. Five new species of *Madrepora*—a genus whose usual limit is 10 fathoms—were found living between 20 and 27 fathoms. The author indicates but does not describe the species which he regards as new.

Alcyonaria and Zoantharia from Port Phillip.§—Dr. S. J. Hickson has a preliminary report on the Alcyonaria and Zoantharia collected by the Port Phillip Biological Survey Committee. The author has had great difficulty in working out the collection, as the same form seems to have frequently had different generic and specific names applied to it. He gives a list of twenty-nine specimens, of which *Clavularia australiensis*, *C. ramosa*, and *C. flava* are new species; of each of these a short diagnosis is given.

Invagination of Tentacles in Rhizoxenia rosea and Asteroides calycularis.‖—In most Cornulariidæ the tentacles contract when the polyp contracts, but they are not invaginated; Prof. G. v. Koch has, however, noticed a true invagination of the tentacles in *Rhizoxenia rosea*. Invagination of the tentacles does not seem to have been noted among the Hexacoralla, but in *Asteroides calycularis* tentacles have been seen to be invaginated at their basal portion, and to be pushed in and out like the tube of a telescope. The matter is worthy of further investigation.

* Proc. Roy. Soc. Victoria, ii. (1890) pp. 135–6.
† Bull. Mus. Comp. Zool., xx. (1890) pp. 61–2 (4 pls.).
‡ Ann. and Mag. Nat. Hist., vi. (1890) pp. 353–74 (3 maps), 443–58.
§ Proc. Roy. Soc. Victoria, ii. (1890) pp. 136–40.
‖ Morphol. Jahrb., xvi. (1890) pp. 399–400.

Terminal Polyp and Zooid in Pennatula and Pteroeides.*—Prof. G. v. Koch gives figures of various stages of young and just adult specimens of *Pennatula phosphorea*. In the earlier stages it is quite easy to make out a terminal polyp, with a terminal pore or terminal zooid at its base. This arrangement is no longer apparent in an example with fourteen leaves, for the polyp is gone though the zooid is still terminal, and the same is the case in a specimen with thirty-eight pinnules. A short notice is also given of two young colonies of *Pteroeides spinosus*.

Structure of Cerianthus americanus.†—Prof. J. Playfair M'Murrich gives an account of the structure of *Cerianthus americanus*. The largest specimen obtained measured about 20 cm. in length, but those described by Verrill were much larger. The mesenteries are arranged on a very different plan to those of *C. membranaceus* and *C. borealis*; more than one pair reach the extremity of the body; there are in all ninety-two mesenteries, twenty-three of which are well developed, or pass more than half-way down the column. The sexes are separate, and the three specimens examined by the author were all females. The examination of the histological structure showed many points of resemblance to *C. membranaceus* and of difference from *C. borealis*. The author gives a detailed account of what he was able to observe. The ova are large and are imbedded in the mesoglœa of the mesenteries; the nucleus is large and always excentric, and usually projects very noticeably beyond the general surface of the ovum; one large nucleolus is always present.

Organization of Monobrachium parasiticum.‡—Herr J. Wagner has made a study of this fine Hydroid, discovered by Méréjkowsky in 1877. In most colonies the centre is almost entirely occupied by sexual individuals, while at the periphery the gonophores are intermixed with the hydranths, and at the extreme edge there are special forms, for which the author proposes the name of pseudonematophores. These last represent the "spiral zooids" described by Allman in *Podocoryne*, and by various authors in other forms. In *Monobrachium* the terminal swelling is a true battery of nematocysts, and the organ has clearly a defensive function. They differ from true nematophores by the possession of a prolongation of the gastric cavity, which is always wanting in true nematophores. Further, they do not emit pseudopodia, and in these two points the pseudonematophores approach the hydranths, between which and the nematophores they form an intermediate stage.

Monobrachium is nourished on the excrements of *Tellina*, to the shell of which it is fixed; and, as the currents produced by the siphons continually bring fresh water, this Hydroid may be regarded as a commensal. On the other hand, the protractile and single tentacles may be of use to the Molluscs, and we may, therefore, have to do with a case of symbiosis.

The ectoderm of the hydranths and of the pseudonematophores is formed by epithelio-muscular cells, every one of which seems to have the power of transforming itself into a supporting cell. The subepithelial

* Morphol. Jahrb., xvi. (1890) pp. 396–8 (7 figs.).
† Journal of Morphology, iv. (1890) pp. 131–50 (2 pls.).
‡ Arch. de Biol., x. (1890) pp. 273–309 (2 pls.).

layer is only well developed at the base of the hydranth and on many points of the hydrorhiza; in section a large number of nuclei become visible, the arrangement of which indicates the presence of several layers of cells with invisible contours. In some parts this layer is closely packed with nematocysts; all these cells are of the same kind—they have an ovoid form, and the filament has several strong spines. It is to be noted that these capsules have no cnidocils.

The author does not absolutely deny the presence of nerve or sensory cells in this hydroid, but he states that he was unable to find them. On the whole, the ectoderm of the hydranths and of the pseudonematophores gives evident signs of atrophy due to parasitism. The endoderm of the hydranth is formed of cells of very large size lying on circular muscular fibres; they form a syncytium on the inner surface, but on the outer the boundaries of the cells can be distinguished; the fusion on the inner surface is due to the fact that two or more adjoining cells send out pseudopodia which touch and fuse. There is thus formed a digestive protoplasmic layer, filled with nutrient and other particles, and entirely covering the internal surface of the gastric cavity.

The structure of the tentacle is interesting, as it presents an intermediate stage between the hollow tentacles of some and the solid tentacles of other hydroids. In fact, by supposing the cells of the internal epithelium of the tentacles of *Hydra* to become so large as to touch at either end of the tentacle, we get the arrangement which obtains in *Monobrachium*. The membrane proper is feebly developed, and is scarcely visible on the hydrorhiza; it gives rise to protuberances or crests among the ectodermal, and more particularly among the endodermal cells, in such a way that, if all the cells are removed, the surface of the membrane shows the contours of the bases of the cells. This appearance, however, is only seen in the median part of the hydranth. The membrane appears to be simple.

The gonophores are placed on short peduncles, and contain a medusa which becomes almost completely developed; there are two and not four sexual sacs. The author describes in detail the histological character of the medusoid body. The spot at which the genital products are matured is not that at which they appear. In the female, at any rate, the embryonic cells of the hydrorhiza of the female colonies are the female elements, and the same is probably true of the males. The author was unable to discover which germinal layer gave rise to the genital products. The sexual products are differentiated in the endoderm of the hydrorhiza, and are matured in the ventral epithelium of the radial canals. There is, then, in *Monobrachium*, a very important migration of sexual cells, notwithstanding the fact that this hydroid possesses an almost completely formed medusa. The embryonic cells pass along the endoderm from the hydrorhiza into the blastostyle, and then into the ventral epithelium of the radial canals, whence they reach the genital sacs by perforating the membrana propria.

Hydroids of Plymouth.*—Mr. G. C. Bourne gives a list of fifty-five species of Hydroids found at Plymouth. Among them is *Haloikema lankesteri* g. et sp. n., which is closely allied to *Halecium*, but is dis-

* Journ. Marine Biol. Assoc., i. (1890) pp. 391-8 (1 pl.).

tinguished by the ringing of the skin, the pedicellate hydrothecæ, and the non-retractile polyp, which is relatively much larger than the polyp of *Halecium*.

Porifera.

Nucleus of Sponges.*—M. J. Chatin recommends the Sponges, and especially the Calcareous forms, as very suitable objects for the study of the nucleus. Little preparation is necessary, as fixation by 33 per cent. alcohol and staining with methyl-green or picrocarmine will generally be found sufficient; where a more rigorous investigation is intended absolute alcohol is a good fixative. The mesodermal elements are the best to study, and especially those near the ectoderm.

The nucleus varies a great deal in form, and is at times ramified; the nuclear membrane is often clearly visible, for the cellular protoplasm is almost always clear and free from granules. The contained plasma has in it nuclein arranged in filaments which are aggregated towards the edges of the nucleus, or in similarly situated nucleoli.

M. Chatin points out that the form of the nucleus of Sponges is very similar to that of the nucleus of Protozoa—a fact, he thinks, of considerable interest in zoological histology, when we reflect on the relationship between Sponges and Protozoa which has been sometimes insisted on.

Protozoa.

Psycho-physiological Studies on Protists.†—Dr. M. Verworn has made an interesting series of investigations on the movements, reactions, and general behaviour of Protists. He began by studying the spontaneous movements of uninjured Bacteria, Diatoms, Rhizopods, Flagellata, and especially ciliate Infusorians. Then he investigated their behaviour in relation to various stimuli—luminous, thermal, electrical, chemical, and mechanical. He made a great number of experiments with excised portions of Rhizopods and Ciliata, studying their movements and their reactions. Finally he watched the normal life, the food-seeking, house-making, pairing of Protozoa.

He allows that the first impression of many Protists is that they possess many of the mental qualities of higher animals, for their movements often suggest sensation and deliberation. Further study does not corroborate this impression; his own conclusion is that "all their movements are expressions of unconscious psychical processes." Their structure is not such that there can be any centralized consciousness; the characteristic movements are retained by little excised fragments; the nucleus is certainly not a psychical centre. "There is no alternative but to identify the psychical processes in the Protist organism with the molecular processes therein, and to seek their fundamental conditions in the qualities of the molecules." Whether Dr. Verworn's conclusions are right or not, the abundant facts which he describes are most interesting.

* Comptes Rendus, cxi. (1890) pp. 889–90.

† 'Psycho-Physiologische Protisten-Studien. Experimentelle Untersuchungen,' 8vo, Jena, 1889, viii. and 219 pp., 6 pls. and 27 figs.

Mechanism of Sucking in Suctoria.*—Herr J. Eismond urges certain objections to the suggestion of R. Hertwig that the sucking mechanism depends on a shortening and subsequent elongation of the sucking tentacles. Observation, however, shows that these tentacles often remain quite stiff, and it is difficult to see how the food would not be ejected on the contraction of the tentacle. We must suppose that the tentacles play only a passive part, and seek elsewhere for the mechanism. It is suggested that it is to be found in the relations of the body-plasma to the outer world; where there is a diminution of pressure there must be a centripetal streaming into the sucking tubules, and so into the body. This is brought about by the contractile vacuoles, the activity of which must play the chief motor part in the sucking mechanism of the Suctoria, and, partly, in the swallowing mechanism of the Ciliata. What the author imagines to happen is, that as the contractile vacuoles pump out watery excretion-products from the body-plasm they act as aspirators, for in their diastole they diminish the turgidity of the body, and consequently produce an ascensive pressure in the sucking tubules.

Amphileptus flagellatus.†—Mr. C. Rousselet, under this name, describes a new species of Infusorian, which he has often found at Keston. It is 1/65 to 1/55 in. in size including flagellum, with a width of 1/100 to 1/120 in. At first sight it might be taken for an abnormal *Trachelius ovum*, but it is a true *Amphileptus*, distinguished from all the known species by its large size and its prominent and long trunk-like filament. The body is highly elastic and changes its form and withdraws its flagellum on the slightest pressure. The flagellum is carried in a graceful spiral curve in front of the body, when the creature is swimming.

The Genus Conchophthirus.‡—Prof. G. Cattaneo gives an account of the interesting Holotrichous Infusorian *Conchophthirus anodontæ* found on the gills of freshwater mussels. He discusses the synonymy of the genus, describes the animal and its movements, finds only one species in the bivalves, and gives reasons for believing that the Infusorians accompany the Glochidia when they leave the mother mussel.

Gigantic Specimens of Actinosphærium.§—Mr. S. Calvin has found near the State University of Iowa some Rhizopods which are distinctly visible to the naked eye. They are probably examples of *Actinosphærium Eichhornii.* But whereas the maximum diameter given by Leidy is 0·85 mm., there are scores in Mr. Calvin's jars more than 0·75 mm., and the largest specimen measured had a diameter of 1·36 mm.

Structure and Development of Spores of Myxosporidia.‖—M. P. Thélohan finds that the nucleus of Myxosporidia divides by karyokinesis. The polar capsules are formed at the expense of small masses of protoplasm which are differentiated in the sporoblast and inclose a nucleus; the mechanism of their formation presents many analogies with that

* Zool. Anzeig., xiii. (1890) pp. 721–3.
† Journ. Quek. Micr. Club, iv. (1890) pp. 114–5 (1 fig.).
‡ Rend. R. Ist. Lomb. Sci., xxii. (1889) pp. 604–14.
§ Amer. Natural., xxiv. (1890) pp. 964–5.
‖ Comptes Rendus, cxi. (1890) pp. 692–5.

observed by Bedot in the nematoblasts of *Velella* and *Physalia*. The protoplasmic mass of the spore is derived from another part of the sporoblast; it incloses two nuclei and a vacuole, the presence or absence of which is constant in one and the same form.

Cercomonas intestinalis.*—Herr E. Müller found in the intestine of an executed criminal an infusorian which accurately answered to the description given by Davaine of *Cercomonas intestinalis*. Directly after the execution, parts of the intestine were placed in Müller's fluid, chromic acid, and also alcohol. The infusorian had an oval or pyriform body, one end of which was continued into a tail, while the other, which was rounded off, carried a whiplike cilium. The length of the body was 0·006 mm., and the breadth 0·002 mm. The protoplasm contained one or two nuclei.

The parasite was only found in the jejunum. The location of the animals in the intestinal mucus was very characteristic; they formed a compact mass covering as with a membrane the surface of the intestinal mucosa, while those lying a little deeper were arranged in groups. The author notes that the presence of these parasites gave rise to no pathological changes.

Hæmatozoon of Malaria and its Evolution.†—M. Laveran, the author of the 'Traité des fièvres palustres,' attacks the position maintained by Golgi, Feletti, Anatolei, and others that the various types of malaria are produced by different micro-organisms of the same class. He considers that the blood-parasite is one and the same although variable in form, and that its development may not always be alike. According to him the type of the fever depends rather on the condition of the patient, on his predisposition, and on the length of his exposure to the malaria, than on differences in the forms of the parasite found in the blood.

Phagocytosis in Frogs and Birds.‡—As another contribution to the doctrine of Phagocytes, Herr Danilewski records his experiments on frogs and birds. Blood infected with hæmogregarinæ was transfused in the anterior abdominal vein of frogs. In 1/2 to 1 hour the foreign corpuscles were found to have been picked up by the large phagocytes of the frog. The hæmoglobin of the corpuscles soon vanishes, in a few hours the contour has become less visible, and in two or three days the parasite alone remains. Finally even this latter becomes more transparent so that at last only the empty cuticular sac and the bright nucleus of the blood-corpuscle are left. If the corpuscle contains only an early condition of the parasite then its destruction is all the more rapid, owing to the want of a cuticle, Observations were best effected by sucking the infected blood with some air into a flattened capillary tube; in this way they could be carried on for two or three days at a temperature of 36°–39°.

* Nordeskt Med. Archiv (Stockholm), xxi. (1889) pp. 1–12. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 591–3.

† La Semaine Méd., 1890, No. 27. See Centralbl. f. Bacteriol. u. Parasitenk., viii. (1890) p. 559.

‡ Annales de l'Institut Pasteur, iv. (1890) p. 432. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) p. 710.

In a similar way the destruction of hæmatozoa by phagocytes was observed when frog's blood was added to that of the bird. The parasites of the bird are considered by the author to be allied to the malarial cytoparasites of man, and they are distinguished as the "malarial" parasites of birds.

When frog's blood is added to that of owls which contains infected corpuscles and melanin granules, a considerable number of the bird's corpuscles are found to be taken up by the frog's large leucocytes within twenty-four hours at 15°–18° C. The process of intracellular digestion goes on until the blood-corpuscles and its parasite have disappeared, the nucleus lasting a little longer. Finally, melanin granules are visible in the protoplasm of the phagocyte, which also shows an active vitality; other and similar observations are recorded of mixing malarial bird's blood with uninfected blood of birds and also with that of the dog.

That birds suffer from malaria the author thinks is proved by the anæmia and melanæmia that occurs in them, and also from the brown and black colour of the spleen and bone-marrow, e. g. in ravens, magpies, and owls. Moreover the presence of melanin granules is easily demonstrated microscopically.

BOTANY.

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

α. Anatomy.

(1) Cell-structure and Protoplasm.

Absorption of Solid Substances by Protoplasm, and Formation of Vacuoles.*—Prof. W. Pfeffer has made a series of observations on the mode in which solid substances are absorbed by living protoplasm, the object of examination being chiefly plasmodes of *Chondrioderma difforme.* He believes that the absorption cannot be the result of chemical irritation nor of sensibility to contact, but of a purely mechanical force, whether from the weight of the substances absorbed, or from the resistance which they offer to the movements of the arms of the plasmode. Passing through the hyaloplasm, these substances are often taken up by vacuoles, though this is not always the case. After a certain period they are again expelled from the plasmode, but only while it is in motion and undergoing changes of form. Absorption of solid substances by protoplasm inclosed in a cell-wall was also observed.

Pfeffer contests the view of de Vries and Went † that all vacuoles must necessarily result from the division of vacuoles already in existence. He was able, by placing the plasmode in a satnrated solution of a substance which is not too soluble and at the same time is not injurious, to produce in the hyaloplasm artificial vacuoles with all the properties of natural vacuoles. He found in these plasmodes no sharp distinction between hyaloplasm and granular protoplasm, the latter being simply the former rendered turbid by imbedded substances. The artificial vacuoles may even possess slight powers of pulsation.

With regard to the consistency of protoplasm, the author asserts that bodies composed of naked protoplasm, and especially the vibratile cilia of swarm-cells and of antherozoids, have a greater power of cohesion than protoplasm inclosed in a cell-wall. With regard to the cause of movements of irritability, such as those of the stamens of Cynaraceæ, he combats the theory of Vines and Gardiner, that it is due to an active contractility of the protoplasm, since, in such cases at all events, the protoplasm does not possess a sufficient degree of cohesion. The cause of the movements must be sought for either in an osmotic elimination of substance, or in a diminution of turgidity.

The author states that certain substances diffuse rapidly through the cytoplasm, while they pass only comparatively slowly through the membrane of the vacuoles; this difference demonstrates, in his opinion, the presence of continuous protoplasmic membranes which determine the osmotic absorption of substances by the protoplasm.

Cell-division in Spirogyra.‡—M. C. Degagny has adopted a new method of observing cell-division in *Spirogyra orthospira*, from which he has obtained interesting results. He exposes the filaments for some

* Abhandl. Sächs. Gesell. Wiss., xvi. (1890) pp. 149–345. See Bot. Centralbl., xliv. (1890) p. 180.

† Cf. this Journal, 1888, p. 981. ‡ Comptes Rendus, cxi. (1890) pp. 282–4.

minutes to the vapour of osmic acid, and then immerses them for 12 hours in the chromo-formo-osmic fluid similar to Flemming's. They are then washed several times, and preserved in a dilute solution of glycerin in water which is allowed to evaporate slowly. The staining reagents used are a similar solution of glycerin tinted by acetified methyl-green and by fuchsin. Immediately after the separation into two portions of the chromatic substances which form the nuclear plate, the granulations stained red, previously disseminated through the protoplasmic masses, accumulated at the poles, concentrating themselves in proportion as the two halves of the nuclear plate approach one another. They unite so as to form a more or less complete disc, near which each half of a nucleole places itself. At this moment the nuclear membrane, stained a pale red, commences to reappear opposite the disc, each half of a nucleole being surrounded on the outer side by the disc of granulations, and on the inner side by the nuclear membrane in the nascent condition. The complete re-formation of the nucleus follows immediately.

Growth of the Cell-wall.*—From observation of a peculiar mode of growth which occurs in the development of the wings on the stem in species of *Euonymus*, Miss Emily L. Gregory has arrived at a conclusion in harmony with Strasburger's hypothesis that growth in surface is effected by stretching, rather than with Krabbe's theory † that such growths take place partly by intussusception.

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

Calcium and Magnesium Oxalate in Plants.‡—M. N. A. Monteverde finds that calcium oxalate is much more widely distributed in grasses than has been generally supposed, and its presence or absence is characteristic not only of the species, but also of the genus, and largely of the tribe. In 162 out of 550 species, and in 29 out of 94 genera examined, he found crystals present. Magnesium oxalate occurs in the form of strongly refractive spherocrystals with radial striation, or of irregular aggregations in the epiderm. When crystals are not present in grasses, all the green cells always contain drops of oil, which shows the reactions of a fatty oil.

In etiolated leaves of grasses much smaller quantities of crystals of calcium oxalate are found than in green leaves; their formation appears to be dependent directly on the light. The author believes that the primary calcium oxalate arises as a secondary product in various chemical changes of the proteids; and that the secondary calcium oxalate, the formation of which goes on *pari passu* with the disappearance of the nitrates in the leaves, must be regarded as a secondary product in the new formation of the proteids.

Yellow and Red Colouring Matters of Leaves.§—According to Sig. L. Macchiati, the red pigment in the leaves of plants isolated by

* Bull. Torrey Bot. Club, xvii. (1890) pp. 247–55 (1 pl.).

† Cf. this Journal, 1888, p. 441.

‡ 'Ueb. d. Ablagerung v. Calcium- u. Magnesium-Oxalat in d. Pflanze' (Russian), St. Petersburg, 1889, 81 pp. and 1 pl. See Bot. Centralbl., xliii. (1890) p. 327.

§ Atti Soc. Nat. Modena. See Morot's Journ. de Bot., iv. (1890), Rev. Bibl., p. xlv. Cf. this Journal, 1889, p. 240.

Arnaud * is identical with the erythrophyll of Bourgarel and the chrysophyll of Harsten; while the yellow or yellow-red substance extracted by Immendorff from green leaves cannot be identified with this pigment; it is a product of transformation of some other colouring substance, probably of erythrophyll. The green substance of the chlorophyll-grains is constantly accompanied by two yellow crystallizable substances, one of which, xanthophyllidrine, is soluble, the other, xanthophyll, insoluble in water. Besides these yellow substances, leaves constantly contain a red substance, erythrophyll, to which authors have given different names, and which Arnaud seeks to identify with the carotin of cultivated carrots.

Pigment of the Synchytrium-galls of Anemone nemorosa.†—Herr F. Ludwig finds that the attacks of the parasitic *Synchytrium Anemones* on *Anemone nemorosa* produce in the epidermal cells of the leaves and flowers a red pigment very soluble in water, with a very characteristic absorption-spectrum, apparently identical with that of anthocyan. It apparently serves the purpose of a protection against snails.

Dulcite in Plants.‡—By extracting with alcohol, Prof. J. Borodin found dulcite in *Melampyrum nemorosum*, *pratense*, *sylvaticum*, and other species of the genus, in all parts except the ripe seeds, especially in the secondary shoots, corolla, and unripe pericarp. In other plants belonging to the Scrophulariaceæ, e. g. *Rhinanthus crista-galli* and *Scrophularia nodosa*, he was unable to find any trace of it. Dulcite was found in all species of Celastraceæ examined, viz. 11 species of *Euonymus*, 3 of *Celastrus*, and 1 of *Schæfferia*, in all parts except possibly the root. That dulcite, like the carbohydrates, takes part in the vital processes of the plant, is shown by the fact that in *Euonymus japonicus* it entirely disappears from the leaves before their fall.

Strophanthine.§—Dr. T. R. Fraser publishes an elaborate account of *Strophanthus hispidus*, and its use in Africa as an arrow-poison. The poison is obtained exclusively from the fruit, where its active principle occurs chiefly in the endocarp, the placenta, and the comose appendages of the seeds. It is however found, though to a smaller extent, in the root and leaves, as well as in the epicarp and mesocarp. From the bark, both of the stem and of the branches, it appears to be entirely absent.

(3) Structure of Tissues.

Collenchyme.‖—Herr C. Müller has investigated the nature and structure of collenchyme more closely than has hitherto been done. He classifies the various forms under the following heads, viz.:—(1) with thickening at the angles (typical collenchyme); (2) with walls thickened on all sides (bast-collenchyme); (3) with walls thickened on all sides and the inner lamella of each cell strongly differentiated; (4) with tangential thickening-plates; (5) with uniform thickening of the walls

* Cf. this Journal, 1890, p. 350.

† Verhandl. Bot. Ver. Brandenburg, xxxi. (1890) pp. vii.–viii. (1 fig.).

‡ Rev. Sci. Nat. St. Pétersbourg, 1890, pp. 26–31 and 55. See Bot. Centralbl., xliii. (1890) p. 175.

§ Trans. Roy. Soc. Edinb., xxxv. (1890) pp. 955–1028 (7 pls.).

‖ Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 150–66 (1 pl.).

which bound intercellular spaces; (6) collenchyme resulting from secondary metamorphosis which has taken place at a late period (meta-collenchyme ; (7) temporary collenchyme or proto-sclerenchyme.

Collenchyme-tissue is always distinguished from bast-cells by being composed of living cells. It seldom contains more than a small quantity of chlorophyll; but, whether in a young or mature condition, its cells are always filled with water, and its primary function is to serve as a store-house for water, which is also always contained in the thickenings. At an early period, however, it always acquires its secondary function as a mechanical supporting-tissue; and this it performs not only while the organs are increasing in size, but also when they have passed over into its permanent condition.

Nutrient Layer in the Testa.*—Herr J. Holfert has investigated the structure of the layer which is almost always found beneath the sclerenchymatous layer in the testa of seeds. Although in the ripe seed this zone has very commonly entirely disappeared, in the unripe seed it consists of cells of ordinary structure, containing abundance of water, starch, and even of chlorophyll-grains. It is a transitory storing-tissue, and consists of parenchymatous cells, the contents of which are used up, during the process of ripening, in secondary cell-wall thickenings and other portions of the tissue of the testa. It may occur in one layer or two, separated by sclerenchyme.

The author classifies the various forms of this tissue under three types, of which the first is by far the most common, viz.:—(1) There are one or more nutrient layers and one or more sclerenchymatous or collenchymatous or thick-walled layers with secondary thickenings; (2) one nutrient layer, and no layers with secondary thickenings; (3) the nutrient layer is replaced by a permanent layer of parenchyme; there are no layers with secondary thickenings. This nutrient tissue is usually developed from one or more rows of cells, not to be distinguished from the rest, in the integument of the unimpregnated ovule. The number of rows of cells almost always increases, and sometimes the tissue is entirely formed, after impregnation. A very large number of special cases are described belonging to a great many different natural orders.

Foliar Fibrovascular System.†—By this term M. O. Lignier understands all the bundles which descend from a leaf, whatever their number or distribution, as well as those which penetrate the limb and the petiole of the leaf, and those which descend into the stem and constitute the leaf-trace. In the simplest case (Conifers and some Angiosperms) this system is composed simply of a single bundle, situated in the plane of symmetry of the leaf; but it is usually much more complicated. One mode of complication consists in a lateral extension, and also often a longitudinal breaking-up of the conducting tissues. The system may, when more complicated, consist of one or more principal bundles distributed over a more or less open convex arc; the broadening of these produces secondary (supernumerary) bundles, which again may be changed from

* Flora, lxxiii. (1890) pp. 279–313 (2 pls.).

† Bull. Soc. Linn. Normandie, 1888–9 (1890) pp. 81–92. Cf. this Journal, 1888, p. 985.

intercalary to internal or external by the folding of the arc. The mode in which these variations and complications take place is often characteristic of natural families.

Cuttings of the Vine.*—According to M. L. Ravaz, at the point where a cutting of the vine puts out a root, the generative layer becomes more active over a space of 4–5 mm. diameter, and forms xylem internally, phloem externally, the root originating in the outermost layer of cells of the phloem. The "digestive pocket" is formed at the expense of the innermost layer of the medullary ray of the preceding year. In order to make its exit, the root has to penetrate the phloem of the preceding year and a layer of bark, and consumes in its progress a very spongy and thin-walled tissue formed from the innermost layer of the corky envelope of the fibrovascular ring. This takes place in nearly all the varieties of the vine examined. Decortication facilitates the rooting of the cutting, but only by promoting the penetration of water into its tissues.

Cystoliths.†—Dr. L. Radlkofer describes the various forms of cystoliths and the cells in which they are contained. The natural orders in which their presence has been certainly determined amount to 10, viz.:—the Urticaceæ, Acanthaceæ, Cucurbitaceæ, Begoniaceæ, Gyrocarpeæ, Olacineæ, Cordiaceæ, Borragineæ, Hydrophyllaceæ, and Verbenaceæ. In addition to ordinary lithocysts, the cystolith may be developed in hairs with moderately thick walls and superficial calcareous deposits, which are frequently collected into rosettes.

Mestome-sheath of Grasses.‡—Herr S. Schwendener finds that in the leaves of Gramineæ the mestome-bundle is usually inclosed in a typical protecting sheath, and that its formation is not dependent on external conditions; but that it can be used, to a large extent, as a taxonomic character. The cells of this sheath are parenchymatous, often with sharpened ends; their walls have roundish or oval pores, and the thickening is usually on the inner side. It frequently, in the smaller bundles, completely surrounds the sieve-portion only. Whether this mestome-sheath is present or not, each separate bundle in the leaves of grasses is surrounded by a parenchymatous sheath.

A similar sheath occurs also in some other natural orders, as in the Stachydeæ among Labiatæ (it is wanting in the Ocymoideæ). It is almost invariably present in underground stems, even when entirely wanting in the aerial organs.

Mucilage and other glands of the Plumbagineæ.§—Mr. J. Wilson in the first place draws a distinction between the two sets of secreting organs, viz. the Mettenian glands, characterized by the secretion of calcium carbonate, which are universally distributed over the vegetative organs, and the mucilage-glands, which are confined to the axillary regions. Glands displaying every stage of gradation from the one form to the other are, however, met with in abundance; there can be no doubt that both sets of glands have the same origin, and it is

* Comptes Rendus, cxi. (1890) pp. 426–8.
† SB. K. Bayer. Akad. Wiss. München, 1890, pp. 115–27.
‡ SB. K. Preuss. Akad. Wiss., xxii. (1890) pp. 405–26 (1 pl.).
§ Ann. of Bot., iv. (1890) pp. 231–58 (4 pls.).

very probable that the Mettenian glands are the primordial form. With regard to the stalked glands on the calyx of *Plumbago*, the author states that one can hardly hesitate to affirm that they are extremely specialized forms of Mettenian glands seen in typical condition on the sepals of *Ceratostigma*, *Statice*, &c. The presence of Mettenian glands is most probably a universal feature in the cotyledons of the family. The absence of mucilage-glands from the cotyledons of *Plumbago*, and their invariable presence in the cotyledons of *Armeria* and *Statice*, point to some occult and exceedingly important functions which mucilage performs in the economy of the species of the latter genera.

Besides numerous Plumbagineæ, a considerable variety of plants having an affinity with this natural order were studied. The glands of Frankeniaceæ and Tamaricineæ most nearly approach them, the latter especially bearing, in respect of both form and function, a marked resemblance to chalk-secreting Mettenian glands. The Frankeniaceæ are recognized to be related, although remotely, to the Plumbagineæ, and it is a remarkable coincidence that they affect maritime situations, and are mucilaginous in character.

Structure of Apocynaceæ.*—According to M. Garcin, it is always possible, by microscopical examination, to determine that the least fragment of stem belongs to either the Asclepiadeæ or Apocynaceæ, the most important common characteristic of these two orders being the presence of unseptated laticiferous tubes. The structure of the bast indicates an alliance with the Solanaceæ, Loganiaceæ, and Convolvulaceæ. The more important points in the anatomy of the Apocynaceæ are described in detail, and the variations which occur within the order.

Campanulaceæ and Compositæ.†—Herr J. Seligmann discusses the differences and resemblances between these two natural orders in the structure of their tissues, and asserts that the phenomena point to a near affinity between the two; the most important difference being the absence of tracheid-fibres in the Compositæ. The Lobeliaceæ present, in many respects, a connecting link between the Campanulaceæ and the Compositæ.

(4) Structure of Organs.

Variations in the Flower of the Snowdrop.‡—Prof. G. Stenzel describes the variations which occur in the flower of the snowdrop in the following points:—The number of perianth-leaves and stamens, whether in the way of increase or diminution—this usually takes place symmetrically in both sets of organs; or in the occurrence of two flowers in the same sheath—this is the result of fastigiation, not of chorisis.

Nectary-covers.§—According to Prof. F. Delpino, the chief function of the lid or cover with which the nectaries of many flowers are provided, is to protect the honey against the visits of hurtful insects, such as ants. The fact that they not unfrequently occur in pendent flowers refutes

* Ann. Soc. Bot. Lyon, xv. pp. 197–448 (2 pls.). See Bot. Centralbl., xliii. (1890) p. 207.
† Bot. Centralbl., xliii. (1890) pp. 1–5.
‡ Luerssen u. Haenlein's Biblioth. Bot., Heft 21, 1890, pp. 1–45 (2 pls.).
§ Malpighia, iv. (1890) pp. 21–3.

the opinion which has been expressed by some writers, that their main purpose is to prevent the access of rain to the nectary.

Variations in the Structure of the Acorn.*—Prof. G. Stenzel describes the variations in the structure of the fruit of *Quercus pedunculata* in the following points:—(1) In their size and shape; (2) In the unequal size of the cotyledons; (3) In the variable number of the cotyledons, which may be reduced to one either by the suppression of one or by coalescence, or may be increased to three or rarely to four; (4) In the lateral position of the plumule; (5) In the occurrence of two, or more rarely of three seeds in the ovary; (6) In polyembryony; more than two embryos were never observed.

Buds of Sempervivum and Sedum.†—Prof. A. Kerner v. Marilaun describes the structure of the buds which detach themselves for the purpose of propagation from *Sempervivum arenarium* and *soboliferum* and *Sedum dasyphyllum.* In the species of *Sempervivum* minute buds are formed in the axil of the leaves of the rosette; these put out filiform stolons, the ends of which are densely covered with leaves; these globular terminal portions become detached by the withering of the lower part of the stolon, are blown away, and develope into new plants. In *Sedum dasyphyllum* it is not uncommon for the flowers themselves to be metamorphosed into a rosette of small leaves; or buds may be found imbedded in the tissue of the upper surface of the very thick leaves of the central portion of the stem, or elevated on long stalks in the axil of the lower leaves. All these become detached and germinate in the same way.

Dormant Buds in Woody Dicotyledons.‡—M. A. Prunet states that all woody plants have dormant buds, but that these buds are often very small, and hidden in the bark; microscopical examination is frequently necessary to determine their existence. Their connection with the pith of the stem is by means of a large medullary ray. These dormant buds are not only met with in the axil of ordinary leaves, but at the base of rudimentary leaves and bud-scales; and one or more additional buds often accompany the normal axillary bud. In exceptional cases the additional buds may appear opposite the point of emergence of the lateral foliar traces, in the axil of the plurifascicled leaves. The duration of dormant buds depends upon their means of defence against the sources of destruction, especially desiccation.

Leaves of Nymphæaceæ.§—Prof. G. Arcangeli describes the structure of the submerged, aerial, and floating leaves of *Nymphæa alba* and *Nuphar lutea*, which agrees with the well-known features of the leaves of other water-plants. The formation of submerged leaves only in great depths he does not regard as the direct result of the greater depth of water, but rather as due to a weakening or decrease of vital energy, resulting from the greater depth of the roots below the surface.

* Luerssen u. Haenlein's Biblioth. Bot., Heft 21, 1890, pp. 46-65 (1 pl.).
† Oesterr. Bot. Zeitschr., xl. (1890) pp. 355-7 (5 figs.).
‡ Journ. de Bot. (Morot), iv. (1890) pp. 258-63.
§ Nuov. Giorn. Bot. Ital., xxii. (1890) pp. 441-6.

Leaves of Conifers.*—M. A. Daguillon draws the following conclusions from his work on the evolution of the leaves of the Abietineæ:—(1) The existence of primordial leaves, that is, of leaves intermediate between the cotyledonary leaves and those of the adult plant, is constant. (2) The passage from the primordial form can take place without numerous transitions, as in *Pinus*, or by insensible gradations, as in *Abies*. (3) This passage is sometimes characterized by a modification in the phyllotaxis. (4) Sometimes also it is marked by a change in the state of the epidermal surface. (5) It is nearly always accompanied by the development, below the epiderm, of one or more sclerenchymatous layers, which afford the leaf protection and support. (6) The pericyclic sclerenchyme, which incloses more or less completely the median vein, acquires a considerable development. Further, among the two sorts of elements of which it is composed (cells with areolated punctations and fibres with smooth membranes), the latter are often absent from the primordial leaves, appearing with the passage from the primordial to the definite form. (7) In certain genera (*Abies, Pinus*) the fibrovascular system of the median vein proceeding from a single bundle of the stem bifurcates in the interior of the adult, while it remains simple in the primordial leaf. (8) In all cases the number of the conducting elements of the xylem and of the phloem augments when the primordial passes to the mature leaf. (9) When the foliar parenchyme is heterogeneous and bifacial, the differentiation of the palisade-tissue is generally accentuated in the adult leaves.

Leaves of Marine Phanerogams.† — Pursuing his examination of the leaves of aquatic plants, M. C. Sauvageau states that the family of Hydrocharideæ contains only three genera adapted to live in sea-water, *Enhalus*, *Thalassia*, and *Halophila*. The leaf of *Enhalus aceroides*, besides its dimensions and absence of ligule, is distinguished from that of all other marine flowering plants by the long fibrous filaments, by the anatomy of the fibrovascular bundles, and by the double orientation of the fibrovascular bundles of the limb. *Thalassia* differs from *Enhalus* in the structure of the limb, the two species of *Thalassia* differing from one another in the nature of the teeth at the extremity of that organ. In *Halophila* there is but very slight differentiation in the structure of the leaf.

The small genera *Halodule* and *Phyllospadix* present nothing very remarkable in the structure of their leaves. *Halodule* has secreting cells which are entirely epidermal; both genera have non-lignified fibres in the vascular bundles between the xylem and the phloem.

Summing up the conclusions of his study of the leaves of marine Phanerogams, M. Sauvageau states that if those flowering plants which live normally in the submerged condition are descended from terrestrial plants which have adapted themselves to this new mode of existence, the adaptation must have taken place in several different ways. The presence and the importance of a more or less lignified mechanical system vary greatly in the different genera. Except in the genus *Halophila*,

* Rev. Gen. de Bot. (Bonnier), ii. (1890) pp. 154–61, 201–16, 245–75, 307–20, 345–58 (4 pls. and 68 figs.).

† Journ. de Bot. (Morot), iv. (1890) pp. 269–73, 289–95, 321–32 (12 figs.). Cf. this Journal, 1890, p. 741.

the anatomical study of the leaf is of great importance for the determination of the genus and the species, the more so in consequence of the rarity of the flowers and of the fruits.

Leaves of Aloineæ.*—Sig. D. Lanza describes the structure of the leaves in a large number of Aloineæ, which agree in all essential characters. The cuticle varies greatly in thickness according to the species; the epiderm is homogeneous, and is composed of a single layer of cells; next to the epiderm comes an assimilating tissue, consisting of a very variable number of cells. Scattered through the assimilating parenchyme are a number of cells with suberized walls and sometimes of great length, containing raphides. The vascular bundles are of uniform structure throughout the order, and each is surrounded by its own endoderm; the cells which contain the peculiar bitter principle constitute a layer outside the sieve-cells. The surface of the leaves of *Haworthia* and *Gasteria* is covered with excrescences originating from below the epiderm, and composed of colourless cells, the function of which appears to be to protect the plant from excessive insolation. The author states that the leaves of *Haworthia fasciata* altogether change their habit with the locality in which they grow, being flat or erect, according as they are exposed to shade or to sunlight. He finds no sufficient characters, either in the flower, the fruit, or the leaves, for distinguishing the genera *Aloe*, *Gasteria*, *Haworthia*, and *Apicra*.

Filaments in the Scales of the Rhizome of Lathræa squamaria.†—Herr A. Scherffel maintains his previous view that these structures are not of a waxy nature, but are living bacteria, of which he finds also the zooglœa-form. This view he supports by microchemical evidence against the adverse criticism of Jost. Their presence, or at all events their abundance, appears to depend on the richness in protoplasm of the scales or glands in connection with which they are found.

Trichomes of Corokia budleoides.‡—Dr. A. Weiss describes the structure and the mode of development from a single epidermal cell of the remarkable hairs which cover both surfaces of young, but the under surface only of mature leaves, as well as the axis of this plant (Cornaceæ). They are of the form which he designates T-hairs, consisting of a very elongated cell fixed transversely at nearly its centre to a pedicel composed of four or five short cells. The membrane of the T-cell is largely impregnated with calcium carbonate; and the hairs evidently serve the purpose of protecting the plant against the attacks of animals, and also against the penetration of the mycele of fungi.

Bulbils of Malaxis.§—According to Herr V. A. Poulsen, the bulbils often found on the apices of the leaves of *Malaxis paludosa* resemble ovules in having their axis clothed with an integument-like sheath. They have neither vascular bundle nor root, and are developed from the epiderm of the mother-leaf. New bulbils are sometimes formed at the margin of the sheath.

* Malpighia, iv. (1890) pp. 145–67 (1 pl.).
† Bot. Ztg., xlviii. (1890) pp. 417–30 (1 fig.). Cf. this Journal, 1889, p. 89.
‡ SB. K. Akad. Wiss. Wien, xcix. (1890) pp. 268–82 (1 pl. and 1 fig.).
§ 'Om Bulbildannelsen hos Malaxis paludosa,' Kjöbenhavn, 1890. See Bot. Centralbl., xliii. (1890) p. 336.

Morphology of Utricularia.*—Prof. K. Goebel describes a number of species of *Utricularia*, chiefly from the East Indies. In *U. orbiculata* the embryo of the very small seeds has no radicle; of the two minute cotyledons, one appears to develope into the first leaf, the other into the first bladder or into a stolon. The terrestrial species are divided into three groups—those in which the leaves are without bladders, those in which the leaves have bladders, and those in which the leaves have normal stolons.

Of the leaves, Goebel describes six kinds, four of them belonging to the aquatic, two to the terrestrial forms. The stolons are of two kinds, leafy and leafless. In the aquatic species the leafy stolons are branching floating shoots, bearing the leaves in two rows; in the terrestrial forms the leaves are usually dorsal, the stolons lateral or ventral. The leafless stolons may either bear bladders, or may be naked rhizoids without either leaves or bladders.

The bladders are found on the primary shoot, on the stolons, and on the leaves. Each species has its own characteristic form of bladder, and these may be classified in three groups:—(1) Those of the aquatic species, which more or less resemble the bladders of *U. vulgaris;* (2) bladders with long antennæ and the upper wall of the funnel elongated (*U. orbiculata, cærulea, bifida, elachista,* &c.); (3) bladders with broad funnel-like opening and a proboscis (*U. rosea, Warburgi* sp. n., &c.). The stolons may be either axial structures or metamorphosed leaves.

Structure of Sapindaceæ.†—Dr. L. Radlkofer discusses in great detail the anatomy and morphology, the limits and affinities, and the classification of the hundred and seventeen genera belonging to this natural order, which he divides into two suborders—the Eusapindaceæ, with a solitary, apotropous, erect or suberect ovule in each loculus; and the Dyssapindaceæ, with two or more (rarely solitary) epitropous and pendulous ovules in each loculus.

β. Physiology.

(1) Reproduction and Germination.

Hybridization and Crossing.‡—Herr W. Focke finds that, while lilies of the group *L. bulbiferum* are almost invariably sterile with their own pollen, they are readily fertilized by pollen from any other individual of the same group. The same is the case with *Hemerocallis flava*, and probably all other species except *H. minor.*

A hybrid is readily obtained between *Tragopogon pratense* and *T. porrifolium.*

The two species of *Melilotus*, *M. albus* and *M. macrorhizus*, the one white, the other yellow, are both freely visited by honey-bees, which, as a rule, confine themselves rigorously to flowers of one colour on the

* Ann. Jard. Bot. Buitenzorg, ix. (1890) pp. 41-119 (10 pls.). Cf. this Journal, 1889, p. 780.

† SB. K. Bayer. Akad. Wiss. München, 1890, pp. 105-379.

‡ Abhandl. Naturw. Ver. Bremen, xi. (1890) pp. 413-22. See Bot. Centralbl., xliii. (1890) p. 34.

same journey. It is, however, possible to obtain hybrids between the two species, and then the standard is always white, and all the remainder of the corolla yellow.

A possible case of parthenogenesis in *Bryonia dioica* is recorded.

Fertilization of Caryophyllaceæ.*—Prof. E. Warming describes the structure of the flowers of a large number of Scandinavian and Arctic Caryophyllaceæ, especially in relation to the mode of pollination.

Honey was found in all the species examined. The flowers are usually proterandrous; the stamens borne on the sepals are developed first, then those borne on the petals, and finally the stigmas; proterogyny occurs in a few species, and is apparently correlated with the reduction of the petals. The author confirms the observation of Müller that the degree of proterandry is in proportion to the size of the flower; but the arctic species, even when large-flowered, are more inclined to homogamy than those from lower latitudes. Self-pollination is frequent, and results in perfect fructification; anemophily is very rare, but occurs in *Silene Otites.* Many homogamous species are pleogamous, and these are generally gynodiœcious; this the author regards as not advantageous, but rather as a degeneration, caused by external or internal conditions. The larger flowers are usually hermaphrodite, while the smaller flowers are more or less reduced. Cleistogamous flowers are not uncommon. In many species the flowers remain closed in dark and cold weather, and are then self-fertilized. He does not find that the female are more fertile than the hermaphrodite flowers.

Fertilization of Araceæ.†—Prof. G. Arcangeli describes the phenomena connected with the opening of the inflorescence of *Helicodiceros muscivorus* (Araceæ). The first day of the expansion of the spathe, he found imprisoned within it as many as 378 insects, of which 371 were Diptera, and 7 Coleoptera. From the entire absence of any digestive glands on the inner surface of the spathe, or any other organs for the absorption of nutritive material, he rejects Schnetzler's explanation that the dead bodies of the insects serve for the nutrition of the plant, and believes that they assist in the process of pollination.

Returning to the fertilization of *Dracunculus*, Prof. Arcangeli‡ adduces additional facts in favour of his view that the flowers of *D. vulgaris* are pollinated chiefly by necro-coleoptera. He was able to effect impregnation by the artificial introduction into the inflorescence of specimens of *Saprinus* and *Dermestes* which had already been pollinated.

Artificial Germination of Milk-weed Pollen.§—Prof. B. D. Halsted has been able to germinate the pollen-grains which constitute the pollinia of *Acerates viridiflorum* (Asclepiadeæ) by immersing them in agar, and was able to watch the very beautiful movements of protoplasm within the pollen-grain after it has put out its tube. These consist of a continuous current round the large vacuoles. The same phenomenon was observed in various species of *Asclepias.*

* Bot. Foren. Festskr. (Copenhagen), pp. 194–296 (29 figs.).
† Nuov. Giorn. Bot. Ital., xxii. (1890) pp. 467–72.
‡ Malpighia, iv. (1890) pp. 254–61. Cf. this Journal, 1890, p. 629.
§ The Microscope (Trenton, N. J.), x. (1890) pp. 229–31 (4 figs.).

Abnormal Germination of Acer platanoides.*—M. L. J. Léger finds that in about 4 per cent. of the instances examined the germination of the seeds of *Acer platanoides* was abnormal; the irregularity was in the following directions:—(1) one of the two cotyledons was more or less bifid; (2) the number of cotyledons was three; (3) each of the two cotyledons was split for 1/3 of its length; (4) the number of cotyledons was four. The structure of the cotyledons is described in each of these cases, especially in regard to the arrangement of their vascular bundles.

Dissemination of the Seeds of Harpagophyton.†—Herr P. Ascherson calls attention to the remarkable way in which the seeds of *Harpagophyton* (Pedaliaceæ) are disseminated in South Africa. The seed-vessels growing on the prostrate branches are covered with hooked appendages, which become fixed in the hoofs of antelopes and cattle. The violent stamping of the animal to get rid of the annoyance splits the hard pericarp and scatters the seeds. The characteristic hooked bristles on the seed-vessels are found even in the aquatic genus of the order, *Trapella*.‡ *Sesamum Schinzianum* is characterized by the unusual occurrence on the same species of both extra-floral nectaries and a viscid hairy covering of the axis.

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

Relations between Host and Parasite.§—Prof. H. Marshall Ward discusses some of the relations between host and parasite in certain epidemic diseases of plants. He shows that the conditions which are unfavourable to the vitality of the host are, in general, favourable to the rapid development and propagation of the fungus-parasite, causing especially thinness and softness in the cell-walls, and a greater permeability and less resistance in the protoplasm, with a larger proportion of organic acids, glucoses, and soluble nitrogenous constituents in the cell-sap. In the case of some of the fungi which are most destructive to plants, while the botrytis-form is saprophytic, the mycele is truly parasitic in the tissues of the host; and this latter is especially vigorous and destructive where the botrytis-form has had abundant food-material to live upon. In addition to a ferment or enzyme, the hyphæ of the mycele have the power of developing large quantities of oxalic acid, which is especially destructive to the protoplasm of the host. Whether a given fungus exists as a parasite or as a saprophyte is, to a large extent, a question of nutrition.

Parasitism of Orobanche.‖—Dr. G. Ritter Beck von Mannagetta gives the characters of the 13 genera of the order Orobancheæ, and a complete monograph of the 82 species of *Orobanche*. With regard to their parasitism, he finds that, while a few species—*O. Laserpitii*, *Hederæ*, and *Artemisiæ*—are known only on a single host-plant, a much larger number grow on many indifferently, *O. minor* on as many as 58 species. The natural orders to which the greatest number of the host-plants belong

* Bull. Soc. Linn. Normandie, 1888–9 (1890) pp. 199–223 (1 pl.).
† Verhandl. Bot. Ver. Brandenburg, xxx. (1889) pp. ii.–v.
‡ Cf. this Journal, 1888, p. 992.
§ Proc. Roy. Soc., xlvii. (1890) pp. 393–443 (16 figs.).
‖ Luerssen u. Haenlein's Biblioth. Bot., Heft 19, 1890, 275 pp. and 4 pls.

are Leguminosæ and Compositæ. With the exception that some hosts seem more favourable to the growth of the parasite than others, the same species of *Orobanche* growing on different host-plants presents no perceptible difference of any kind. On the other hand, they inflict great injury on many cultivated crops, especially hemp, clover, and tobacco.

Phanerogamic Parasites.*—Dr. F. Johow gives a summary of all that is at present known with regard to parasitic flowering plants, which he classifies under four heads, viz.: — Euphytoids, which have developed from ordinary terrestrial autotrophous plants (Loranthaceæ, most Santalaceæ, Rhinantheæ, Orobancheæ, &c.); (2) Lianoids, developed from climbing plants (*Cuscuta*, *Cassytha*); (3) Epiphytoids, those that resemble epiphytes except in their parasitic habit (Loranthaceæ, some Santalaceæ); (4) Fungoids, which present no relationship with any autotrophous group (Balanophoraceæ, Cytinaceæ). Each of these classes, except the last, may be again divided into Holoparasites and Hemiparasites. Some again are obligatory, and others facultative parasites. The total number of species known is somewhat over a thousand, of which about one-half belong to the Loranthaceæ.

As regards the choice of a host, some species grow only on a single host-species, as *Loranthus aphyllus* on *Cereus peruvianus*, *Cuscuta Epilinum* on the flax; others only on different species of the same genus; others only on different genera of the same family; while others again have no such restrictions. Some again choose in preference different hosts in different districts; thus, for example, the mistletoe grows in some regions almost exclusively on the apple, in others on the pine; *Arceuthobium Oxycedri* only on *Juniperus Oxycedri* in Europe; in North America on different species of *Pinus*. Many parasites confine their attacks to special parts of the host-plant; as the Loranthaceæ entirely to branches, the Balanophoraceæ entirely to roots. The organ for the absorption of nutriment is, in all except the Cytinaceæ, differentiated haustoria, which are apparently, from a morphological point of view, metamorphosed roots. In the Cytinaceæ the entire vegetative structure of the parasite, imbedded in the interior of the host, serves as a haustorium.

A special description is also given of the mode of parasitism in the different groups; and the species or genera belonging to each are enumerated.

Rooting of Bulbs and Geotropism.†—M. H. Devaux states that the anomalous method of rooting by means of stalked bulbs in the common tulip has been observed by Germain de Saint Pierre, Irmisch, and Royer. But this method of rooting is not confined to the tulip. In various species of *Allium*, *Muscari*, *Scilla*, *Hyacinthus*, *Calystegia*, *Sagittaria*, *Tamus*, &c., one or more internodes of the stem may become enlarged, and thrust vertically into the ground by their free extremity; this extremity bears a bud which is destined to be transformed into a bulb or tubercle. This phenomenon appears to be the result of geotropism.

* Verhandl. Deutsch. Wissensch. Ver. Santiago, ii. (1890) pp. 68-105 (10 figs.).
† Bull. Soc. Bot. France, xxxvii. (1890) pp. 155-9.

Assimilation and Respiration.*—Prof. Kreusler has determined, from experiments chiefly on the bramble and cherry-laurel, that the optimum temperature for the exhalation of carbon dioxide is about 45° C., a rise of 5° above this showing a considerable diminution in the energy of the respiration; he finds no confirmation of the theory of a "post-mortal" respiration. The assimilating energy shows no considerable variations between 15° and 30° C.; above 30° it begins gradually to diminish, falling to zero at a temperature between 45° and 50° C.

Assimilation by Red Leaves.†—From observations on the red varieties of the beech, the birch, and the sycamore, M. H. Jumelle concludes that in trees with leaves of a red or copper colour, chlorophyllous assimilation is always less intense that in the same trees with green leaves; in the case of the copper-beech and purple sycamore, this is reduced to one-sixth of the normal amount.

Influence of high altitudes on Assimilation and Respiration.‡—As the result of a series of experiments on a number of species, chiefly herbaceous, Prof. G. Bonnier finds that in the same plants, placed in the same external conditions, the specimen grown in an alpine climate modifies its functions by the augmentation of chlorophyllous assimilation and transpiration, while respiration and transpiration in the dark appear to be scarcely affected by the change.

Permeability of Wood to Air.§—M. Kruticki distinguishes in this respect three classes of wood, viz. (1) Those which present great permeability, as the oak and poplar, in which the air can penetrate under a pressure of from 3 to 10 mm. of mercury; (2) Those of low permeability, like the birch and maple, which require a pressure above that of the atmosphere; and (3) Those of moderate permeability, which are very numerous. The air contained in the branches has not always the same composition; in winter it contains less oxygen than the atmospheric air, but a larger proportion of nitrogen, and especially of carbonic acid; with the commencement of spring, the proportion of oxygen increases, while that of carbon dioxide diminishes, so that when the buds expand, the composition of the imprisoned air is very nearly that of the atmosphere.

(3) Irritability.

Action of Water on Sensitive Movements.‖—M. H. Léveillé gives the details of an experiment on this point with *Mimosa rubricaulis*; the following conclusion was arrived at:—plants, if placed under water, retain their sensitiveness as long as they retain any vigour.

Movements of the Leaves of Porlieria hygrometrica.¶—Dr. G. Paoletti states that the diurnal movements of the leaves and leaflets of this plant (Zygophyllaceæ) is due to unequal turgidity of the two cells

* SB. Niederrhein. Gesell. (Verhandl. Naturhist. Ver. Preus. Rheinl.), lxxiv. (1890) pp. 54–60.

† Comptes Rendus, cxi. (1890) pp. 380–2.

‡ T. c., pp. 377–80; cf. this Journal, 1890, p. 486.

§ Script. Bot. Hort. Univ. Imp. Petropolitanæ, ii. See Bonnier's Rev. Gen. de Bot., ii. (1890) p. 324.

‖ Bull. Soc. Bot. France, xxxvii. (1890) p. 153.

¶ Malpighia, iv. (1890) pp. 34–40.

which compose the primary and secondary motor nodes (those of the entire leaf and of the leaflets), caused by the greater amount of light and heat to which the upper one of the two is subject in the morning. If exposed either to continuous darkness or to continuous light, the movements will continue for some days, but with decreasing energy, and will finally cease altogether.

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

Formation of Albuminoids.*—In order to test the correctness of the theory that the chromatophores are the seat of the synthesis of the albuminoids in plants, M. Chrapowicki cultivated plants of *Phaseolus vulgaris*, *Cucurbita Pepo*, and *Zea Mays* in a non-nitrogenous saline solution obtained by replacing the potassium and calcium nitrates in Knop's solution by potassium chloride and calcium sulphate. The development was at first normal, but was soon retarded and finally entirely arrested. The leaves were cut off and placed in normal Knop's solution, and the formation of the albuminoids watched under the Microscope. They were formed at the expense of the nitrates in the solution, and always made their appearance first in the chromatophores.

γ. General.

Action of Solar Heat on the Floral Envelopes.†—M. E. Roze has endeavoured to determine by experiment whether the direct effect of the sun's heat varies with the different colours of flowers. When a flower which has opened in the shade is suddenly exposed to solar radiation, it absorbs at first a certain quantity of heat, then rapidly gives off a large portion of this caloric, and, if then again placed in the shade, gradually loses the absorbed heat, and places itself in equilibrium with the temperature of the surrounding air. Red or violet floral envelopes absorb and give off more rays of heat than blue or yellow, and these latter more than white. A thermometer placed over the first rises, when transferred from the shade to the sun, as much as 8°; one over the second 6°–7°; over the third 5°–6°; while over green leaves it does not rise more than from 2° to 3°. These latter absorb as much heat as petals, but give off again only a small quantity. This radiation of heat from the petals has probably a great effect in promoting the dehiscence of the anthers. The author found also that heat is powerfully absorbed by the soil from the sun's rays, and is given off again to the whole plant, and especially to the parts in contact with the earth. A thermometer placed above the prostrate leaves of *Plantago major* rose to 44°, and in the case of *Hypochæris radicata* to 46°, while the temperature of the surrounding air was only 28°.

Biology of the Ericaceæ.‡—M. L. Fliche has examined various species of Ericaceæ with a view to determine the quantity of mineral elements which they require. He finds that the plants belonging to

* Arb. St. Petersburg Naturf. Gesell., xviii. See Bonnier's Rev. Gén. de Bot., ii. (1890) p. 359.

† Bull. Soc. Bot. France, xxxvi. (1889), Actes du Congrès de Bot., pp. ccxii.–ccxiv.

‡ Rev. des Eaux et Forêts, Nov. 10, 1889. See Bull. Soc. Bot. France, xxxvii. (1890), Rev. Bibl., p. 107.

this order can be classed under two categories, calcifugous and calcicolous; the composition of the ash being nearly uniform in each class; but the difference between the two is very pronounced, although some genera, such as *Erica*, have representatives in each group. In the calcifugous species, e. g. *Erica cinerea*, *Calluna vulgaris*, the proportion of silica in the ash is very high, sometimes exceeding 30 per cent., while that of lime is not more than 20 per cent.; in the calcicolous species such as *E. multiflora*, the proportion of silica is not more than 13 per cent., while that of lime may be as much as 31, and that of potassa as much as 22 per cent.

Myrmecophilous Plants.*—Herr K. Schumann describes a number of fresh myrmecophilous trees and shrubs, chiefly from the East Indian Archipelago, viz.:—*Gmelinia* (*Vitex*) *macrophylla* (Verbenaceæ); among Rubiaceæ *Remijia physophora* and *Nauclea lanceolata*, where the ants inhabit chambers in the stem, and *Myristica heterophylla* sp. n.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Sphenophyllum and Asterophyllites.†—From examination of a specimen from the Carboniferous strata of Silesia, Mr. A. C. Seward concludes that *Asterophyllites* is not a distinct genus of Vascular Cryptogams, but that it must be regarded as a morphological condition of *Sphenophyllum*, with reduced leaves having only a single vein.

Muscineæ.

Peristome.‡—M. Philibert now brings to a close his discussion of the differences between the Nematodonteæ and the Arthrodonteæ, and the transitions between these two groups. The following are the author's conclusions:—That the Nematodonteæ attain their highest degree of development in the Polytrichaceæ, having probably passed through a series of stages of less complexity, corresponding to the series of Dawsonieæ. The Arthrodonteæ give rise to a great variety of forms. The Leptostomeæ and the Splachnaceæ appear to have preserved traces of forms transitional between the Nematodonteæ and the Diplolepideæ; the Funariaceæ and the Orthotrichaceæ resemble the latter in certain characters. There is also an affinity between the genera *Splachnum* and *Bryum*; and to the Bryaceæ belong the Hypnaceæ, and all the Pleurocarpeæ, whose development has been posterior to that of other mosses.

Microspores of Sphagnaceæ.§—Herr S. Nawaschin maintains that the so-called microspores of certain species of *Sphagnum* belonging to the *acutifolium* group are not organs of the moss itself, but are spores of a parasitic fungus belonging to the Ustilagineæ, probably an undescribed species of *Tilletia*.

Javanese Hepaticæ.‖—Under the name *Treubia* Prof. K. Goebel describes a new genus of Hepaticæ from Java, belonging to those

* Verhandl. Bot. Ver. Brandenb., 1890, pp. 113–23. Cf. this Journal, 1890, p. 486.
† Mem. and Proc. Manchester Lit. and Phil. Soc., 1890 (3 figs.).
‡ Rev. Bryol., xvii. (1890) pp. 39–42. Cf. this Journal, 1890, p. 488.
§ Bot. Centralbl., xliii. (1890) pp. 289–90.
‖ Ann. Jard. Bot. Buitenzorg, ix. (1890) pp. 1–40 (4 pls.).

which form a link between the thalloid and the foliose forms. While the leaves are the largest known among Hepaticæ, the position of the sexual organs (archegones only have at present been observed) allies it with the thalloid forms. The cells of the stem are infested by a parasitic, or possibly symbiotic, fungus.

Colura ornata sp. n. is epiphyllous; the water-sack characteristic of the genus is surmounted by a comb-like projection from the surface of the leaf. A species of *Plagiochila* with water-sacks is also described.

Kurzia crenacanthoidea, described by its discoverer as an alga, is in reality a species of *Lepidozia* with confervoid habit.

Characeæ.

Histology of Characeæ.*—Dr. W. Overton's researches on this subject relate mainly to two points:—

(1) The nature of the spiny bodies found in the cells. The species examined for this purposes was chiefly *Nitella syncarpa*. They were found in all the mature internodes of the stem and leaves, where they obtain a diameter of 22 to 24 μ in the young oospheres, in the cortical cells of the oosperm, in the shield-cells of the antherids, occasionally in the manubria, but not in the other cells of the antherids. They are clothed with a distinct membrane, and often occur in dense masses, when they assume a polygonal form. Microchemical reactions show that they are of a proteid nature, and that they frequently contain tannin; they are peculiarly resistant to the action of acids, even when concentrated. They may be compared to a certain extent with aleurone-grains. The living cells of young internodes contain also a number of hyaline vesicles imbedded in the protoplasm, which are also clothed with a distinct membrane, and are clearly of a similar nature to the spiny bodies. In the species of *Chara* examined (*C. fragilis* and *hispida*) no structures were found resembling either of those above described.

(2) The structure of the hard envelope of the oosperm. This envelope is not lignified in the correct sense of the term; i.e. it does not show the microchemical reactions of lignin, but rather those of cuticularized and suberized membranes. After removal of the calcareous deposit, the envelope of the oosperm of *Chara fragilis* consists of three layers:—the outermost is nearly black, is furnished with spiral thickening-bands, and bears a number of short spines; the middle layer is brown and smooth; the innermost is the true membrane of the oosperm, is light brown and transparent, and is but slightly cuticularized.

Algæ.

Algæ of Behring's Sea.†—Herr F. R. Kjellman describes the seaweeds of this sea, which are partly of an Arctic, partly of a more southern character, with some peculiar to the region. Several new species are described, and one new genus of Phæosporeæ, *Analipus*, with unilocular zoosporanges, a horizontal almost crustaceous thallus, from which rise the fertile branches, simple, solid below and fistulose above.

* Bot. Centralbl., xliv. (1890) pp. 1–10, 33–8 (1 pl.).

† K. Svensk. Vetensk.-Akad. Handl., xxiii. (1889) 58 pp. and 7 pls. See Bot. Centralbl., xliv. (1890) p. 150.

Sargassum.*—Prof. J. G. Agardh publishes a monograph of this genus of seaweeds, with a description of the different forms assumed by the various organs. 143 species are described, of which 24 are new. The author classifies them under five subgenera, viz.:—*Phyllotricha*, *Schizophycus*, *Bactrophycus*, *Arthrophycus*, and *Eusargassum*, founded generally on the form and disposition of the receptacles. Of the five subgenera, *Schizophycus* comprises only a single species, while 93 are included in *Eusargassum*.

New Genus of Phæosporeæ.†—M. E. Bornet proposes the new genus *Zosterocarpus*, founded on *Ectocarpus Œdogonium* Men., which he separates from *Ectocarpus* with the following diagnosis:—Thallus monosiphonius ramosus; sporangia plurilocularia divisione periferica articulorum exorta, soros crustiformes orbiculares v. annuliformes in articulis ramulorum formantia; cellulæ singulæ sporangiorum simplices breves haud septatæ apice poro apertæ.

Prasiola and Schizogonium.‡—M. E. de Wildeman considers that it has been established that *Schizogonium* and *Hormidium* are simply forms of development of the same organism. The family Ulotricheæ must therefore be reduced to the genus *Hormiscia* alone of the genera included under it by De Toni, to which should be added *Prasiola*, which the author proposes to remove from Ulvaceæ, and thinks it probable that to it will finally be referred the species at present placed in *Schizogonium*.

Myxochæte, a new genus of Algæ.§—Under the name *Myxochæte barbata*, Herr K. Bohlin describes a new species and genus of green algæ, growing in fresh water, epiphytic on *Vaucheria sessilis*, and nearly allied to *Chætopeltis*. The thallus is discoid, and usually consists of a single layer of cells, is invested in mucus, and each cell is provided with two hyaline bristles; the branches are irregularly aggregated, and each cell contains a single chlorophyll-mass.

Neomeris and Bornetella.‖—Prof. C. Cramer describes a number of species of the verticillate Siphoneæ, chiefly belonging to the above-named genera, viz.:—*Polyphysa Peniculus*, *Botryophora Conquerantii*, *Neomeris Kelleri*, *N. dumetosa*, *Bornetella nitida*, *B. capitata*.

Observation of the structure of the mantle-sheath, and of the mantle-caps, especially in *Neomeris* and in *Bornetella*, lead Prof. Cramer to the conclusion that they are formed by intussusception. By the mantle-cap is meant the upper deciduous, by the mantle-sheath the lower permanent portion of cellulose layers formed over the apical cell between the layers of hairs; this last becomes at length strongly calcified; the others are free from lime. The sporanges and spores are described in both these genera; also cubical crystalloids in the cells of

* Handl. K. Svenska Vetensk.-akad., 1889, 133 pp. and 31 pls. See Bull. Soc. Bot. France, xxxvii. (1890) Rev. Bibl., p. 110.

† Bull. Soc. Bot. France, xxxvii. (1890) pp. 139–48 (1 fig.).

‡ Bull. Soc. Belg. Microscop., vi. (1890). See Notarisia, v. (1890) p. 1035.

§ Bih. K. Svensk. Akad. Handl., xv. (1890) 7 pp. and 1 pl.

‖ Denkschr. Schweiz. Naturf. Gesell., xxxii. (1890) 48 pp. and 4 pls. Cf. this Journal, 1888, p. 464.

the stem of *Botryophora Conquerantii*, and spherocrystals of inulin in sterile specimens of the same species.

Phytophysa.*—Under the name *Phytophysa Treubii*, Mdme. Weber van Bosse describes an epiphyllous alga from Java belonging to the Phyllosiphonaceæ, found on the stems, leaves, leaf-stalks, and buds of a species of *Pilea*, where it causes internal galls. *Phytophysa* resembles *Phyllosiphon* in its manner of living, in part, at least, at the expense of its host. Both are surrounded by a thick membrane; *Phyllosiphon* is rich in grains of starch, *Phytophysa* in grains of cellulose; in both each cell contains a considerable number of minute nuclei. *Phytophysa* is distinguished from *Phyllosiphon* by its spherical form, and by producing galls.

Gonium pectorale.†—Dr. W. Migula has subjected this organism to a careful investigation, and finds that the entire colony, as well as each individual cell, is inclosed in a mucilaginous envelope, often of extreme tenuity, and of nearly the same refrangibility as water. The interstitial space between the envelopes of the separate cells is composed of a central quadrangle and four longer and twelve shorter isosceles triangles. When the colony consists of only four cells, there are two more or less regular usually isosceles triangles, thus presenting a clear distinction from *G. tetras*, in which the four cells are arranged around a nearly square intercellular space. The young colonies are already surrounded by their envelope when they escape from their mother-colony. The protoplasm of the cilia presents somewhat different reactions from that of the cells, and their vibratility is confined to their apical portion. When cell-division is taking place, the cilia of the mother-cell persist often until the sixteen daughter-cells are fully formed. The movement of the colony is of a more trembling nature than that of *Volvox*; and there are no protoplasmic threads connecting the cells. The *Gonium*-colony enters into a resting condition as a result of desiccation, closely resembling that of *Pandorina*; the membranes become thicker and denser, and the cilia disappear, as do finally the pigment-spot and the two cilia. The resting-cells have a diameter of about 12–15 μ; they are dark green, and are filled with a granular endochrome. Each breaks up on germination into four biciliated swarm-cells, closely resembling the cells of an ordinary *Gonium*-colony, but at first wanting the mucilaginous envelope, which, however, is soon formed; these developed, as far as was seen, only into four-celled colonies. In the resting condition the *Gonium*-cells are very liable to be attacked and entirely destroyed by a parasite. The chromatophores break up very readily into a number of very minute chlorophyll-granules.

Fossil Algæ.‡—M. G. Maillard classifies all structures described as fossil algæ under two categories, viz.:—(1) Those which appear as simple half-cylindrical elevations on the under-side of the strata, and are always more or less compressed. (2) Those which can be separated from the rock in which they are imbedded. To the first category, the

* Ann. Jard. Bot. Buitenzorg, viii. (1890) pp. 165-88 (3 pls.).
† Bot. Centralbl., xliv. (1890) pp. 72-6, 103-7, 143-6 (1 pl.).
‡ Mém. Soc. Palæontol. Suisse, xiv. (1887) 5 pls. See Bot. Centralbl., xliii. (1890) p. 126.

algal nature of which is very doubtful, belong the greater number of palæozoic forms, such as *Crossochorda*, *Cruziana*, and *Harlania*, and possibly also *Spirophyton* and *Alectorurus;* in the mesozoic strata, *Helminthopsis*, *Gyrochorte*, and *Cylindrites*, from the Lias ; from the tertiary strata, *Helminthoidea*, *Palæodictyon*, and *Münsteria* from the alpine Flysch. The second category, which he regards as comprised of true fossils, includes *Chondrites* and *Theobaldia*, and probably also *Discophorites* and *Gyrophyllites* from the Jurassic, *Taonurus* and *Nulliporites* from palæozoic strata; *Chondrites*, *Taonurus*, *Caulerpa*, *Sphærococcites*, *Discophorites*, and *Gyrophyllites* from the chalk; *Chondrites*, *Caulerpa*, *Tænidium*, *Halymenites*, *Hormosira*, *Sphærococcites*, *Gyrophyllites*, *Nulliporites*, *Aulacophycus*, and *Taonurus* from tertiary strata. As regards the systematic and phylogenetic position of these algæ, he considers that we have very little evidence.

Fungi.

Carbohydrates in Fungi.*—M. E. Bourquelot gives a résumé of the results of his analyses of the genus *Lactarius*. Mannite, volemite, trehalose, and glucose were the hydrocarbons found; the proportion, however, of these varies from one species to another, and even from one year to another in the same species.

New Ustilagineæ.†—In a general summary of the Ustilagineæ of Denmark, comprising 47 species, Herr E. Rostrup describes the following as new:—*Entyloma Ossifragi*, parasitic on *Narthecium ossifragum*, *E. catenulatum* on *Aira cæspitosa*, *Ustilago Pinguiculæ* on *Pinguicula vulgaris*, *Tuberculina maxima* on *Peridermium Klebahni*, itself parasitic on *Pinus Strobus*.

Dissociation of a Lichen.‡—Sig. U. Martelli records the natural dissociation of a lichen, a variety of *Lecanora subfusca*, into its constituent algal and fungal elements. The central portion of the patches, which were growing on an old wall, were of a deep green colour, caused by large masses of *Protococcus viridis;* while the periphery consisted of nearly colourless mycelial filaments. The cause of this dissociation appears to be excessive humidity, which prevents the fungus putting out its "crampons" or short filaments which take up the gonids.

Bouquet of Fermented Liquors.§—The opinion long ago expressed by M. Pasteur that the flavour and special qualities of certain wines are due to their particular ferment, finds support from the fact recorded by M. G. Jacquemin, who, in endeavouring to impart flavour to barley wine by making it from wort leavened with the special ferments of wines of delicate flavour, found that the sugar-water in which the ferment was kept obtained the exact flavour of the various wines used, such as Champagne or Burgundy. He also imparted the flavour of apples and pears by using their ferments in barley wort.

* Bull. Soc. Mycol., v. See Rev. Mycol., xii. (1890) p. 192. Cf. this Journal, 1890, p. 644.

† 'Ustilagineæ Daniæ,' Kjöbenhavn, 1890, 52 pp. See Bot. Centralbl., xliii. (1890) p. 388.

‡ Nuov. Giorn. Bot. Ital., xxii. (1890) pp. 450-1.

§ Comptus Rendus, cx. (1890) pp. 1140-2.

Indian Rusts and Mildews.*—According to Dr. A. Barclay, the most prevalent form of rust on wheat, barley, and oats in India, is not *Puccinia graminis*, but *P. rubigo-vera*; the æcidio-form appears to occur on *Berberis Lycium*. The following rusts occurring in India are also described:—*Puccinia Sorghi* on *Sorghum vulgare*, *Melampsora Lini* on flax, *Uromyces Pisi* on *Cicer arietinum* and on *Lathyrus sativus*, *Puccinia Fagopyri* on buckwheat.

Puccinia digraphidis.†—By culture experiments, Mr. H. T. Soppitt has proved that the æcidium of *Convallaria majalis* known as *Æcidium Convallariæ* is a heterœcious Uredine, and that the host which bears the uredo- and teleuto-spores is *Phalaris arundinacea*. For the uredospore generation he proposes the name *Puccinia digraphidis*.

New Ramularia on Cotton.‡—Under the name *Ramularia areola*, Prof. G. F. Atkinson describes a new parasitic fungus forming brown spots on the under side of the leaves of the cotton-plant in Alabama.

Uredo notabilis.§—Among other new fungi from Australia, Herr F. Ludwig describes this remarkable species of *Uredo*, parasitic on the phyllodes of *Acacia notabilis*. It causes conspicuous inflated bladders, as much as three cm. in diameter; the epispore of the uredospores is distinguished by its remarkable reticulate sculpture, so that they might readily be taken for teleutospores.

A beautiful new *Clathrus*, *C.* (*Ileodictyon*) *Tepperianus*, is also described from South Australia.

Æcidium Schweinfurthii.‖—Under this name Herr P. Hennings describes a remarkable new species of parasitic fungus which causes large galls on the ovary or young fruit of *Acacia fistula* in Central Africa.

New Type of Dermatomycosis.¶—M. R. Blanchard describes a disease in the skin of a green lizard, in the form of tumours produced by a mucedineous fungus belonging to the genus *Fusarium* or *Selenosporium*. The tumours are permeated throughout by septated conids springing from mycelial filaments of two kinds, acrogenous, and springing laterally from the mycele. The author regards this as an example of a fungus ordinarily saprophytic, which becomes parasitic under exceptional conditions.

Phalloideæ.**—Dr. E. Fischer gives a complete account of the history of development of the Phalloideæ, which begins with the broadening of the end of a hyphal bundle, in which the central bundle and the volva-jelly are formed as denser portions of the tissue, while between these there remains an intermediate tissue which is not at once differentiated. The first differentiations of this intermediate tissue bring about the variations in the form and structure of the receptacle, and of the distribution of the glebe, which afford specific characters. From this

* Journ. of Bot., xxviii. (1890) pp. 257–61 (1 pl.).
† T. c., pp. 213–6.
‡ Bot. Gazette, xv. (1890) pp. 166–8 (4 figs.).
§ Bot. Centralbl., xliii. (1890) pp. 5–9 (2 figs.).
‖ Abhandl. Bot. Verein. Brandenburg, xxx. (1890) pp. 299–300.
¶ Comptes Rendus, cxi. (1890) pp. 479–82.
** Denkschr. Schweiz. Naturf. Gesell., xxxii. (1890) 103 pp. and 6 pls. See Bot. Ztg., xlviii. (1890) p. 496.

point the development of the receptacle is very uniform. As regards classification, the author first divides the Phalloideæ into the Clathreæ and Phalleæ; *Kalchbrennera* being nearly related to the former. The genera are then described in detail, many of those belonging to the Clathreæ passing gradually one into another.

New Genera of Basidiomycetes.* — In a critical account of the Gasteromycetes and Hymenomycetes of Finland, comprising 1255 species, Herr P. A. Karsten describes, in addition to a large number of new species, the following new genera:—*Phisisporinus* (Polyporeæ, separated from *Poria*), *Onnia* (Polyporeæ, separated from *Polyporus*), *Elfvingia* (Polyporeæ, from *Fomes*), *Kneiffiella* (Grandinieæ, from *Hydnum*), and the following under Thelephoreæ:—*Lomatia* (separated from *Thelephora*), *Sterellum* (from *Stereum*), *Chætocarpus* (from *Thelephora*), *Trichocarpus* (from *Xerocarpus*), *Cryptochæte* (from *Thelephora* and *Corticium*), *Phanerochæte* (from *Thelephora*), *Peniophorella*, *Hymenochætella*, *Glœocystidium* (from *Grandinia*), *Diplonema*, *Coniophorella* (from *Hypochnus*), *Hypochnopsis* (from *Hypochnus* and *Lyomyces*).

Protophyta.

α. Schizophyceæ.

Defensive Structure of Diatoms.†—Continuing his observations on this subject, Dr. D. Levi-Morenos classifies the general forms of diatoms under three heads, viz.:—(1) Spherical, with polyhedral, conical, and cylindrical derivatives. (2) Fusiform, with naviculoid and bacilliform derivatives. (3) Irregular, with bi-, tri-, and pluripolar derivatives. In each group those forms appear to have specially survived which were best calculated, in the modes already indicated, either to resist being swallowed by aquatic animals, or, if swallowed, to emerge rapidly and uninjured from the intestinal canal.

Pelagic Diatoms.‡—Sig. O. E. Imhof has examined the pelagic flora of the Lake of Zürich at depths varying from 30–60 metres, and finds diatoms at all these depths, accompanied by a few Nostocaceæ, Oscillariaceæ, and Chroococcaceæ, and by abundance of Schizomycetes. At a depth of 60 metres the following diatoms were found,—*Asterionella formosa*, *Nitzschia pecten*, *Synedra longissima*, *Cymatopleura elliptica*, *Diatoma* sp., *Fragillaria* sp., and *Cyclotella* sp.; while at a depth of 100 m. *Anabæna circinalis* was abundant. The numbers of the two first-named diatoms were greater at a depth of 80–90 m. than at lesser depths.

β. Schizomycetes.

Drawings of Bacteria.—The authorities of the Natural History Museum, South Kensington, have placed in the central hall of that institution a small temporary exhibit, consisting of a set of highly magnified drawings of bacteria. It includes such prominent forms as *Bacillus tuberculosis* Koch and the bacillus of fowl-cholera, and is the work of Dr. W. Migula.

* 'Kritisk Ofversigt af Finlands Basidsvampar,' Helsingfors, 1889, 470 pp. See Bot. Centralbl., xliii. (1890) p. 383.
† Notarisia, v. (1890) pp. 1007–14, 1092–6. See this Journal, 1890, p. 650.
‡ Notarisia, v. (1890) pp. 996–1000.

Researches on Micro-organisms.*—Dr. A. B. Griffiths in the third part of his communications deals first with the alkaloids of living microbes, the origin of which is not yet thoroughly understood. In examining the action of certain antiseptics and disinfectants on microbes, he found that *Bacillus tuberculosis*, *B. subtilis*, *B. œdematis maligni*, *Bacterium allii*, or Beneke's *Spirillum* may have their growth inhibited by three per cent of salicylic acid. Various microbes are capable of being dried up in the dust of the atmosphere for several months without losing their vitality. Observations have been made on the effect of cold and of electrical currents, and the latter were proved to be powerful germicides.

There are a larger number of micro-organisms in the summer than either in the spring or winter, and they appear to reach their maximum during the month of August. The number in the air decreases as one ascends. There are more in crowded than in less densely populated centres, and there are fewer when the air is at rest than at any other time. Dr. Griffiths thinks that the most rational method of treating contagious diseases where microbes reside in the blood is by the injection of some germicidal agent.

Milk and Coffee, and their Relation to Microbes.†—M. Miquel gives a résumé of his observations on the number of microbes present in milk. In a cubic centimetre of milk, on its arrival at the laboratory, which was two hours after it had been taken from the cow, 9000 bacteria were found. In another hour 31,750 were found, while in 25 hours there were over 5,000,000. The number of microbes varies much with the temperature; for example, if the milk is raised 25°, the number of germs is enormous. The greater part of these microbes are innocuous; many probably aid in the digestion of the milk. It has been pointed out that an infusion of coffee possesses antiseptic properties, and that typhoid bacilli and erysipelas bacilli cannot live more than a certain time in it; and in the case of cholera the bacillus can only resist it for a short period.

Septic and Pathogenic Bacteria.‡—From an examination of the water which is believed to have caused an outbreak of typhoid fever at Springwater, New York, Mr. G. W. Rafter and Mr. M. L. Mallory have come to the conclusion that septic bacteria are inimical to pathogenic bacteria, and may even be used to destroy them.

Contribution to the Study of the Morphology and Development of the Bacteriaceæ.§—M. A. Billet confines his remarks to four members of the Bacteriaceæ, and more particularly to the zooglœa of *Cladothrix dichotoma*, which, on account of its ramified appearance, obtained the name *Zooglœa ramigera*. The existence of this definite zooglœic form induced Dr. Billet to search among the other Bacteriaceæ for this particular stage, and he was fortunate enough to be able to find a definite

* Proc. Roy. Soc. Edinb., xvii. (1889–90) pp. 257–70.
† Rev. Mycol., xii. (1890) pp. 199–200.
‡ 'Report on the Endemic of Typhoid Fever at Springwater, N.Y.,' 1890, 21 pp. and 3 pls.
§ Bull. Scient. France et Belg., 1890, 288 pp. See Rev. Mycol., xii. (1890) pp. 187–8.

zoogloeic form in three other species — *Bacterium osteophyllum* and *B. Balbiani* spp. nn., and *B. parasiticum*.

Red Bacillus from River Water.*—Prof. A. Lustig describes a bacillus which secretes a red pigment and liquefies gelatin. In plate-cultivations of 8 per cent. pepton-gelatin, colonies developed in 48 hours. In the centre of the colonies the pigment is first observed. In less than three days the pigment had spread to the periphery, and in 4–6 days the whole of the gelatin had become liquid, forming a sticky mass. Cultivations were also made in agar, potato, blood-serum, bouillon, and milk, in all of which the characteristic raspberry-red pigment was developed. No development took place in distilled water, although the vitality of the organism remained, as was shown by inoculating gelatin after the water had remained unclouded for months.

The bacillus grew with the formation of pigment in the absence of oxygen and in presence of hydrogen.

The individual elements are $1 \cdot 8$–$3 \cdot 0$ μ long, and about half that in breadth.

Endogenous spore-formation was never observed, nor could such spores be demonstrated by any method of staining, and reproduction was evidently by arthrospores. The pigment was extracted from potato cultivations by scraping off the growth, rubbing it up with a few drops of strong acetic acid, and then treating it with ether until all the pigment was dissolved. The ether was then allowed to evaporate spontaneously. The pigment thus obtained was of a violet-red colour, insoluble in water, but soluble in acetic acid, alcohol, benzin, ether, and chloroform, and was of course altered or discharged by the various decolorizing reagents.

This bacillus, which was obtained from river water in Piedmont, is believed by the author to be distinct from the red bacillus of Eisenberg, which is aerobic and is said to be endosporous. The red bacillus of Frank is endosporous, and that of Fraenkel developes a red-yellow pigment.

New Marine Schizomycete, Streblothricia Bornetii.†—This new genus of Bacteriaceæ, described by M. L. Guignard, forms small colourless zoogloeæ about the size of a pin's head, and having a characteristic shape. They are found in clefts of sea-washed rocks; in their external aspect they bear some resemblance to Nostocaceæ, and in their manner of growth to the Rivulariaceæ, but possess neither spores nor heterocysts. Within the zoogloea-jelly are radiating filaments about 1 μ thick, which at first are straight and closely packed, but afterwards become intertwined, forming a confused mass. These filaments are made up of approximately isodiametric members with finely granular contents inclosed in a pretty thick membrane.

Non-formation of Pigment by Bacillus of Blue Milk.‡—Like *Bacillus prodigiosus* and *pyocyaneus*, which, when cultivated under unfavourable circumstances, lose their power of forming their specific

* Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 33–40.

† Comptes Rendus Soc. Biol., xliii. (1890) p. 383. Cf. Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) p. 465.

‡ Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 455–7.

pigment, so the bacillus of blue milk is found to become in similar circumstances incapable of developing its characteristic pigment. Of this defect Dr. P. Behr narrates four examples. The specimens were obtained from cultivations made by competent observers. These four achromatic species were cultivated by the author on various media, such as gelatin, agar, potato, milk, and the results are compared in a series of four tables. This loss of the chromogenic function is possibly only a temporary aberration.

Colour and Pathogenic Differences of Staphylococcus pyogenes aureus and S. albus.*—MM. Lannelongue and Achard attack the view expressed by Rodet and Courmont, that *Staphylococcus pyogenes aureus* is identical with *S albus*, and that the one easily passes into the other. Although *S. aureus*, even in fresh cultivations and in old ones, frequently loses its colour, yet this colour can always be obtained again by breeding from a fresh cultivation, while the white can never be thus changed into orange.

The pathogenic properties of the two micro-organisms are of different intensity, those of *S. aureus* being much stronger than those of *S. albus*.

Acid- and Alkali-formation by Bacteria.†—Dr. T. Smith gives details of some interesting experiments corroborative of the influence of sugar in causing the formation of acid in certain bacterial cultivations. Hog cholera bacillus β was inoculated on four media:—(1) Pepton bouillon; (2) pepton bouillon with one drop of 10 per cent. glucose solution; (3) pepton bouillon with two drops sugar solution; (4) pepton bouillon with four drops sugar solution. In twenty-four hours (1) was slightly alkaline, (2) and (3) were slightly acid, and (4) strongly acid. After seven days (1), (2), and (3) were alkaline, but (4) remained acid.

A similar set of experiments was made with typhoid bacillus. In 24 hours all were distinctly acid. After 10 days the sugarless solution had become alkaline, the other three remaining acid.

The inference from these observations seems to be that by the judicious addition of small quantities of sugar an increased growth of many alkali-forming bacteria may be induced, the acid derived from the sugar diminishing the alkalinity of the cultivation.

Germicidal Action of the Blood in different conditions of the organism.‡—The experiments of A. Rovighi embraced the germicidal property of normal blood, that of definite disease, and that where the condition was merely febrile. Experiments were also made to determine the optimum temperature of germicidal action. By employing Buchner's method, the following results were obtained. The blood of healthy men possesses the property of completely destroying the typhoid bacillus, while on *Staphylococcus pyogenes aureus* and Friedländer's pneumobacillus it exerts a transient and less energetic action.

In blood taken from pneumonia patients, the germicidal influence

* La Semaine Méd., 1890, No. 25. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) p. 429.

† Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 389–91.

‡ Riforma Med., vi. (1890) p. 656. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) p. 561.

(Friedländer's pneumo-bacillus, *St. pyogenes aureus*, typhoid bacillus) appears to be considerably diminished or altogether absent. In the blood of severe dyscrasias it is retained.

The blood of rabbits which had been kept at a temperature of 41°–42° until they became notably hyperthermic, destroys a larger quantity of typhoid bacilli, bacilli of rabbit septicæmia, and of *St. pyogenes aureus* than the blood of normal rabbits. The germicidal action of the normal blood of men and rabbits on typhoid bacillus and *St. pyogenes aureus* is slower and less marked at 12° than at 36°. At 42° for *St. pyogenes aureus* it appears to vanish quickly.

Preservation and Sterilization of Milk.*—The preservation and sterilization of milk, when effectual, are attended, says H. Bitter, with several inconveniences, such as the costliness of the process and the loss of the odour and taste of the fluid; these difficulties have been removed by the "Pasteurization" of milk, the object of which is to sterilize milk at temperatures between 65° and 80°, so that while the bacteria are killed, the taste and odour are but little diminished. An essential part of the process is to cool the fluid, immediately after heating, down to 10°–12°, since gradual cooling allows the development of any remaining germs between the temperatures of 40° and 20°. Care must also be taken lest re-infection of the milk take place in the cooler, or in the vessels used for transporting the fluid from place to place.

The author describes and gives an illustration of the apparatus which he has devised for pasteurizing milk.

Nitrification.†—In a second memoir on nitrifying organisms, S. Winogradski gives the results obtained from pure cultivations of the organism isolated by him. This was a colourless elliptical or roundish cell, with a diameter of 1 μ, and is termed by the author *Nitromonas*. This organism, it is found, may grow normally and continue to exert its functions in a medium which contains no trace of any organic carbon compounds. The principal conclusion arrived at is that perfect synthesis of organic material is possible through the action of organic beings, independently of sunlight. Hence it may be said that the life-history of *Nitromonas* is characterized by the phenomena of construction, and in this respect differs from that of other micro-organisms, the functions of which are principally destructive.

Destruction of Anthrax Bacilli in the Body of White Rats.‡—Dr. G. Frank, in answer to the explanation given by Metschnikoff about the disappearance of anthrax in white rats after inoculation under the skin, or in the anterior chamber of the eye, considers that the general validity of phagocytosis is in no way improved by the experiments or the explanation. Objection is taken to inferences drawn from cover-glass preparations as being misleading owing to the well-known difficulty of determining whether a bacillus is above, beneath, or within a cell in cover-glass or hollow slide preparations. This deficiency should be

* Zeitschr. f. Hygiene, viii., No. 2. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 506–7.

† Annales de l'Institut Pasteur, iv. (1890) p. 257. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 392–5.

‡ Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 298–300.

corrected by sections made through the inoculation spot at various stages of the disease. Had the inventor of phagocytosis done this, the layer of necrotic tissue which separates the bacilli devoted to destruction from the leucocytes would not have escaped his notice. In other words, they are cut off from the organism by certain morbid anatomical conditions produced by the action of the bacilli at the spot in question, the bacilli and the tissue being destroyed by the poison secreted by the micro-organisms.

Penetration of Glanders Bacillus through the intact Skin.*—From inunction experiments made with bacillus of glanders on the uninjured skin of guinea-pigs, M. Cornil concludes that the bacilli gain entrance through the hair-follicles, whence they pass to the cutaneous lymph-spaces. The author infers this from observing that the number of bacilli in the central cavity of the follicle is considerably greater than in the circumjacent connective tissue.

The number of animals treated by inunction (the bacilli were mixed up with some ointment) was fifteen, out of which two contracted the disease. The histological appearances were those of inflammation of the skin, most marked about the follicles. The bacilli were stained with anilin-fuchsin.

Can Bacteria be introduced into the body by being rubbed in through uninjured skin?†—In order to answer this question, M. S. D. Machnoff selected strong anthrax cultivations on agar, and rubbed them into the skin of guinea-pigs. In three cases the agar cultivation alone was used; in four others it was mixed with lanolin. The hair on the back was shorn off short, and the mixture rubbed and pressed in with the finger protected with a caoutchouc cap. All the seven animals died of anthrax in about three days, and in none was there any obvious lesion of the skin. In order to meet the objection that the animals had possibly been infected by inhaling or swallowing the anthrax, three guinea-pigs were smeared over with the lanolin cultivation mixture, and all three remained unaffected. Microscopical sections made from the skin cut out before death where the inunction had been practised, failed to show the presence of bacilli except in small numbers in the hair-follicles, and this only after 48 hours of the rubbing. In sections made from skin removed after death, many, though not all, show accumulations of bacilli in the corium, and these seemed to have distinct relation to the hair-follicles and not to the horny layer of the epidermis. From these observations the author concludes that it is possible that bacteria may be introduced into the animal body through the uninjured skin, and that if so their probable path is through the hair-follicles.

It would have been more satisfactory had mention been made of the skin-glands, and if sections had been made from those parts of the skin where inunction had not been practised.

Effect of Micro-organisms on the Fowl-embryo.‡—Herr M. Lederer, in making experiments as to the transmission of micro-organisms to the

* La Semaine Méd., 1890, No. 22. See Centralbl. f. Bakteriol. u. Parasitenk., viii (1890) pp. 334-5.

† Russkaja Medicina, 1889, No. 39. See Centralbl. f. Bakteriol u. Parasitenk., vii. pp. 441-3.

‡ Mittheil. aus d. Embryol. Institute d. K.K. Universität Wien, 1890, pp. 66-74.

embryo, used freshly fertilized hen's eggs, which were artifically incubated in the usual manner. When development had proceeded for various lengths of time, a small piece of shell and of the shell-membrane was removed, and the embryo inoculated with various micro-organisms; the aperture thus made was closed again, and sealed down with wax and a cover-glass. The micro-organisms used were saprophytes, e. g. pink yeast, *Staphylococcus albus*, *Micrococcus prodigiosus*, *Bacterium violaceum*, and others. About two hundred eggs were inoculated, and in all cases development was stopped, and this result was usually accompanied by decomposition. The author comes to the conclusion that the transmission of infection to the embryo of birds takes place in a manner different from that observed in Mammalia.

Water Bacteria and their Examination.*—Herr A. Lustig has recently published a work on the "diagnosis of water bacteria, with directions for their bacteriological and microscopical examination." In dealing with these micro-organisms, the author first treats of those pathogenic to man, next those that are noxious to animals, and thirdly those which are harmless; the series is further subdivided into cocci, bacilli, and spirilla. Although there is a copious literature of water bacteria, yet, as it is much scattered, this work, which brings together the descriptions and results of many writers, cannot fail to be useful, more especially as the diagnosis tables are accompanied by practical directions for the bacteriological investigation of water.

Action of Products secreted by Pathogenic Microbes.†—The work of M. Bouchard is in the first place a review of what is at present known as to the action of bacterial secreta on micro-organisms and on animal organisms; and secondly, a record of the author's own views. It will be sufficient here to allude to the various theories of immunity, which in this book are discussed at length. According to the author, acquired immunity depends on two factors:—first, an increased germicidal influence of the animal fluids; and secondly, an increased inclination of the cells to act as phagocytes. If, therefore, the leucocytes acquire an increased tolerance for the bacterial virus, and at the same time the germicidal power of the animal fluids is augmented, the organism may then be said to have obtained an acquired immunity for the disease in question.

Fraenkel's Bacteriology.‡—The third edition of Fraenkel's Outlines of Bacteriology has just appeared. As far as the lines on which it was originally constructed are concerned, it remains the same, differing from its predecessors chiefly in the additional facts which it records. Thus, several kinds of bacteria are described in the special part for the first time, the position of some is altered, e. g. cholera bacilli are now ignored in favour of the term vibrio. This part is further expanded by the additional space given to the bacteriological examination of air and water.

* 'Diagnostica dei batteri delle acque con una guida alle ricerche batteriologiche e microscopiche,' Torino, 1890, 8vo, 121 pp. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 594–5.

† 'Actions des produits sécrétés par les microbes pathogènes,' Paris, 1890. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 433–5.

‡ C. Fraenkel, 'Grundriss der Bakterienkunde,' 3rd ed., 1890, 515 pp. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) p. 621.

Bacteriology for Agriculturists.*—With regard to C. Kramer's Bacteriology, it will be sufficient to say that it is specially intended for the use of those engaged in agricultural pursuits. Only the first part has appeared, and this deals first with the morphology and biology of bacteria, and also with the methods of examining and cultivating them. The remainder deals with the bacteria in the soil, the changes produced in soil by bacteria, the decomposition of manure and other organic substances, the symbiosis of Leguminosæ and bacteria, and finally with the diseases induced by bacteria in plants and animals.

Baumgarten's Annual Report on Pathogenic Micro-organisms, including Bacteria, Fungi, and Protozoa.†—The second half of Baumgarten's report on pathogenic microbes for the year 1888 has recently appeared. Beyond stating this fact it is scarcely necessary to say more than that it deals with the literature of the subject in the usual exhaustive manner, and will be found indispensable by those working at pathogenic microbes.

DANZIGER.—**Tuberculose bei einem Hahn.** (Tuberculosis in a Cock.)
Allgem. Med. Centralzeitung, 1889, No. 88.
DUBLER, A.—**Die Wirkungsweise der Bakterien auf den menschlichen Körper.** (The Mode of Action of Bacteria on the Human Body.)
Korrespondenzbl. f. Schweiz. Aerzte, 1890, No. 19, pp. 612–24.
GOSIO, B., & A. SCLAVO.—**Contributo allo studio delle fermentazioni bacteriche.** (Contribution to the study of Bacterial Fermentation.)
Riv. d'Igiene e Sanità Pubbl., 1890, Nos. 12/13, pp. 449-65.
GÜNTHER, C.—**Einführung in das Studium der Bakteriologie mit besonderer Berücksichtigung der mikroskopischen Technik.** (Introduction to the study of Bacteriology, with special reference to Microscopical Technique.)
Leipzig, 1890, large 8vo, ix. and 244 pp.
HUNT, E. M.—**Micro-organisms and Leucocytes: our present status as to each.**
Med. Record, XI. (1890) No. 14, pp. 376–8.
KRUEGER, R.—**Beitrag zum Vorkommen pyogener Kokken in der Milch.** (On the presence of *Micrococcus pyogenes* in Milk.)
Centralbl. f. Bakteriol. u. Parasitenk., VII. p. 590.
KRUSE, W.—**Ueber Blutparasiten.** (The Parasites of the Blood.)
Virchow's Archiv, CXX. p. 541; first communication.
LAURENT, E.—**Etude sur la variabilité du bacille rouge de Kiel.** (Study on the Variability of the Red Bacillus of Kiel.)
Annal. de l'Institut Pasteur, 1890, pp. 465-83.
LUBARSCH, O.—**Ueber die Ursachen der Immunität.** (On the Causes of Immunity.)
Fortschr. d. Med., 1890, pp. 665-72.
MARMOREK.—**Bakteriologischer Beitrag zur Kenntniss der Influenza.** (Contribution to the Bacteriology of Influenza.)
Wiener Klin. Wochenschr., 1890, Nos. 8 & 9.
RUFFER, M. A.—**Notes on the Destruction of Micro-organisms by Amœboid Cells.**
Brit. Med. Journ., 1890, No. 1548, pp. 491-3.
SCHRÖN, V.—**Zur Genese der Mikroorganismen.** (The Development of Micro-organisms.) *Allgem. Wiener Medic. Wochenschr.*, 1890, pp. 435-6.
STERN, R.—**Ueber die Wirkung des menschlichen Blutes und anderer Körperflüssigkeiten auf pathogene Mikro-organismen.** (On the Action of Human Blood and other body-fluids on Pathogenic Micro-organisms.)
Zeitschr. f. Klin. Med., XVIII. (1890) pp. 46–71.

* Wien, 1890, 8vo, 171 pp. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 462–5.

† 'Jahresbericht über die Fortschritte in der Lehre von den Pathogenen Mikroorganismen, umfassend Bakterien, Pilze und Protozoen,' Braunschweig, 1890, Jahrg. iv. (1888) 2te Hälfte, pp. 257–587.

MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Report of the Committee of the American Society of Microscopists on Uniformity of Tube-length.†—The following Report has been issned by the American Society of Microscopists :—"Believing in the desirability of a uniform tube-length we unanimously recommend :—

(1) That the parts of the Microscope included in the tube-length should be the same by all opticians, and that the parts included should be those between the upper end of the tube where the ocular is inserted and the lower end of the tube where the objective is inserted.

(2) That the actual extent of tube-length as defined in section 1—Be, for the short or Continental tube, 160 mm. or 6·3 in., and 8½ in. or 216 mm. for the long tube, and that the draw-tube of the Microscope possess two special marks indicating these standard lengths.

(3) That oculars be made par-focal, and that the par-focal plane be coincident with that of the upper end of the tube.

(4) That the mounting of all objectives of 1/4 in. and shorter focus should be such as to bring the optical centre of the objective 1½ in. below the shoulder; and that all objectives be marked with the tube-length for which they are corrected.

(5) That non-adjustable objectives be corrected for cover-glass from 15/100 to 20/100 mm. (1/130 to 1/170 in.) in thickness.

These recommendations give a distance of 10 in. (254 mm.) between the par-focal plane of the ocular and the optical centre of the objective for the long tube, and are essentially in accord with the actual practice of opticians.

At the request of the committee, a joint conference was held with the opticians belonging to the society and present at the meeting. They expressed their belief in the entire practicability of the above recommendations, and a willingness to adopt them.—Signed, Simon H. Gage, A. Clifford Mercer, Prof. Barr."

Swift and Son's Improved Student's Microscope.—At the October meeting of the Society, Mr. G. C. Karop exhibited and described this instrument (fig. 1), which he said had been brought out by Messrs. Swift at his suggestion. The aim was to produce a Student's Microscope of a superior design, with which high-class optical appliances could be used.

The body-tube is made to take the full-size eye-pieces in general use, and short enough to work with objectives adjusted to the Continental tube-length.

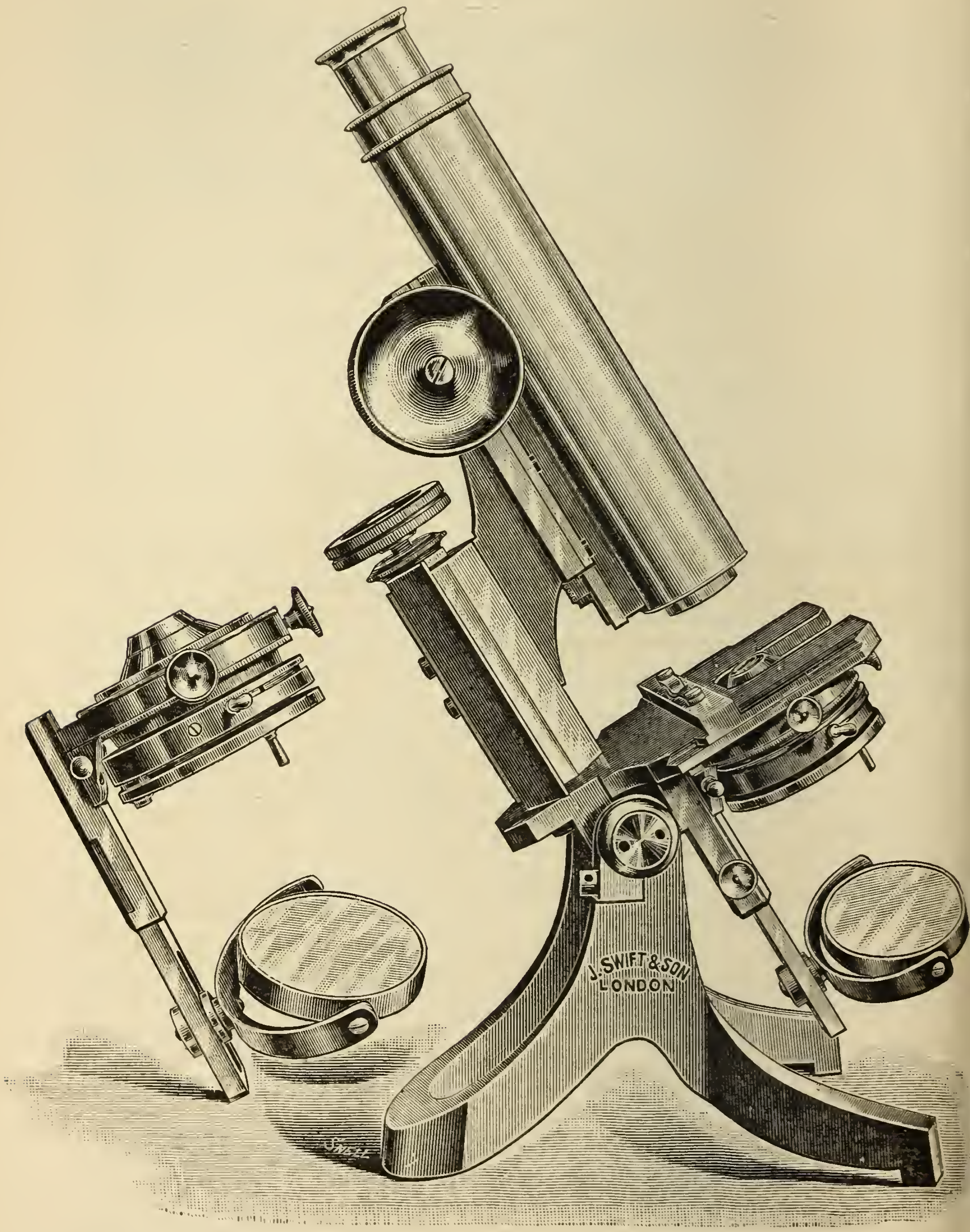
A draw-tube lengthens to the English standard of 10 in. The bearing carrying the body is made longer than usual in students' instruments, so as to give greater firmness with low-power objectives. The fine-adjustment was that known as Campbell's Differential Screw

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

† Microscope, x. (1890) p. 297.

system, and is arranged for very delicate focusing. Both the coarse and fine adjustments are provided with extra large milled heads to afford a firm grasp. The stage is of the Nelson horse-shoe shape, and

Fig. 1.



large enough to take culture-plates ; this form is adopted for lightness and for the facility it gives in feeling the working distance of the objective. Instead of the usual spring clips, a sliding frame is provided with sprung guides moving in grooves at the sides of the stage; small clips are applied for use in the horizontal position. The Mayall mechanical stage can be applied if required. The sliding-bar carrying the substage is specially well fitted so that a condenser of fairly large aperture may be focused, and a clamping screw fixes it in position. The substage has mechanical centering movements, and an iris-diaphragm. The mirror is removable in case it may be desired to work with direct light from the lamp.

We are requested by Messrs. Swift to note that at a small additional cost they can apply a rack-and-pinion instead of the sliding movement to the substage.

Mason's Improvements in Oxy-hydrogen Microscopes.*—Mr. R. G. Mason, of 69, Clapham Park Road, Clapham, S.W., has introduced the above form of lantern and table Microscope, a patent for which has been applied for. Until the present time the lantern Microscope has been a distinct instrument from the table form of stand. By the union of the above parts an instrument is obtained that, when not in use for

Fig. 2.

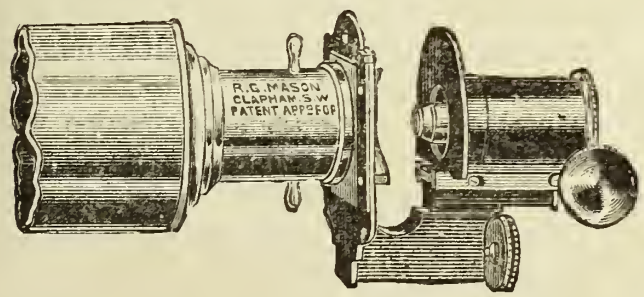
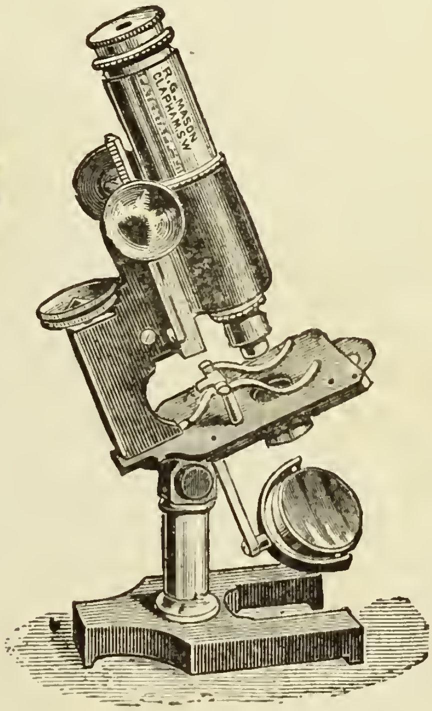


Fig. 3.



screen projections, can be easily altered, as shown by fig. 3. No unscrewing is required, and there are no loose parts. Fig. 2 shows the instrument as used on the lantern. It is very convenient for the science teacher or general lecturer, as a demonstration may be made to either a small or large audience with equal facility. The lower part, which carries the joint for inclining the instrument at any angle, is fitted with concave and flat mirrors on swinging arm, also with the universal size substage fitting tube for apparatus. The body and draw, which fits into the upper part, is of large diameter, and is screwed with the Society's size screw, thus enabling any ordinary microscopic objective to be used with it. It is fitted with a first-class rack, and also screw fine motion working steadily under high powers. This fine motion is especially useful in photo-micrography. The stage being of the usual form, both object and objective are in view, and easily manipulated while in use, thus doing away with an objection that is often present in the older forms of lantern

* Engl. Mech., lii. (1890) pp. 306-7.

Microscope. A further improvement is a spring clip, enabling the object to be easily changed without scratching the labels, &c., its construction admitting of either a deep zoophyte trough or the thinnest 3 × 1 slip being held gently but firmly. The parts are supplied separately, so that any one needing only the lantern arrangement can add the other at any future time.

(3) Illuminating and other Apparatus.

The Substage Condenser: its History, Construction, and Management; and its effect theoretically considered.*—Mr. E. M. Nelson remarks—"The substage condenser is nearly as old as the compound Microscope itself. The first microscopical objects were opaque, and in very early times a lens was employed to condense light upon them. It was an easy step to place the lens below the stage when transparent objects were examined.

Coming to more modern times we find that the culminating type of non-achromatic Microscope was fitted with a substage condenser, but it had a very brief existence, not being able to hold its own against the recently introduced achromatic. Had the invention of achromatism been delayed, it would, I have no doubt, have had enormous popularity for those times. I allude to the Wollaston doublet with its substage condensing lens, particularly that form designed by Mr. Valentine and made by Andrew Ross in 1831.

Before proceeding we must remember by whom the Microscope was used at that time. As far as this country was concerned, it was merely looked upon as a philosophical toy. It was principally to be found in the hands of a few dilettanti; science of every kind was tabooed, the Microscope being placed at the lowest end of the scale.

Now, the Microscope of the dilettanti is usually a perfect instrument of its kind, fully supplied with apparatus, the greater part of which is absolutely useless, but among this apparatus there would always have been a substage condenser. One of the principal things the dilettanti have done for us is the keeping up through early achromatic days of the continuity of the condenser.

On the Continent, where science held a much more important place, the real value of the Microscope was better understood, and it at once took an important place in the medical schools. But the increase of light due to the more perfect concentration of rays by achromatism enabled objects to be sufficiently illuminated by the concave mirror to meet their purposes. Therefore, we find that on the Continent the Microscope had no condenser. Of course there were isolated exceptions, Amici's for example; but I think we may safely say that for every Hartnack made with a substage condenser there were upwards of one thousand made without.

England followed the Continental lead, and now the "foolish philosophical toy" has entirely displaced in our medical schools the dog-Latin text-book with its *ordo verborum*. But the kind of Microscope adopted was not that of the English dilettanti, but the condenserless Continental. It may be said that the Microscope for forty years—that

* Journ. Quek. Micr. Club, iv. (1890) pp. 116–36. For the use of the accompanying plate we are indebted to the kindness of Mr. Nelson and the Quekett Microscopical Club.

is, from the time it was established in the schools in, say, 1840 to 1880, has been without a condenser. Not only did those who used the condenserless Microscope consider the condenser an unnecessary appendage, but they looked down upon it and regarded it in the same category as one of the multitudinous appliances that are packed in such a wonderful manner in the apparatus cabinet of a Microscope made for exhibition.

In 1880 a change came from two separate causes—first, the rise of bacteriology; secondly, the introduction of a cheap chromatic condenser by Abbe in 1873.

Taken by itself, the introduction of the Abbe condenser had not much effect, but as Zeiss's Microscopes had for some time been displacing the older forms, and when the study of bacteriology arose, oil-immersion objectives of greater aperture than the old dry objectives (especially those of the histological series) were used, illumination by the mirror was soon discovered to be inefficient, so a condenser became a necessity. The cheap Abbe condenser was the exact thing to meet the case.

Since 1880 the percentage of educational Microscopes, medical or otherwise, without condensers, has been daily on the decrease. There has not been, during the past history of the Microscope, a more marked change of opinion with regard to any apparatus than that which has taken place in connection with the condenser.

It is worthy of notice that this change of opinion has been so complete that those who formerly condemned all condensers now look upon the Abbe chromatic (probably the worst condenser ever constructed) as a distinct advance in microscopy!

It must be remembered that the end of an educational Microscope is not to discover anything new, but to follow the figures given in the text-books, and when the text-books kept on the level of the larger objects any tube with a piece of glass at either end was sufficient for the purpose; but as the text-books improved and went deeper into the structure of things it was necessary that the student's Microscope should be of a better description. For example, as long as the text-books wrote about and figured the spiral vessels in the blowfly's tongue, so long the student did not require a Microscope capable of showing the cut suctorial tubes.

As I mentioned above, the "few," principally dilettanti, had all along used a condenser. I myself had not long entered the microscopical world as a member of the latter class before I found out that a condenser was a necessity. Now, as I have used all the kinds of condensers that have been introduced, I will give my own history in connection with them, as it will be the history of the condenser.

My first condenser was a Gillett; this was in power a 1/4, and it had 80° of aperture. The Gillett is practically the first achromatic condenser really constructed as such; before that time objectives were used, the rule being to select that objective which was next lower in power to the objective on the nose-piece. The manner of centering—for centering was duly insisted upon even in those early times—was so funny that I must recall it. Vertical movement was performed by the substage, but the horizontal movement by the Microscope body!

The Gillett was an elaborate instrument; it was supplied with a correctional lens adjustment for the aberrations arising from the thickness of the slip. I have a distinct affection for the Gillett, for it was with that condenser I taught myself what a critical image was. In 1874, however, I purchased a P. and L. new formula water-imm. 1/8 of N.A. 1·21. These and similar lenses by Tolles far surpassed anything at that day. There was a greater difference between these lenses and their cotemporaries than there was between the homogeneous immersion and these same lenses four years later. I can only liken the improvement which those lenses ushered in to that which has lately been achieved by Abbe's apochromatics. It was the possession of this lens (P. and L. new formula 1/8) that first made the inadequacy of the Gillett apparent to me. This led me to get P. and L. dry achromatic condenser, which I still have. This condenser was designed by Powell in 1857; it is a 1/5 in power, and ·99 N.A. in aperture, and is the best ever introduced.

I must now say a word or two on low power condensers. Low power objectives had, somehow or other, been left out in the cold, no condenser having been provided for them. A sop, in the shape of a paraboloid or spot lens, was every now and then thrown to them, but, as far as I know, the first low power condenser we hear of is Webster's, in 1860.

The next was Abbe's chromatic,* 1873; Swift's achromatic, 1874; Abbe's achromatic, 1888, and Powell's new one, last year.

On the Continent the Microscope may be said to have remained condenserless until the rise of bacteriology compelled the general adoption of the Abbe in 1880. I will now give a parallel table showing the data and form of various condensers that have been introduced since the days of achromatism:—

England.	Continent.
1826. Single lens, Tulley.	1827. Single lens, Amici.
1840. Objective.	1833. Chromatic, Chevalier.
1850. Gillett, three pairs, N.A. ·65.	1839. Objective, Dujardin
1857. Powell, two pairs and single, anterior middle concave, N.A. ·99.	
1865. Webster, single front, achromatic back.	
1874. Swift, two pairs and single front, N.A. ·9.	1873. Abbe, chromatic, N.A. 1·2, hemispherical front, crossed back.
1878. P. and L. achromatic, improved anterior middle plane, ·99 N.A.	(? date) Another form, N.A. 1·4, single front, Herschelian doublet back.
1881. P. and L. oil chromatic, same as Abbe only higher power, N.A. 1·3. Ditto, truncated, N.A. 1·4.	
1887. P. and L. oil achromatic, N.A. 1·4, three pairs and single front.	1888. Abbe achromatic, two pairs and a single front, N.A. 1·0.
1889. P. and L. low power achromatic, N.A. 1·0, one pair and two singles.	

* Abbe's chromatic stopped down makes a far better low power condenser than it does a high power, as the stop reduces the abnormal amount of spherical aberration.

This table shows that here, at least, there was an activity with regard to the condenser that was totally absent abroad. It must, moreover, be remembered that the list gives only types of condensers: Ross, for instance, made improvements on the Gillett, and Smith and Beck made numerous forms of condensers which have not been mentioned, simply because they were not typical. Messrs. Crouch and Collins made numerous condensers, mostly after the Webster type. So also, on the other side, Nachet and Hartnack fitted object-glasses as condensers, only to a much more limited extent. My impression is that, if statistical tables were available, it would be found that up to 1880 there were more condensers turned out by any one well-known English maker than by all the Continental firms put together.

We now come to the use of the condenser, and the first question that arises is with regard to the nature of the source of light: Is daylight or lamplight to be used?

I find with low and medium powers, the condenser being centered to the optic axis, the plane mirror used, and a window-bar focused on the object, that daylight gives very good results, especially if a brightly illuminated white cloud is the illuminating source; but when the white cloud has blown across the field, leaving only blue sky, the illumination becomes poor. My complaint against daylight illumination for low power work is that I believe it not only to be always changing, but also very injurious to the eyesight. When I began Microscopic work the white cloud was everything, but on account of the above-mentioned drawbacks I adopted artificial illumination. The most extraordinary ideas prevailed respecting artificial illumination. The history is as follows:—Brewster wrote a treatise on the Microscope in 1837, and in it explained his method of illumination. He was very keen on monochromatic illumination; this he obtained from some chemical substances flaming in a saucer, without any wick or chimney; light from this was parallelized by a bull's-eye formed by a Herschelian doublet, and this brought to a focus by another exactly similar lens. He is very particular to enforce that the image of a diaphragm placed between the source of illumination and the bull's-eye should be focused on the object. This was in preachromatic days, and the kind of Microscope he experimented upon was the simple Microscope, the lenses being jewel singles, doublets, triplets, Coddingtons, which last were his own invention, &c.

With such a source of illumination, unless his object had been in rays considerably condensed, he would not have seen anything at all. Be that as it may, the fact is that the rule of having the source of light in focus has been handed down by the text-books all along, only with this curious proviso, viz. that each author had his own particular directions for disregarding the rule.

Taking Andrew Ross first, whose directions are considered so admirable that Quekett says he will quote them at length, we find that after he has given instructions with regard to centering, he says that delicate objects are best seen by racking the condenser within, and objects having some little thickness without the focus. Further on he says that slight obliquity of the illumination subdues the glare attendant upon perfectly central and full illumination by lamplight; he then goes on to say how this slight obliquity may be secured. The above words form the keynote for artificial illumination in every subsequent text-book. They are repeated by Carpenter, who, after giving directions as to centering and focusing the image of the lamp-flame on the object, says that "the direction of the mirror should then be sufficiently changed to displace the image and to substitute for it the clearest light that can be obtained." Further, he recommends that while with daylight the condenser should be used in focus, with lamplight it should be somewhat racked down. From this I gather that Dr. Carpenter's best artificial illumination is oblique light out of focus. Of course the actual fact is that daylight focus is not nearly so important as lamplight. In illustration of another kind of mistake, as late as ten years ago it was recommended that the diaphragm be placed above the condenser as giving a better result than when placed below.

Of course the optical effect is precisely the same, the only thing is that the diaphragm below the condenser is much more readily manipulated and is much more likely to be accurate in centering, unless the one above be of the cap form. To change a cap diaphragm necessitates either the removal of the slide or the condenser, and all for no purpose. The next idea was worse, viz. the calotte diaphragm. This being fixed to the stage and not to the substage, gave as often as not excentric pencils. Whatever diaphragm is used it obviously must be centered to the condenser and must move with it, otherwise it will be put out of centre during the operation of centering the condenser to the optic axis of the objective.

Further, the calotte diaphragm is useless for ordinary illumination without a condenser, as the apex is not the proper place to cut the illuminating cone. The proper place, therefore, for a diaphragm, when no condenser is used, is some distance from the object, and when a condenser is used, is at the back of the combination. Further, when a diaphragm is above the condenser the apertures become almost microscopic in size, and a very small difference between them will make a considerable difference in their effect; but when they are placed behind the combination they may be larger, and it becomes more easy to graduate them in accordance to any desired effect.

Again, it is a fallacy to suppose that a Kelner eye-piece is superior to a condenser as an illuminator for high powers.

A Kelner eye-piece, if a C, is only 1 in. in power, and has a small angular aperture somewhat less than 45°, therefore it cannot possibly give a cone at all comparable with that from a most elementary condenser. It might be used as a substage condenser for low powers, but from its small aperture it would hardly give a good dark-ground illumination for a 1-in. objective.

With regard to low power condensers, the Webster (as designed by Webster) is the proper form. There are many so-called Webster condensers in existence which are on a totally wrong principle. The right kind of Webster has a single front lens and a back lens composed of a plano-concave flint and a crossed convex crown, the cemented surfaces having a deep curve to overcorrect the lens. The other kind, which is quite wrong, has an achromatized front and a single back; it is merely done for cheapness, as small achromatic pairs are not so expensive as large ones, and the back lens of a condenser is always larger than the front.

Another mistake is that direct light is more critical than indirect, which means, in other words, that illumination without a mirror is more critical than illumination with a mirror. Presupposing the same conditions, viz. the same condenser with the same stop, the centering and focus being precise, the optical conditions must be identical and the result the same. The ground is entirely cut away from the one only thing which could possibly affect the result—I allude to the loss of light by reflection at the mirror, by the fact that you have, with merely a 1/2-in. paraffin wick, more light than you know what to do with. So much is this the case that in my own practice I am in the habit of using a double cobalt pot-glass screen to reduce the intensity.

I am aware that direct illumination is a most convenient and time-saving method, especially when the instrument is well tucked up on its trunnions, but that it makes any perceptible difference in the criticalness of the image I am not prepared to admit.

With regard to mirrors, a good deal of misapprehension exists. It matters little whether the mirror be dusty or scratched, or the silver in bad condition; the only effect these will have will be to cause a little less light to fall on the back lens of the condenser, a matter supremely unimportant. An old scratched dull mirror will yield as critical an image as the finest worked up silver on glass Newtonian flat.

The three things that are of paramount importance are the direction of the light, the angle of the cone, and the spherical aberration of the condenser. Mirrors which yield secondary reflections are to be avoided, but if they can be turned round in their cells the secondary images can be easily eliminated.

Having touched upon the errors in the use of the substage condenser, let me say a few words with a view of clearing up some strange notions that are held with regard to its office. The original prevailing idea with regard to the office of a substage condenser was, I believe, in the first instance, that of a contrivance by which more light could be secured; afterwards it became chiefly important as an oblique illuminator; but its true function as that of a cone-producer was not generally recognized. As this view of mine will probably be met by the criticism that in the text-books, both ancient and modern, we read "that the condenser must be accurately focused," that the use of the diaphragm is for the purpose of contracting the cone of illumination" (many similar passages might be quoted), I nevertheless contend that there are other passages which conclusively prove that the writers were ignorant of the true function of the condenser.

The following is an example :—"If the cone of rays should come to a focus in the object, the field is not unlikely to be crossed (in the daytime) by the images of window-bars or chimneys, or (at night) the form of the lamp-flame may be distinguished upon it; the former must be got rid of by a slight change in the inclination of the mirror; and if the latter cannot be dissipated in the same way, the lamp should be brought a little nearer."

This passage proves that the end-all and be-all in the writer's mind was the agreeableness of the illumination; when the glare of the lamp-flame becomes unpleasant, the cone may go to the wall.

If the importance of the cone had been paramount in the mind of the writer, he would have certainly suggested the obvious method of softening down the intensity of the flame-image by interposing coloured screens. Taking the whole tenor of the passage, there cannot be the least doubt that the ends sought for were suitable intensity of light and equable illumination of field; the frequent mention of the word cone being more accidental than insisted on for the sake of the cone itself.

It is as a cone-producer wherein the efficacy of the condenser lies. If, as is implied in the text-books, it were only light-intensity which gave criticalness to the image, that could be secured by exchanging the light from the 1/2-in. paraffin wick for that from the electric arc, but such an exchange would cause no alteration in the character of the image so long as the aperture of the cone remained the same.

The real office of the substage condenser being a cone-producer, the first question that arises is, What ought to be the angle of the cone?

This is really the most important question that can be raised with regard to microscopical manipulation. To this I reply that a 3/4 cone is the perfection of illumination for the Microscope of the present day.* By this I mean that the cone from the condenser should be of such a size as to fill 3/4 of the back of the objective with light, thus N.A. 1·0 is a suitable illuminating cone for an objective of 1·4 N.A. (dark grounds are not at present under consideration). This opinion is in direct opposition to that of Prof. Abbe in his last paper on the subject in the December number of the R. M. S. Journal for 1889, where he says:—"The resulting image produced by means of a broad illuminating beam is always a mixture of a multitude of partial images, which are more or less different (and dissimilar to the object itself). There is not the least rational ground—nor any experimental proof—for the expectation that this mixture should come nearer to a strictly correct projection of the object (be less dissimilar to the latter) than that image which is projected by means of a narrow axial illuminating pencil." †

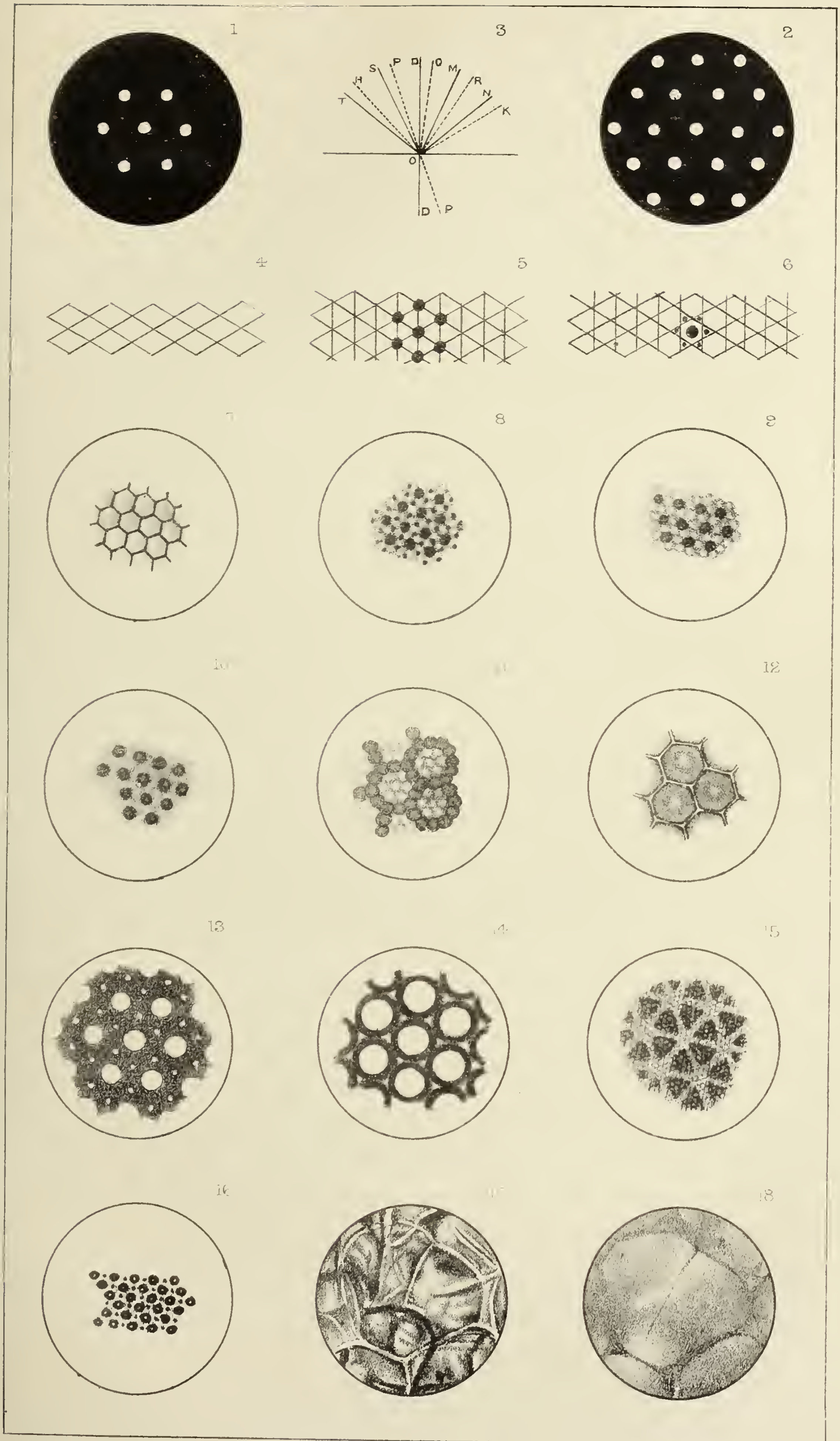
This paper I consider to be the most dangerous paper ever published, and unless a warning is sounded it will inevitably lead to erroneous manipulation, which is inseparably connected with erroneous interpretation of structure.

If you intend to carry out his views and use narrow-angled cones, you do not need a condenser at all—more than this, a condenser is absolutely injurious, because it affords you the possibility of using a large cone, which, according to Prof. Abbe, yields an image dissimilar to the object. If there is the slightest foundation for Prof. Abbe's conclusion, then a condenser is to be avoided, and when a mirror is used with low powers care must be exercised to cut the cone well down by the diaphragm.

In the opening sentence of the paper Prof. Abbe says, "The diffraction theory leads to the following conclusions in regard to the mode of illumination in question." We are, therefore, thrown back on the diffraction theory, for the discussion of which I must ask your kind

* Mr. Comber (R. M. S., May 21st, 1890) states that in practice he finds a 2/3 cone best for photomicrography. A 2/3 cone (photographically) is to a 3/4 cone (visually) as 10/12 is to 9/12. Mr. Comber's experience is therefore in accordance with this statement.

† R.M.S. Journal, 1889, Part 6, p. 723.



E. M. Nelson photo

West, Newman
Horace Knight } lith.

indulgence, as the only other avenue for such a purpose has been closed to those who do not accept Prof. Abbe's theory in its entirety.

The diffraction theory has been likened, as you are aware, to the theory of gravitation. Let us, therefore, compare them. The theory of gravitation may be said to rest on three points—viz. mathematical proof, physical law, and experimental proof;—moreover, it is not afraid of criticism.

The diffraction theory rests on no mathematical proof—in the main it accepts the physical law of diffraction; but on experiment it utterly breaks down, all criticism is stopped, and everything connected with it has to be treated in a diplomatic kind of way.

Both theories may be said to resemble an arch, being built up on theory and experiment, and held in equipoise by a keystone at the top. The diffraction arch, after being built up on theory and experiment, culminates with the calculation of the Eichorn intercostals as its keystone. The discovery of these intercostals on the *P. angulatum* (which has been likened to the discovery of the planet Neptune) was arrived at by "a mathematical student, who had never seen a diatom, and who worked the purely mathematical result of the interference of the six spectra."

In the same way the discovery of Neptune may be called *a* keystone of the gravitation theory. It would be incorrect in this connection to say *the* keystone, because the gravitation theory has many keystones, while the diffraction theory has only the one, viz. the Eichorn intercostals. If, for instance, one could prove that the planet Neptune had no objective reality, but was a mere optical ghost, the gravitation theory would be seriously compromised. If, this evening, I can prove that the Eichorn intercostals are ghosts, then I maintain that I have taken the only keystone from the diffraction theory arch, and the conclusions which Prof. Abbe has arrived at in consequence of that theory, with regard to illumination by means of the wide-angled cone, are fallacious.

Let me at this place state that I wish it to be distinctly understood that I am not, in this paper, attacking Prof. Abbe's brilliant discovery that the image in the Microscope is caused by the reunion of rays which have been scattered by diffraction, neither do I question what I venture to think is his far more brilliant experiment, which exhibits the duplication of structure, when the spectra of the second order are admitted, while those of the first are stopped out. I regard these facts as fundamental truths of microscopy. The thanks of all true microscopists are due to Prof. Abbe for giving them to us. It will be then asked, how can you disagree with that which you admit? The point is, that it is in the meaning of the word "diffraction image" that the difficulty lies. Let me explain. There are in reality three kinds of diffraction images, for which I will now substitute the following names, "true diffraction image," "true diffraction ghost," and "false diffraction ghost," in place of those I used in my previous paper.* Now I maintain that both Prof. Abbe and his exponents at the R.M.S. have fallen into the grievous error of not distinguishing between these

* Q.M.J., Ser. II., vol. iv., No. 25, p. 17, "true, true false, and false."

three images, viz. the true diffraction image, and the true and false diffraction ghosts. You will naturally ask, how do you distinguish between these three images? A true diffraction image goes in and out of focus like a daisy under a 4 in. In other words, a true diffraction image is one out of which it is impossible to make another image by focal adjustment. A diffraction ghost, on the other hand, is one which changes into other images on focal adjustment, a false diffraction ghost being an image which is dissimilar to the original, and a true diffraction ghost one in which it is fairly in accordance with the original.

A true diffraction image is produced by a large cone of illumination, except in those cases where the structure is so fine, in relation to the aperture of the objective, that the large cone does not cause the spectra to overlap one another and the dioptric beam.

True and false diffraction ghosts are produced by small cones, except in those cases where the structure is either so coarse that the spectra overlap, even with the small cone, or so fine that only spectra of the first order are taken up by the objective; in this latter case a false diffraction ghost becomes impossible. Taking the ghosts first, the reason why there is a change of image on alteration of focus may be seen on reference to plate II. fig. 3. Let O be an object having about 20,000 interference elements per inch, let DD be an infinitely thin dioptric beam in the optic axis, then S and M will be the spectra of the first order, and T and N those of the second. If the object be examined by an objective whose aperture is greater than the angle T O N, i. e. upwards of 100°, a diffraction ghost will be seen, because at the longer focus the spectra S and M will be united with D, and a representation similar to the true structure will be produced; but on shortening the focus the spectra T and N will be united with D, and a picture having double the fineness of the original structure will be seen. (You require no stop at the back of your objective to perform this experiment; the spherical aberration, which is always present, even in the best corrected lenses, will be sufficient to prevent the union of S and M with T and N. See Mr. Leroy's results on applying the Foucault test to Microscope objectives, R.M.S.J., 1890, p. 224: the spherical aberration varied from tenths of mm. to several mm.) It is therefore a diffraction ghost, because the image alters on focal adjustment; it is a true ghost at the upper focus and a false ghost at the lower focus.

Let us now see what takes place when a large cone is used. Let PP be an isolated pencil of such a cone, then HQ will be spectra of the first order, and R a spectrum of the second, and K one of the third order. These dotted lines are drawn at a little distance from the others for the sake of clearness, but they are supposed to be either coincident with or very near the others. Here we see at the upper focus that a spectrum of the second order R is combined with a dioptric beam P, and a first diffraction spectrum Q, and this takes place in addition to the combination of S and M with D mentioned above. Bringing in a diffraction spectrum of the second order will tend to improve the image. At the lower focus even now there will be a first diffraction spectrum H, combined with a third order spectrum K, together with the combination of H and N with D as above. This combination would give a confusion of images, so it comes to pass that images with a wide angled cone at the lower focus are blotted out. To state the combinations more concisely at the upper focus, we have two first order spectra and a dioptric beam; and a first and second order spectrum and a dioptric beam.

At the lower focus you have two second order spectra and a dioptric beam; and two first orders and a third order.

It may be as well to explain to those not acquainted with optics, that these combinations are caused by the spectra T N and H K passing through the same zone of the objective. The union of a set of spectra such as S D M makes a certain kind of image, and the union of P Q R will make a very similar image, not absolutely similar, but so similar that it would be difficult to tell the difference between them. So it comes to pass that the superposition of a number of very similar images strengthens the picture and gives a resultant image very close to the original structure. But the image caused by the union of T D N is totally dissimilar to the original, and H Q K would also be very dissimilar and the superposition of a number of these can only make a stronger dissimilar picture, or if the pictures, which are superposed. differ widely from one another, then the superposition of them will produce a fog. By way of illustration, suppose I made a large number of photomicrographic lantern slides, using certain spectra, which gave an image closely resembling an original known structure, and suppose each lantern slide to be a picture, resulting from a different narrow dioptric beam, such as D and P in our diagram, and others lying between them, we should then have a number of lantern slides, all very similar to the original and consequently to one another. Now suppose we had a number of lanterns and projected these several images at once on the screen, the several images would combine to form a strong image closely resembling the original structure. If, however, we make other lantern slides, using spectra, such as T N, which double the original structure, and if these are projected on the screen in place of the others, we shall get a strong image of a structure altogether dissimilar to the original. But if we increase the number of our lanterns, and project the other images as well, we shall have a confused image on the screen, or fog. Another illustration may help to simplify the matter. Suppose it were possible in photographing a dog with an ordinary camera, by manipulations at the back of the objective, to obtain, either an image only very slightly dissimilar to the real dog (such as an image slightly out of focus), or with other manipulations to obtain a picture of a hayrick. If a number of these slightly dissimilar images of the dog were projected on the screen, we should still have the image of a dog, and one that we could readily recognize. But if we projected the images of the hayrick, we should not have the slightest idea that the original object was a dog, and further, if the images of the hayrick were projected at the same time as those of the dog, the result would be a confused mass of light in which it would be impossible to recognize any image. Whether any particular lantern slide turn out a dog or a hay-rick, depends on the physical union of various other oscillations, but whether the image of either the dog or hayrick be a strong one, or a mass of fog, depends on the mechanical combination of similar or dissimilar images.

We must now return to the Eichorn intercostals; the history regarding these is as follows:—

The six spectra of the first order of *P. angulatum* (fig. 1) were set to a student who had never seen a diatom, and he calculated the presence of an intercostal. These intercostals were afterwards seen by Mr. Stephenson, and the student's discovery was likened to that of Neptune. There is a double error here. The first is that the intercostal is a function of the spectra of the second order, and can neither be calculated, originated, nor seen by those of the first order.

Secondly, the intercostal is not a true diffraction image, but is a false diffraction ghost, and is caused by the reunion of the spectra of the second order, and the exclusion of the first order.

The very data given to the student have to be excluded before an intercostal can appear or be calculated!

The error in connection with the exhibition of the intercostals of the *P. angulatum* is that no sufficient checks were imposed to render it absolutely certain that no spectra of the second order were present at the time the intercostals were seen. The intercostals have also been accounted for by a fallacious geometrical picture. Thus, the six spectra (fig. 1) account for three sets of lines ruled at 60° to each other. Now, as I pointed out in the 'English Mechanic,' vol. xliii., No. 1108, p. 337, two very different pictures are produced according to whether the third line be ruled through the apices of the rhombs (fig. 4) or not. It is for those who uphold the truth of the intercostals to show which spectrum or what arrangement of the six spectra determines that the third line does not pass through the apices of the rhombs (fig. 6). The contrary is really the fact, viz. that if there is any truth at all in the diffraction theory, then with a spectral arrangement as set to the mathematical student the third line must pass through the apices of the rhombs (fig. 5). Figs. 4, 5, and 6 show the rhombs and the formation of the two kinds of pictures. In passing, it is as well to note that objectives being for the most part spherically undercorrected, generally show the intercostals at the lower focus. In other words, you have to lower your objective in order to obtain the reunion of the spectra of the second order by means of the outer zone of the objective. Intercostals are due to illumination by means of a narrow cone, which allows and aids zonal differences to operate on the spectra, uniting those of the second order, whilst excluding those of the first.

Illumination by a large cone neutralizes the effect of these zonal differences, and intercostals disappear.

I have given much attention to diffraction ghosts, and have made several photographs of them for your inspection. Instead of confining my investigations to *P. angulatum*, as has been usually done, I thought it better to select very coarse structures, concerning the true appearance of which all microscopists are entirely agreed. In the first instance, I experimented with the coarse hexagonal structure of a *Triceratium*, which measured 1/3600 in. A photograph × 387 taken with a large cone I will now project (fig. 7). The illuminating cone was now cut down by closing the iris diaphragm, and the aperture of the objective stopped down until the spectra at the back of the objective appeared as in fig. 2. The next photograph (fig. 8) shows the image due to those spectra; this shows the intercostals, and is what I term a false diffraction ghost. You will observe that the objective has been placed at a lower focus. If the same, i. e. the upper focus, had been used, then a picture similar to the true image taken with the large cone would be seen, except that the walls of the hexagons would be considerably thicker, and in the centre of each areolation there would be a dark spot.

If the illuminating cone be enlarged to a 3/4 cone the image will closely resemble the critical image (fig. 7) already shown, and moreover will be a true diffraction image, because it will go in and out of focus as a daisy under a 4-in. In examining the various images presented by a hexagonal grating in focal alteration, when a small cone of illumination is used, I found that these false diffraction ghosts followed a certain sequence, and might be grouped in three classes, which I term degrees. The false diffraction ghost of the first degree requires spectra of the second order (fig. 2), for its production. It is the Eichorn intercostal image.

The next experiment was performed with the narrow cone as before, but with the aperture of the objective reduced so that the second order of spectra (fig. 1), were cut out; according to my theory no intercostals should now be visible; on taking the photograph, however, a trace of them could be distinguished (fig. 9). This is such an interesting result that I have printed the negative. The fact was that I had cut out the second order spectra visually but not photographically. On further cutting down the aperture quite up to the end of the spectra of the first order, no intercostals could either be seen or photographed (fig. 10).

This is an additional proof that the intercostal image is a function of the spectra of the second order. Further, if an intercostal on *P. angulatum* is resolvable by means of spectra of the first order, which diverge about ·5 N.A. from the central dioptric beam, as affirmed by Eichorn, Abbe, and the anonymous writer of the article on microscopic vision in the R. M. S. Journal,* then the theoretical limit tables at the back of the Journal had better be torn up. The intercostals would count about 95,000 per in., and according to those tables they would cause the spectra of the first order to diverge about ·99 N.A. from the dioptric beam. So it would require an aperture of nearly 2·0 N.A. to grasp all the six. Therefore all these years the tables at the back of the R. M. S. Journal, and the anonymous article on microscopic vision, which is a condensed summary of all their and Prof. Abbe's teaching on the subject, are, as I have often pointed out, contradictory. This last experiment on the *Triceratium* with only the spectra of the first order admitted, shows that on focal alteration only a change from positive to negative diffraction images takes place, i. e. black to white dots; in other words, a black hexagon with a white centre changes to a white hexagon with a black centre and *vice versa*. The word hexagon is here incorrect; the pattern strictly speaking under these conditions is black or white circular dots arranged in a quincunx form. This experiment is most important, because it shows that when a small cone of illumination is used a more truthful image is secured by

* R.M.S.J., Ser. 2, vol. i. pp. 354.

reducing the aperture of your objective until all spectra are cut out, except those of the first order. The reasoning is as follows: With a small cone and an aperture sufficient to take in many orders of spectra on focal alteration, you obtain a series of changing images similar to those seen in a kaleidoscope. Without *à priori* conclusions you do not know your focus, consequently you cannot select the true diffraction ghosts from among the false diffraction ghosts.

But the moment the aperture of the lens is contracted so that only the spectra of the first order are admitted, one image and one image only is possible. This image is certainly not a very good image of the structure, nevertheless it cannot be very dissimilar.

In the case before us, instead of getting well-defined hexagons like those of a bee's honeycomb, we have in place of them circular bright spots, spaced correctly and in arrangement precisely similar to the original.

But it may be urged that all this only applies to diatom work, and has nothing whatever to do with ordinary microscopical objects. If you will pardon me for a moment I will endeavour to prove to you that it is of the highest importance with regard to almost every microscopical object, But first let me draw your attention, before leaving the *Triceratium*, to a false diffraction ghost of the second degree (fig. 11). This picture is only possible when four orders of spectra are admitted. Here you will notice that each bar of the hexagon is broken up into three dots, and six spots with a central one are imaged in each areolation. This is a difficult one to photograph on account of the great brightness of the areolations, which accounts for the images in those parts being weak. To show that this is a subject not at all confined to diatomic structures, the next experiments will be performed on the eye of a fly.

The spectra arising from this structure are identical with those from similar diatomic structures, only they are not so widely spread out, the intervals being 1/800 in. This proves that diffraction does not begin at 1/2500 in. I will first project the critical image (fig. 12) taken with a 3/4 cone × 165. The illuminating cone was now reduced, and the spectra, as in the next picture, allowed to pass into the objective (fig. 13). We now get the Eichorn intercostals. This shows that the diffraction theory has just as important a bearing in connection with a common entomological object as with a diatom. The next picture (fig. 14) was taken with a large cone, but the aperture of the lens was reduced so that it should bear the same proportion to the eye of a fly as an oil-imm. of 1·4 N.A. does to the *P. angulatum*. Here you will notice that the hexagon runs into a kind of square shape. A similar appearance can be obtained with a *P. angulatum*.

The structure of the eye of the fly being very coarse it is possible to pick up the whole of the diffracted fan; this, as seen at the back of the objective, is in itself such a beautiful object that I have endeavoured to produce it, but as yet without success. It is a beautiful star with hyperbolic edges, and is, as far as I am aware, unknown, nor figured anywhere. If this whole diffraction fan be admitted to the objective, then we get a false diffraction ghost of the third degree (fig. 15), and this is the last and most complicated ghost you can have. The foundation of the picture is composed of three lines drawn at 60° to one another, the third line passing through the apices of the rhombs. I will next project a false diffraction ghost of *P. formosum*, showing intercostal dots (fig. 16). These were produced in precisely the same manner as the others. The focus, you will notice, is only slightly within the true focus. The greater the aperture of the objective used the less out of focus the object requires to be in order to produce the intercostals. Now I have shown you the three degrees of diffraction ghosts; these are all produced, and can only be produced by the small cone. It cannot be wondered that Prof. Abbe and his exponents say that "whether for example, *P. angulatum* possesses two or three sets of striæ, whether striation exists at all, whether the visible delineation is caused by isolated prominences, or depressions, &c., no Microscope, however perfect, no amplification, however magnified, can inform us."*

Again, we read "that every attempt to discover the structure of finely organized objects - as, for instance, diatom-valves—by the mere observation of their microscopic images, must be characterized as wholly mistaken." And again, "The interference images of minute structure, however, stand in no direct relation to the nature of the object, so that the visible indications of structure in a microscopical image are not always or necessarily conformable to the actual nature of the object examined."

The explanation of all this is that Prof. Abbe takes cognizance of one kind of image, and that one a diffraction ghost, and it is perfectly true that so long as you are dealing with diffraction ghosts you cannot, for certain, determine the nature of the structure you are observing.

At different foci when a small cone is used there are different images, and without *à priori* knowledge it is impossible to determine the correct focus, and consequently the true diffraction ghost. Now it is the function of the condenser to put an end to all these difficulties; it enables you to illuminate by means of a wide-angled cone, and then you have a true image at one definite focus, and at any other focus there is no image at all to confuse you.

Of course it must be understood that when the structure is very fine, and the spectra are diffracted through great angles, your widest-angled cone really becomes a narrow one in relation to that structure; and then you are obliged to make the best you can with diffraction ghosts. But there is, on that account, not the least reason why, for all coarser structures, you should not have a true diffraction image by means of a large cone instead of either a true or false diffraction ghost by a small cone.

Eventually our diffraction ghosts with very fine structures and wide-angled cones may through increase in the apertures of our objectives and improvements in our condensers, be changed to true diffraction images.

Prof. Abbe's last paper takes account only of small differences between very similar images, and ignores altogether the enormous differences due to the union of different orders of spectra and the exclusion of others. He is in fact straining at the gnat and swallowing the camel. In his paper he disregards the possibility of getting (to

* M.M.J., xiv. (1875) p. 220.

return to our former simile) a picture of a hayrick instead of a dog, while he insists that a small cone is preferable to a large one lest the dog appear foggy. To which I reply that a foggy dog is preferable to a hayrick, however sharp.

When the illuminating cone is enlarged so that it fills about 3/4 of the back of the objective, one image, and one image only, can be produced, which, as I have said, goes in and out of focus as a daisy under a 4-in. There can be now no doubling of the structure, and no multiple images are produced. Spherical aberration in the lens merely veils the image under an appearance of fog or mist. The clearness and distinctness of the image may be marred by its means, but the image cannot be altered in form.

I have only one more point to bring to your kind notice, and that is the statement that the wide-angled cone, by means of the superposision of dissimilar images, obliterates uncoloured histological tissues.*

The truth regarding this is that the wide-angled cone gives you a faithful representation of uncoloured histological tissues (very likely not the preconceived images regarding them), blotting out all those parts which are out of focus. In other words, it gives you a truthful picture of a definite plane in the structure. To illustrate this I have selected the thinnest and most transparent histological object, and one which would be more likely to be blotted out than any other with which I am acquainted. I have photographed this both with a wide and narrow cone, and you shall judge for yourselves which is the more faithful picture. The object is cartilage in a young rat's tail, of which I will project a low power view, × 8, in order that you may identify it. I now show you an image (fig. 17), × 390 diams., taken with a small cone. The most prominent features in this image are the parts which are out of focus. I wish to draw your particular attention to a cell-wall seen end-on running nearly in a vertical direction in the centre of the slide. The focus was adjusted precisely on that point, and I would like you to notice the apparent thickness of that line.

I will now show you the same object (fig. 18) taken by a large cone, and you will at once understand the extreme tenuity of that particular cell-wall which in the previous picture was so thickened by false diffraction ghosts. This picture, I maintain, is a true representation of an exquisitely thin cell-wall; there is no blotting out of any structure in focus, only a removal of false diffraction ghosts. Of course it may be useful to produce a false image for the purpose of obtaining an idea as to the relative position of the part in focus to those parts out of focus. But this has nothing to do with the bare fact of the obliteration of structure by means of a wide cone.

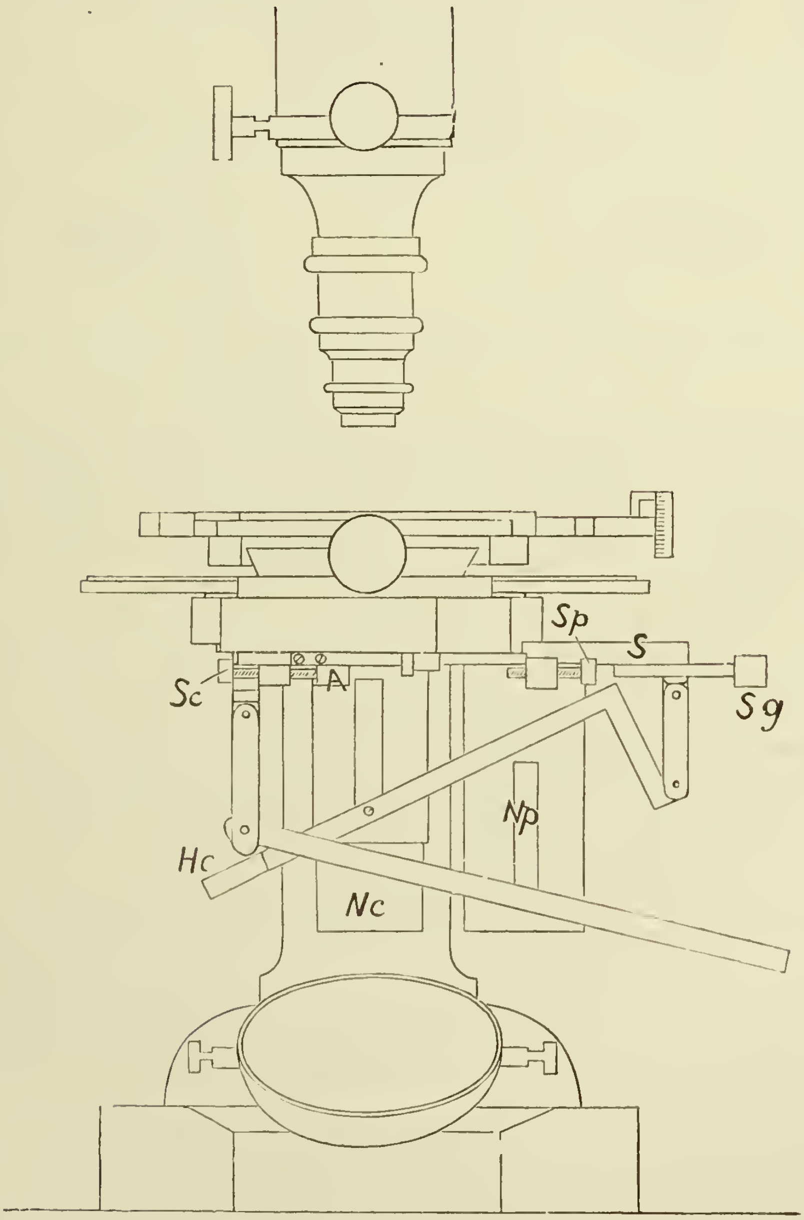
In conclusion, I believe the objection to the use of a narrow-angled cone to be due to the fact that it emphasizes zonal differences, and the efficacy of the wide-angled cone that it as far as possible neutralizes the effect of those differences. Prof. Abbe states (p. 724) "there is not the least rational ground, nor any experimental proof, for the expectation that this mixture [he is alluding to the mixture of slightly dissimilar images in consequence of the employment of a wide cone] should come nearer to a strictly correct projection of the object than that image which

* R.M.S.J., 1889, Part 6, p. 723.

is projected by means of a narrow axial illuminating pencil." Now, I take it that I have proved to you this evening one thing at least, that there is rational ground and experimental proof for the expectation that this mixture does come very much nearer to a strictly correct projection of the object than that image which is projected by means of a narrow-angled illuminating pencil. Finally, I am of opinion that a correct understanding of diffractional effects will, more than anything else, tend to produce in the minds of microscopists a true appreciation of the importance of the achromatic condenser."

Apparatus for the rapid change from parallel to convergent polarized light in connection with the Microscope.*—Dr. E. A. Wülfing gives a description of an apparatus invented by himself,

FIG. 4.



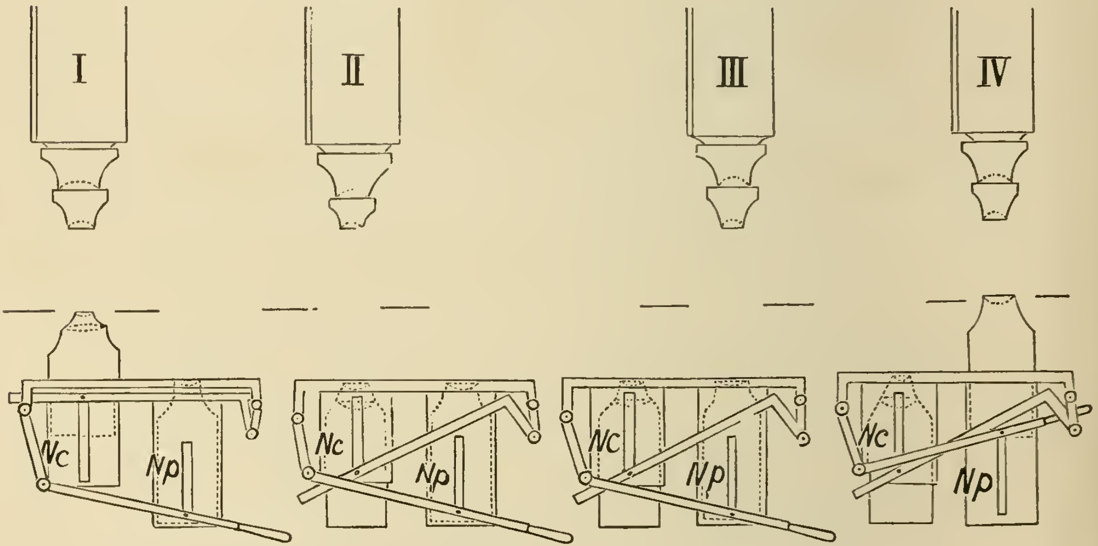
intended to save time in studying mineral or rock sections by polarized light. A plate S (fig. 4), sliding in a groove beneath the stage of the

* Neues Jahrb. f. Mineralogie, 1889, ii. p. 199–202.

Microscope, bears on its under surface two vertical tubes containing two Nicol prisms N *c* and N *p*, one of which N *c* is permanently arranged for observation by convergent light, i. e. with the usual two convergent lenses, whilst the other N *p* bears the usual lens employed in observations by so-called parallel light. Both of these polarizers, together with their lenses, can be raised or lowered independently of one another by means of suitable forked two-pronged levers H *c* and H *p*.

When changing from one form of illumination to the other, the Nicol prism last in use is pushed down, the plate S is slid in its groove so as to bring the other Nicol to the centre of the stage, and this second Nicol is then raised by its lever into position beneath the mineral section. These four stages in the process are shown in the diagrams I. to IV. (fig. 5), where I. shows Nicol N *c* in its highest position,

Fig. 5.



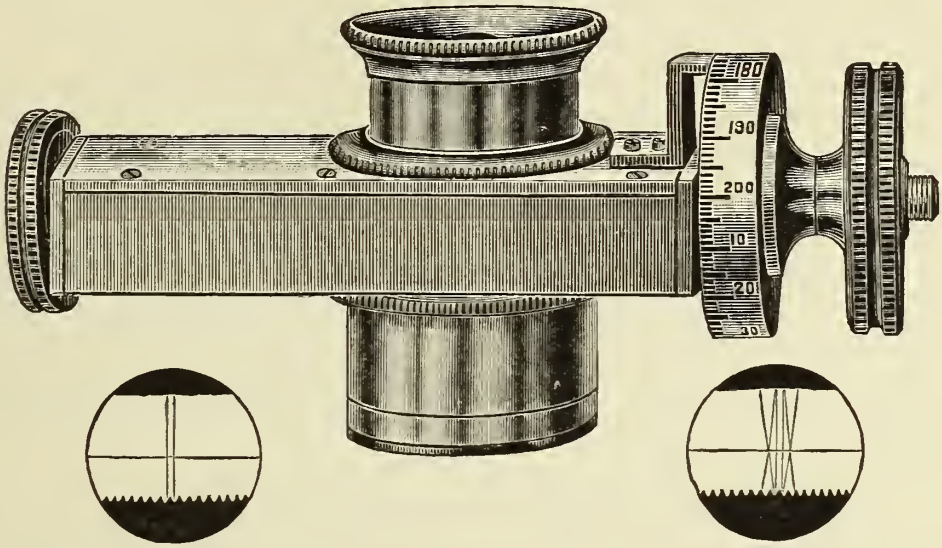
beneath the section; Nicol N *p* in its lowest position on one side, not in use. II. Nicol N *c* in its lowest position beneath the section; Nicol N *p* in its lowest position on one side, as before. III. Nicol N *c* in its lowest position, pushed aside; Nicol N *p* in its lowest position beneath the section. IV. Nicol N *c* in its lowest position, pushed aside as before; Nicol N *p* in its highest position beneath the section.

The catch or stop at A can be turned aside to permit of both polarizers being pushed aside for observation by ordinary light. Dr. Wülfing has the apparatus attached to a Fuess No. 1 large Microscope. It would require special fitting to other patterns. The apparatus is made by Zimmermann, Mechaniker, Hauptstrasse, Heidelberg, and costs, without Nicol prisms and lenses, 60 marks. It will be observed that two polarizers are required.

Bulloch's improved Filar Micrometer.—Fig. 6 shows this instrument, of which a short description was given in this Journal for 1886, p. 132, in which we described it as having a second screw, worked by a milled head at the opposite end to the micrometer-screw, which moves both sets of lines together, so that it is possible to set the graduated screw-head at zero for any particular measurement.

Mr. Bulloch now describes it as follows:—"The improvement consists in the secondary slide, by which the whole micrometer is movable; avoiding the uncertainty of adjustment made by the ordinary micrometer in getting contact with the cross-hair at zero; as the amount of

FIG. 6.



spring with the best mechanical stage (excepting micrometer stages) prevents the cross-hairs being brought gently and perfectly in contact with the object to be measured."

Mr. Bulloch writes as follows with regard to the additional diagonal lines shown in one of the small figs.:—"From my experience in comparing micrometers and getting the value of divisions of the screw, much better results can be reached by intersecting the line on the micrometer with the cross line in the eye-piece micrometer; for when using the ordinary filar micrometer it is almost impossible to judge the amount of space left between the line on the micrometer and the spider line."

(4) Photomicrography.

Photomicrographs and Enlarged Photographs.—At the December meeting of the Society, Mr. J. Mayall, jun., read the following note:—

The application of photography to microscopy has received in recent years so great an impulse from the introduction of the dry-plate processes, that the Society has received very large accessions to its collection of photographs—especially of such as have been produced with a view to illustrating various theories of diatom structure.

Apart from the question how far it is legitimate to infer the structure of such diatom valves either from the images seen in the Microscope or from those produced by photomicrography—a question which Prof. Abbe's researches appear to answer in the negative—it appears to me that, unless great discretion is used, the after-processes of enlarging from photomicrographs may easily lead microscopists astray in giving fictitious appearances of contrast in the structure, leading to the belief that such strong images must necessarily represent what was visible in the Microscope. It is well known that photomicrographs frequently give a very erroneous rendering of the different tints seen on delicate and transparent objects in the Microscope; and when this erroneous rendering is supplemented by the artificial contrasts due to chemical intensification of the original negatives, or to the after-processes of copying and enlarging, it becomes of the first importance in cases where photographs are brought forward in illustration of special points, that either the original negatives, or reproductions of them as exact as possible, should be exhibited. When, as in many cases—notably by Dr. Van Heurck—enlarged photographs are brought forward without any precise description of the process of their production, and without the original photomicrographs for comparison, useful criticism is difficult if not impossible. All that can be said about them amounts to expressions of vague astonishment that the image should look so strong and so highly magnified. I think it would be advisable in all cases to distinguish between photomicrographs produced with the Microscope, and enlarged photographs from photomicrographs: the former can only be usefully criticized by one who is familiar with the object as seen in the Microscope; the latter need other criteria whence their utility may be estimated, and, above all, they need the presence of the originals from which they were enlarged.

(5) Microscopical Optics and Manipulation.

The full Utilization of the Capacity of the Microscope, and means for obtaining the same.*—In a paper read before the American Society of Microscopists, Mr. E. Bausch said:—The cover-glass may truly be called a necessary evil, for while absolutely required in microscopical investigations, there is no adjunct to the Microscope that has been and is productive of so much evil, and has so retarded the utilization of benefits made possible by the advance in the construction of objectives. This fact was appreciated as early as 1837, when the angular apertures were what would now be considered extremely limited, and the appreciable effect of variations in thickness of cover-glass was not then nearly so pronounced as it is at the present time, even in modern objectives of a narrow angle.

The accommodation for the different thicknesses was obtained by varying the distance between the systems of objectives, and has been followed with modifications in the mode of obtaining the necessary motion up to the present day. While open to some objection, it accomplishes the purpose quite satisfactorily, and must continue to be used until something better is suggested.

One of the purposes of the homogeneous immersion is, as we know, the avoidance of the necessity of the cover-correction, in that the cover-glass, immersion fluid and front of objectives are to be one homogeneous mass, but even under these conditions, which in practice were found to be not constant, it has been found advisable to provide cover-correction to obtain the highest possible results. However, even should this not be found necessary in the development of improvements in this class of objectives, it must be remembered that the majority of objectives will always be dry, and especially so when such improvements, which we hope are still to be made, are accomplished. It is an unfortunate circumstance that with this class of objectives the influence of variation

* Microscope, x. (1890) pp. 289–96.

in thickness of cover-glasses is most apparent; but since it is so, we should, if possible, provide an agency which, eliminating the personal factor of efficiency, will give under all conditions, results closely equal to those under which the objectives were originally corrected.

It is surprising to see how little attention is paid to this subject in the large majority of standard works on the Microscope. Almost all books give carefully prepared illustrations and descriptions showing the effect on the course of light by the interposition of the cover-glass, and after giving conclusive evidence of its disturbing influence, still, in a general way, say it is of little moment. Thus, in a German work of the highest standing, which has also been translated into the English language, is found the following utterance, freely translated:—

"In regard to modern Microscopes, which we have had opportunity to examine, we have not found the differences in thickness such as occur in commercial cover-glass, when, for instance, three to six are equal to a mm., have any noticeable influence on the microscopical image."

In another work of great popularity are found the following quotations:—"That the effect of thickness of cover-glass has a great influence on the perfection of the microscopical image is beyond the slightest question, and certainly deserves the most careful attention of the optician as well as the observer, but whether the devices for its removal are of such great importance and so absolutely necessary as it is claimed, is another question."

"On the other side, the difference in the cover-glass used in different directions for the most delicate preparations is hardly of any account. I, at least, possess, besides my individual preparations covered with glass of about 1/5 mm. thickness, a collection of objects which I obtained from London and Paris, in which there is such a slight difference of cover-glass thickness that I can observe them all with my objectives of powers from 2 to 1·3 mm. (equivalent to about 1/12 to 1/20 in.) without showing the slightest difference in optical qualities, and in the definition and clearness of the image under the same illumination, as I have convinced myself by careful comparative tests."

With such statements to guide the microscopists, it is not surprising that the subject should have received so little attention, and that any efforts to lead to improved methods of manipulating objectives should have almost completely failed because of a lack of the true understanding of their need and consequent failure to create interest. The belief is quite general that any time devoted to this subject is wasted, and might better be utilized in other directions. I hope to be able to show that this is entirely wrong, and may here say that while I may be considered an extremist in the other direction, my efforts emanate from the desire to put it in the power of every microscopist to obtain the highest possible results from his optical battery, and equal to those obtainable by the optician.

When, in 1887, Prof. S. H. Gage addressed a circular letter to all opticians in the world inquiring for the dimensions of their standard tube-length, as well as for the thickness of cover-glass which they used as a standard in the correction of objectives, I looked forward to the result with considerable interest, as it would bring together data which it was impossible otherwise to obtain.

At the meeting of this Society in 1887 at Pittsburgh, he gave the results of his efforts, which show some astonishing facts. I would here say that while for a long time I had felt that a system that would permit the full utilization of the optical capacity of objectives of different makers under varying conditions of cover-glasses was desirable, I was then forcibly impressed with the absolute necessity of a plan which would offer this advantage. One is as much surprised by the differences in cover-glasses used by various makers in correcting non-adjustable objectives, as by the great differences in the length of tube, which influences so considerably the spherical aberration of the objectives. With a thickness of 0·1 mm. for the thinnest, and 0·25 mm. for the thickest, it is only too apparent that with the additional variation in lengths of tubes, it is beyond the power of the microscopist to obtain even approximately the best results from his objectives. More than this, a large quota of the advance made in recent years in the capacity of objectives has been lost.

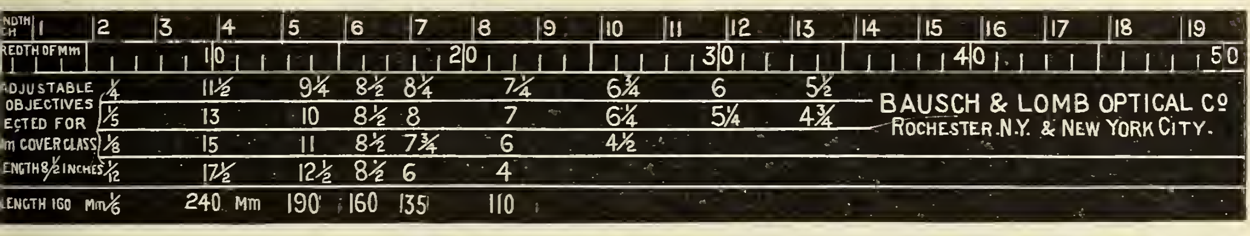
As Prof. Gage states, "A uniform thickness for cover-glass for unadjustable objectives seems also desirable," and this would be the easiest solution of the question, but while, on the one hand, the makers of objectives have not yet agreed to use one standard on account of the technical difficulties involved in departing from their established precedent, on the other, the microscopist would hardly be willing to bear the expense which would be occasioned by the loss of cover-glass not conforming to the standard, in order to use those of one thickness. This expense might be greatly reduced by using selected covers of one standard on objects for all medium and high-power objectives, and the balance on all other preparations, on which only low powers would be used, but this would of course be of little avail in face of the fact that manufacturers follow no standard.

The greatest difficulty is met with non-adjustable objectives. As is well known, compensation for thickness may be obtained in the proper adjustment of tube-length, but while not all Microscopes are suitably provided with draw-tubes, the requisite experience and skill are lacking with a large number of microscopists to make the correction properly in this manner, as well as in objectives especially provided with collar correction. I am sure that microcopists of long experience will bear me out in the statement that results with adjustable objectives depend upon individual skill, and that many such objectives now in use fail to give results corresponding to their capacity. It would seem, therefore, that any system to permit the full utilization of the capacity of objectives should depend on no personal factor, in fact, should be mechanical, and this I have followed out in the system that I shall explain.

In an objective corrected for normal thickness of cover-glass there will be spherical over-correction with thick covers and under-correction with thin covers, the amount of correction varying in a different ratio to the amount of variation from the normal thickness. The chromatic correction will also lose correspondingly, but not to so high a degree. While a deviation of a few hundredths of millimeter in either direction will not signify, that which occurs in covers classified in price lists under one number is sufficient seriously to affect, and in the higher powers totally obliterate the definition, which under normal conditions it may possess.

The microscopist is therefore not obtaining such results as his objectives should enable him to obtain, and the efforts of the conscientious optician to provide classified objectives of reliability and similar performance are almost entirely nullified. In making the necessary experiments some astonishing results appear. With a non-adjustable dry 1/5 corrected for a cover-glass of 0·16 mm., employing the extremes of cover-glass

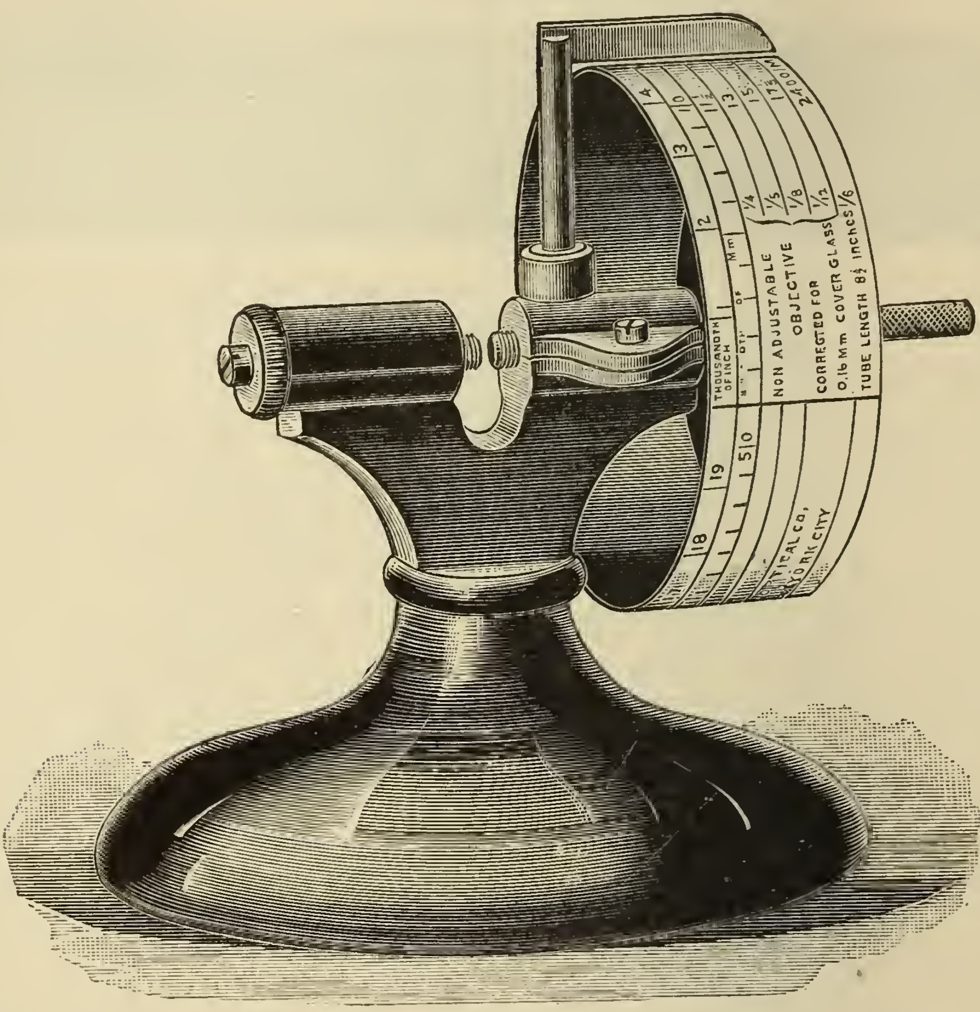
Fig. 7.



which are used by the various manufacturers as standard as obtained by efforts of Prof. Gage, I found that for 0·25 mm. a tube-length of 6 in. is required to obtain the proper correction, while for a thickness of 0·1 mm. 13 in. of the tube-length are necessary. In a 1/8 objective adjusted under the same conditions, $4\frac{1}{2}$ in. are the requisite for a cover of 0·25 mm., and for 0·1 mm. 15 in. The further fact is shown that with a 1/5, which under conditions of tube-length and cover-glass given above shows certain structure well defined, absolutely fails to show anything of it under a cover-glass of 0·1 mm. on one side and 0·25 mm. on the other, and further a marked chromatic over or under correction. With a cover of 0·14, which would seem but a slight variation from the standard, the objective is spherically highly under-corrected, and with 0·18 highly over-corrected. With objectives of high power the difference is still more marked. For these experiments I have had Mr. J. D. Möller, of Germany, mount a series of *Pleurosigma angulatum* dry and *Amphipleura pellucida* in balsam under a series of covers varying from 0·1 mm. to 0·34 mm. each carefully measured and marked. I have used these objects because they are my favourite tests, and it goes without argument in saying that any preparation showing structure under the above objectives will be affected to the same extent by the varying conditions of cover-glass as these objects, and in objects of still finer structure the limit of visibility will be reached correspondingly sooner.

The system which I have devised to aid in overcoming these difficulties depends in the first instance upon a micrometer for measuring the thickness of cover-glass. While the delicate instruments made by M. Grossman, of Germany, are excellently suited for this purpose, they are expensive. I have endeavoured to overcome this objection by constructing a plain screw which, while not so sensitive to the touch, is sufficiently so for all practical purposes. The instrument is provided with a stand of japanned iron. Cut horizontally through the top is a thread of 1/50 in. pitch, and 3/16 in. outside diameter; a recess is cut on the top below the line of the screw, and at right angles to it for placing the covers. The one-half of the top of the stand which receives the micrometer screw is slotted longitudinally to the depth of the screw, and is provided with a set screw to take up wear. The other half has the fixed screw, adjustable, however, for final adjustment. The end of the micrometer screw is milled, but of a small diameter, so that no force can be exerted to endanger the cover-glass. Fixed on the screw between two nuts is a brass drum with a 1/2 in. face; a knife-edge index-finger is fixed to the top of the stand, and projects over the top of the drum; to the outside diameter of the drum is fixed a strip of glazed paper

Fig. 8.



Actual size.

provided with a series of divisions. The first gives the thickness of cover-glass in thousandths of in., the second in hundredths of mm. The third indicates the proper tube-length with various thicknesses of cover-glass with a non-adjustable 1/4 corrected under a tube-length of 8½ in., and cover thickness of 0·16 mm.; the fourth gives the tube-length of a 1/5 in. objective under the same conditions; the fifth for a 1/8, and the sixth for a 1/12 for same conditions of tube-length and cover; the seventh is for a 1/6 with the same cover, and tube-length of 160 mm.

In objectives provided with cover correction the graduation is so arranged as to read to 0·01 mm. No matter what the power of objective or whether dry or water-immersion, the number gives proper correction for a thickness corresponding to it. Thus, with a cover-glass of

·20 mm. the collar of such an objective needs merely to be set at 20 to give the proper correction, and consequently the best results. On the other hand, with an objective which is graduated on this system, the correct thickness of cover-glasses can be determined by obtaining the proper correction on preparations previously made, but on which the thickness of cover-glass is not noted, and the thickness may be marked on them for future convenience. To do this successfully, however, considerable experience is requisite. All the other scales give the correct tube-length in inches and millimetres for covers corresponding to them, and in this manner offer a ready and definite means of correction. The tube-lengths required for the thinnest and thickest covers are so extreme that probably no convenient means for obtaining them can be practically arranged, but they can be so approximately if not entirely. At any rate, the micrometer will detect the requirements before using the covers, and those deviating considerably from the normal can be used on objects for use with low powers only, in which case the effect will not be very appreciable.

In this system I do not overlook the fact that variation in tube-length involves a variation in magnifying power, but except in cases when micrometers are used, I consider this of secondary importance, as it always is in comparison with the results obtained in resolving and defining power.

This system involves four conditions :—

First. That all cover-glass be measured before using, and that the thickness be noted on the preparation.

Second. That for convenience all draw-tubes be marked in inches or millimetres, or both.

Third. That adjustable objectives be corrected according to this scale.

Fourth. That the same tube-length and cover-glass thickness be used in all original corrections of objectives.

As regards the first condition, there are many microscopists now who measure all their covers before using them, but the mere knowledge of thickness has been of no value up to the present time, because this in itself has been no guide in obtaining better results except by approximation. My aim in connection with this system has been to devise an instrument which shall possess a high degree of accuracy, and shall still be so inexpensive that its price should be no obstacle to its general use.

The celebrated preparer of objects, Mr. J. D. Möller, and others, have kindly agreed to mark the thickness of covers on their objects, so as to aid in the introduction of this system, and other preparers can no doubt be induced to do so if its advantages can be proved.

As regards the second point, many manufacturers now graduate their tubes, and modern requirements demand that this should be more generally done. Our company intends, as soon as it can possibly arrange to do so, to graduate the tubes of all its instruments.

As to the third and fourth conditions, I cannot, of course, presume to ask manufacturers to adapt their standards to this system. While it will be a convenience to a large number of microscopists, I must leave it to the merits that this system may possess, to exert their influence in this direction.

On the Amplifying Power of Objectives and Oculars in the Compound Microscope.*—Dr. G. E. Blackham writes:—"A great deal has been said and written on this subject, and still the matter is not as clear and accurate as could be desired.

The European opticians usually name their objectives and oculars in an arbitrary manner, as No. I., No. II., No. III., &c., or A, B, C, &c., but these designations give no clue to the amplifying powers, except that the lower numbers or earlier letters usually indicate the lower magnifying powers. The No. I. objective of one maker does not, however, necessarily correspond with the No. I. of another maker, and the No. I. objective does not necessarily correspond in amplifying power with the No. I. ocular of the same maker.

The English makers have attempted to avoid this confusion and, to introduce a degree of uniformity, have long adopted a system of nomenclature based upon the amplifying power; that is, if a combination of lenses magnifies equal to a single convex lens of one-inch focus, the combination is *called* a one-inch; if the same as a single lens of one-quarter inch focus, it is *called* a quarter-inch, &c., &c. This system has long been in use in England and this country for objectives, and more recently has been extended to oculars (or eye-pieces, as they are commonly called). This was supposed to give a very simple and accurate means for determining the power of any objective or ocular or combination of objective and ocular, provided only that they were correctly named by the maker and were used on a tube of the standard length. The rule commonly in use is based upon the assumption of the arbitrary distance of ten inches as the distance of distinct vision, and that the number of times the focal length is contained in ten inches is the amplifying power; so that a *one*-inch lens would magnify ten times, a one-fourth inch forty times, a one-tenth inch one hundred times, &c., &c. The image of the object projected by the objective being again magnified by the ocular, it was further assumed that the same rule would apply, and therefore that the amplification produced by the combination of a 1/10 objective with a one-inch ocular would be found by multiplying the assumed power of the 1/10 objective (100) by the assumed power of the one-inch ocular (10) = 1000 diameters. And so, by the application of this simple rule, every owner or user of objectives and oculars of the new nomenclature could calculate correctly the theoretical power of each and of any combination, with the understanding that, if the distance between the optical centre of the objective and that of the ocular varied, the amplifying power would vary in proportion.

The object of the present paper is, 1st, to show the incorrectness of this rule, in that the real image projected by a simple convex ten inches from its optical centre is *not* amplified the number of times the focal length is contained in ten inches, and that the same rule of amplification that is true and correct for the objective that projects a *real* image cannot be true and correct for the ocular, which projects a *virtual* image; and, 2nd, to present a correct method of determining the (linear) amplifying power of any objective or ocular, correctly named on the equivalent focal length system, and of any combination of such objective and ocular at any given distance between their optical centres.

* Proc. Amer. Soc. Microscopists, xi. (1889) pp. 22–31.

Now, in so far as the amplification of the image projected by the objective is concerned, the distance of distinct vision is of no consequence whatever, but the result is governed solely by the well-known optical law that, "The linear dimensions of object and image are directly as their distances from the optical centre of the lens." The correctness of this can be demonstrated by actual measurement, for the image is as real as the object, and its distance from the optical centre of the lens and its dimensions can as easily be measured.

Before proceeding to the further discussion of this subject it may be well to define some of the optical terms which I shall be obliged to use. I am quite aware that, for the majority of my hearers, this is a work of supererogation that almost savours of impertinence; but there are always beginners amongst us, and it is for their sakes that I insert these elementary definitions.

Definitions.—Optical Centre.—The point through which all rays traversing a lens with parallel directions at incidence and emergence must pass. In double convex or double concave lenses it lies in the interior of the lens; in plano-convex or plano-concave lenses it lies on the curved surface; while in a meniscus of either kind it lies outside the lens altogether.

Principal Axis.—The straight line passing through the centres of curvature of both faces of a double convex, a double concave, or a meniscus lens, or passing through the centre of curvature of the curved face and cutting at right angles the plane face of a plano-convex or a plano-concave lens, is called the Principal Axis; the optical centre is always in this line.

Secondary Axes.—All other straight lines passing through the optical centre are called "Secondary Axes."

Principal Focus.—The point at which rays originally parallel to the principal axis are made to converge (approximately) to one point.

Focal Length.—The distance from the optical centre to the principal focus.

Conjugate Foci.—Rays emerging from a point more distant than the principal focus on one side of a convex lens and passing through the lens will be brought to a focus at a point on the other side of the lens, and the points thus related are called conjugate foci.

As one conjugate focus advances from infinite distance (parallel rays) to the principal focus, the other recedes from the principal focus to infinite distance, the most distant focus always moving most rapidly, and the least distance between them is therefore attained when they are equidistant from the optical centre, in which case the distance of each from the optical centre is $2f$, and their distance from each other $4f$. If either is less than the principal focus, then the other becomes negative; that is, the rays are no longer brought to a focus on the *opposite* side of the lens, but are only rendered less divergent, as if coming from a more distant point on the *same* side, and this point from which they *appear* to come (the more distant of the two) is called the virtual conjugate focus. In this case, as one conjugate focus advances towards the optical centre, the other advances in the *same* direction till they become coincident.

Secondary principal and conjugate foci exist in each of the secondary axes of a convex lens, and are under the same laws as the primary foci.

Each point in an object has its conjugate point in the image of it formed by a lens, and this image, if on the opposite side of the lens, is real and inverted; if on the same side, is virtual and erect. The linear dimensions of the object and image are directly as their distances from the optical centre of the lens; so that, if the object be nearer than the image, then the image is magnified, and *vice versa.*

Formulæ.—The formulæ for the determination of the conjugate foci when

f = principal focus (or focal length);
p = one conjugate focus;
p' = the other conjugate focus.

When the conjugate foci are on opposite sides of the lens (real image):

$$\frac{1}{p} + \frac{1}{p'} = \frac{1}{f}.$$

This formula suffices for the determination of either of the conjugate foci, the other conjugate focus and the focal length being given; or of the focal length, the two conjugate foci being given; and as it applies equally well to points in the secondary axes, it suffices equally to determine the distances of the object and image (and thence their relative linear dimensions), if one of these distances and the focal length of the lens be given.

When the conjugate foci are on the same side of the lens (virtual image) the formula becomes

$$\frac{1}{p} - \frac{1}{p'} = \frac{1}{f}.$$

The plus sign here becomes minus, or, to express it in other terms, as the two conjugate foci are now on the same side of the lens, it is the difference instead of the sum of their reciprocals that equals the reciprocal of the focal length. This formula is as applicable as that for real conjugate foci to the determination of the places, and therefore of the relative linear dimensions, of image and object; but, of course, the change of sign produces marked differences in the results when the given quantities are the same; that is to say, with a given focal length and image distance, the distance of the object, and therefore the ratio between its linear dimensions and those of the image, will vary according as the image is real or virtual.

In the compound Microscope we have to deal with both real and virtual images; the real produced by the objective, and the virtual by the ocular.

The real and inverted image produced by the objective becomes in its turn the object of which the ocular produces a virtual image; erect so far as it is concerned, but, of course, still inverted as regards the original object.

The degree of amplification of the real image produced by the objective depends upon two factors: 1st, the focal length of the objective, and, 2nd, the distance from its optical centre at which the image is formed. It can be formed at any distance from the focal length of the objective up to infinity.

In most Microscopes of the English and American model the tube is of such length that the image is formed at a distance of about ten inches, and that distance is therefore taken as the basis of calculation, and the formula then is

$$\frac{1}{p}\ \frac{1}{\text{(object distance)}} + \frac{1}{p'}\ \frac{1}{\text{(image distance)}} = \frac{1}{f}\ \frac{1}{\text{(focal length)}};$$

or, substituting the image distance 10 for p':

$$\frac{1}{p} + \frac{1}{10} = \frac{1}{f}.$$

With this formula let us work out the case of a 5-in. objective; then

$$\frac{1}{p} + \frac{1}{10} = \frac{1}{5};$$

$$\frac{1}{p} = \frac{1}{5} - \frac{1}{10} = \frac{1}{10};$$

$$\frac{p}{1} = \frac{10}{1};$$

$$p = 10;$$

that is, the object and image are equidistant from the optical centre, and therefore of equal size, and there is no amplification. Of course, it can be assumed that the image distance p' is greater than 10 in., as in case the draw-tube is used, when the formula will show that, with a 5-in. objective, the image is larger than the object, or p' can be taken as less than 10 in., when the formula will show that, with a 5-in. objective, the image is less than the object.

Keeping 10 in. for our image distance, let us take the case of a 1/5 in. objective, then $f = \frac{1}{5}$.

$$\frac{1}{p} + \frac{1}{10} = \frac{1}{\frac{1}{5}}$$

$$\frac{1}{p} + \frac{1}{\frac{1}{5}} - \frac{1}{10} = \frac{50}{10} - \frac{1}{10} = \frac{49}{10}$$

$$p = \frac{10}{49}$$

$$a\ \text{(amplification)} = \frac{10}{\frac{10}{49}} = 49 \text{ times.}$$

By this formula we can easily calculate the amplification of the real image projected at 10 in. by any simple-convex lens, if the focal length of the lens be known; and I present herewith a table so calculated for most of the focal lengths used for Microscope objectives. (Table A.)

It will be noted that the amplifications obtained are, in every case, less than those obtained by the number of times the focal length is contained in 10 in., and the reason is that one conjugate focus (the image distance) being at less than infinite distance, the other conjugate focus (the object distance) *must* be at a greater distance than the focal length, and therefore a quantity greater than the focal length must be used for the divisor, and the quotient (the amplification) must be less.

As a 1-in. simple-convex lens amplifies the image projected by it at 10 in. from its optical centre 9 times, a 1-in. objective should do the same (without reference to its actual focal length). If it fails to do so, if the image projected by it at 10 in. from its optical centre is amplified more or less than 9 times, then the objective has been incorrectly named; it is not a 1-in. objective, but something else.

The Ocular.—Having disposed of the real image projected by the objective, we come to the virtual image projected by the ocular; here the formula is

$$\frac{1}{p} - \frac{1}{p'} = \frac{1}{f};$$

substituting the image distance 10 for p' we have

$$\frac{1}{p} - \frac{1}{10} = \frac{1}{f}.$$

With this formula let us work out the case of a 5-in. ocular:

$$\frac{1}{p} - \frac{1}{10} = \frac{1}{5}$$

$$\frac{1}{p} = \frac{1}{5} + \frac{1}{10} = \frac{3}{10}$$

$$p = \frac{10}{3}$$

$$a = \frac{10}{\frac{10}{3}} = \frac{30}{10} = 3 \text{ times.}$$

The wide difference of this result from that obtained for a lens of the same focal length used as an objective shows very plainly the absurdity of using, as many of us have done, and as many of the books teach, the same general rule for determining the amplifying power of objective and ocular, viz. to divide 10 in. by the focal length expressed in inches.

I present herewith a table of amplifications of virtual images projected at 10 in. by simple lenses corresponding to the most commonly used oculars. (Table B.)

The total amplifying power of any combination of objective and ocular is obtained by multiplying the amplifying power of one by that of the other.

For instance, the total amplifying power of a Microscope with tube of standard length carrying a 1-in. objective and a 2-in. ocular should be $9 \times 6 = 54$, instead of $10 \times 5 = 50$, as per the usual rule.

It is to be noted, however, that while the formulæ here given are theoretically correct for the objective and ocular respectively, and are applicable to any image distances by substituting the desired image distance for p', as 10 was substituted for it in the examples given, yet there are many complications in the practical application of any formula to the determination of the actual amplification obtained by the modern compound Microscope; among these complications are,

1st. The highly complex construction of many objectives, making it very difficult to ascertain with any degree of accuracy the position of the optical centre, which difficulty is still further increased when the objective under consideration is furnished with a correction arrangement for various thicknesses of cover-glass, which, by varying the relative positions of its component lenses, varies its actual and nominal focal length and the position of its optical centre. The exact position of the optical centre of the ocular is also, at times, difficult of determination.

2nd. The refractive condition of the observer's eye is also a factor in the amplification under which the image is finally *seen*, for the reason that the dioptric system of the observing eye becomes, in fact, a part of the ocular, and any difference of its refractive power greater or less than that required to focus on the retina rays proceeding from a radiant situated at the given image distance, must be added to or subtracted from the refractive power of the ocular, and thus decrease or increase its focal length. That is to say, a person who can and does accommodate for precisely 10 in. while looking through the Microscope will, if all the other conditions are rigidly complied with, see the image under the exact amplification indicated by the formula, while one, who by reason of myopia or of excessive use of the muscle of accommodation accommodates for a less distance, will see it under a greater amplification, and the emmetrope or hyperope who relaxes his accommodation to less than that required to bring rays from a radiant at 10 in. to a focus on his retina, will see it under a less amplification than that indicated by the formula. For instance, let us take the case of the combination of 1-in. objective and 2-in. ocular for which we have found the total amplication, when image distances are taken as 10 in. in case of both objective and ocular, to be $9 \times 6 = 54$. If the observing eye be accommodated for just 10 in., the image will be seen clearly and under an amplification of $\times$ 54. If, however, the eye is accommodated for any other distance, then the image will not be clearly seen and a change must be made in the adjustment of the Microscope to make it clear. The reason is that the excess or defect of the refraction of the eye above or below what is required to accommodate it to 10 in. has, in effect, been added to or taken from the refractive power of the ocular.

Suppose an observer, as the result of myopia or from spasm of, or voluntary action of the muscle of accommodation, accommodates for a distance of 5 in. instead of 10 in.; he has, in effect, added to the refractive power of the ocular the refractive power of the lens which represents the difference between a refractive power of 10 in. and of

5 in. The refractive power of a lens is the reciprocal of its focal length. Hence the equation is

$$\frac{1}{5} - \frac{1}{10} = \frac{1}{10}.$$

Then refractive power of ocular + excess of ref. of eye = ref. power of eye and ocular taken as one, or

$$\frac{1}{2} + \frac{1}{10} = \frac{6}{10} = \frac{1}{1 \cdot 66}.$$

Hence the resulting amplification will be as if the ocular had a focal length of 1·66 instead of 2, and the formula will be

$$\frac{1}{p} - \frac{1}{10} = \frac{1}{1 \cdot 66}$$

$$\frac{1}{p} = \frac{1}{1 \cdot 66} + \frac{1}{10} = \frac{11 \cdot 66}{16 \cdot 6}$$

$$p = \frac{16 \cdot 6}{11 \cdot 66}$$

$$a = \frac{10}{\frac{16 \cdot 6}{11 \cdot 66}} = \frac{1166}{16 \cdot 6} = 7.$$

Hence for the observer whose eye is accommodated for 5 in., the expression for total amplification of the 1-in. objective and the 2-in. ocular will be $9 \times 7 = 63$.

On the other hand, let us take a case much more unlikely to occur in practice, that of a person who by reason of excessive hypermetropia or paralysis of accommodation, is unable to focus any but parallel rays upon his retina, or, in other words, to accommodate for any point nearer than infinite distance. If such an observer make use of the same combination of objective, he has in effect subtracted from the refractive power of the ocular the refractive power of the lens, which represents the difference between a refractive power 0 and of 10 in. = 1/10; then

$$\frac{1}{2} - \frac{1}{10} = \frac{4}{10} = \frac{1}{2 \cdot 5}.$$

Hence the resulting amplification will be as if the ocular had a focal length of 2·5 instead of 2, and the formula will be

$$\frac{1}{p} - \frac{1}{10} = \frac{1}{2 \cdot 5}$$

$$\frac{1}{p} = \frac{10}{25} + \frac{1}{10} = \frac{125}{250} = \frac{1}{2}$$

$$p = 2$$

$$a = \frac{10}{2} = 5.$$

Hence, for the emmetropic observer whose accommodation is entirely relaxed, or for any observer whose eye is accommodated for parallel rays, the total amplification of the 1-in. objective and the 2-in. ocular will be 9 × 5 = 45.

For strict accuracy, the change in the position of the image produced by the objective, if the adjustment for the different eyes be produced in the usual way by means of the fine or coarse adjustment moving the objective to or from the object, should be taken into consideration, but the amount is so small, about 2½ per cent. in the first case, and 5 per cent. in the second, that it may be neglected without seriously impairing the practical accuracy of the general result, while if the adjustment for different eyes be made with the draw-tube moving the ocular only, the position of the image produced by the objective is not changed, and therefore, so far as it is concerned, the original formula remains strictly correct."

"TABLE A.

"Amplification (linear) of Real Images projected at 10 in. from optical centre by simple bi-convex lenses.

Focal Length of Lens in inches.	Linear Amplification of Image.	Focal Length of Lens in inches.	Linear Amplification of Image.
5	1	1/4	39
4	1·5	1/5	49
3	2·33	1/6	59
2	4	1/7	69
1	9	1/8	79
3/4	12·33	1/9	89
2/3	14	1/10	99
1/2	19	1/12	119
4/10	24	1/16	159
1/3	29	1/25	249

TABLE B.

"Amplification (linear) of Virtual Images projected at 10 in. from optical centre by simple bi-convex lenses.

Focal Length of Lens in inches.	Linear Amplification of Image.	Focal Length of Lens in inches.	Linear Amplification of Image.
5	3	3/4	14
4	3·5	1/2	21
3	4·33	4/10	26
2	6	1/3	31
1½	7·73	1/4	41
1	11		

"NOTE.—In the Huyghenian ocular (the form most commonly in use) the field-lens, while mechanically part of the ocular, is optically part of the objective, in that it contributes to the formation, not of the virtual image projected by the ocular, but of the real image projected by the objective, upon which it acts negatively, diminishing its size while increasing the superficial area brought into view at one time. So that, in this form of ocular it is the eye-lens alone that contributes to the reamplification of the image, but the negative action of the field-lens must, of course, always be taken into consideration when attempting to determine the amplifying power of a Huyghenian ocular by calculation."

New Method for Constructing and Calculating the Place, Position, and Size of Images formed by Lenses or Compound Optical Systems.* —The late Prof. G. Govi wrote :—" The theory of lenses and of compound systems has taken a new form, and reached far greater perfection since Moebius, Gauss, Listing, and others have introduced the consideration of certain planes and cardinal points, which simplify the construction of the place, position, and size of the images, allowing account to be taken of the thickness of the refractive medium traversed by the light. But the preparatory operations, either as constructions or calculations, by which we succeed in determining the place of the points and cardinal planes in lenses or systems, are long and wearisome, and often out of proportion to the importance of the result we hope to obtain; and, above all, it is always most difficult to determine by experiment the place of these planes and points in lenses already worked or in optical systems already constructed.

Physicists, therefore, in spite of the practical methods and instruments proposed for the purpose by Cornu, Gariel, and others, are for the most part limited to considering the lens as having no thickness, and to calculate directly and for every limiting surface the path taken by the rays in traversing the given media, thus sacrificing a part (and at times not a small one) of the necessary precision, or increasing the fatigue of the calculations when many determinations of the same optical system are in question.

The suggestion, therefore, of a quicker method for constructing and calculating the images given by thick lenses will not be unwelcome to students, the same method being also applicable to any optical system whatever.

This method requires the determination of two points which, very probably, have not until now been taken into consideration by physicists or mathematicians who have treated of these matters; probably they passed them unawares, because if any one had pointed out their importance and usefulness they would at once have been recognized, and the very latest treatises on optics would have recalled them.

The two new points, by which the theory of lenses is very much simplified, and which are easily determined by observation, are the images of the centres of curvature of the two faces, anterior and posterior, of the lens, seen through that one of the two faces to which they do not belong. In order to obtain them it is necessary to suppose that the luminous rays diverging from the centre of curvature of one face, or converging towards it, meet the second face of the lens where by refraction they are made to converge towards the image of this same centre, or diverge from that image when it becomes virtual. We thus have on the axis of the lens the places of the two images q and q_1, (fig. 9), of the centres c and c_1, and of the curvature of the two faces al and bl_1.

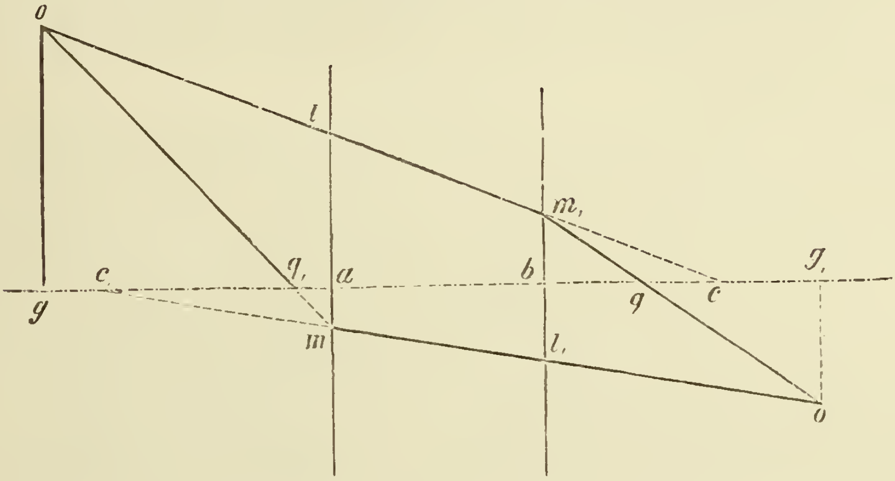
Having fixed the position of these two points, which we may call the centric points of the given lenticular system, nothing else is needed to determine any conjugate focus of a point situated upon the axis or outside the principal axis of the system, and to obtain the size and position

* Rend. R. Accad. Lincei, iv. (1888) pp. 655–60 (3 figs.).

of the real or virtual images which may be produced by the system itself.

The determination *à priori* of these points (like the determination of the points and planes of Gauss and Listing), demands the knowledge of the length and sign of the radii of curvature of the two surfaces of the lens, that of the thickness of the lens, or the axial distance of the two refracting surfaces, and finally that of the relative velocity of light in the three successive media—that is to say, of their relative indices of refraction. We can with these data alone construct or calculate the

FIG. 9.



place of the centric points q and q_1, without first determining the principal foci and the principal distances or anterior foci of the two surfaces of the lens; we can also, if we wish, determine these quantities which, introduced in successive calculations or in ulterior constructions, abbreviate or simplify the work.

In any case, having obtained the two centric points, we have no further need either of the optic centre, or of its two images, or the nodal points of Listing, or Gauss' principal planes, or the principal foci of the whole lens, to construct or calculate the places, positions, and size of the images. And as such constructions are made very quickly, we may use them in order to find the final effect of any series whatever of surfaces and of different refracting media, centered on the same axis.

It is not, therefore, necessary in the case of optic systems to have recourse to the laborious process of construction or calculation by means of successive images, for there can always be determined in every optic system (however complex) the images of the centres of curvature of its first and of its last surface, seen successively through the whole of the rest of the system, observing the image of the centre of the first surface through the second, then the image of this image through the third, and so on to the image of all the preceding images, seen through the last surface, and repeating the same operation in the opposite direction for the centre of the last surface and for its successive images up to the last, which is seen through the first surface. In this way the centric points of the whole system are obtained, by means of which we can construct afterwards or can calculate with great rapidity the image of any point placed at any distance whatever from the system.

The greater simplicity of the new method arises from considering those rays which undergo neither deviation nor displacement either at the entrance into or exit from the different media, so that the faces of the lens or the external surfaces of the system perform the function of the principal planes of Gauss, the centres of curvature of these surfaces that of the nodal points of Listing, and their images or centric points that of the principal foci of the optic system.

Without now entering into minute details of the new method, it will be sufficient to show how, by having recourse to it, we can easily find the centric points of a given lens, and how, once these points are found, we can easily construct the image of any object seen through the lens. We shall thus see whether the proposed method deserves or not to be preferred to others.

In order to find practically the position of the centric points of a given lens, we measure its thickness γ, and with the spherometer, or by reflection or otherwise, the radii of curvature r and r_1 of its first and second surfaces. Having obtained these quantities we place normally to the axis of the lens an object of a known size $o\,g$, at a determinate distance $a\,g$ from one of the faces, and we find the image $o_1\,g_1$ either real or virtual of the object, seen through the lens, measuring this image, and determining its distance $b\,g$ from the other surface.

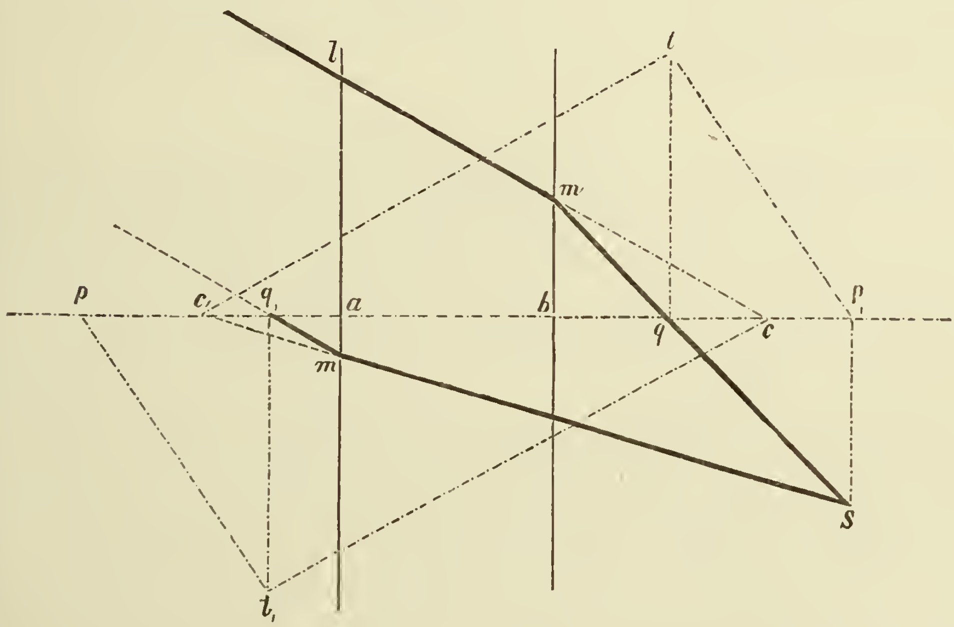
Then by drawing a straight line from the extremity o of the object to the centre c of curvature of the first face of the lens, this straight line will cut the last face in a certain point m_1; by drawing a straight line from the extremity o_1 of the image to the centre of curvature c_1 of the last face, we mark by m the point in which this straight line cuts the first face of the lens. Join o_1 to m_1, the point q, in which the straight line $o_1\,m_1$ cuts the axis of the lens, will be the first centric point, that is, the place of the image of the centre c of the first face seen through the second. Let o be similarly joined to m, the point g_1, in which the line $o\,m$ cuts the axis, will be the second centric point, that is, the image of the centre c_1 of the second face seen through the first. Having thus obtained the points q and q_1, the construction of the principal or conjugate foci of the system and that of all the images which it can give, can be made exceedingly rapidly, and we can then deduce very easily the places of the principal planes, the nodal points, the optic centre, &c., if we wish to treat the problems relating to the given lens by the methods of Gauss, Listing, or other mathematicians.

The preceding diagram shows at once how we may obtain the image of a point o placed outside the axis of the lens. (If the point given were on the axis, we might raise from it a perpendicular to the axis, and determine the image of any point on this perpendicular, drawing from the image obtained a normal to the axis itself. The meeting point of this normal and the axis would be the place of the image of the given point.) Let a straight line be drawn from the point o to the centre c of the face through which it is intended the light should pass; such a straight line will represent a luminous ray, which starting from o will pass, neither deviating nor displaced through the lens, until it meets in m, the second face. The ray having reached m, will deviate towards the point q, the image of c; draw the line m_1 q on which prolonged will be found the image of o. From the point o draw through q_1 the line o q, until it meets the first face of the lens in m. Through m and c_1 draw the line c_1 m, which prolonged will pass without deviation out of the lens, and will meet m_1 q in a point o_1; the point o_1 will be the image of o.

If from the point o the perpendicular o g be let fall on the axis, and from o_1 the line o_1 g_1, the point g_1 will be the place of the image of the point g seen through the lens.

In order to obtain the principal foci of a given lens, draw a radius l c (fig. 10) to the centre of its first face, and draw its corresponding refracted ray m_1 q, then through the point q_1 draw q_1 m parallel to l c, drawing m c_1 and prolonging it till it meets m_1 q_2 prolonged in S.

Fig. 10.



The point S will be the image of a point situated at an infinite distance in the direction of c m l. Drawing from S a normal to the axis we obtain in p_1 a principal focus of the lens. The same construction repeated for the other face will give the second principal focus p, or the point of the principal distance of the lens.

We can obtain the second focus more quickly when once the first is known, profiting by a very simple relation which exists between the two distances q p_1 and q_1 p of the two principal foci from the centric points.

Representing by r the radius of curvature a c_1 of the first face of the lens l_1, by r the radius b c_1 of the other face, by x the distance b q of the centric point q from the second face of the lens, by x_1 the distance a q_1 of q_1 from the first face, and denoting by F the distance q p_1 and by F_1 the line q_1 p we readily obtain the following relation:—

$$\frac{F - r_1 + x}{F_1 - r + x_1},$$

which gives directly F, if we know F_1, or F_1 when F is known.

The construction of this formula is very simple. From the points q and q_1 let two normals be drawn to the axis; through the centre c draw $c\ t_1$ until it meets in t_1 the normal passing through q_1; let $c_1\ t$ be drawn through the centre c_1 parallel to it, until it meets in t, the other normal $q\ t$. Having then joined the principal focus p (which we suppose to be known) with t, let a parallel to $p\ t$ be drawn through t_1; the point p_1, where it cuts the axis, will be the other focus, or the principal distance of the lens.

The same graphic process, and therefore the formulas derived from it, are very easily applied also to optic systems composed of lenses without thickness. In this case we first determine the successive images of the centre of the first and of the last lens seen through all the others; then, considering the centres of the lenses as we just before considered the centres of curvature (since we suppose the rays to pass through these centres without deviation and without displacement) we make relatively to them and to their images the constructions already indicated, and so we solve with rapidity all problems relating to optic instruments composed of thin lenses."

(6) Miscellaneous.

"**New Inventions.**"—"Her Majesty's Royal Letters Patent have been granted to the inventor of a wonderful as well as useful little appliance. This is a Pocket Microscope and Floriscope combined, about 3 in. in length and $1\frac{1}{4}$ in. square. It is constructed upon an entirely new principle, and has a magnifying power and definement superior to some of the most elaborate and expensive instruments, and yet so simple that any schoolboy or girl can use it. Its magnifying power is registered as 150 diameters, or 22,500 surfaces, and distinctly shows all the thousands of different kinds of animalcula in water, &c., or any other microscopic objects. This new patent was sealed by the Comptroller-General of Patents on the 13th of August last, and is now offered to the public at the nominal price of 1*s.* each, and sent free by parcel post upon receipt of postal order value 1*s.*—stamps not taken—with a 12-page pamphlet of instructions for use, and a large double sheet of engravings in black and gold (with key) free. The inventors and manufacturers also guarantee that, in any case where the instrument is not approved of and returned within reasonable time, a postal order value 1*s.* will be forwarded by return of post. The medical profession, chemists, schoolmasters, teachers and students, as well as parents and guardians, should send for one on approval. This is no foreign rubbish, but of good English workmanship throughout. Address, Conway Rae & Company, The Premier Patent Microscope Depôt, Stafford Street, Birmingham."

Upon reading the above advertisement in 'Nature'* we applied for one of the Microscopes, and were informed that for an additional remittance of 6*d.* we should receive an instrument of superior make, giving "better definement," with four extra "object-glasses," and a larger pamphlet of instructions. As we were desirous of comparing the two qualities of Microscopes, we requested both to be forwarded.

The lower priced one consists of a tin tube of square section, having a tin diaphragm with square aperture in the middle. At one end is

* October 11th, 1890.

another similar diaphragm of stamped brass fitting after the manner of a cap, but with internal flange; a similar cap, but with deeper flange, is applied at the other end, and this has a circular hole in the centre, against which a blown-glass spherical lens of about 1/4 in. diameter is pressed on the inner side by a tin plate with corresponding central hole. The object is placed between two square plates of glass and thrust up against the lens, a tin diaphragm follows, and these are held in position by a roughly bent piece of tin serving as a spring. The ends of the caps are stamped with an inscription and lacquered; the tin tube is also lacquered.

The higher priced Microscope differs from the other, (1) in having the tin tube coloured in addition to being lacquered; (2) it has four extra pairs of glass plates termed "object-glasses"; and (3) a fuller pamphlet accompanies it.

Whilst wholly disclaiming any desire to depreciate the quality of these Microscopes, we are compelled to state that the whole manufacture suggests that of common toys of tin. And as it would be obviously unfair to compare their optical quality with that of more expensive instruments, we have compared it with a Stanhope lens, such as is commonly sold in the London streets at the price of 1*d*. each, including wire and tin mounting and a pair of glass plates for clipping objects, and our impression is that the latter is not inferior.

The late Mr. Brady, Hon. F.R.M.S.*—We give, almost verbatim, a copy of the best of the notices we have seen of our deceased Fellow. As it is from the pen of Prof. M. Foster, Sec. R.S., it is written by one who knew him well.

Henry Bowman Brady was born on February 23rd, 1835, at Gateshead. His father, an esteemed medical practitioner of that place, belonged to the Society of Friends, and retained to the end the dress and manner of conversation of that body. The father's house, for many years the home of the son, was one of those charming Quaker abodes where strength and quietude sit side by side, and where homely plenty and orderly preciseness hide, for a moment, from the stranger the intellectual activity which is filling the place. Though the son, when I knew him, had abandoned the characteristic dress and speech of the society, without, however, withdrawing from the body, the influences of his surroundings moulded his character, making him singularly straightforward and free from any manner of guile.

After an ordinary school career spent in Yorkshire and Lancashire, and an apprenticeship under the late Mr. T. Harvey, of Leeds, and some further study at Newcastle in the laboratory of Dr. T. Richardson, which may be considered as the forerunner of the present Newcastle College of Science, he started in business in that city as a pharmaceutical chemist in 1855, while yet a minor. That business he conducted with such ability that in 1876 he felt able to resign it to Mr. N. H. Martin, and to devote the whole of his time to scientific work. He contributed to science in two ways—one direct, the other indirect. Of the many scientific movements of the last thirty years or so, one, not of the least remarkable, has been the scientific development of the pharmaceutical

* Nature, xliii. (1891) p. 299.

chemist. Into that movement Brady threw himself with great vigour, especially in his earlier years. He was for many years on the Council of the Pharmaceutical Society, and the progress of that body was greatly helped by his wide knowledge of science and of scientific men and things, as well as by his calm and unprejudiced judgment.

His more direct contributions to science were in form of researches in natural history, more especially on the Foraminifera. His first publication seems to have been a contribution, in 1863, to the British Association as a report on the dredging of the Northumberland coast and Dogger Bank; his last was a paper which appeared in the October number of our Journal. Between these two he published a large number of researches, including a monograph on Carboniferous and Permian Foraminifera, an exhaustive report on the Foraminifera of the 'Challenger' expedition, as well as monographs on *Parkeria*, *Loftusia*, and *Polymorphina*, in which he was joint author.

By these works he not only established a position, both in this country and abroad, as one of the highest authorities on the subject, but, what is of more importance, largely advanced our knowledge. Every one of his papers is characterized by the most conscientious accuracy and justice; and though his attention was largely directed to classification, and to the morphological points therein involved, his mind, as several of his papers indicate, was also occupied with the wider problems of morphological and biological interest which the study of these lowly forms suggests. I have myself often profited by his wide knowledge and power of accurate observation in discussing with him questions of this kind arising out of his studies, and learning from him views and opinions which, to his critical mind, were not as yet ripe enough for publication.

The leisure of the last fifteen years gave him opportunity for travel, and he visited various parts of the world, utilizing many of his journeys —notably one to the Pacific Ocean—in the collection and study of Foraminifera. Some of these travels were undertaken on the score of health, to avoid the evils of an English winter, for he was during many years subject to chronic pulmonary mischief.

During his last journey for this purpose—one to the Nile in the winter of 1889-90—he met with difficulties, and failed to receive the benefit from the change which he had secured on former occasions. During the last two or three years, and especially during the last year, his condition gave increasing anxiety to his friends; the malady against which he had so long struggled seemed to be beating him at last; and we heard with sorrow rather than with surprise that the fierceness of the recent cold had conquered him. Settled for the winter at Bournemouth, and full of cheerful hopes for the coming summer, he succumbed to a sudden attack of inflammation of the lungs, and died on January 10th, 1891.

Science has lost a steady and fruitful worker, and many men of science have lost a friend and a helpmate whose place they feel no one else can fill. His wide knowledge of many branches of scientific inquiry, and his large acquaintance with scientific men, made the hours spent with him always profitable; his sympathy with art and literature, and that special knowledge of men and things which belongs only to the travelled man, made him welcome where science was unknown; while the brave patience with which he bore the many troubles of enfeebled health, his unselfish thoughtfulness for interests other than his own, and a sense of humour which, when needed, led him to desert his usual staid demeanour for the merriment of the moment, endeared him to all his friends.

Angling and Microscopy.—A "microscopical evening" could, we should have thought, hardly be looked for at an angling society, but the following appears in 'Flood and Field' of the 29th November, 1890:—

"Gresham Angling Society.—There was a good attendance again on Tuesday, with Mr. Vail in the chair. This being a 'Microscopical Evening,' Dr. Brunton and Messrs. Norman, Parker, and Bentley showed a number of interesting subjects. Among other objects, Dr. Brunton exhibited a hank of so-called *silk*, sold by City houses for fly-tying, &c. Under the Microscope this proved to be nothing but *jute*, a fact which explains the frequent breaking away of large fish, and the consequent loss of tackle, temper, &c."

The Microscope and the McKinley Tariff.—Among numerous examples of the mischievous working of the McKinley tariff, the New York 'Nation' cites the instance of Microscopes. Since the branch of medical science known as bacteriology assumed so much prominence, these articles have risen in the United States from the rank of a toy to that of the most valuable and important of all medical instruments. Meanwhile a foolish legislature has been doing its best to make Microscopes artificially dear, and more and more difficult to procure. It was bad enough before the new tariff; but it is now worse. In spite of the touching appeals of eminent medical men, a Microscope which could be bought in Germany for 94 dollars now costs in America over 150 dollars. This is but one of many examples given of how the tariff is felt to be affecting the vital interests of the American people.

β. Technique.*

(1) Collecting Objects, including Culture Processes.

Experiments on Cultivation Media for Infusoria and Bacteria.†—In his experiments with anthrax, Dr. Hafkine obtained varying results; thus when cultivated in the aqueous humour of rabbits, guinea-pigs, or dogs, sometimes copious development occurred, but sometimes it altogether failed. When sown with typhoid bacillus the inhibitive action of the humour was very manifest, reducing the number of viable bacilli from 1880 to 7 in four hours. This result is explained by the author on the supposition that the bacilli, which had been cultivated for a long time in pepton bouillon, had not yet become acclimatized to the new medium. For by gradually adding an increasing amount of aqueous humour to the pepton bouillon, in twelve successive generations a strong increase in fresh humour was eventually obtained, indeed it was greater than in the bouillon. Control experiments made with bacilli obtained directly from a typhoid patient, behaved in a manner analogous to the artificial

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

† Annales de l'Institut Pasteur, iv. (1890) p. 363. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) p. 435.

cultivations in aqueous humour. The germicidal action of the humor aqueus is explained conformably to the ideas of Metschnikoff, with whom the author is working, as being entirely due to an imperfect adaptation to the new medium.

Silicic Acid as a Basis for Nutrient Media.*—Prof. W. Kühne employs silicic acid as a basis for nutritive media which will bear prolonged exposure to high temperatures, and which have the further advantages of resisting the action of organisms and reagents. To make the compound, the author mixes, with frequent shaking, three parts of commercial silicate of soda (sp. gr. 1·08) and one part dilute hydrochloric acid (HCl sp. gr. 1·17 one part, and water two parts). The mixture is then freed, in a dialyser, from free acid and from sodium chloride, by suspending the dialyser for four days in a stream of running water. The pure solution is then condensed to a specific gravity of 1·02 by heating it in a platinum vessel. In this condition it contains 3·4 per cent. pure acid, is as thin as water, can be boiled, is miscible with alcohol, and only coagulates on addition of neutral salts. The nutrient addendum employed by the author was meat-extract: a piece of Liebig's extract about the size of a bean is dissolved in 22 ccm. of water, and of this solution 0·5 to 1 ccm. is added to 4 ccm. of silicic acid. If it be desired to set it quickly some cooking salt must be added. Thus obtained the jelly is of the proper consistence, transparent as glass, and scarcely coloured by the meat-extract. It bears the addition of sugar, glycerin, &c.

Pure Cultivations of Green Unicellular Algæ.†—M. W. Beyerinck has obtained pure cultivations from two species, *Chlorococcum protogenitum* Rabenh. and *Rhaphidium naviculare* sp. n., which are frequent in stagnating water near Delft. The author succeeded in getting rid of the numerous water bacteria by the following method:—Ditch water was boiled up with 10 per cent. gelatin, and before setting was mixed with a drop of the water coloured green by the algæ. In this mixture only those bacteria which liquefy gelatin could develope. The number of such colonies may be few enough not to liquefy the whole of the gelatin in two or three weeks. With a hand-lens the algar colonies may then be recognized as dark green points. These can then be distributed to fresh gelatin and so pure cultivations obtained. *Rhaphidium* was found to excrete a trypsinoid ferment which liquefied gelatin. It multiplied by fission. *Chlorococcum* does not liquefy gelatin, and was cultivated on seven different nutritive media with a neutral or slightly acid reaction. Development in all the seven media proceeded at about the same pace, but the colour of stroke cultivations was very different.

In sterilized ditch water with 1 per cent. gelatin previously liquefied by pancreas, the growth advances well, and after three or four weeks there results a yellow fluid with a dark green sediment of *Chlorococcum*.

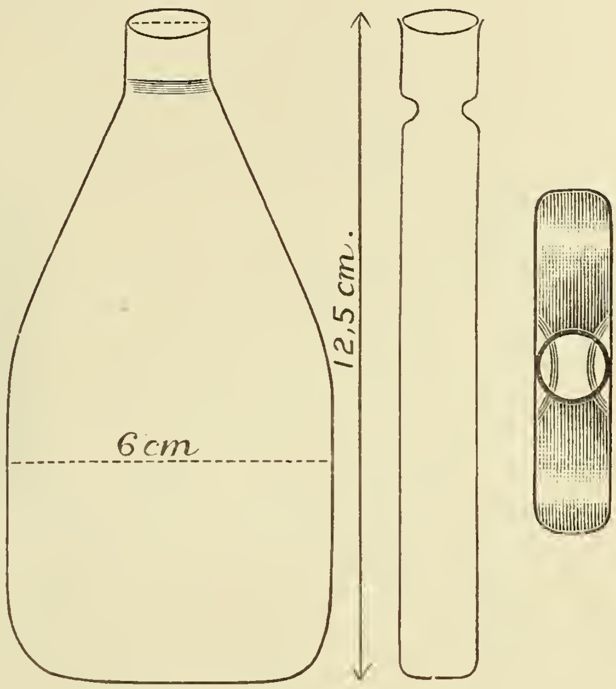
* Zeitschr. f. Biologie, xxvii. n.s. ix. (1890) No. 1. Cf. Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 410–11.

† 'Aanteekeningen van het verhandelde in de sectie-vergaderingen van het Provinciaal Utrechtsch Genootschap voor kunsten en wetenschappen gehouden den 25 Juni 1889,' pp. 35–52. Cf. Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 460–2.

By mixing this sediment with liquefied gelatin, and pouring it into test-tubes, or flattening it out between two glass plates, an equally coloured green cast or plate is obtained which serves excellently for studying the action of light on chlorophyll and the excretion of oxygen.

Flat Flask for cultivating Micro-organisms.*—Dr. J. Petruschky has devised a convenient apparatus for cultivating micro-organisms on the plate or surface principle. It is merely a flat flask, and is made in two shapes. Shape A is made of thin lamp-glass, and the B shape of thick or plate glass. Both have pretty much the same form; that is, they are flat and somewhat triangular, or rather like a flat worm. Their general aspect is seen from the illustrations, which give a front and side view, and also the view down the neck when looked at from above. There is a slight difference in the measurements; those of the A pattern being, height 10–11 cm., breadth 5½–6 cm., width (same measurement as neck) about 1½ cm. In the neck there is a circular indentation. The measurements of the B pattern are, height 12·5 cm., breadth 6 cm., width (same as neck) 2 cm. In this pattern the indentation is confined to the broad side of the neck.

Fig. 11.



The A pattern is more suitable for delicate work, such as the differentiation of typhoid colonies, while the B form suffices for isolation, enumeration, and inoculation purposes.

These flat flasks are specially adapted for the bacteriological examination of water, and for the cultivation of anaerobic microbes in hydrogen.

Apparatus for filtering perfectly clear Agar.†—Dr. J. Karlinski has invented an apparatus for filtering agar, and though it agrees with that devised by Jakobi, differs from the latter in that its intention is, besides obtaining a perfectly clear solution, to prevent the too quick cooling and setting of the medium.

The apparatus, seen in section, fig. 12, consists of a tin vessel *a*, the upper end of which is closed with a perforated caoutchouc plug, and its bottom ends in a tube fitted with a stopcock.

The vessel *a* is surrounded by the vessel *b*, made of similar material, and from near the bottom passes out a short closed pipe. The space *b*

* Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 609–14 (3 figs.).
† T. c., pp. 643–5 (2 figs.).

is intended to contain hot water, which is heated by means of a spirit-lamp. In the vessel *a* is placed a layer of cotton-wool 10 cm. thick, and this is, before using, damped with hot water.

The agar solution, made according to Jakobi's formula, is then poured into *a*, and the aperture closed with the caoutchouc plug, to which is attached the hand-bellows. The agar solution is thus made

Fig. 12.

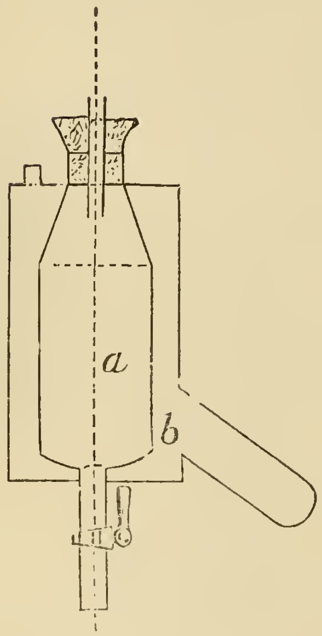
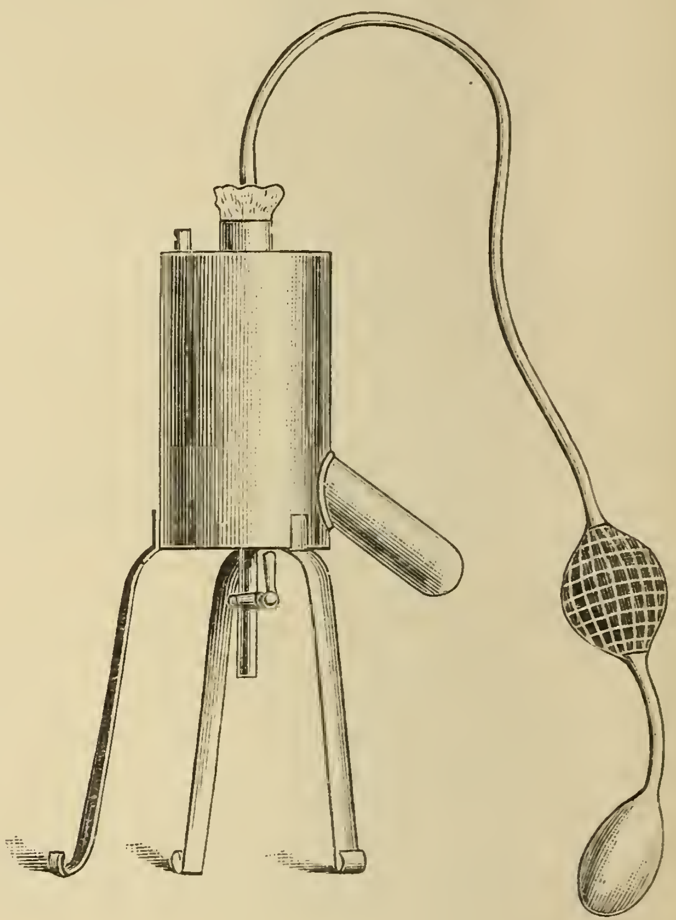


Fig. 13.



to run out through the pipe at the bottom by means of compressed air, and is allowed to flow into sterilized vessels. The hot-water jacket prevents the agar from cooling too quickly, so that many test-tubes may be filled very easily. Fig. 13 gives an outside view of the whole apparatus.

Pure Cultivations of Gonococcus.*—Herren H. von Schrötter and F. Winkler recommend the albumen of plover's eggs as an excellent nutritive medium for easily obtaining pure cultivations of Neisser's gonococcus. The medium is prepared after the method of Dal Pozzo.†

* Mittheil. aus d. Wiener Embryol. Institut, 1890, pp. 29-34.
† See this Journal, 1888, p. 1037.

(2) Preparing Objects.

Methods for the Preservation of Marine Organisms employed at the Naples Zoological Station.*—Prof. Playfair McMurrich writes, "Unfortunately for our students, especially those living inland and depending largely for their knowledge of marine forms upon dried or preserved specimens in museums, the old-fashioned methods of throwing any material which the collector may find into a jar of alcohol without further attention, or else drying it in the sun, are still almost the only ones made use of for the preservation of museum specimens. The result is that the majority of forms which the student has for study are either dried skeletons, or shrivelled up monstrosities giving no idea whatever of the actual appearance of the creatures supposed to be represented by them. How many college museums possess a specimen of coral showing in any recognizable form the polyps by which the skeleton coral was formed? Or how many have even a satisfactorily prepared Lamellibranch?

There are, however, in this country, a few collections which show a marvellous improvement in their manner of preparation, and which have been purchased from the Naples Zoological Station, whose conservator, Salvator Lo Bianco, has for several years been devoting himself to the discovery of the best methods for the preservation of the form and colour of the marine animals occurring in the Mediterranean. Until the present, however, his discoveries have not been made common property, except in the few cases where most successful methods for preserving certain forms have been published in connection with accounts of their structure. The last number of the Naples 'Mittheilungen,'† however, contains a full description, by Lo Bianco, of the methods found most successful for the preservation of the various forms which occur at Naples, and which are undoubtedly applicable to the similar forms found upon our own coast. An abstract of these methods is given in the following pages, in the hope that they may be found useful by the museum curators of this country, and that their application may result in the much-needed improvement of the appearance of the specimens found in the majority of the college museums.

It must be fully understood, however, that much depends upon the skill of the preparator, and that want of care and patience will frequently counteract all the advantages to be derived from a good method. All who have had the opportunity of examining specimens prepared by Lo Bianco can appreciate readily the great advantages which may result from the careful application of his methods, and can perceive how greatly we are indebted to him and to Prof. Dohrn for their publication.

Alcohol is, of course, indispensable as preservative fluid, but certain precautions are necessary in its use. Except in a very few cases it is unnecessary to use it in its full strength, 70 per cent. being quite sufficient for preservation, and producing much less contraction and fragility in delicate organisms. Strong alcohol should be reduced with distilled water to the desired strength, ordinary spring water frequently contain-

* Amer. Natural., xxiv. (1890) pp. 856–65.
† See Mittheil. Zool. Stat. Neapel, ix. (1890) pp. 435–74.

ing a sufficient amount of carbonate of lime and other substances in solution to give a cloudy precipitate, after a time, which may effectually destroy the appearance of a specimen.

Furthermore, delicate organisms should first be placed in weak alcohol (35 to 50 per cent.) for from two to six hours, the changing of the fluids being effected by a siphon, a small quantity of the weak alcohol being withdrawn and stronger added, until finally the desired strength is obtained. With delicate gelatinous structures the increase in the strength of the alcohol should be as gradual as possible. In many cases it is necessary to use a hardening or fixing reagent before the final consignment to alcohol, which is principally useful as a preservative. The most fixing reagents, according to Lo Bianco, are the following:—

Chromic acid.—1 per cent. in fresh water. Objects should not remain in the fluid longer than is necessary to fix them, as they are apt to become brittle. Subsequently they should be well washed with distilled water to prevent the formation of a precipitate when placed in alcohol, and also to prevent their taking on too green a tinge from the reduction of the acid.

Acetic acid, concentrated, kills rapidly contractile animals, but must be used with caution, as it produces a softening of the tissues if they are subjected for too long a time to its action.

Osmic acid, 1 per cent. solution, hardens gelatinous forms well, and preserves their transparency, but its prolonged action renders the objects brittle and gives a dark brown tint. Objects hardened in it should be well washed in distillled water before being placed in alcohol.

Lactic acid.—1 part to 1000 parts sea-water fixes larvæ and gelatinous forms well.

Corrosive sublimate.—Saturated solution in fresh or sea-water; may be used either hot or cold. It acts quickly, and preserves admirably for histological purposes. It is especially good combined with copper sulphate, acetic acid, or chromic acid. Objects hardened in it should be subsequently well washed in distilled water and in iodized alcohol (the recipe for which is given below), to remove all traces of the sublimate, which in alcohol crystallizes out in the tissues of the organisms and so injures the preparation.

Bichromate of potassium.—5 per cent. solution in distilled water hardens gelatinous organisms slowly, without rendering them fragile. It gives, however, a precipitate in alcohol, and discolours the specimen. The discoloration, however, may be removed by adding to the alcohol a few drops of concentrated sulphuric acid.

Copper sulphate.—5 per cent, or 10 per cent. solution in distilled water, used either alone or in combination with corrosive sublimate, kills larvæ and delicate animals without distortion. The objects should be subsequently repeatedly washed with water to remove all traces of the salt, otherwise crystals will form when the object is placed in alcohol.

Various combinations of these reagents are especially useful, and some of those most serviceable are given here:—

Alcohol and chromic acid.—70 per cent. alcohol, 1 per cent. chromic acid, equal parts.

Alcohol and hydrochloric acid.—50 per cent. alcohol, 100 ccm.; Hydrochloric acid, concentrated, 5 ccm.

Iodized alcohol.—35 per cent. or 70 per cent. alcohol, 100 ccm.; Tincture of iodine, 2·5 ccm.

Chrom-acetic acid, No. 1.—1 per cent. chromic acid, 100 ccm.; Concentrated acetic acid, 5 ccm.

Chrom-acetic acid, No. 2.—Concentrated acetic acid, 100 ccm.; 1 per cent. chromic acid, 10 ccm.

Chrom-osmic acid.—1 per cent. chromic acid, 100 ccm.; 1 per cent. osmic acid, 2 ccm.

Chrom-picric acid.—1 per cent. chromic acid, Kleinenberg's picro-sulphuric acid, equal parts.

Copper sulphate and corrosive sublimate.—10 per cent. solution of copper sulphate, 100 ccm.; saturated solution of corrosive sublimate, 10 ccm.

Potassium bichromate and osmic acid.—5 per cent. solution of potassium bichromate, 100 ccm.; 1 per cent. osmic acid, 2 ccm.

Corrosive sublimate and acetic acid.—Saturated solution of corrosive sublimate, 100 ccm.; concentrated acetic acid, 50 ccm.

Corrosive sublimate and chromic acid.—Saturated solution of chromic sublimate, 100 ccm.; 1 per cent. chromic acid, 50 ccm.

Frequently great difficulty is experienced in killing an animal without producing a considerable amount of contraction, and in the case of elongated forms, such as Nemerteans and other worms, without causing them to coil up or become twisted, To avoid this, it is expedient to narcotize the animals before killing them, and for this purpose Lo Bianco recommends immersion in weak alcohol. He uses generally a mixture of sea-water 100 ccm. and absolute alcohol 5 ccm. In other cases 70 per cent. alcohol may be carefully poured upon water in which the specimen lies, so that it forms a layer at the surface. It will gradually mix with the subjacent water, and in the course of a few hours will narcotize the animal, so that it may be treated with fixing reagents without fear of contraction,

Chloral hydrate, 1 to two parts sea-water, is also efficient as a narcotizing agent, and has the advantage of allowing a recovery of the animal, if there should be necessity for it, by placing it in fresh sea-water. For some sea-anemones tobacco smoke is useful, the smoke being conducted by a V-shaped tube into a bell-jar covering the vessel of sea-water in which is the anemone. Certain of these reagents will prove most satisfactory with some animals, others with others. Lo Bianco details the best method for treating the various forms in a second portion of his paper, and an account of some of his methods of procedure, so far as they concern forms which resemble those found upon our coast, may now be presented.

Sponges.—Direct immersion in 70 per cent. alcohol, with subsequent renewal of the fluid, is recommended for the majority of forms. To avoid contraction in the case of the Halisarcidæ, they should be left for half an hour in 1 per cent chromic acid, or in concentrated solution of corrosive sublimate for fifteen minutes. To prepare dried specimens the sponges should be washed in fresh water for a few hours, and then allowed to remain in ordinary alcohol for a day, after which they may be dried in the sun.

Anthozoa.—The first care must be to place the forms belonging to this group in fresh salt water, to allow them to expand, a result which may not be obtained until the following day in some cases. Alcyonarians should be killed with chrom-acetic solution No. 2, withdrawing the water in which they lie, until there is left just enough to cover them, and then adding a volume of the chrom-acetic solution double that of the sea-water. The animals should be removed from this mixture the moment they are killed, since the acid will quickly attack the calcareous spicules, which are important for the identification of the Alcyonaria, and placed in 35 per cent. or 50 per cent. alcohol, it being well to inject the alcohol into the mouths of the polyps to keep them freely expanded. The preparation should finally be preserved in 70 per cent. alcohol.

Regarding the Actinians no definite rule for preservation can be given. Much of the success of the preparation depends on the form employed, some species contracting much less readily and less perfectly than others. Some may be killed in a fair condition by pouring over them boiling corrosive sublimate, and then, before consigning them to alcohol, treating for a few minutes with one-half per cent. chromic acid. This method may be employed with small forms such as *Aiptasia*. Narcotization may be tried with others. For this purpose, remove from the vessel in which the animals are contained, two-thirds of sea-water, and replace it with a 2 per cent. solution of chloral hydrate. After a few minutes the fluid is again removed, and cold concentrated sublimate solution is poured in. Tobacco smoke in some cases, as with *Adamsia*, will act satisfactorily, if followed with vapour of chloroform for two to three hours, after which the animals may be killed in chrom-acetic solution No. 2, and hardened in one-half per cent. chromic acid.

Edwardsia may be narcotized by gradually adding 70 per cent. alcohol to the sea-water in which they are, and subsequently may be killed with hot corrosive sublimate.

Cerianthus should be killed with concentrated acetic acid, placing it as soon as possible in weak alcohol, in which it should be suspended, so that the tentacles may float freely—if necessary, disentangling them.

Corals should be allowed to expand fully, and should then be killed with boiling solution of corrosive sublimate and acetic acid used in volume equal to that of sea-water containing the coral. The colony should then be transferred to 35 per cent. alcohol, some of this fluid being injected into the mouth of each polyp. The injection should be repeated at every change of the alcohol, and the specimens should be preserved in 70 per cent. alcohol, after washing them well in iodized alcohol.

Hydromedusæ.—For the hydroid colonies the best fixing reagent is hot corrosive sublimate. The smaller Tubularian medusæ should be killed either in the mixture of corrosive sublimate and acetic acid, or in Kleinenberg's picrosulphuric acid. Larger forms may be fixed with concentrated acetic acid, and then allowed to fall imto a tube containing the alcohol and chromic acid mixture, in which they are gently agitated and allowed to remain for fifteen minutes, after which they should be transferred to 35 per cent. alcohol, and gradually carried to 70 per cent.

Small Campanularian medusæ, e. g. *Eucope* and *Obelia*, may be killed in the mixture of copper sulphate and corrosive sublimate. *Æquorea* should be killed with concentrated acetic acid, and immediately transferred to chrom-osmic mixture for fifteen to thirty minutes. The same method answers for *Cunina*, while *Liriope* should be treated at once with chrom-osmic from five to twenty minutes.

Scyphomedusæ are the best fixed with 1 per cent. osmic acid, to the action of which they are subjected until they assume a pale brown tint. They should then be thoroughly washed with fresh water before being placed in 35 per cent. alcohol, and should be finally preserved in 70 per cent.

Siphonophores.—The forms of this group should be preserved soon after capture, and specimens in good condition should be selected.

Agalma and similar forms should be killed in the mixture of copper sulphate and sublimate, which should be used in volume equal to or double that of the sea-water in which the animal floats. The mixture should be poured in rapidly, and not over the animal. When killed, the specimen should be carefully lifted upon a large horn spatula, and transferred to 35 per cent. alcohol for a few hours, and then placed in 70 per cent. It is recommended to preserve the animals in tubes just large enough to contain the specimens, and placed within a second larger tube. In this way evaporation of the alcohol is prevented, and also injury of the specimen from movements of liquid is avoided.

Physalia should be placed in a cylinder filled with sea-water, the animal being lifted by the pneumatophore. When well expanded, it is killed by pouring over it the sublimate and acetic acid mixture (one-quarter the volume of the sea-water), and when dead, is transferred to a cylinder containing one-half per cent. chromic acid, and then after twenty minutes to 50 per cent. alcohol, and finally to 70 per cent.

Velella may be killed with chrom-picric or sublimate and chromic acid mixture, and after a few minutes should be transferred to weak alcohol. *Porpita* may be fixed by dropping Kleinenberg's picro-sulphuric acid into the vessel in which it is contained, and when the blue colour commences to change to red it should be transferred to Kleinenberg's fluid, and after fifteen minutes to weak alcohol.

Diphyes may be killed expanded by hot corrosive sublimate.

Ctenophora may be killed by throwing them into the chrom-osmic mixture, where they should remain for fifteen to sixteen minutes, according to the size, and then gradually passing them through alcohol to 70 per cent. A mixture composed of pyroligneous acid, concentrated, 1 vol.; corrosive sublimate solution, 2 vol.; one-half per cent. chromic acid, 1 vol., is also recommended as a fixative.

Echinodermata.—Starfish may be prepared with the ambulacral feet in full distension by allowing them to die in 20 to 30 per cent. alcohol. Echinoids should be placed in a small quantity of water, and killed with chrom-acetic mixture No. 2, being removed from it as quickly as possible, as the acid corrodes the test. To preserve the internal parts it is necessary to make two opposite openings in the test, so that the alcohol may penetrate the interior readily.

Holothurians, such as *Thyone* and *Cucumaria*, after the tentacles are fully expanded, should be seized a little below the bases of the tentacles by forceps, using a slight pressure, and the anterior portion of the body should then be immersed in concentrated acetic acid. Alcohol (90 per cent.) should then be injected into the mouth, and the specimens placed in 70 per cent. alcohol. The injection should be repeated each time the alcohol is changed.

Synapta should be fixed by immersion in a tube containing a mixture of equal parts of sea-water and ether (or chloroform), where they remain completely expanded. They should then be washed for a short time in fresh water, and passed into alcohol, taking care to increase the strength of this very gradually.

Vermes.—Cestodes, Trematodes, Turbellaria, as well as Nemathelminths, are most satisfactorily killed with corrosive sublimate, either cold or hot. *Sagitta*, however, succeeds best in copper sulphate and sublimate or chrom-osmic mixture.

Nemerteans should be narcotized in a solution of chloral hydrate in sea-water 1 per cent., where they should remain for six to twelve hours. They are then to be hardened in alcohol. Gephyreans may be narcotized with 1 per cent. solution of chloral hydrate in sea-water, or in alcoholized sea-water, three to six hours; or may be killed at once in one-half per cent. chromic acid, which last method may be also applied to Hirudinea.

Chætopods are best narcotized in sea-water containing 5 per cent. of absolute alcohol, or by adding gradually to the surface of the sea-water in which they are contained a mixture of glycerin 1 part, 70 per cent. alcohol 2 parts, and sea-water 2 parts, hardening them subsequently in alcohol. *Chætopterus* is best killed with 1 per cent. chromic acid, in which they should remain for half an hour; while the Hermellidæ, Aphroditidæ, and the Eunicinæ may be killed in cold corrosive sublimate. Some of these, such as *Diopatra*, may, however, be narcotized in alcoholized sea-water.

Serpulidæ, before treatment with corrosive sublimate, should be narcotized in 1 per cent. chloral hydrate, which causes them to protrude wholly or partly from their tubes.

Crustacea.—Cladocera, Copepods, and Schizopods may be killed in corrosive sublimate dissolved in sea-water. Ostracods may be thrown at once into 70 per cent. alcohol. Cirripeds die expanded in 35 per cent. alcohol, and if some specimens contract it is easy to draw out the cirri with forceps. Amphipods and Isopods may pass directly into 70 per cent. alcohol, except the Bopyrids and Entoniscids, which should be killed in the mixture of equal parts of 90 per cent. alcohol and sublimate solution.

To avoid the casting-off of the appendages of the Decapods they should be allowed to die in fresh water, care being taken not to allow them to remain in it longer than is necessary, as it causes a distortion of the membranous appendages.

Pycnogonids will die in one-half per cent. chromic acid, with the appendages fully extended.

Mollusca.—Lamellibranchs, Prosobranchs, and Heteropods should be narcotized in alcoholized sea-water. To avoid the closure of the valves of Lamellibranchs on immersion in 70 per cent. alcohol, little plugs of wood should be placed between the margins of the valves. The same result may be effected in the case of Prosobranchs by tying the internal edge of the operculum to the shell.

Of the Opisthobranchs the Æolidæ may be the best preserved by pouring over them concentrated acetic acid in volumes equal to or double that of the sea-water containing them. Dorids should first be narcotized by gradually adding 70 per cent. alcohol to their sea-water, and then killed with concentrated acetic acid or boiling sublimate. The larger forms may be killed in 1 to 5 per cent. chromic acid.

Pteropods are preserved well in Perenyi's fluid for 15 minutes, whence they are passed to 50 per cent. alcohol. Gymnosomatous forms should be first narcotized with 1 per cent. chloral hydrate, and then killed in acetic acid or sublimate.

Decapod Cephalopods may be fixed directly in 70 per cent. alcohol, making an opening on the ventral surface to allow the alcohol to reach the internal parts.

Bryozoa.—The genera *Pedicellina* and *Loxosoma* may be left for an hour in 1 per cent. chloral hydrate, and then killed with cold corrosive sublimate, washing them immediately afterwards. Some species of *Bugula* give good results when the expanded animals are suddenly killed by pouring over them hot corrosive sublimate. With other forms it is sometimes possible to preserve them well expanded by adding 70 per cent. alcohol gradually to the surface of the water in which they are, or by narcotizing first in weak chloral hydrate or in alcoholized sea-water. The results are, however, uncertain, and depend largely on the skill of the preparator. Brachiopoda may be treated in the same manner as Lamellibranchs.

Tunicates.—*Clavellina*, *Perophora*, and *Molgula* may be killed with the orifices expanded by immersing them in 1 per cent. chloral hydrate for 6 to 12 hours. They should then be killed in chromic-acetic mixture No. 2, and quickly transferred to 1 per cent. chromic acid, injecting some of the fluid into the body. After half an hour they should be transferred to 35 per cent. alcohol, the injection being repeated, and finally to 70 per cent. Other simple forms may be treated in the same manner, or may require the 2 per cent. solution of chloral hydrate, or may be killed by pouring a little 1 per cent. chromic acid on the surface of the water in which they are, subsequently hardening in 1 per cent. chromic acid. The method recommended for *Perophora* may be employed for compound Ascidians, using, however, corrosive sublimate instead of the chrom-acetic mixture.

Salpæ vary considerably in consistency, according to the species, and different methods are consequently required. The denser forms, such as *S. zonaria*, should be placed in a mixture of 100 ccm. fresh water and 10 ccm. concentrated acetic acid, where they should remain for 15 minutes. They should then be washed in fresh water for 10 minutes, and pass gradually into alcohol. Less dense forms such as *S. democratica mucronata*, may be fixed in chrom-acetic mixture No. 1, and then passed directly into fresh alcohol; while the soft forms such as *S. pinnata* and *maxima*, should be placed in chrom-osmic mixture for 15 to 60 minutes, then washed in fresh water, and transferred to weak alcohol.

Fishes.—*Amphioxus* will die with the buccal cirri distended in sea-water alcoholized to 10 per cent. They should then be transferred to 50 per cent. alcohol, and gradually to 70 per cent.

Other forms may be preserved in alcohol (70 per cent.), taking care to make a ventral incision, and also to inject the alcohol and renew it frequently at first. If it is wished to preserve some of the larger Selachians for some months in order to prepare at leisure the skeleton, the intestines should be removed, and the animals placed in a 10 per cent. solution of salt.

Elasmobranch embryos may be fixed in corrosive sublimate, leaving them in the solution for 5 to 15 minutes, afterwards washing well in iodized alcohol. Embryos of *Torpedo* with the yolk were preserved by immersing them in a mixture of equal parts of 1 per cent. chromic acid and corrosive sublimate for 15 minutes, and then transferring to alcohol. Transparent fish-eggs may be preserved for the purpose of demonstration by subjecting them for a few minutes to the action of the alcohol and hydrochloric acid mixture, and then transferring them to pure alcohol.

Some Hints on the Preparation of Delicate Organisms for the Microscope.*—Mr. E. Lovett observes that such organisms as the ova of Mollusca, Crustacea, fishes, &c., are often of such a nature as to be very difficult of permanent preservation, but he has succeeded in overcoming the difficulty satisfactorily by means of a fluid, the density of which he modifies in accordance with the organism about to be mounted. The fluid was composed as follows:—Three parts pure alcohol, two parts pure glycerin, and one part distilled water. This strength was suitable for young crustaceans, the ova of the fishes, and for the tougher ova-sacs of the Mollusca. For the ova of crustaceans and insects, and for those of very small fishes, one or two parts more of distilled water may be added; whilst for such exceedingly delicate substances as the ova of the nudibranchiate Mollusca, zoophytes extended from their capsules, and for various delicate fresh-water forms, a weaker formula than this is necessary; but as practice is the best instructor, he recommends students to be guided by what they find to be the best proportions.

This fluid should be put into small glass tubes, with corks bearing numbers corresponding to those in a note-book, so that full details of the contents may be recorded. These tubes should be taken down to the shore by the collector, and the organisms should be placed therein alive, direct from the sea. The length of time required for the preservation of the object by the fluid varies, according to the organism, from a week to a year, but some of Mr. Lovett's best preparations had been soaking, before being mounted, for five or seven years; and as a proof of the value of the preservative fluid, he cites the mucus-like ova mass of an *Eolis*, which was in quite its natural condition, although eight years of age as a micro-slide. The cement used by Mr. Lovett for fixing cells for this fluid, for fixing the cover-glasses to the cell-wall, or for covering sunk cells, is composed of equal parts of red lead, white lead, and brown litharge, pounded to a powder and kept dry. When wanted for use, a little is mixed with japanner's gold size as thick as required, and it must be used with great care to insure success; but in this case also practice is the best way to satisfactory results.

Improved Method of preparing Ascidian Ova.†—Dr. T. H. Morgan found that the ordinary methods of preparation do not show the boundaries of the cells of the follicle in sections of young ova. He made,

* Trans. Croydon Micr. and Nat. Hist. Club, 1889–90, pp. 203–4.
† Journal of Morphology, iv. (1890) p. 198.

therefore, various experiments, and found the following method satisfactory. The fresh ovaries were teased apart in very dilute osmic acid, washed in distilled water, and placed in a 1 per cent. solution of silver nitrate, where they remained for half an hour; they were then put into acetic acid for the same length of time, and placed in the sunlight. On examination under the Microscope the cell-boundaries were distinctly seen.

Simple Method of examining living Infusoria.*—Herr J. Eismond has discovered a method of slowing those rapid movements of Infusoria which make the examination of these objects during life so difficult. The method is based on that of crystallographers, who retard the formation of crystals by the addition of a colloidal material. He added a drop of thick watery solution of cherry-gum, and obtained the desired effect. In a very short time the Ciliata were seen to be imprisoned, with all their cilia moving actively, but effecting no change in position. All the vital processes can be most satisfactorily observed in Infusoria so treated, and a certain amount of locomotion can be allowed by using a less dense solution. Small Crustacea, Worms and Flagellata, and other marine animals, may be well studied by this method. It may be added that gum-arabic and other fixing materials are useless.

New Method for demonstrating Tubercle Bacilli in Sputum.†—Dr. E. Czaplewski recommends the following method which he says gives ideal pictures in about three minutes of tubercle bacilli in sputum. Three solutions are required :—(1) The Ziehl-Neelsen carbolic-fuchsin. (2) Saturated alcoholic solution of yellow fluorescin to which methylen-blue is added to excess. (3) Saturated alcoholic solution of methylen-blue.

A very thin layer of sputum must be fixed on the cover-glass in the usual manner. On the cover-glass held in a pair of forceps, sputum side upwards, is then let drop sufficient of the fuchsin solution to form a complete layer. It is then held over the flame of a spirit-lamp until it vaporizes or begins to boil. The fuchsin is then run off and the cover-glass waved to and fro in the fluorescin solution six to ten times, and a ter this in the methylen-blue solution ten to twelve times. The cover-glass is next quickly washed in pure water and then at once laid with the prepared surface upon a clean slide. The superfluous water is then expressed by means of a piece of blotting-paper placed on the top, and any deposit of pigment removed with a moist cloth. Finally, a drop of cedar oil is laid on the back. The preparation is then ready for examination. Hence it will be seen that the organisms are observed in water, but the preparation may of course be mounted in the usual manner.

Method for Differential Diagnosis of Bacilli of Typhoid (Eberth).‡—The procedure consists in a modification by J. Gasser of Noeggerath's method for recognizing the typhoid bacillus. To a test-tube full of nutrient agar twenty drops of a saturated aqueous solution of fuchsin are added, the mixture sterilized and poured into a Petri's

* Zool. Anzeig., xiii. (1890) pp. 723–4.

† Centralbl. f. Bacteriol. u. Parasitenk., viii. (1890) pp. 685–94.

‡ La Semaine Méd., 1890, No. 31. Cf. Bakteriol. u. Parasitenk., viii. (1890) p. 411.

capsule. When set the surface is scratched with the bacillus and then incubated at 37°. In four hours the cultivation has developed, the agar round about it being decolorized. The whole plate has lost its colour in six to eight days, but the cultivation itself is quite red.

Control experiments with numerous other micro-organisms showed that typhus bacillus and *B. coli communis* were the only two which decolorized the medium. It is said that the two may be distinguished by the fact that *B. coli comm.* does not exceed the inoculation track, while typhus bacillus forms a broader strip with irregular margins.

New Criterion for distinguishing between Bacillus Choleræ Asiaticæ and the Finkler-Prior Bacillus.*—If these two bacilli, say Herren O. von Hovorka and F. Winkler, be cultivated on plover's egg albumen they may easily be distinguished. The Finkler-Prior bacillus rapidly liquefies, and imparts a yellow colour to the medium, while Koch's comma bacillus neither liquefies nor stains it. This difference is clearly distinguishable in the first six days of the cultivation.

Reference Tables for Microscopical Work.†—Professor A. B. Aubert has compiled the following tables which have been in great part translated and adapted from Dr. Behrens' 'Tabellen zum Gebrauch bei Mikroskopischen Arbeiten.' They address themselves especially to workers in the various departments of microscopy where such aids to the memory may be helpful in everyday work. The methods given are such as have received the approval of many of the best workers at home and abroad. A glance at the tables will generally give all the information necessary to any one fairly familiar with micro-manipulation, and while they do not aim at replacing the larger and more complete works, it is hoped that they will prove useful on the work-table of microscopists generally.

Preservative and Mounting Media :—Alcohol-glycerin.—Glycerin, 1 part; alcohol (96 per cent.), 1 part; water, 1 part. Specially recommended for plants, entire or in parts.

Canada balsam in alcohol, chloroform, benzol, turpentine, xylol.—The balsam is hardened by low heat until brittle when cold, broken up or pulverized, dissolved in the solvents, filtered through paper, and evaporated until of the thickness of syrup.

Boroglyceride.—Dissolve as much boracic acid in warm glycerin as possible. The solution is thick when cold; use for mounting some animal or plant preparations in the same way as balsam.

Canada balsam :—The thick balsam is heated, and the mounting done on the warm table; the object must first be soaked in absolute alcohol, then in oil of cloves.

Glycerin and carbolic acid :—Glycerin, 100 grm.; absolute alcohol, 50 grm.; water, 50 grm.; carbolic acid, 3 grm. For plant sections, &c.

Chloride of calcium concentrated, or 33, 25, 12 per cent. For vegetable preparations, &c.

Dammar :—Dissolve gum dammar in equal parts of benzol and turpentine; the solution is filtered and evaporated to syrupy thickness.

* Mittheil. aus d. Embryol. Institute der K. K. Univ. Wien, 1890, pp. 10–14.
† Micr. Bull. and Sci. News, vii. (1890) pp. 35–6.

Farrant's medium:—Gum arabic, 1 ounce; glycerin, 1 ounce; water, 1 ounce; arsenious oxide, 1½ grains. Dissolve the oxide in water, then the gum, without heat; when entirely dissolved add the glycerin, take care not to form bubbles; can be filtered through fine flannel. Specially recommended for delicate plant or animal tissues.

Glycerin:—Concentrated or diluted with water, to which may be added a few drops of acetic or carbolic acid. For vegetable and animal preparations.

Glycerin-jelly:—Glycerin, 120 grm.; water, 60 grm.; gelatin, 30 grm. Dissolve the gelatin in warm water, add the glycerin, filter, if necessary, through flannel. All forms of glycerin-jelly must be used warm. For vegetable and animal tissues.

Deane's medium:—Similar to glycerin-jelly but with the addition of honey and a small quantity of alcohol. Used in place of glycerin-jelly.

Glycerin-salicylic vinegar:—Glycerin, 1 vol.; water, 4 vol; salicylic vinegar, 0·1 vol. For Infusoria.

Glycerin-salicylic vinegar for larvæ, *Hydra*, Nematodes, &c.:—Glycerin, 1 vol.; water, 2 vol.; salicylic vinegar, 0·1 vol. Salicylic vinegar is made by dissolving 1 part salicylic acid in 100 parts pyroligneous acid, sp. gr. 1·04.

Goadby's medium:—Corrosive sublimate, 0·25 grm.; alum, 60 grm.; boiling water, 2300 grm.

(3) Cutting, including Imbedding and Microtomes.

Imbedding Seeds by the Paraffin Method.*—Mr. W. W. Rowlee writes:—"The modifications that may be made of the paraffin method of imbedding objects for sectioning are very many. There is always, however, some danger of shrinking delicate and very soft plant tissue. This is due to the use of heat in the process of infiltration; and probably some of the non-heat-employing methods will be found preferable where such delicate tissue is to be imbedded. But for objects that will withstand this process of infiltration, the paraffin method has many advantages over others. Imbedded in paraffin, objects are held firmly, and may be preserved as long as desired without further attention.

For imbedding mature seeds I have found nothing equal to paraffin. The texture of the seed is often very dense, and offers much resistance to the knife. For this reason I found it better to use the harder grade of paraffin. A second serious difficulty that was met with in imbedding seeds was the fact that there was little, if any tissue connecting the embryo † with the seed-coats. Thus it would happen too often that just as the sections were being taken through the middle of the seed—and the most valuable ones are those near the centre—the embryo would leave the coats and the whole series would be spoiled. The inner surface of the inner coat in many seeds is highly polished, and as soon as there is nothing to retain the embryo but its adhesion to the coat, it will loosen. The paraffin does not hold the two together as would be expected. It was suggested that, in order to soften the tissue

* Amer. Mon. Micr. Journ., xi. (1890) pp. 228-30.

† The term "embryo" is used here where on some accounts it would be better to use the word "nucleus." The embryo is often but a very small part of the substance contained within the seed-coats.

and thereby make it more susceptible of infiltration, it would be well to thoroughly soak the seeds in water before hardening in alcohol. This was tried, and there was a great improvement in the results. Fewer of the sections went to pieces after they were transferred to the slide, and the parts of the seed kept their respective positions much better.

In order to study the microscopic structure of seeds, much more satisfactory results can be obtained if the sections are kept in series. It is often necessary to have two or more successive sections before a correct idea of the seed can be obtained.

The method is a modification of the one used and taught in the histological laboratories of Cornell University. In its practical application it is as follows:—In choosing seeds to section, great care is taken to get those which are well filled. This precaution is especially important, as many seeds, for various reasons, never develope more than the coats or the enveloping ovary coats. If a seed has a straight embryo, or even a bent or curved one, it is better to determine by dissection just how the parts of the embryo are arranged with reference to the external parts of the seed. Thus, the seeds of *Helianthus tuberosus* are flattened, and slightly wedge-shaped. The embryo within is straight, and the upper or inner surface of the cotyledons lie in a plane parallel to the plane in which the seed is flattened. Moreover, the cotyledons are in the upper broader end of the seed. Where the seed has no external character, as in a *Eupatorium*, by which the position of its internal parts may be located, one has either to take the chances of getting the sections in the right plane, or open the coats enough to see how the parts are arranged, and then mark the seed in some way. Having selected a well-filled seed, I next put them in water at the ordinary temperature of the laboratory from 24 to 36 hours. From the water they are transferred to weak alcohol (40 per cent.), and gradually hardened by transferring to stronger until they are in 95 per cent. alcohol. Schultze's apparatus may be used to advantage in hardening. Next transfer to equal parts of alcohol and chloroform for from 4 to 8 hours, the time depending on the size of the seeds. Then in pure chloroform for the same length of time. Then for 24 hours into chloroform with as much paraffin in it as it will dissolve at the ordinary temperature. From this into paraffin softened with chloroform, the melting-point of which is about 36° C. The specimens are kept in this melted paraffin 24 hours. I have always been careful not to let the temperature go above 47° C., although I think it probable that a somewhat higher temperature would not injure the tissue of a seed. From this the seed may be imbedded in hard paraffin, and will be found to be thoroughly infiltrated.

The seeds may be sectioned in the paraffin blocks either free-hand or with a microtome. It is highly essential that the sections be kept in series, and that none be missing. The texture of a seed is so fragile that when cut in thin sections the least carelessness may spoil a section. A very effectual way to keep sections intact when they are cut in paraffin is that proposed by Dr. Mark.* It consists in collodionizing the object as the sections are taken. Very thin collodion should be used, and applied to the cut surface after the section is taken, Lee † recommends that 'the collodion be of such a consistency that,

* Amer. Nat., 1885, p. 628. † 'Vade-mecum,' 2nd ed., p. 150.

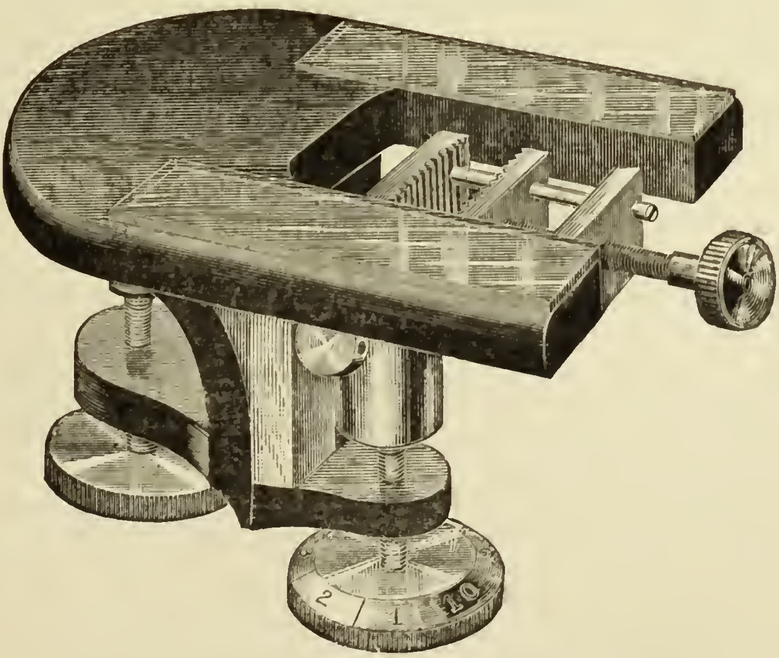
when applied to a surface of paraffin, it dries in two or three seconds. This has no tendency to cause the sections to roll. . . . As soon as the collodion is dry, which ought to be in two or three seconds, cut the section, withdraw the knife, and pass the collodionized brush over the newly exposed surface of paraffin.' The sections are placed collodion side down on the slide. They may be fastened by first painting the slide with a few drops of clove-oil collodion, placing them in it, and then evaporating off the clove oil.

The sections are then placed in xylol for 15 minutes. This removes the paraffin. They are then washed in alcohol, afterwards with water, and stained. I have found no stain that was as effective in staining seeds as hæmatoxylin. They should be stained from 3 to 5 minutes. After washing the staining agent away with water, dehydrate with alcohol, and clear. Three parts of turpentine and two parts of carbolic acid make a very good clearing mixture. Canada balsam dissolved in xylol is used for mounting. In sections thus prepared one can distinguish without difficulty in shepherd's purse, golden-rod, or any endospermous seed, the coats, the plumule composed, as is the lower tip of the radicle, of small thin-walled nucleus-bearing cells. These two regions of growth are connected by slightly elongated cells, which are also thin-walled. The larger cells making up the tissue of the cotyledons are stored with food. In many seeds a trace of a fibrovascular system may be seen; also the peculiar arrangement and markings of the cells composing the coats.

Seeds differ so much, that one would need to make many variations in method to suit different cases; but as a general method I have found this to be a success, and I believe the histology of any seed may be demonstrated by applying it."

Microtome.*—Messrs. Bausch and Lomb write:—"We have found that the section-cutters formerly made by us and other manufacturers

Fig. 14.



* Proc. Amer. Soc. Micr., xi. (1889) pp. 133-4.

are in some respects not suited to modern requirements. We have therefore ceased to make such, and have replaced them by new instruments, which we shall hereafter class under the head of microtomes.

The instrument presented here is dissimilar from the Laboratory and Student microtomes of our manufacture in not having mechanical movement for the knife; it is intended to be fastened to the table-top by means of thumb-screw. The cutting-plate of the instrument is inlaid with glass to obtain perfect smoothness. To the carriage are directly fitted the micrometer-screw with graduated disc, and a section-clamp which is acted upon by the former. The pitch of the screw is 1/50 in., graduation on disc 10, and the finest degree of feed 1/500 in. The regular section-knives as well as the ordinary razors can be used with the instrument."

(4) Staining and Injecting.

Brown-staining Bacillus.* — Herr D. Scheibenzuber describes a bacillus which he has isolated from rotten plover's eggs, and of which the chief characteristic is that it stains the gelatin in the immediate vicinity of the colonies of a brownish colour. The colonies when grown on plates are stated to consist of a central area, which is surrounded by a radiately striated zone. The gelatin surrounding the colonies is not liquefied; when cultivated in test-tubes (puncture cultivation), the inoculation track becomes characteristically serrated, and produces a brown pigment.

When examined with 1/20 oil-immersion the micro-organism is found to be a short bacillus pointed at both ends.

New Method for Staining and Mounting Tubercle Bacilli.†— Dr. H. Kühne recommends the following method for staining tubercle bacilli:—

After the cover-glasses have been prepared, that is, coated with sputum and dried in the flame, they are stained in carbolic fuchsin for five minutes. They are then thoroughly decolorized in 30 per cent. nitric or sulphuric acid, and subsequently washed in water and dried. After this they are examined in a drop of anilin oil stained slightly yellow with picric acid. This mixture is best made by adding 2 to 3 drops of concentrated solution of picric acid in anilin oil to a capsule full of anilin oil.

Preparations obtained in this way will remain fit for examination for at least a week. If permanent preparations are desired, the cover-glass, after it has been decolorized by the mineral acid, is placed for some minutes in an aqueous solution of picric acid, then dried and mounted in the usual manner.

Staining Flagella of Spirilla and Bacilli.‡—Dr. Trenkmann finds that the flagella of bacteria may be stained with very satisfactory results in the following manner:—

The cover-glass having been prepared from a cultivation in the usual manner, is immersed for 6 to 12 hours in a solution of 2 per cent.

* Mittheil. aus d. Embryol. Institute d. K. K. Univ. Wien, 1890, pp. 1–9 (4 figs.).
† Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 293–7.
‡ T. c., pp. 385–9.

tannin and 1/2 to 1/4 per cent. HCl. The preparations are next carefully washed and placed in iodine water. Gram's iodine or one drop of iodine tincture to 10 ccm. water does very well, but iodine mixed with water and allowed to stand for 24 hours (shaking frequently) answers better.

In the iodine solution the covers remain for about one hour; they are then washed in water, and stained with gentian-violet. The violet solution is made in a 25 ccm. test-tube. One drop of a saturated alcoholic solution of gentian-violet solution is mixed with 10 ccm. distilled water. Half of this is poured away and the test-tube filled up with anilin water. In this solution the covers remain for about 30 minutes.

Afterwards the author advises using a less quantity of hydrochloric acid, and to have three different solutions, viz.:—Two per cent. tannin, with 1, 2, and 3 per 1000 HCl. The 1 per 1000 may be made by mixing 10 grm. of a 2 per cent. tannin solution and 2 drops of 8 per cent. HCl.

Impregnation of Bone Sections with Anilin Dyes.*—Herr N. Matschinsky finds that saturated aqueous solutions of anilin pigments are excellent for demonstrating the growth-appearances of bone. The pigments used were eosin, safranin, gentian-violet, methylen-blue, methyl-green, iodide-green, and fuchsin, and though all were satisfactory, eosin and safranin gave the best results.

The bones examined were sectioned transversely and longitudinally, and were both macerated and fresh. If fresh, the fat was removed by immersing the sections for half an hour in ether, and after having been polished up, the dust removed, and washed in water, they were transferred to the staining solution.

Macerated bones were allowed to remain for about 48 hours, but if kept at a temperature of 40° C., the staining was more rapid. Sections of fresh bone stained more slowly.

When removed from the staining solution the sections were dried, and having been again carefully polished up, were examined in air or in Canada balsam.

From examination of different bones and bones of different ages (young, adult, old), it was found that the staining was proportionate to the changes going on. Thus, in young bone the staining was more pronounced in the subperiosteal and subendosteal regions than in adult bones, and much more than in old osseous tissue.

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

To rectify Turpentine for Microscopical Use.†—Mr. Charles C. Faris writes:—As it is difficult to obtain nice, clear turpentine for microscopical purposes, I want to give other workers the benefit of my experience in rectifying the ordinary fluid. I proceed as follows:—

Take one pint of the common turpentine and mix in a quart bottle with 4 oz. of 98 per cent. alcohol. Agitate well, and let stand until the two fluids separate. Decant the turpentine (which will form the lower layer) from the alcohol, and mix it with one pint of clear water.

* Anat. Anzeig., x. (1890) pp. 325–36. † The Microscope, x. (1890) p. 179.

Agitate thoroughly, and let stand until these two fluids separate, then from the water decant the turpentine (which this time will form the upper layer), and finally, mix with the turpentine about 1 oz. of powdered starch, and filter through paper.

By pursuing the foregoing plan any one may secure a pure, limpid, and brilliant turpentine. The alcohol used in rectifying it need not be wasted, as it will do to burn, to clean slides, or for other purposes. I usually make a large quantity, and recover the alcohol by distillation.

(6) Miscellaneous.

Biological Examination of Potable Water.*—Mr. G. W. Rafter describes a modification of Prof. W. T. Sedgwick's method of determining the number of organisms in drinking water. The water is filtered through a short column of fine sand in the stem of a funnel, the sand being supported on a plug of wire-cloth placed beneath it. The sand retains the whole of the organisms contained in the water. After the completion of the filtration, the sand is washed with distilled water into a test-tube, and shaken, when all the sand falls to the bottom and the organisms remain uniformly distributed through the water. A definite quantity of this is taken out by a pipette and placed in a cell of known dimensions. The enumeration of the organisms is accomplished by transferring the cell to the stage of the Microscope and examining with the aid of the micrometer.

Tests for Glucosides and Alkaloids.† — Herr A. Rosoll gives the following tests for berberin and cytisin:—Berberin dissolves in concentrated nitric acid with a reddish-brown colour, and may then be precipitated in star-like groups of crystals of berberin nitrate by the successive action of alcohol and nitric acid; or it can be precipitated as characteristic green capilliform crystals by potassium iod-iodide from the alcoholic solution; the crystals being again soluble in sodium hyposulphate. It occurs in all the organs of mature plants of *Berberis vulgaris.* Cytisin occurs in all parts of the laburnum, but there are only traces in the leaves or flowers. It gives a red-brown precipitate with potassium iod-iodide, leaf-like groups of crystals with picric acid; a light reddish-yellow solution with sulphuric acid, which becomes yellow, brown, and finally green, on addition of a small piece of potassium bichromate; a yellow turbidity with phosphor-molybdic acid. Tests are also given for coniferin, phloroglucin, vanillin, salicin, syringin, hesperidin, solanin, saponin, tannin, veratrine, strychnine, brucine, colchicine, nicotine, aconitine, and atropine. The author asserts that strychnine occurs in solution in the drops of oil held in solution in the endosperm-cells, and not, as sometimes stated, in the thickenings of the cell-walls.

Materials of the Microbe-Raiser.‡—Dr. S. Hart makes the following somewhat amusing remarks:—" Some of the means and methods

* Proc. Rochester (N.Y.) Acad. Sci., 1890, 10 pp. and 4 figs.

† 'Ueb. d. mikrochemischen Nachweis d. Glycoside u. Alkaloide,' Stockerau, 1890, 25 pp. See Bot. Centralbl., xliv. (1890) p. 44.

‡ " Invisible Assailants of Health," 'Popular Science Monthly.' See Amer. Mon. Micr. Journ., xi. (1890) p. 232.

of the micrologist in his researches must be mentioned. His outfit is extensive and novel. It includes the best known Microscopes and a well-constructed incubator with heater and thermometer, numerous test-glasses, beakers, filters, acids, alkalies, deep-coloured dyes, and a good supply of prepared cotton.

In studying the life-history of his microbes he will require a well-supplied commissariat. He must be a professional caterer and a bountiful feeder. He must have fluids, semi-fluids, and solids, broths of various meats, peptonized food, the serum of blood *à la Koch*, and Pasteur's favourite recipe with the French refinement: Recipe, 100 parts distilled water, 10 parts pure cane-sugar, 1 part tartrate of ammonium, and the *ash* of 1 part of yeast. Among the substantials must be found boiled white of egg, starch, gelatin, Japan isinglass, and potato, the last from South as well as North America."

A Query.—As "Novice" will perhaps get the best advice by means of our Journal we hasten to give his questions the widest publicity we can:—"I am thinking of starting a street exhibition with four Microscopes (two by Beck and two by Watson). Will some kind reader please tell me which objectives I should use to please the public most —1/4, 1/2, 1, 2, or 3 in.? Also please tell me of a few good mounted objects that will please them as well; and which objectives I should use to get the best result when examining a frog's foot. And do you think there is a living of, say, 35*s.* per week by going from town to town? Any information on the above will be gladly received by—NOVICE."

* Eng. Mech., lii. (1891) p. 471.

PROCEEDINGS OF THE SOCIETY.

Meeting of 17th December, 1890, at 20, Hanover Square, W., Prof. Urban Pritchard, Vice-President, in the Chair.

The Chairman having declared the meeting to be made special for consideration of matters adjourned from the adjourned special meeting held 19th November, the Secretary said that the Council were still unable to recommend any course of action on the matters under consideration, and therefore advised that the adjournment of the special meeting be *sine die*.

It was moved by Mr. J. M. Allen, seconded by the Rev. Canon Carr, and resolved, "That this special meeting be adjourned *sine die*."

The Minutes of the meeting of 19th November last were then read and confirmed, and were signed by the Chairman.

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

	From
Six Slides of *Leptodora hyalina* .. .. Slide of *Ceratium longicorne*	*Mr. T. Clarke.*
Three Lithographs of Fresh-water Sponge Two Photomicrographs of ditto	*Mr. J. Clark.*

Mr. T. Clarke's letter relating to his donation of slides was read.

Mr. Joseph Clark's description of his lithographs and photomicrographs was read.

Mr. G. F. Dowdeswell's note was read with reference to a small eye-piece thread-micrometer which he had sent to the meeting for exhibition, and which he stated was made about five years ago, and embodied the same principles as the one exhibited by Mr. Nelson at the meeting of the Society in May, and described in the August number of the Journal. A short further communication from Mr. Dowdeswell was also read in reply to some observations and inquiries with reference to the "simple form of warm stage," exhibited and described at the meeting of the Society in October last.

Mr. J. Mayall, jun., said he thought that the means by which it was proposed to keep this stage warm—i. e. by applying a small flame below the projecting corner of it—were not sufficiently precise to render it possible to keep the temperature within a variation of one degree, as suggested by Mr. Dowdeswell. According to the opinion of Dr. Dallinger it was of the utmost importance, that in all observations bearing upon the influence of temperature on the forms of life and development, the means of regulating and maintaining the temperature of the stage should be absolutely under control, and he feared this could hardly obtain with the method described by Mr. Dowdeswell.

Mr. E. M. Nelson having examined the micrometric eye-piece, said it appeared to him to be a "Jackson eye-piece micrometer," and that was all. It had no movable thread so far as he could see; the scale moved sometimes, but not the web.

Mr. Mayall said the apparatus was so shaky that he supposed it had met with an accident. The general construction reminded him of the designs of the Continental screw-micrometers, and also of the screw mechanism frequently employed on the Continent for stage movements, centering, &c., in most of which unnecessarily long and thin screws were applied, which were very liable to be bent, and to become loose in their sockets. He thought the defective condition of Mr. Dowdeswell's micrometer should serve as a warning to opticians generally of the error of making screw-axes too long and thin, especially those having milled heads, and, consequently, intended to be moved by hand. In all the high-class screw-micrometers and similar mechanism, the actuating screws and their bearings were made large and substantial, with a view to securing accuracy of movement, durability, and freedom from flexure. He might mention particularly that in examining a large number of Microscopes by different makers, he had observed that the centering screws of the mechanical substages were generally too slight, and were provided with such short sockets that they were very liable to become shaky. These were points of importance in the construction of Microscopes and accessory apparatus.

Mr. Mayall said he had prepared a short note for publication in the Journal (see *ante*, p. 107) upon a matter in connection with photo-micrography, which he thought the Fellows of the Society would agree with him called for some protest—the practice of sending photographs there as specimens and illustrations without at the same time stating the details of the process by which they were produced. On submitting the note to Prof. Bell, it had been thought advisable to deal with it as a communication to the Society, in the hope that it might lead to useful discussion. Before inviting discussion, he said his attention had been specially drawn to the subject by the fact that at one of their recent meetings a photograph of *P. angulatum*, by Dr. Van Heurck, had been exhibited, and had elicited from Mr. Frank Crisp the observation that it was "remarkable." In making that observation, Mr. Crisp certainly supposed that he was criticizing a photo-micrograph pure and simple—produced directly with the Microscope—and on the fact of that supposition the observation was doubtless fully justified. On examining the print again more closely, he (Mr. Mayall) was inclined to suspect that it was not really a photomicrograph, but merely an enlarged copy of one, and that a very large part of the strength of the image was probably due to the copying process employed. He therefore applied to Dr. Van Heurck for information and found that the print was an enlarged copy, as he had suspected. He thought that was an important example to cite of the erroneous value that might be given to a photographic rendering of a microscopic object, in consequence of the full and proper data not having accompanied the photograph; for assuredly, if Mr. Crisp had been aware of these data, his commendation of the photograph would have been modified. Mr. Mayall explained that the limit of useful magnification for the production of photomicrographs had hitherto been found at about 1000 diameters, and it should not be overlooked that differences in the photographic manipulations would very largely influence the results obtained by different workers. He thought that many workers had been rather betrayed by the reducing power of some of the more recent developing agents, such as hydroquinone, and, instead of aiming at the reproduction, as far as possible, of the images seen in the Microscope, they had aimed at producing photomicrographs of the greatest possible strength of contrast, and thus exaggerated effects of black and white had become the order of the day. Those who had not the facility of producing photomicrographs were thus apt to think their own manipulation with the Microscope must be defective, because they found it impossible to see in the Microscope images so strong and definite as those shown in the recent photomicrographs.

Mr. E. M. Nelson said the subject was one of importance in connection with matters which had occupied much of his attention. As regarded the 1000 diameter limit mentioned by Mr. Mayall, he thought he had been able to exceed that, his experience leading him to say that sharpness could be obtained up to 20 times the initial magnifying power of the lens. He had produced good photographs direct from the Microscope up to × 1500, and recently showed one untouched and undoctored × 1650. In most cases, however, × 1000 would be found a useful limit; and he might add that he had taken sharp pictures with a 1 in. objective exceeding 20 times the initial power of the lens. With regard to the hydroquinone developer, he thought it would not give more contrast than was obtained in other ways; if they had a feeble image on the screen they would only get a feeble photograph from it, and with high powers he had never been able to get in this way much more than he could see. But with lower powers they could undoubtedly get very strong contrasts, and could sharpen up a picture with hydroquinone, using lenses up to 1/4 in. dry, though it could not be done with an oil-immersion. With a dry 1/4 in., or with a 1 in. lens, they could under-expose and then get a perfectly black and white "chalky" picture, as mentioned by Mr. Mayall. As regarded enlargement, it was a thing he was utterly opposed to, and he thought that all such prints ought to be marked as such, on front and back too, if necessary, to prevent any one being deceived by them. Intensification should be regarded much in the same way; the picture shown ought to be the same as the image seen. He did not believe in effects produced by doctoring processes, either carried out by chemicals or by projection with a lens. These were purely mechanical processes, and as useless for scientific purposes as if drawn with a brush upon the screen.

The Chairman inquired if they could tell whether the photograph before them was an enlargement, or whether it had been taken direct?

Mr. Nelson said it was easy to say it was an enlargement, but the method employed in its production could not be determined by inspection. The chief use of enlargement was to convert a poor, weak picture into a bold, sharp one.

The Chairman remarked that people who were dissatisfied with a photograph were accustomed to be told that the sun could not lie; but it seemed as if something of the sort could happen through the medium of the processes mentioned.

Mr. Mayall said that when a draughtsman made a drawing of an image seen in the Microscope, he adopted some conventional method of representing differences of colour, light and shade, &c., and in some points his personal equation was an important factor, as evidenced by the different renderings that would be given by different draughtsmen. Bnt it should not be supposed that by means of photography all these difficulties were conquered, and that the photographic interpretation could be wholly relied upon for giving uniform results. Photography itself might be said to have a considerable range of "photographic equation," due to the variety in the processes that were available, and it was an extremely difficult matter to suggest any one process that should be regarded as a standard or guide for general adoption in connection with Microscopy. It was quite certain that a skilled manipulator could so direct the processes that almost any point could be accentuated in a photograph. As an example, he might mention that Mr. Nelson had shown him negatives of a *Triceratium* in which the general contours of a hexagonal "pit" were very well shown, but in which it was hardly possible to detect any differentiation at the bottom of the pit, though in the Microscope a dotted appearance was seen. A new negative was made with much less exposure, and though the general contours were not so evident, the dotted appearance in the pits was shown. This was clearly an instance that photography had its own methods or conventionalities in dealing with particular points—the mere reduction of the exposure enabled the sensitive film to pick up faint differences in luminousness of closely adjacent parts which had previously been blurred together by the over-exposure. He thought the importance of having the full data given with every photomicrograph would soon be recognized, and that the comparison of results would thus become more useful. At present the matter was somewhat chaotic, for it frequently happened that the processes employed were so mixed up that no proper comparisons could be made. Photomicrographs were produced with sunlight, diffused daylight, electric light, oxy-hydrogen light, petroleum light, gaslight, &c.; the negatives were intensified or not, or were developed in some special way; the exposures were timed to exhibit this or that point; the plates were isochromatic or not; and yet the results were dealt with as if the comparisons were being fairly made on the same lines. Or, again, enlarged photographs were made from many of these photomicrographs by processes which were known to completely alter the character of the originals, and these were compared with each other, or with the various originals, in such a way that the whole subject became confused. In twenty years hence, the student who should examine the Society's collection of photographs would be sorely puzzled to determine what the present generation of photomicrographers had really been aiming at.

The Chairman thought the thanks of the Society were due to those gentlemen who had favoured them with communications, and who had sent exhibits to the meeting. The causes which had operated in preventing the attendance of the President and Prof. Bell had no doubt deterred many others from being present that evening. He also announced that the next meeting would be the Annual Meeting in conformity with the alteration in the Bye-laws, and would be held on January 21st, when the election of Officers and Council would take place, and the President would deliver his annual address.

The Chairman said that in conformity with the Bye-laws the Council had nominated Mr. W. T. Suffolk to audit the Treasurer's account, and a second Auditor must be appointed by the Fellows. On the motion of Mr. J. Mason Allen, seconded by the Rev. Canon Carr, Mr. J. D. Hardy was appointed as Auditor.

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

Mr. J. Clark :—Lithographs and Photomicrographs of early stage of Freshwater Sponge.

Mr. T. Clarke :—Slides of *Leptodora hyalina* and *Ceratium longicorne.*

Mr. G. F. Dowdeswell :—Eye-piece Thread-micrometer.

New Fellows :—The following were elected *Ordinary* Fellows :— Messrs. Lawrence Briant, F.C.S., and William Snow, B.A.

Annual Meeting, held 21st Jan., 1891, at 20, Hanover Square, W., the President (Dr. C. T. Hudson, F.R.S.) in the Chair.

The Minutes of the meetings of 17th December last were read and confirmed, and were signed by the President.

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

	From
Cowan, T. W., The Honey Bee: its Natural History, Anatomy, and Physiology. xi. and 220 pp., 72 figs., and frontispiece. (8vo, London, 1891)	*The Author.*

The President said it was with great regret that he had to notify the death of one of their Honorary Fellows, Dr. H. B. Brady, F.R.S. He had suffered, as no doubt they were aware, from a long illness, and had died at a comparatively early age, but he had left behind him, as the fruit of twenty-five years' study of the Foraminifera, results that might well be considered the ample reward of long life and unvarying health. For, besides many memoirs on his favourite subject, written either alone or in conjunction with the late Prof. W. Kitchen Parker and Prof. Rupert Jones, he published single-handed that splendid report on the Foraminifera of the 'Challenger' expedition, which had so extended their knowledge, and confirmed his high reputation. On his enthusiasm and unflagging industry it was needless for him to dwell; but he might be permitted to add, that those who had the pleasure of knowing him well, mourned for the loss, not only of an accomplished scientist, but of a sterling friend. In addition to this loss, he had also to record the death of Prof. G. Govi, another of their Honorary Fellows, which occurred in 1889, but the notification of which was omitted from the Report of the Council in 1890. To fill the vacancies thus created, it was proposed to elect Prof. Hermann Fol, of Nice, and Prof. Sir Joseph Lister, Bart., F.R.S., nominations in favour of whom were then read to the meeting and ordered to be suspended in the usual manner.

Mr. Swift exhibited and described a new form of Petrological Microscope which he had made under the instructions of Mr. Allen Dick, which differed from the ordinary patterns in having no revolving stage, but was so constructed that, whilst the object remained fixed, the eye-piece and the tube below the stage could be revolved.

The President expressed the thanks of the Society to Mr. Swift for exhibiting and explaining the features of this Microscope.

Mr. E. M. Nelson exhibited a new Apochromatic Condenser by Powell and Lealand, which gave a larger aplanatic solid cone than it had hitherto been found possible to obtain.

Prof. Bell then read the Report of the Council for the past year, as follows :—

REPORT OF THE COUNCIL.

Fellows.—During the year 1890, forty-one new Fellows were elected, which is about the average of the last ten years, whilst thirty-six died or resigned.

Three Honorary Fellows, Prof. H. Frey, Prof. W. Kitchen Parker, F.R.S., and Mr. J. Ralfs, died; their places were supplied by the election of Prof. Leydig, of Würzburg, the most distinguished of living histologists, Mr. H. B. Brady, F.R.S., well known for his numerous writings on Foraminifera, and Prof. W. C. Williamson. F.R.S., whose investigations have told us so much as to the flora of past ages.

The death of Prof. G. Govi, Honorary Fellow, occurred in 1889, but his name was inadvertently omitted from the Report of last year.

The list of Fellows now contains 663 Ordinary Fellows, 1 Corresponding, 49 Honorary, and 88 Ex-officio, or a total of 801.

Finances.—As many of the Fellows who died or resigned were either compounders or subscribers under the old scale of one guinea, the annual revenue from subscriptions has been increased by 29*l.* 8*s.*

The capital funds of the Society are 1200*l.* in freehold mortgages, and 780*l.* 17*s.* 3*d.* invested in India 3 per cents., which is 95*l.* 2*s.* 5*d.* less than the amount reported last year, this being the sum expended in the removal of the Society's property from King's College to the premises now occupied.

Rooms.—The Council are glad to report that the removal of the Library, Instruments, &c., to the new premises, at 20, Hanover-square, was effected without accident or loss of any kind.

Library.—The Council note that during the past year the increased usefulness of the Library has been evidenced by the number of Fellows visiting the rooms or applying for the circulation of volumes, periodicals, &c., by means of the printed catalogue now issued.

The Council are aware that the Society's collection of works on the Microscope requires large additions to render it available for historical reference, and they hope progress will be made in the near future towards greater completeness of the Library in this direction.

Instruments.—The Council are informed by the Secretaries that several applications have been made by Fellows during the past year for the use of a high-class Microscope, with objectives, &c., of the most approved construction, and they hope to deal with the subject satisfactorily during the ensuing year, as they fully recognize the importance of having such an instrument at the disposal of the Fellows.

Journal.—The Council observe that, under the editorship of Prof. F. Jeffrey Bell, the Journal has been maintained on the lines so ably laid down by Mr. Frank Crisp, and they trust that the continued publication on those lines will lead to its augmented prosperity.

Transactions.—The Council urge upon the Society the great importance of obtaining original communications for publication in the 'Transactions'; they would impress upon the Fellows that such communications are of special interest at the meetings, and that it is on their publication that the scientific position of the Society is estimated.

Upon the motion of Mr. J. M. Allen, seconded by the Rev. Canon Carr, it was resolved that the Report be received and adopted.

The Treasurer, Mr. Frank Crisp, presented his annual statement of accounts, and read the balance-sheet, duly audited by Messrs. Suffolk and Hardy, who were elected Auditors at the preceding meeting (see p. 158).

Upon the motion of Prof. Lionel S. Beale, F.R.S., seconded by Dr. Hebb, the adoption of this Report, together with a vote of thanks to the Treasurer for his services during the past year, was duly passed.

The President having appointed Mr. J. Mason Allen and Mr. Edward M. Nelson to act as Scrutineers, the ballot for the election of Officers and Council for the ensuing year was proceeded with.

The President then read his Annual Address (see p. 6), concluding with the exhibition of a number of coloured transparencies, some in illustration of portions of his subject, and others to demonstrate the adaptation of this plan for the display of diagrams on various points in natural history and astronomy.

The Rev. Canon Carr said he rose for the purpose of heartily thanking the President for the address which he had just delivered, and for the exhibition of his beautiful drawings. The Fellows were thankful to see him amongst them again, and hoped that his presence might be regarded as an indication that his health had been fully restored. They also further hoped that the fears which had been entertained with regard to his eyesight might not be realized. He felt sure that all who were present had been very much pleased with the address, and would heartily join in giving their best thanks to the President for it.

Prof. Bell had much pleasure in seconding the vote of thanks to the President for his address, and also for his services to the Society during the past year. The lateness of the hour, and the knowledge that Dr. Hudson was anxious to leave as soon as possible, were reasons why he should not make any lengthened remarks in support of a resolution which he felt sure commended itself to every Fellow of the Society who had listened to the address: he would therefore ask Canon Carr to put it at once to the meeting.

The motion was then put to the meeting, and carried by acclamation.

The President, in reply, thanked the Fellows of the Society heartily for the cordial manner in which they had received his address, and also for the honour done to him by his election as President during the three previous years. In accepting the office, he had fully anticipated that the state of his health would have admitted of his attendance at the meetings more often than had unfortunately been possible; but he could assure them that it had given him great pleasure to come as often as he had been able, and he hoped still to be able to come to future meetings whenever circumstances permitted.

THE TREASURER'S ACCOUNT FOR 1890.

Dr.

1890.	£	s.	d.
To Balance brought from 31st December, 1889	114	19	6
„ Interest on Investments	77	14	3
„ Admission Fees	79	16	0
„ Annual Subscriptions	884	3	2
„ Compositions	139	2	6
„ Reprints of papers sold	6	1	6
„ Catalogues sold	0	15	0
„ Old Chairs and Cases sold	8	16	0
„ India 3 per cent. Consols sold (£95 2s. 5d.)	90	0	0
	£1401	7	11

Cr.

1890.	£	s.	d.
By Rent, Gas, and Attendance	192	17	6
„ Salaries, Reporting, and Commission	194	9	0
„ Books and Binding	114	2	0
„ Expenses of Journal (less receipts)	539	19	2
„ Postage of Journal	56	4	5
„ Reprints of Papers	5	16	0
„ Stationery and Miscellaneous Printing	35	15	3
„ Coffee at Evening Meetings	19	2	6
„ Fire Insurance	2	5	0
„ Petty Cash	39	11	0
„ Expenses of Removal	90	15	11
„ Balance remaining 31st December, 1890	110	10	2
	£1401	7	11

Frank Crisp, *Treasurer.*

Investments, 31*st December*, 1890.

1200*l.* Freehold Mortgages. 780*l.* 17*s.* 3*d.* India Three per Cents. (including 100*l.* Quekett Memorial Fund).

The foregoing Annual Account examined and found correct, 5th January, 1891.

J. D. Hardy,
W. T. Suffolk, } *Auditors.*

The Scrutineers having handed in the result of their examination of the balloting papers,

The President declared that all the Fellows nominated were elected as follows:—

President—*Robert Braithwaite, Esq., M.D., M.R.C.S., F.L.S.

Vice-Presidents—*Prof. J. William Groves, F.L.S.; *Albert D. Michael, Esq., F.L.S.; *Prof. Charles Stewart, Pres. L.S.; Charles Tyler, Esq., F.L.S.

Treasurer—Frank Crisp, Esq., LL.B., B.A., V.P. and Treas. L.S.

Secretaries—Prof. F. Jeffrey Bell, M.A.; and John Mayall, Esq., Jun., F.Z.S.

Twelve other Members of Council—*Prof. Lionel S. Beale, M.B., F.R.C.P., F.R.S.; Alfred W. Bennett, Esq., M.A., B.Sc., F.L.S.; Rev. W. H. Dallinger, LL.D., F.R.S.; *James Glaisher, Esq., F.R.S., F.R.A.S.; Richard G. Hebb, Esq., M.A., M.D.; *Charles T. Hudson, Esq., M.A., LL.D. (Cantab.), F.R.S.; George C. Karop, Esq., M.R.C.S.; Thomas H. Powell, Esq.; *Prof. Urban Pritchard, M.D.; Walter W. Reeves, Esq.; William Thomas Suffolk, Esq.; and Frederic H. Ward, Esq., M.R.C.S.

Mr. G. C. Karop then moved that the thanks of the Society be given to the Auditors and Scrutineers for their services, and the motion having been seconded by Mr. F. Justen, was put to the meeting by the President, and carried unanimously.

The President said he had now the pleasure of welcoming to the Chair his well-known and learned successor Dr. Braithwaite, and of congratulating the Society, not only on so happy a choice, but also on the fact that the Zoological Dynasty had made way for a Botanical one. Variety was the salt of life, and it was a fortunate thing that their large and flourishing Society contained members who, though of very various tastes, resembled one another in their zealous pursuit of natural science, and in the success with which they pursued it. With the wish that Dr. Braithwaite might have a long, happy, and prosperous reign, he became now one of the most loyal of his subjects.

Dr. Braithwaite, who was very cordially received on taking the Chair, said he had in the first instance to thank the retiring President for the kind way in which he had referred to him, and next to thank the Fellows of the Society for the honour conferred upon him by his election to the position he was about to occupy. He could assure them that, so far as he was able to sustain it, the high position which the Society then held should not suffer from the change which they had made. He knew that the position was not a light one, but he was encouraged by the sight of many old friends before him to believe that those who so ably assisted him in the discharge of similar duties at another Society some years ago, would also give him the benefit of their assistance during the coming year. One observation, however, he should very much like to make before he sat down; he thought it very desirable that original papers should fill a much

* Have not held during the preceding year the Office for which they were nominated.

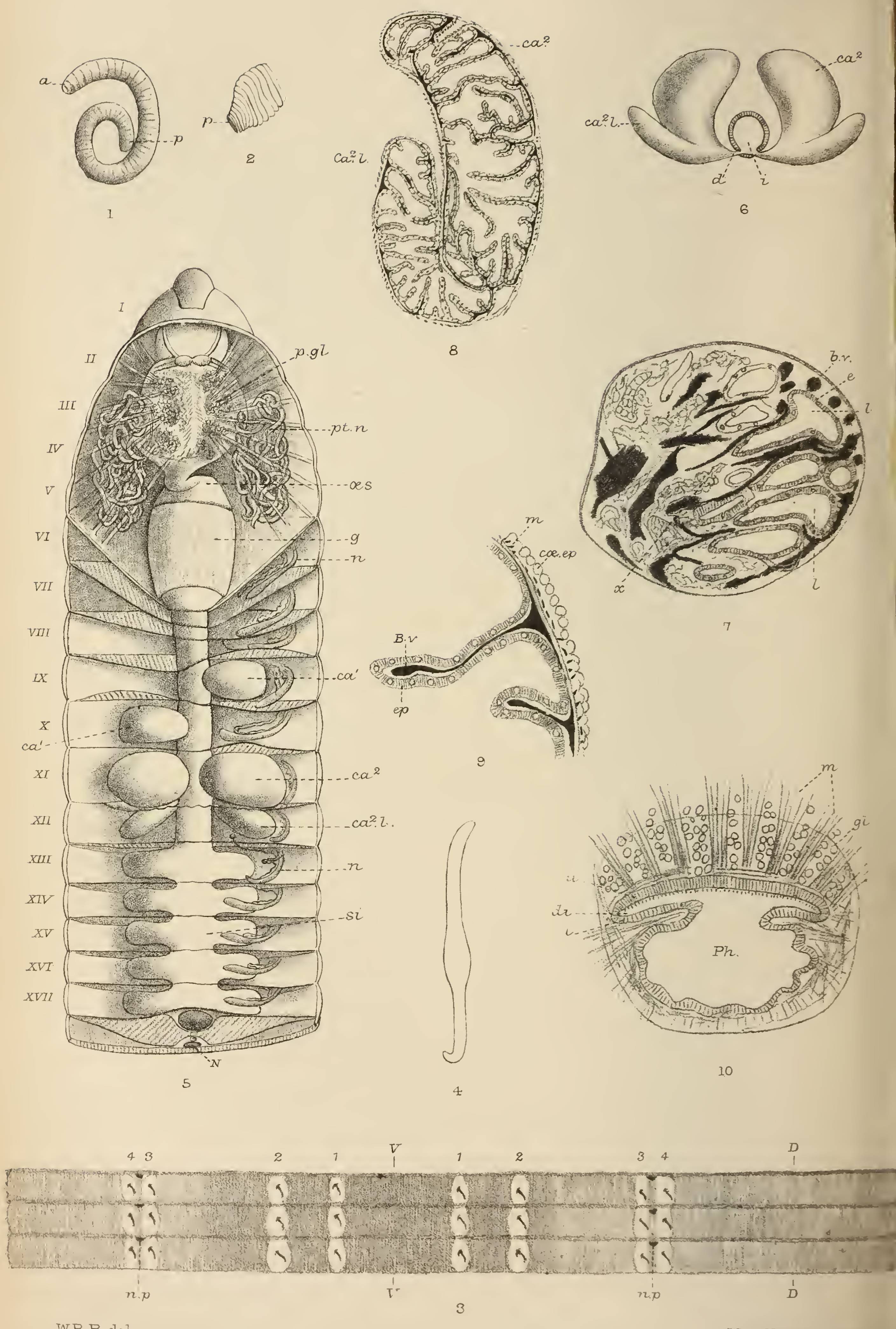
larger space in the Journal than was at present the case. The Journal had already a world-wide reputation, and the surest way to maintain this would be to increase as far as possible the number and value of their original communications to the Society.

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

Mr. E. M. Nelson:—Powell and Lealand's new Apochromatic Condenser.

Mr. J. Swift:—Improved form of Dick's Polarizing Microscope.

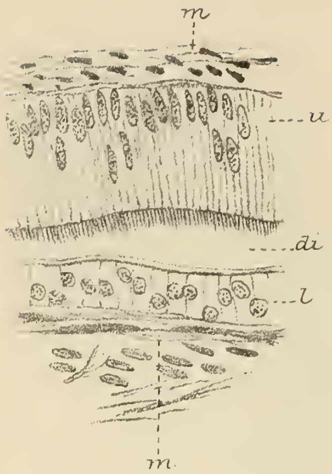
New Fellows:—The following were elected Ordinary Fellows:—Messrs. Alfred L. Blow, F.C.S., and Arthur D. Howard.



W.B.B. del

West, Newman imp.

Emınia equatorialis.



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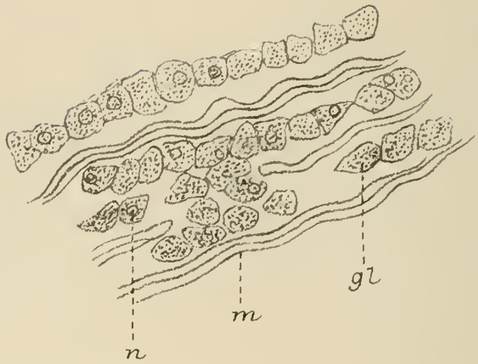

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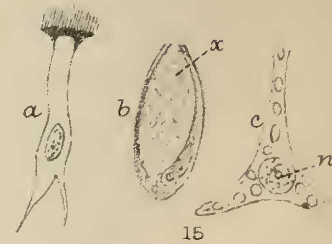

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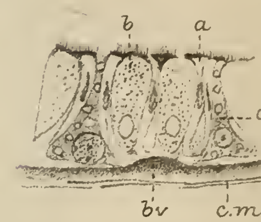

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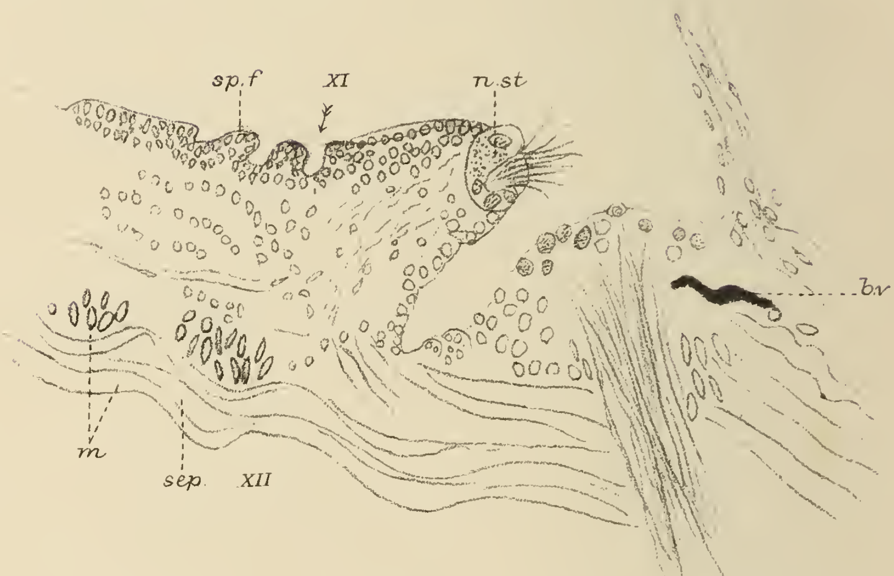

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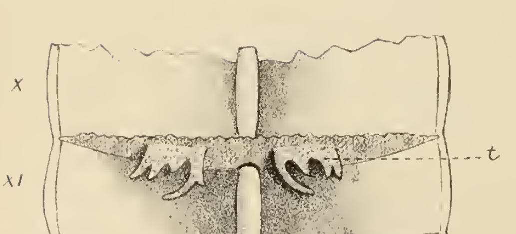

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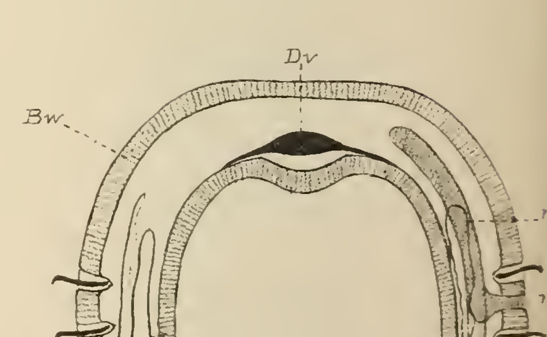

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W.B.B. del

West, Newman imp

Eminia equatorialis.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

APRIL 1891.

TRANSACTIONS OF THE SOCIETY.

III.—*Report on an Earthworm collected for the Natural History Department of the British Museum, by Emin Pasha, in Equatorial Africa.*

By W. Blaxland Benham, D.Sc., Assistant to the Deputy Linacre Professor of Comparative Anatomy in the University of Oxford.

(*Read* 18*th February*, 1891.)

Plates III and IV.

During the month of May in the year 1890, I was invited by Prof. Jeffrey Bell to examine a small earthworm received from Emin Pasha, and collected by him at Karagué in Equatorial Africa. As a superficial examination at the Natural History Museum did not enable me to form any reliable opinion as to the genus of the worm, I asked that I might be allowed to examine it more thoroughly by means

EXPLANATION OF PLATES III. and IV.

Fig. 1.—The worm, natural size, as preserved in spirit. *a*, anterior end. *p*, posterior end.

„ 2.—The posterior end enlarged, to show characteristic diminution in diameter immediately in front of the anus (*p*).

„ 3.—A strip of the body-wall flattened out and mounted permanently to show the arrangement of the setæ and position of the nephridiopores. The lines *V V* and *D D* indicate the ventral and dorsal mid-lines. 1, 2, are the inner or ventral couple of setæ. 3, 4, the outer couple. *np*, nephridiopore.

The shading indicates the relative thickness of longitudinal muscles, which are more abundant ventrally than elsewhere.

„ 4.—One of the setæ, the hooked end being free.

„ 5.—General view of the internal anatomy. The figure is diagrammatic, being composed from the study of the series of longitudinal vertical sections. The nephridia are figured only on the right side.

ca^1, the anterior calciferous glands, that on the right side being in somite IX. and on the left in somite X. ca^2, the second pair of calciferous glands. $ca^2 l$, the posterior lobe of this gland in somite XII. *g*, gizzard. *œs*, œsophagus, bent upon itself. *n*, nephridia. *pt.n*, peptonephridium, partly hidden by the radiating muscles of the pharynx. *si*, sacculated intestine. *p.gl*, groups of cells forming "pharyngeal glands."

„ 6.—The second pair of calciferous glands, supposed to be seen from behind of dissection or serial sections. To this Dr. Günther most kindly assented, and to him I beg to express my very hearty thanks for this privilege so courteously granted; to Prof. Bell too, who has allowed me to examine, from time to time, many specimens of earthworms that the Museum has received, my thanks are due. A condition was attached to Dr. Günther's consent, that I should return to him any preparations of the worm which I might have occasion to make. As the worm is a unique specimen this was only just and reasonable, and I readily agreed to it.

The single specimen was of too small a size to dissect, and moreover, such a dissection would not have exhibited, without too great

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(diagrammatic). ca^2, the chief lobe in somite XI. $ca^2.l$, lobe in XII. *i*, cut intestine. *d*, duct of gland opening into intestine.

Fig. 7.—Section of anterior calciferous gland of right side from a longitudinal section. *b.v*, blood-vessels. *e*, lining epithelium of the gland. *l*, lumen. *x*, vacuolated cells in the centre. (Slide VI. *b* 7 *et seq.*)

„ 8.—A section through the posterior calciferous gland and its lobe ($ca^2.l$) showing the more extensive lumen. (Slide XI. *b.*)

„ 9.—A portion of the preceding under a high power. *B.v*, blood-vessels. *ep*, excreting epithelium, with striated protoplasm. *cœ.ep*, vesicular cœlomic epithelium. *m*, muscles in the wall of the gland.

„ 10.—Diagrammatic drawing of transverse section of the pharynx, compiled from longitudinal sections. *gl*, groups of gland cells, constituting a "pharyngeal gland." *m*, rows of muscles, alternating with the glands. *u*, the upper wall. *l*, lower wall of diverticulum (*di*).

„ 11.—A portion of the preceding (*di*, fig. 10) more highly magnified. *di*, the lateral part of the diverticulum. *u*, the upper ciliated epithelium. *l*, the lower, cuticulated epithelium. *m*, muscles.

„ 12.—A group of gland cells from the wall of the pharynx. *gl*, gland cells in strings. *n*, nucleus of one such cell. *m*, muscle-fibres.

„ 13.—Transverse section of the body posterior to the genital region, slightly diagrammatic in so far as the nephridia are shown, with nephridiopore on one side, and setæ. 1, 2, 3, 4, the four setæ on one side. *D.v*, dorsal blood-vessel with intestinal branches. *s.i.v*, subintestinal vessel. *s.n.v*, subneural vessel. *N*, nerve-cord. *n*, nephridium. *f*, its nephrostome. *n.p*, nephridiopore. *B.w*, body-wall. *I.w*, intestinal wall. (Both are represented quite diagrammatically.)

„ 14.—A portion of the intestinal wall to show the three kinds of cells, *a*, *b*, *c*, forming its lining, with *b.v* blood-vessel, *c.m* circular muscles.

15.—The three cells represented isolated as is the case in some of the damaged sections. *a*, ordinary ciliated columnar cell. *b*, goblet cell, with *x*, the secretion. *c*, deeply staining triradiate cell, with spherular secretory contents. *n*, nucleus.

„ 16.—General diagrammatic view of the genital system (immature worm), compiled from examination of longitudinal sections. The alimentary canal is supposed to have been removed. *t*, testis. *f*, funnel of spermduct. *s.s*, sperm-sac. *o*, ovary. *od*, funnel of oviduct. *os*, probable ovisac. *n*, nerve-cord.

„ 17.—A portion of a section through the spermiducal funnel, very highly magnified. (Slide VI. *b* 3.)

sp.f, rudimentary sperm-funnel not yet ciliated. *n.st*, nephrostome imbedded in the thickening which will give rise to the sperm-funnel. *b.v*, blood-vessel. *sep*, septum between somites XI. and XII. *m*, muscles of septum.

The arrow points to the position of the internal aperture of the spermduct, which can be seen a few sections from this. (Slide VI. *a* 5.) Cf. this drawing with those of Bergh, loc. cit. in text.

destruction of some parts, all that was necessary to ascertain its structure; so that, after making a careful drawing and making all necessary superficial examination, I cut off the first twenty segments of the worm, and after staining this anterior portion, and imbedding it in the usual way, I cut it into a number of consecutive sections by means of a "ribbon microtome."

I made the sections, as nearly as I could, in planes parallel with the median plane of the animal, and they are all arranged in order on the accompanying slides. Unfortunately many of these sections are a good deal torn, and organs therefore displaced; this was due to the dirt and grit in the alimentary canal—a fruitful cause of the imperfection of sections, which is familiar to those who have cut longitudinal sections through earthworms. But a sufficient number of sections are perfect enough for my purpose of identifying the genus to which the worm belongs.

In addition to this series of sagittal sections, I cut a small portion of the next following region of the worm into a number of transverse sections. Further, a small portion of the body-wall is spread out, flattened, and mounted, in order to show the disposition of the setæ and the nephridiopores. The remnant of the worm, together with these preparations and a drawing of its appearance and colour in spirit, was returned to the Natural History Museum.

In the case of the longitudinal sections each slide is numbered with Roman numerals I. to XIII. The number is written at one corner, which is the right top corner when the slide is placed in the proper position. The series starts in each slide at this point, and passes to the left side. That is row *a*. Row *b* in the same way starts at the right side and should be followed to the left.

In my drawings I refer to the sections thus:—IV. *a* 6 indicates the sixth section from the right side along row *a*, on the fourth slide of the series. These slides then can be referred to in order to confirm or contradict my statements.

Description of Eminia equatorialis gen. et sp. nov.

The worm, as will be seen from the following description, is the type of a new genus, to which I give the name *Eminia*. Its specific name refers to the region of Africa in which it was collected. The worm is immature, there being no trace of a clitellum or any other external sexual character.

In colour (in spirit) it is brownish, tending to green in the middle and posterior parts of the body, owing to the partial transparency of the body-wall, and the consequent visibility of intestinal contents. This colouring is shown in the sketch deposited in the British Museum.

The length of the worm is about 2 in.; see fig. 1 which is of the natural size, and represents it coiled as it was in spirit. The number of segments in relation to the length is very great, being about 190.

The *clitellum* being undeveloped and the *male pores* being invisible no clue to its affinity was afforded by its external character.

The *setæ* are eight in number in each segment, arranged in four couples. The outer couple, where the setæ are close together, is lateral; the inner couple, i. e. that nearer the ventral mid-line, is ventro-lateral (figs. 3, 13) and the setæ are further apart.

If we take as our unit the distance separating the two setæ of the outer or lateral couple, the inferior setal space is represented by 3, the lateral space, between the two couples, is 6; the ventral space between setæ I and I is 6; the dorsal space between setæ IV and IV is 18.

Or written as a formula, $i = 3\,o$ and $L = V = 6\,o$, where i = space between the two setæ of inner couple, o = space between two setæ of outer couple; L means space between inner and outer couples of one side; V = space between the inner couples.

The setæ themselves are small, measuring 0·135 mm., and are sharply hooked at their free extremity (fig. 4).

The *nephridiopores* are visible under a lens, and are placed in a line with the outer couple, between the setæ III and IV (figs. 3, 13).

There are no *dorsal pores*.

The *prostomium* is small and completely dovetailed into the peristomium or buccal somite (as in *Lumbricus*). In the specimen the prostomium was partly hidden, being bent into the mouth.

The anterior 11 somites are much larger than the rest, they are more decidedly brown in colour, have thicker walls, and each is marked with a distinct ridge surrounding the body.

The *anus* is terminal and circular; the circumanal somite is very small; the penultimate and three or four previous preanal somites gradually widen out to attain the normal diameter of the worm (fig. 2).

The Internal Anatomy.—The arrangement of the internal organs was studied by means of longitudinal sections, but the general relations are shown in diagrammatic fashion by figs. 5 and 16.

The *alimentary canal* (fig. 5) consists of the usual thin-walled buccal region which lies in front of the cerebral ganglia in somite III. Immediately behind the latter lies the thick-walled pharynx, occupying somites III and part of IV, though appearing more extensive. The dorsal wall of the pharynx, as is always the case, is thicker than the ventral wall (see fig. 10), and this thickness is due in part to the groups of radiating and other muscle-fibres and in part to groups of gland cells which are arranged in strings between the radiating muscles (see fig. 12).

These gland cells stain very deeply in borax-carmine, owing to the abundance of granules present in them, which almost conceal the round nucleus.

The presence of these "pharyngeal glands" is very frequent in earthworms; and although they are usually regarded as being used in digestion, their communication with the interior of the pharynx has never been recognized; I myself have been no more fortunate than my predecessors.

Another peculiarity in the pharynx, which from my own observations on various genera seems to be very general, but which has received no detailed description, is the following:— The lumen is of different shape in different parts of the pharynx, as Claparède figured some twenty years ago. One of the most constant diverticula is a dorsally placed, flattened, and laterally extended pouch, communicating with the general pharyngeal cavity anteriorly, or sometimes along its whole extent (fig. 10). The epithelial cells of the roof of this dorsal pouch differ from those of the floor; the latter are short, columnar or sometimes nearly cubical cells, with a distinct cuticle and a round nucleus. The cells forming the upper lining of the dorsal pouch are very much longer and narrower; the nucleus is elongated oval, and lies usually near the base of the cell; moreover, these *dorsal cells are ciliated* (fig. 11). This last fact I have observed in several genera, including *Allolobophora*, *Criodrilus*, *Allurus*, and others; and am unaware of any previous mention of the fact in earthworms, though a similar condition is met with in *Polygordius*, according to Fraipont, and in *Nais*, where it forms Semper's "branchial region of pharynx." Claparède in his figures of *Lumbricus* represents, distinctly, a cuticle, and the cilia are indeed so closely set as to give the appearance of a striated cuticle. I have in *Allolobophora* sp. examined a teased portion of a living pharynx and have seen the cilia working.

The following region, the œsophagus, is thin-walled, fairly wide, and laterally compressed; in somite V it widens out and leads into the *gizzard*. This organ occupies only *one somite*, the fifth, but it pushes backwards the thick septa which bound posteriorly the fifth, sixth and seventh somites, so that on a casual examination it would appear—especially, probably, on dissection—that the gizzard occupied these somites, but by tracing out the septa, it is sufficiently easy to determine that it occupies but one somite.

Behind the gizzard the tubular intestine (or as it is sometimes called, the post-ventricular œsophagus) commences; it is considerably narrower than the previous regions, the walls are thinner, the epithelium secretes a cuticle, and it is provided with calciferous glands on its course.

The sacculated intestine commences in segment XIII or XIV; it is not at all an easy point to be sure of, as the septa behind the thirteenth and following somites are extremely thin; they are, too, bulged forwards, and are close together, so that the intestine may commence in XIV, or even XV, but I believe XIII is the somite in which the sacculated intestine commences. There is practically no typhlosole. The intestinal epithelium presents (figs. 14, 15), three different sorts of cells: (*a*) ciliated columnar cells; (*b*) goblet cells with granular contents; and (*c*) peculiar ⊥-shaped cells, which I have not observed in other worms; these cells contain small spherical globules, and stain very much more deeply in borax-carmine than do the other constituents.

Although the dorsal wall is very slightly pushed inwards by the dorsal vessel, in some sections this feeble typhlosole is scarcely recognizable, and I am doubtful whether it is a real structure, or only artificial (fig. 13).

The *calciferous glands* present a peculiar asymmetry. There are two pairs, slightly differing in structure (see figs. 5, 6, 7, 8). The second pair is bilobed externally; the main part occupies somite XI, a smaller lobe lying in somite XII. This hinder pair of glands is symmetrical.

The anterior pair, which are not lobed, are affected by a curious asymmetry; on one side there is gland in somite IX, on the other in somite X (see fig. 5). All these glands communicate with the intestine on its ventral surface (fig. 6). Each gland consists of a sac, the cavity of which is broken up by a large number of trabeculæ, containing blood-vessels, the whole cavity being lined by a *striated* cubical epithelium. The structure of the two glands is somewhat different. The posterior gland has a much more extensive lumen (fig. 8) and numerous thin and incomplete trabeculæ, or lamellæ; whilst in the anterior gland these lamellæ unite (fig. 7) and interrupt the lumen to a greater extent than in *Lumbricus* and other forms, resembling the calciferous gland of *Urobenus*, figured by me in Q. J. M. Sci., xxvii. pl. ix. fig. 43, and the "Chylustaschen" of *Polytoreutus* Mich. The posterior gland with its numerous free infoldings of the wall, resembles more nearly the calciferous glands of *Lumbricus*, the ventrally placed gland of *Eudrilus*,* and the modified wall of *Diachæta Windlei*.† But none of these authors figure the *striation* of the lining cells (fig. 9).

Genital system (fig. 16).—A single pair of *testes* situated in somite XI. and a pair of ciliated funnels in the same somite constitute the only definite male organs. The duct I can trace through septum XI/XII, but no further. A structure, which I take to be the *sperm-sac*, lies in somite XII attached to the septum XI/XII, close to the funnel; it is empty of young or developing spermatozoa, and in fact a lumen is difficult to detect; the wall is made up of small cells, and a network of blood-vessels is present. There is a pair of these structures. I can find no prostate, nor could I detect the sperm-pore.

Of the female organs, I find the *ovary* in the usual somite, XIII; and behind it the funnel of the oviduct, which passes into the next segment and leads into an apparently solid mass of cells, which I take to represent the future ovisac. I can find no spermathecæ.

* Beddard, P.Z.S., 1887, pl. xxxviii. fig. 3.
† Beddard, Q. J. M. Sci., xxxi. pl. xx. figs. 10, 11.

Both the gonads and their ducts are evidently in a very early condition of development, and closely resemble those figured by Bergh in early stages of *Lumbricus.**

The funnels of sperm and oviduct are evidently formed, in the same way as Bergh has described, as a modification of part of the nephridial funnel,† and the cells do not yet bear cilia; the ducts are apparently not yet formed.

I figure (fig. 17) a portion of a longitudinal section through septum XI/XII, showing a normal nephrostome, on one side of which is the commencement of the sperm-funnel; it closely resembles Bergh's fig. 19, if the sperm-funnel were drawn out laterally.

The *nephridia* are present as a pair of large tubes in each segment behind the fifth; each consists of a "narrow tube," with funnel, a "middle tube," and a wide tube as in *Lumbricus*. This nephridium is much shorter than in that genus, and the tube is less convoluted (fig. 13); the muscular duct is relatively greatly developed, and is produced into a cæcum, extending up the side of the intestine nearly to the dorsal vessel. The nephridiopores are in a line with the outer couple of setæ. The anterior segments are occupied by a pepto-nephridium (fig. 5, *ptn*) such as we find in *Urochæta* and other genera. It is a large mass of tubules lying at the side of the pharynx and œsophagus; the tubules have every resemblance to that of an ordinary nephridium, and at least two funnels are present, one in the sixth, the other in the seventh. I have not been able to ascertain whether the duct opens internally to the pharynx, or externally.

As to the *nervous system* and *vascular system* I have nothing characteristic to describe, except the position of the *subneural* vessel, which, instead of being surrounded by the sheath of the nerve-cord, as in *Lumbricus*, is removed from this, and in fact lies in the body-wall (see fig. 13), as Beddard has recently described in *Perichæta*.‡

There are peculiar sacs in VIII and IX with several setæ lying below the calciferous glands in the latter segment, and apparently isolated from the epidermis. I do not know the meaning of these structures.

The *Affinities of Eminia*.—It is "meganephric," non-prostatiferous, octochætous; hence it belongs to one of the three families, *Geoscolecidæ* (mihi), *Rhinodrilidæ* (mihi), or *Lumbricidæ*.§ With the last it cannot be included, owing to the forward position of gizzard, lateral position of nephridiopores, and for other reasons.

From the Rhinodrilidæ it differs in the possession of a *single* pair of testes, and sperm-sacs, although in the position of gizzard, nephridiopores, and nephridial cæcum it resembles some of the members of the family.

* Zeitschr. f. Wiss. Zool., xliv. pl. xxi. figs. 20, 21, 22.

† Cf. also Beddard, Proc. Roy. Soc., 1890.

‡ Q. J. M. Sci., xxx. pl. xxix. fig. 7.

§ Op. c., xxxi. p. 218.

The genera which possess only *one pair of testes and sperm-sacs* —which are the chief characters on which we can rely in the case of the present worm—are *Geoscolex*, *Urochæta*, *Diachæta* (which I have grouped together as a family Geoscolecidæ, separated from the Rhinodrilidæ by the above character, by the separation and alternation of the setæ, and other minor characters).

With these genera *Eminia* shows considerable agreement. In *Diachæta* the testes have the same position as in *Eminia*, in somite XI. The gizzard is in somite VI; a large pair of peptonephridia, resembling those of *Eminia*, have a similar position; but in *Diachæta* (though in *D. Windlei* there are modifications of the œsophageal wall), no distinct calciferous glands occur, nor is the nephridium provided with a "cæcum"; the setæ are moreover characteristically scattered and alternate.

From *Urochæta* and *Geoscolex*, where the setæ are posteriorly scattered and alternate, *Eminia* also differs in the position of testes, in number and position of calciferous glands, and in position of gizzard.

The nephridia of *Urochæta* are unlike those of *Eminia*, which however resemble those of *Geoscolex*, although the peptonephridia of the two are alike. The nephridiopores have the same position in the two genera.

This Central African earthworm is therefore a new genus; it agrees more closely with the *Geoscolecidæ* than with the *Rhinodrilidæ*, and perhaps serves to connect the two families. It is difficult to say—till we can obtain fully developed specimens—to which genera *Eminia* is most nearly allied. I thought at an early stage of my examination of the worm that *Eminia* might be a young stage of *Urochæta*, in which the characteristic arrangement of the setæ at the posterior end of the body had not yet been acquired, but a comparison of the nephridia and their funnels and other structures showed me that the two are distinct.

It is most unfortunate that this is the solitary specimen collected; if a few others had been collected at the same time we might have been able to fill in the gaps which at present must remain as such.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

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

α. Embryology.†

Fate of the Human Decidua reflexa.‡—Prof. C. S. Minot has arrived at some conclusions in regard to the well-known but imperfectly understood disappearance of the decidua reflexa. The view most generally accepted has been that it fused about the fifth month with the decidua vera, and that accordingly the layer of decidua nearest the chorion during the latter half of pregnancy represents the decidua reflexa. Minot has studied normal uteri of two, three, five to six, and seven months' gestation. These show that at two months the decidua reflexa is undergoing hyaline degeneration, that at three months the degeneration is considerably more advanced, and that by the sixth and seventh months the reflexa can no longer be found. Therefore the theory seems justified that the reflexa degenerates and is completely absorbed. This is the more probable, since recent investigations have shown that in many placental mammals there is an extensive pseudo-pathological destruction of the mucosa uteri during gestation. As to the cause of the degeneration, Prof. Minot simply regards it as the result of a reflex nervous activity,

Transplantation and Growth of Mammalian Ova within a Uterine Foster-mother.§—Mr. W. Heape records an experiment by which it is shown that it is possible to make use of the uterus of one variety of rabbit as a medium for the growth and complete development of fertilized ova of another variety of rabbit. Two ova were taken from an

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

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

‡ Anat. Anzeig., v. (1890) pp. 639–43 (1 fig.).

§ Proc. Roy. Soc. Lond., xlviii. (1891) pp. 437–8.

Angora doe rabbit which had been fertilized by an Angora buck thirty-two hours previously: the ova were, at the time, divided into four segments. They were immediately transferred into the upper end of the fallopian tube of a Belgian hare doe rabbit which had been fertilized three hours before by a buck of her own breed. When the Belgian doe gave birth she produced six young, four of which were like herself and her mate, and two of which were undoubted Angoras. So far as this single experiment goes it does not favour the view that a uterine foster-mother has any effect on her foster-children, or that the presence and development of foreign ova in the uterus of a mother affects the offspring of the mother born at the same time.

Maturation of the Ova of Elasmobranchs.*—Prof. N. Kastschenko has investigated the process of maturation in the ova of *Pristiurus melanostomus*, *Torpedo ocellata*, and *Scyllium canicula*. One polar body is formed by karyokinesis, while the ova are still in the ovary; a second may be formed subsequently, perhaps at the time of fertilization. No extrusion of portions of the germinal vesicle was observed, but there is probably some absorption of nuclear material by the yolk.

Early Stages in Development of Elasmobranchs.†—Prof. A. Schneider, who has made a study of the early stages of the development of Elasmobranchs, reports that the tissue of the embryo consists of protoplasm with nuclei; the caudal portion consists of mesoderm and ectoderm. In the mesoderm the protoplasm becomes collected around the nuclei, and the cell-territories give off processes and form a connected stellate tissue, In the ectoderm the protoplasm remains continuous; that layer is connected with the mesoderm by stellate tissue.

The mesoderm gives rise to the dorsal medulla and brain as well as to the primitive vertebræ and lateral plates; in the anterior region the mesoderm is formed from the middle line of the outer layer, and the ectoderm appears at the sides. The primitive vertebræ are from the first connected by the motor-nerves with the dorsal medulla; they and the lateral plates are at first connected, but afterwards become separated. The connective tissue and the muscles are developed from the lateral plates and primitive vertebræ, the latter giving rise to the longitudinal muscles, and the former to the enteric and cardiac musculature, the fin-muscles, the musculature of the gills and jaws, and to the vessels.

Yolk-sac of Young Toad-fish.‡—Prof. J. A. Ryder has studied the functions and histology of the yolk-sac of *Batrachus tau*. Unlike other fish-larvæ, the young do not escape from the egg-membrane immediately after its rupture, but continue to adhere to it by a discoidal area, and are thus indirectly attached to foreign bodies. The cellular membrane which covers the lower pole of the yolk-sac is much thickened as compared with the rest of the outer wall of the yolk. The thickening is due to the peripheral ends of the cells of the epidermis being prolonged in the form of a homogeneous and almost vitreous-looking material.

The whole of the free surface of the epidermis covering the yolk-sac is

* Zeitschr. f. Wiss. Zool., l. (1890) pp. 428-42 (1 pl.).

† Zool. Beitr. (Schneider), ii. (1890) pp. 251-66 (1 pl.).

‡ Proc. Acad. Nat. Sci. Philadelphia, 1890, pp. 407-8.

studded with scattered goblet or mucus-secreting cells. The yolk-sac is also remarkable for the presence of a layer of smooth muscular fibres under the epidermis, which appears to originate from the splanchnic mesoblast. Nothing of this kind seems to be known in the yolk-sac of any other young fish. There is no reason for supposing, as some ichthyologists have, that the fixation of the young is a voluntary action.

The Origin of Blood from the Endoderm.*—Herr H. K. Corning describes peculiar strands of cells in the endoderm of embryos of *Tropidonotus natrix* at the gastrula-stage, and inclines to think that they are connected with the endodermic formation of blood. The same appearances were seen in the gastrula-stage of *Lacerta agilis*, but with less distinctness. Herr Corning notices that Kupffer, in 1882, described similar strands in the gastrula-stage of *Coluber Æsculapii*, and interpreted them as vascular structures, but traced them to a "parablastic" origin, or, in other words, to the much-discussed yolk-nuclei.

β. Histology.

Streaming Movements of Protoplasm.†—Prof. C. Frommann maintains that the movements of fluids in what may be called the "artificial cells" made by Quincke and by Bütschli are in many ways different from those exhibited by living matter. Quincke sought to explain streaming movements by supposing a periodic distribution of albuminoid soap along the surface of the plasma, but this would not explain the occasional coexistence of streams in opposite directions within the cells of *Tradescantia* or *Urtica*, nor the occasional sudden stoppage or even reversal of movement, nor several other characteristics of protoplasmic movement. As to the relations between protoplasmic streaming and that of fine foam globules, e.g. those of Bütschli's emulsions, &c., it must be remembered that the former is retarded and stopped by cutting off the supply of oxygen, which is sufficient evidence of the dependence of the movement on metabolism. In regard to Bütschli's theory of the predominantly vacuolar structure of protoplasm, Frommann admits what he has previously demonstrated in detail, that there are many illustrations of vacuolated protoplasm, that in many cases the structure is rather that of a broken than of a complete network, that framework and network may result from the modification of vacuoles with originally intact walls, but he urges, as he may naturally do with some confidence, that in many cases apart from the presence of vacuoles there is a genuine network.

Cell-Structure.‡—Dr. K. C. Schneider finds that both the protoplasm and the nucleus of cells have a homogeneous framework, the bars of which are directly connected through the nuclear membrane. This framework consists typically of looped fibres of equal thickness, which have the power of uniting with one another and so giving rise to membranes. This formation of membranes may be very well seen in cells rich in vacuoles, such as the eggs of *Ascaris megalocephala*. When the vacuolation is very considerable almost all the free fibres may pass into

* Arch. f. Mikr. Anat., xxxvi. (1890) pp. 516–27 (1 pl.).
† Anat. Anzeig., v. (1890) pp. 648–52, 661–72 (4 figs.).
‡ Zool. Anzeig., xiv. (1891) pp. 44–6, 49–50.

membranes and a honeycomb-like structure is obtained. The closer the fibres the more refractive the membrane.

The common characters of the intermediate mass of the protoplasm and nucleus are shown by the fact that, if the nuclear membrane be destroyed or the nuclei have no membrane, no differences of any kind can be seen in the apparently homogeneous ground-substance. The most essential difference between protoplasm and nucleus lies in the presence of chromatin in the latter. By this term chromatin we are to understand a substance which stains with numerous colouring matters, and in distribution varies considerably. The agglomeration of chromatin-grains into small masses is of the highest interest, as it throws light on the morphological significance of nucleoli. The origin of nucleoli can be very well observed in *Sphærechinus*. Sometimes there are seen spherical parts of the framework which contain regularly distributed chromatin-grains; no membrane can be observed. Other nucleoli already show a membrane, and the framework, though as closely meshed as in the first, is not so distinctly recognizable. In a third case, though certainly present, the framework is difficult to see, and there is here and there a tendency to the formation of internal concentric membranes. Finally, when the nucleoli are completely developed, there is a highly refractive membrane. Just as the nucleoli are formed from chromatin-grains, so they may again be resolved into them, for the membranes may break up again into fibres.

The author has succeeded in demonstrating the identity of the bars of the framework with spindle-fibres. The contractility of the former may be shown by the mode of transportation of spermatozoa in, for example, *Strongylocentrotus* from the periphery to the centre. Before contracting, part of the fibre elongates, and perhaps breaks at a point of attachment.

Two New and Undescribed Methods of Contractility in Filaments of Protoplasm.*—Prof. J. A. Ryder has investigated the peculiar phenomena of contractility presented by the stalk of *Vorticella* and the body of *Trypansoma Balbianii*. The true state of things in the former has never yet been adequately described. The muscular filament of *Vorticella* passes downwards through its sheath in a spiral manner, and is only in contact along a spiral line with the inside of the transparent investing sheath. The filament thus makes eight or nine complete turns within its sheath, which is itself not in contact with the spiral muscular filament, except along the already mentioned spiral line. If, then, this spiral line of contact is in turn traced upon the muscular filament it will be found to describe a spiral around the latter. To fully satisfy the mechanical conditions of the problem, it is necessary to assume that the contractile filament of *Vorticella* is composed of alternating and superposed discs of singly and doubly refractive plasms. Observations of mounted preparations of *Carchesium polypinum* show that the coiled parts of the muscular filament are actually composed of discoidal elements, such as are met with in ordinary muscular-fibre. Further study showed that the discs of anisotropic matter are in contact along the concave or inner side of the coils, and not in contact on the outer

* Proc. Acad. Sci. Philadelphia, 1891, pp. 10-12.

or convex sides or faces of the coils, where a wedge-shaped mass of isotropic material seems to be interposed between the outer edges of the successive anisotropic discs.

While we have in *Vorticella* unequally contracting discs fixed in a spiral order, *Trypanosoma Balbianii* exhibits a rapid reversal of the spiral in a dextral or a sinistral direction; the contractile discs (not, however, yet observed), are supposed to have waves of contraction revolving in them.

Suitable Object for Study of "Direct" Nuclear Division.*—Prof. H. Hoyer found the pulmonary sacs of two frogs full of a large number of specimens of *Rhabdonema nigrovenosum* which he preserved in strong alcohol; several specimens were afterwards stained in an alcoholic solution of borax-carmine for 24 hours, then extracted in strong alcohol to which 1 per cent. hydrochloric acid had been added, for one hour; they were next placed in glacial acetic acid for a quarter of an hour, then in a mixture of equal parts of glacial acetic and creosote, and afterwards in pure creosote; they were then teased and the particles mounted in a concentrated solution of Canada balsam in creosote. The large, polygonal, very granular, but only feebly stained epithelial cells of the enteric canal were seen to show some very remarkable appearances. Most of them contained a single large, rounded, sharply limited, darkly granulated nucleus, ·0014–·025 mm. in size, These nuclei were coloured intensely red, and each contained a very deeply stained, large, round nucleolus which was inclosed by an uncoloured, relatively broad, clear area; this last is probably an artificial product due to preservation in alcohol. Various cells of different kinds were found among those just described, and some of these had three to four nuclei of various sizes.

γ. General.

Biological Terminology.† —Prof. T. J. Parker accepts Mr. Harvey Gibson's criticism of his term blastobium for asexual generations, and proposes to replace it by agamobium, which will correspond with gamobium, Prof. Parker's already proposed term for sexual generations. Prof. Parker thinks that we must be thorough in our reforms and must give up the erroneous use by botanists of the term ovary; he proposes to speak of it as the venter of the pistil. Just as Haeckel and others have suggested some useful terms for the more important embryonic stages of animals, so Prof. Parker suggests some for similar stages in plants. The stage in mosses and vascular plants next important after the oosperm-stage is that in which the embryo consists of a mass of cells nearly or quite undifferentiated; to this the already formed name of polyplast may be applied. In vascular plants there is another stage of importance—that in which there is formation of a cotyledon and of the primary roots; this it is proposed to call the *phyllula*.

Anabiosis.‡—Prof. W. Preyer has for the last twenty-five years interested himself in anabiosis—the revival of lifeless organisms and parts of organisms, after a state which differs from apparent death in the total suspension of all the functions, and from death itself in the retention of

* Anat. Anzeig., v. (1890) pp. 26–9.
† Nature, xliii. (1890) pp. 141–2.
‡ Biol. Centralbl., xi. (1891) pp. 1–5.

the potency of living. He recalls some of his experiments with frozen frogs, in which the circulation and other vital movements cease, but which revive when thawed, provided the internal temperature has not gone below a minimum of $-2 \cdot 5^\circ$ C. The same is true of the excised heart. Prof. Preyer also relates some of his observations on the revival of desiccated rotifers and Tardigrades, and maintains that there is no *vita minima* in such cases, but a genuine lifelessness, from which the organism may recover.

Chlorophyll in the Animal Kingdom.*—M. E. Penard discusses some of the reputed cases of the presence of chlorophyll in animals, and comes to the conclusion that, in the actual state of our knowledge, we cannot consider chlorophyll as ever being a direct product of animal protoplasm. He does not deny that, in some of the Flagellata, chlorophyll exists in chromatophores of endogenous origin, but such forms present other characters which are vegetable and not animal in character.

Origin of the Liver.†—Dr. T. W. Shore has been led by his investigations to the now recognized view that the "liver" of invertebrates is not morphologically the same as that of vertebrates. It is the gland of the mid-gut, and when present, has essentially the same nature in all; it is composed of cæcal pouches, which are lined by secreting epithelium and surrounded by connective-tissue membranes. The liver of vertebrates is made up of a network of tubules, interlacing with a network of blood-capillaries and with no basement membrane separating the blood-capillaries from the liver-cells.

The "liver" of invertebrates is essentially a gland, secreting a digestive fluid containing ferments; that of vertebrates is primarily an organ of nutrition for the embryo, and has been adapted to perform similar functions in the adult; in its evolution it is intimately associated with the absorption of the food-yolk of the egg. The pancreas of vertebrates is somewhat similar in structure and functions to the "mid-gut gland" of invertebrates, but we cannot certainly say whether or not the two organs are morphologically equivalent.

Fauna of Amber.‡—Herr R. Klebs has had the opportunity of examining several hundred thousand pieces of amber. In it, as is well known, various animals, largely insects, became entangled as the amber solidified. The order most numerously represented is that of the Diptera, and of some of the genera of these there are numerous species—*Chironomus* being represented by at least forty, and *Ceratopogon* by twenty-six. All the groups of Hymenoptera except the Braconidæ and Craniidæ are represented, and forty-nine of the seventy-five families of Coleoptera. Of the Orthoptera the Blattidæ are the most numerous. *Campodea* has not been certainly detected. Termites are numerous, and there are about one thousand specimens of Microlepidoptera.

The larger number of Arachnids imbedded were various forms of Spiders, but there are also many Mites. Only one true Scorpion has been found. As may be supposed, the bulk of the Crustacea are Isopods.

* Arch. Sci. Phys. et Nat., xxiv. (1890) pp. 638–48.
† Journ. of Anat. and Physiol., xxv. (1891) pp. 166–97 (1 pl.).
‡ Biol. Centralbl., x. (1890) pp. 444–8. See Ann. and Mag. Nat. Hist., vi. (1890) pp. 486–91.

Nematoid worms were rarely found. Only twelve specimens of Mollusca are recorded, and parts of Vertebrates—such as feathers or hair—are very rare. The nearest allies of the amber fauna are, to-day, found in North America and Eastern Asia.

B. INVERTEBRATA.

Notices of Entozoa.*—Prof. J. Leidy draws attention to the discovery in *Simia satyrus* (the Orang) of *Ascaris lumbricoides* and *Trichocephalus dispar*, which are common parasites of Man. With them were found examples which are provisionally placed in the genus *Filaria* and called *F.* (?) *primana* sp. n. *Ascaris diacis* from the body-cavity of *Quiscalus quiscala* and *Atractis* (*Ascaris*) *opeatura* from the Iguanid *Cyclura baelopha* are new. About a pint measure of *Trichocephalus affinis* was taken from the large intestine of the Bactrian Camel. Several dozen of *Cheilospirura uncinipenis* were found in the gizzard of *Rhea americana*. *Trichosomum* ? *tenuissimum* sp. n. was found imbedded in the liver of a mature Brown Rat. A dozen females of *Echinorhynchus pellucidus* were found attached to the lining membrane of the intestine of a whale, *Mesoplodon sowerbiensis*; *E. paucihamatus* sp. n. was frequent and abundant in the small intestine of the Black Bass (*Micropterus nigricans*). Five new species of *Distomum* are recorded, as are two new Cestodes. *Pentastomum proboscideum* is reported from *Coluber constrictor* and the Skunk (*Mephitis mephitica*).

Mollusca.

α. Cephalopoda.

Development of Chromatophores of Octopod Cephalopoda.†—M. L. Joubin has been able to study the development of the chromatophores in the Argonaut and the Octopus. In the embryo of the former the skin is composed of an ectodermal epithelium, which covers a loose mesodermal connective tissue. In the dorsal interocular region one may best see scattered ectodermal cells becoming longer than those around them; they then gradually sink into a kind of funnel-shaped depression, taking with them the neighbouring cells. The large cell is destined to form the essential part of the chromatophore; as it becomes very large its protoplasmic contents are divided into two layers. This cell is, later, only attached by a narrow surface to the invaginated ectodermal cells, and finally becomes free; later on it loses its spherical form and becomes a biconvex lens.

Meantime, changes have been going on in the mesodermal cells; below the invagination they are disposed by five or six, in a circle, but they soon increase to twenty and form a larger circle; in form they are ovoid and elongated. The edge of the ectodermal cell then comes into contact with this crown of ovoid cells and the chromatophore is formed. The accessory mesodermal parts at first resemble muscular fibres, but later on become connective. The nerve-endings in each chromatophore can be shown in a living animal by a special preparation of methylene-blue. The cutaneous nervous plexus with each fibre ending in a slight swelling can then also be seen.

* Proc. Acad. Nat. Sci. Philadelphia, 1890, pp. 410–8.
† Comptes Rendus, cxii. (1891) pp. 58–60.

γ. Gastropoda.

Origin and Development of Central Nervous System in Limax maximus.*—Miss Annie P. Henchman, who has made a study of this subject, has arrived at the following conclusions. The whole of the central nervous system arises directly from the ectoderm. The cerebral ganglia partly arise as a pair of true invaginations, one on each side of the body in front of the pleural groove and behind and below the bases of the ocular tentacles. During development the neck of each invagination becomes a long, narrow, tube-like structure, which remains open throughout the period of embryonic life. The chief part of these ganglia is formed from cells which are detached at an early period from the deep ends of their cerebral invaginations, or from adjacent ectoderm; the portions which persist as the walls of the infoldings finally form distinct lateral lobes of the brain.

All the other ganglia originate by cell-proliferation from the ectoderm without invagination. The ganglia arise separately, and with the exception of the abdominal and pallial ganglia, in pairs, one on either side of the body. They become connected with each other by the outgrowth of nerve-fibres.

In advanced stages the central nervous system consists of five pairs of ganglia and an azygous ganglion, which together form three complete rings surrounding the œsophagus.

If a series of sections be examined from behind forwards there are first seen the paired pedal ganglia, which lie under the radular sac, and are joined to each other by an anterior and a posterior commissure. Behind these there is an abdominal ganglion, which lies a little to the right of the median plane. A pair of visceral ganglia occupies the posterior angle formed by the outgrowth of the radular sac from the œsophagus; they are separated by the abdominal ganglion, whence connectives pass to them. There then follows a pair of pleural ganglia which are not joined by a commissure, and do not give off nerves; they are only united by means of connectives to the pedal, visceral, and cerebral ganglia of their own sides. Next in front comes a pair of cerebral ganglia with their supra-œsophageal commissure, and with connectives to the pleural, pedal, and buccal ganglia. And, lastly, there is a pair of buccal ganglia.

The paper concludes with a critical notice of the work of preceding observers.

Pericardial Gland of Gastropoda.†—Prof. C. Grobben gives an account of the pericardial gland, which is found in so many Gastropods; it is derived from the epithelium of the secondary body-cavity, and is closely connected with the blood-vascular systems. After describing the anatomical details of the organ in various Gastropods belonging to different groups, the author points out that the relations of the organ to the blood-vascular system are very similar to those which obtain in Cephalopods and Lamellibranchs; but the epithelial cells are nearly always flat, and no striation or formation of concretions is to be observed. Although, therefore, there is no evidence from the structure

* Bull. Mus. Comp. Zool., xx. (1890) pp. 169–208 (10 pls.).
† Arbeit. Zool. Inst. Wien, ix. (1890) pp. 35–56 (1 pl.).

of the pericardial cells that the organ in question has an excretory function, the author does not doubt that the cells are excretory. The flattened form is well adapted to the outpouring of fluid, and the student need only be reminded that there is pavement epithelium in the Malpighian bodies of the Vertebrate kidney.

Another argument in support of this view is afforded by the fact that the gland is best developed in the Opisthobranchiata. These forms have generally a very large ciliated renal funnel, the colossal cilia of which are capable of producing a powerful stream, and so must effect great suction on the pericardial fluid. As no concretions are to be observed in the cells, and as they do not stain when carmine is injected, it is probable that water alone is excreted by these glands.

When we come to consider the morphology of the pericardial gland of the Mollusca, we observe that the organ is not always developed in the same place or in the same way. In Lamellibranchs the glands may take their origin from the pericardial investment of the auricle, and in others from the anterior angle of the pericardium. Among the Gastropoda the organ is borne by the auricle in the Prosobranchiata, while in the Opisthobranchiata there are very various spots at which the organ may be developed, and the same is the case also with Cephalopods.

For Gastropods, as for Lamellibranchs, the oldest pericardial glands appear to be the atrial, and such are seen in the Prosobranchiata. The variety of positions occupied by the gland in Opisthobranchs is probably due to independent acquirement of these new positions, and such glands should be recognized as secondary.

Everything seems to show that the pericardial gland is an important organ in Mollusca. The extent of its development may stand in inverse relation to that of the cœlom, and it may have some relation to the quantity of water needed by the animal.

Vision of Pulmonate Gastropods.*—M. V. Willem has made a number of observations on the vision of snails, slugs, and other pulmonates, which has led him to the following conclusions:—They have a well-developed tactile sense, and are able to detect slight shocks of the ground on which they are supported, and slight movements of the surrounding medium. The terrestrial forms see very badly, and direct themselves chiefly by means of their olfactory and tactile sensations. They have a confused image of large objects at the distance of about a centimetre, but they do not distinguish at all clearly the forms of objects beyond a distance of one or two millimetres. The aquatic Pulmonata do not see distinctly at any distance whatever. The Mollusca do not seem to have that special power of seeing movements which has been demonstrated in Arthropods. The reaction to light varies, different species of snails and slugs being some fond of, and others fearful of light. The dermatoptic powers vary in various species.

δ. Lamellibranchiata.

Crystalline Style.†—Prof. F. E. Schulze does not believe that this consists of reserve-material, as Hazay and Hasloff have maintained. In fact, histological examination shows that it is an epithelial secretion,

* Comptes Rendus, cxii. (1891) pp. 247-8.
† SB. Gesell. Naturf. Freunde, 1890, pp. 42-3.

and the suggestion of Barrois that it serves, along with the gelatinous layer in the stomach, to protect the walls of the gut by surrounding sharp particles with mucus, is accepted by Schulze as most probable. He compares its functions to that of the epithelial glands which lie near the internal apertures of the gill-clefts in Batrachian larvæ.

Renal Function of Acephalous Mollusca.*—M. A. Letellier has investigated the renal function in *Pecten* and *Cardium*. He finds that the organ of Bojanus gets rid of excess of water, urea, and various neutral nitrogenous bodies and phosphates, as well as, accidentally, uric acid. The organ of Keber (gland of Grobben) extracts from the blood the acid it contains; in both the forms studied the acid was hippuric acid.

Hermaphrodite Lamellibranchs.†—Prof. P. Pelseneer has continued ‡ his studies on the hermaphroditism of certain Lamellibranchs, and now asserts the existence of an entire group exhibiting hermaphroditism. Since describing *Lyonsiella* and *Poromya* he has made investigations as to *Thracia*, *Lyonsia*, *Clavagella*, *Myochama*, and *Cuspidaria*; and he now states that no form of the Anatinacea or Septibranchiata yet studied has been shown to have the sexes separate. We may conclude that they are hermaphrodite, but the male and female gonads separate—an arrangement not known in any other Mollusc. This disposition of parts does not certainly indicate a condition once common to the whole class, as Gegenbaur believes, for all the hermaphrodite Lamellibranchiata are specialized, while the most archaic forms (the Protobranchiata) are not only diœcious, but have never presented an example of such partial hermaphroditism as may be sometimes seen in the Frog or the Herring.

Otocysts of Nuculidæ.§—Prof. P. Pelseneer shows that the Lamellibranchiate Nuculidæ have, at all ages, otocysts which communicate freely with the exterior, and they are the only known Mollusca in which this arrangement is found. The possession of this archaic character confirms the opinion several times expressed by the author that the Nuculidæ are the most primitive of existing Lamellibranchs. In addition to the evidence afforded by the gills, the nervous system and the renal and generative organs, there are other points which Dr. Pelseneer promises to communicate later on.

Molluscoida.

α. Tunicata.

Embryonic Development of Pyrosoma.‖—Prof. W. Salensky states that the egg of *Pyrosoma* is meroblastic. Before fertilization a certain number of cells make their way out from the follicular epithelium; these may be known as calymmocytes. During segmentation the calymmocytes make their way in between the blastomeres and take part in the formation of the body of the embryo; they undergo a considerable change in their protoplasm and nuclei. The differentiation of the germinal layer commences with the division of the segmented germ into an

* Comptes Rendus, cxii. (1891) pp. 56–8.
† Zool. Anzeig., xiv. (1891) pp. 5–8. ‡ See this Journal, 1890, p. 448.
§ Zool. Jahrb. (Abth. f. Anat. u. Ontog.), iv. (1890) pp. 501–4.
‖ T. c., pp. 425–77 (3 pls.).

upper and lower layer; the former gives rise to the ectoderm, and the latter to the mesoendoderm. In the latter, before further differentiation, there appear three series of cavities—those of the cœlom and of the notochord.

The ectoderm gives rise to the nerve-ganglion, which is a thickening, and to the two peribranchial tubes, which are invaginations of the ectoderm. These tubes become, in the course of development, separated from the ectoderm, grow forwards as well as backwards, and do not till later become connected with the independently formed cloacal orifice. Of the two mesodermal tubes, which are at first equally developed, the right alone continues to grow, and becomes the pericardial sac. The left tube breaks up into cells, which either remain separate or (possibly) take part in the formation of the cellular zone which surrounds the germinal disc.

Sense-organ of Salpa.*—Mr. A. Bolles Lee gives an independent account of an organ imperfectly figured and described in Russian by Ussow in 1876. In *Salpa mucronata* there are two of these organs; they are end-organs of a recurrent twig of the third nerve, and are symmetrically placed on either side. In a living specimen the organ may be seen to consist of a stem terminating in a bulb, which is surmounted by a delicate hyaline claviform appendage. The stem is a cellular tube formed by a process of the inner mantle.

In good preparations the bulb may be seen to be composed of a central tuft of sense-cells and a surrounding calyx of supporting cells; the latter varies a good deal in form. The minute details of structure are described, and the author sees much that is plausible in the view that the organ is either a taste-bulb or was one once. But on the other hand, a little reflection shows that while the *Salpa* has in its cellulose mantle a highly watery and highly hygrometric jelly, it has in this organ one whose shape must be affected by change in the density of the circumambient water; these changes would pull on or relax the sensory hairs of the organ, and it, probably, is a hydrometric apparatus.

β. Bryozoa.

Cristatella.†—Mr. C. B. Davenport has investigated the origin and development of the individual in this colonial Bryozoon. He finds that most individuals give rise to two buds, one of which forms a new branch, while the other continues the ancestral branch. The median buds migrate to a considerable distance from the parent polypide before giving rise to new buds. Descendants from common ancestors, equal in age, are arranged similarly in the same region of the colony. New branches are formed on either side of ancestral branches.

The greater the difference in age between the youngest and the next older bud, the greater the distance between the points at which they begin to develope. In typical "double buds" both polypides arise from a common mass of cells at the same time. From the neck of old polypides a stolon-like process of cells is given off to form median buds.

The alimentary tract is formed by two evaginations of the bud, and

* Quart. Journ. Micr. Sci., xxxii. (1891) pp. 89–97 (1 pl.).
† Bull. Mus. Comp. Zool., xx. (1890) pp. 101–52 (10 pls.).

while one forms the œsophagus, the other gives rise to the stomach and rectum. On the fusion of the blind ends of these two pockets a continuous tube is formed. The central nervous system arises as a shallow pit in the floor of the atrium; this pit becomes closed over by a fold of the inner layer only of the polypide, which thus forms a sac, the walls of which become the ganglion. The kamptoderm (Kraepelin), or funicular sheath of Allman and Nitsche, is formed by the conversion of the columnar epithelium of the two layers of the wall of the atrium into pavement epithelium. The funiculus arises from amœboid cells derived from the cœlomic epithelium. The wall of the colony grows by cell-proliferation at its margin.

The budding of *Cristatella* presents conditions transitional between direct and stoloniferous budding; this genus differs from *Alcyonella* in that the tip of the branch grows independently of the polypides. Each of the layers of the younger bud arises from a part of the same cell mass as that which gave rise to the corresponding layer of the next older bud. The digestive epithelium and the nervous tissue are both derived from one and the same layer of cells, the inner layer of the bud. The alimentary tract of a young *Cristatella* is similar to that of a young endoproctous Bryozoon. The author does not agree with Harmer in saying that the ganglion of the Phylactolœmata arises exactly as in the Endoprocta.

The circumoral region of the ring canal of *Cristatella* is in free communication with the cœnocœl in all stages of development, and is not, as Kraepelin maintains, closed. The two arms of the lophophore arise independently of each other. The ancestral Bryozoon probably possessed a U-shaped row of tentacles which encircled the mouth in front, and ended freely behind. The tentacles near the mouth are, phylogenetically, the oldest. The epistome arises as a fold continuous with the wall of the œsophagus below and the floor of the atrium above, and it communicates with the cœnocœl by means of the epistomial canal. The migration of the funiculus is probably assisted by amœboid cells. The origins of the retractor and rotator muscles migrate along the radial partitions from roof to sole; the separation of the two muscles is secondary and due to the separation of their points of insertion. The disintegration of the neck of the polypide is begun by a metamorphosis of the protoplasm of its cells; the metamorphosed cells break away and leave the atrial opening. That part of the body which lies round the atrial opening arises by proliferation of cells derived from the neck of the polypide. The ectodermal cells become metamorphosed by an intercellular secretion of small gelatinous balls which fuse; the contents of more than one cell often fuse into a single large mass.

Arthropoda.

α. Insecta.

Ontogeny of Insects.*—Dr. E. Urech has made a physical and chemical analysis of the urine of a large number of species of Butterflies, and has discovered a close relation between its pigments and those which colour the wings of Lepidoptera in general. The first urine is alone

* Arch. Sci. Phys. et Nat, xxiv. (1890) p. 526.

pigmented and the fluid emitted subsequently is entirely colourless. *Pieris brassicæ* has a white, and *Vanessa urticæ* an intensely red pigment. As the blue and violet of Butterflies are colours produced by interference, there is nothing astonishing in the fact that these colours are not seen in the urine. The colour of insects about to leave the chrysalis stage is not the same in all; it is most often yellow of varying degrees of intensity; in many species of *Bombyx* it is pale, but of a deep hue in *Vanessa*. The blood of *Deilephila euphorbia* is coloured an intense olive-green, and that of *Cossus ligniperda* is pale yellow.

Life-history of Emenadia.*—M. A. Chobaut has been able to follow the life-history of *Emenadia flabellata*. The eggs are laid in the soil in mid-July, and are hatched during the first days of August, when the nest of the solitary wasp *Odynerus* is being provisioned. The minute larva climbs into such a nest, establishes itself in a cell, and becomes eventually an internal parasite in the young wasp. Not till the beginning of June in the following year does it appear again on the surface as an external parasite. It soon makes an end of its victim, pupates in mid-June, and is ready to pair early in July. The primary larva, which seeks actively for a host, has legs, antennæ, and cuirass-like armature. The second form of larva, which possesses and devours its host, has no legs, nor antennæ, nor protective plates. The species of *Emenadia* are parasitic on solitary wasps (*Odynerus*, *Eumenes*, &c.) much in the same way as *Rhipiphorus paradoxus* is on certain social wasps (*Vespa germanica* and *V. vulgaris*). In their larval dimorphism and temporary or persistent endoparasitism, the Rhipiphoridæ connect the vesicant beetles with the *Strepsiptera* or *Stylopidæ*.

Function of the Antennæ in Myrmedonia.†—Herr E. Wasmann has experimented with various species of *Myrmedonia*, small beetles which insinuate themselves as unwelcome guests of the ant *Lasius fuliginosus*. The latter, though soft-skinned and slow, and thus liable to be preyed upon by the beetles, who eat both adults and brood, hunts the robbers with persistence. Wasmann's experiments lead him to believe that the antennæ of *Myrmedonia* are not so important in seeking for food as in detecting hostilely excited ants. The detection of food at a distance is probably in greater part at least due to the palps, but these are too small to extirpate for crucial experiment. Those without feelers have a better appetite, probably because they are no longer troubled by apprehensions of approaching ants.

The Spermatozoa of Coleoptera.‡—Dr. E. Ballowitz continues his study of the minute structure of spermatozoa. In previous papers, some of which have been recorded in this Journal, he has shown that the contractile part of the spermatozoa of mammals, birds, reptiles, amphibians, and fishes, and notably the so-called "undulatory-membrane" or fringe accompanying the axial filament of the tail—consists of or contains very fine fibrils to which the contractility is probably due. Prof. V. Graber §

* Comptes Rendus, cxii. (1891) pp. 350–3.
† Biol. Centralbl., xi. (1891) pp. 23–6.
‡ Zeitschr. f. Wiss. Zool., l. (1890) pp. 317–407 (4 pls.).
§ Biol. Centralbl., x. (1891) pp. 721–31.

gives a summary of all these researches, and in the present paper Ballowitz extends his observations to Coleoptera.

In beetles there are two main types of spermatozoa, connected, however, by intermediate forms. There is a double-tailed type already described by Bütschli and v. la Valette St. George, and there are others which are single-tailed. Bütschli showed that in the double spermatozoon, one tail filament is straight and stiff, the other is undulating and contractile. Ballowitz describes this type in *Hylobius, Chrysomela, Calathrus*, &c., and shows that the straight or supporting portion of the tail is elastic, but somewhat stiff, resistant to reagents and without any fibrillar structure, while the contractile fringe consists of an extremely complicated system of fibrils. The single-tailed type of spermatozoon, as seen e. g. in *Melolontha* and *Hydrophilus*, has no supporting fibres. The tail is twisted in a spiral, corresponds to the contractile fringe of the double type, and exhibits a complicated fibrillar structure. There is no need to attempt explaining how these spermatozoa, carefully macerated, &c., divide into peripheral, median, and fringing fibres, and these again into fibrils, for the details are unintelligible without the figures. The main point is the further demonstration of fibrillation in eminently contractile structure. Very interesting are Ballowitz's descriptions of the movements of the spermatozoa, e.g. how the fringed type works its way like the screw of a steamer. Raising the temperature of the medium from 20°–30° C. quickens movement; the optimum is from 30°–35° C.; above this towards 40° C. the power of movement is lost. Strong movements, especially in warmth, tend to produce a fibrous disruption of the spermatozoon. It is even observed that one of the contractile fibres of a complex spermatozoon may move independently of the others.

Parthenogenesis of Ants induced by heightened temperature.*— Herr E. Wasmann was able during three successive winters to induce parthenogenesis in the workers of *Formica sanguinea* and their helpers *F. fusca*, by artificially warming the nests. On one day as many as twelve workers of *F. sanguinea* were seen laying eggs. Most of them were large workers, but small forms were also affected, and the smaller the ant the more tedious was the egg-laying. Sometimes, however, they got obstetric assistance from others. Of the many hundreds of eggs thus laid none attained full development; as eggs or as larvæ all were devoured by the ants. It remains to corroborate these important physiological experiments by histological examination of the ovaries to see how their development is affected.

Can Ants hear?†—Herr E. Wasmann relates an interesting fact which he observed in studying a small colony of *Formica rufa*. The upper glass plate of a formicarium like that of Lubbock's had been cracked and mended with sealing-wax. When the dry sealing-wax was scratched with a needle, the ants suddenly raised their antennæ, moved rapidly, and sought to inspect the glass plate. They did so often, but paid little heed if the wax was rubbed with some smooth object which did not produce the small shrill sound caused by the needle. As Forel does not believe that ants hear, and as Lubbock's opinion that they do is based

* Biol. Centralbl., xi. (1891) pp. 21–3.

† T. c., pp. 26–7.

on the anatomical discovery of probable sound-producing and sound-perceiving structures, Wasmann is naturally very cautious as to the conclusiveness of his own observation.

Development of Chironomus.*—Herr R. Ritter has reinvestigated the development of the reproductive organs, and has shown by means of sections that they arise from previously extruded "pole-cells" as Metschnikoff suggested, and as Balbiani carefully described. But as Balbiani did not make sections of the embryos, Ritter's corroboration is of much value, for he has followed the "pole-cells" from their appearance at the posterior pole of the ovum before the blastoderm is formed, through their stages of division and subsequent insinking, to their establishment as reproductive organs. By his sections Ritter has also confirmed what Weismann described in regard to the invagination of the hind-gut, while he agrees with Graber in referring the wall of the mid-gut to two lateral strands which arise from the union of segmentally disposed endoderm. His results are antagonistic to Völtzkow's, according to which the wall of the mid-gut arose by proliferation from fore and hind-gut.

After patient watching, Ritter was able to observe the nocturnal egg-laying. The insects after much hesitation lighted on the sides of the aquarium a little above the level of the water. A chain of eggs connected by gelatinous material is extruded on to the water; the jelly swells, and the chain floats. When the process is finished (in about five minutes), the insect moors the floating eggs by glueing the proximal end of the chain, and flies away. The author gives some interesting illustrations of the insect's marked preference for localities where the eggs are least likely to be frozen.

Histology of the Gut in the Larva of Ptychoptera contaminata.†—Prof. A. van Gehuchten has studied the histology of the gut in this Dipterous larva. In the œsophageal valve there is a remarkable vascular cavity between the proventricular epithelium and the muscular tunic. It is traversed by a muscular and elastic network with blood in the meshes. The lamellæ and fibrils of the network consist solely of plasmic reticulum without any enchylema. In this fact the author finds support for his theory of the structure of muscle, which he discusses at some length. The protective marginal portion (or "plateau") of the secreting cells is described very carefully; it is produced by a differentiation of the plasmic framework, and exhibits much complexity and variety. Like the nucleus it is passive during secretion.

Mechanism of Secretion in Larva of Ptychoptera contaminata.‡—Prof. A. van Gehuchten finds that the glandular epithelial cells of the mesenteron of the larva of this dipterous insect are well adapted for the study of the mechanism of secretion. The cells are provided with a protective cuticle which prevents external lesions. The products to be eliminated are formed in the body of the cell in consequence of the special activity of the cell; the elaborated products raise the covering

* Zeitschr. f. Wiss. Zool., l. (1890) pp. 408–27 (1 pl.).
† La Cellule, vi. (1890) pp. 185–289 (6 pls.).
‡ Anat. Anzeiger, vi. (1891) pp. 12–25 (7 figs.).

membrane and project into the intestinal cavity. These projecting vesicles then become free, either by constriction at their base or by the formation of a new membrane at the edge of the cytoplasm. This fall of vesicles gorged with the products of secretion into the intestinal cavity constitutes the excretion. The cell may then return to a condition of repose or commence a new secretion. An epithelial cell can go through the work of secretion and excretion several times without destruction. The cell is destroyed on the loss of its nucleus. Destroyed cells are replaced by fresh cells which are always to be found at the base of the secreting cell. The nucleus does not take any active part in the phenomenon.

Odoriferous Glands of Earwigs.*—Dr. J. Vosseler describes in *Forficula* and *Chelidura* the odoriferous glands which lie under the two pairs of lateral folds on the second and third abdominal segments. Each consists of a retort-like vesicle, containing a yellowish or brownish emulsion which can be ejected by a muscular action to a distance of 5–10 cm. and is well known to have an odour like carbolic acid and creosote. The emulsion is secreted by large cells which resemble, as Leydig suggested, the nematocysts of Cœlenterates. The secretion occupies the greater part of the cell, the nucleus is displaced to the side, a long chitinous tubule corresponds to the cnidocil. When the emulsion is ejected, the entire vesicle is compressed by external musculature, and the external aperture is opened by the *contraction* of a special muscle which is normally relaxed. The secretion is doubtless offensive, but it probably serves also as a useful varnish.

Stridulating Organ of Cystocœlia immaculata.†—Mr. R. T. Lewis gives a description of the sound-producing apparatus of this grasshopper. On each side of the third segment of the abdomen there is a yellow line about 5 mm. long which consists of a curved tube closed by a delicate operculum; arching over this tube is a graduated series of eight semicircular teeth. The counterpart is to be found on the inner surface of the femur of the hind leg, where there is a bow of fine teeth.

β. Myriopoda.

Hungarian Myriopoda.‡—Dr. E. Daday de Deés has written a monograph on the Myriopoda of Hungary. After a general account of the study of Myriopods, their structure, life, distribution, and classification, he proceeds to the diagnosis of genera and species classified as Diplopoda, Pauropoda, Chilopoda, and Symphyla. Three new species of *Julus*, four of *Polydesmus*, three of *Brachydesmus*, four of *Lithobius* are described among the rest.

Marine Myriopoda and Resistance of Air-breathing Arthropods to Immersion.§—Prof. F. Plateau calls attention to the two marine Myriopods found on the shores of Europe which are submerged at each

* Arch. f. Mikr. Anat., xxxvi. (1890) pp. 565–78 (1 pl.).
† Journ. Quek. Micr. Club, iv. (1891) pp. 243–5 (1 pl.).
‡ 'Myriopoda Regni Hungariæ' (in Hungarian), Budapest, 1889, 128 pp. and 3 pls.
§ Arch. Sci. Phys. et Nat., xxv. (1891) pp. 132–4.

tide; these are *Geophilus* (*Scotioplanes*) *maritimus* and *G.* (*Schendyla*) *submarinus*. There is nothing extraordinary in this resistance, for essentially terrestrial *Geophili* can exist in sea-water from twelve to seventy hours, and in fresh water from six to ten days. Forty-six genera and nearly eighty species of Arthropods are known to frequent the shores and to allow themselves to be submerged, though they breathe air. This resistance is not due to any special structure but to the general property of abranchiate Arthropods of being able to resist asphyxia for a long time. Swimming insects, such as the Dysticina which take with them a layer of air, resist submersion for a shorter time than insects which are exclusively terrestrial; this appears to be due to the greater activity of swimming insects in water and to the consequent using up of the oxygen possessed by them.

δ. Arachnida.

New Genus of Leaping Acari.*—M. Topsent and Dr. Trouessart describe a new form of leaping Acari which they call *Nanorchestes amphibius*; it was found on the shore at Calvados. The animal leaps so actively that the only way to catch it is to have pincers dipped in oil or glycerin. At first sight, nothing in the structure of the animal indicates the extreme agility of which it is possessed. The very sharp distinction between the abdomen and the cephalothorax, the presence of a single hook at the extremities of the legs, and other characters distinguish this form from any of the Eupodinæ, in which sub-family it may be placed. The form of the legs does not offer any explanation of the mechanism of leaping, for the hinder legs are no different from the others. It is probable that the animal folds its four pairs of legs under it and springs by suddenly separating them; the form of the tarsus would support this explanation.

Pycnogonidea of Norwegian North Sea Expedition.†—Prof. G. O. Sars gives detailed descriptions and drawings of all the species collected by the Norwegian North Sea Expedition, the material for which was very copious. This, with other specimens at his disposal, has enabled the author to acquire a good general view of the Pycnogonidian fauna of the Northern and Arctic Seas. The large number of species of Nymphonidæ is found to be eminently characteristic of the Northern Seas as contrasted with the Mediterranean, and the northern forms are also as a rule much larger; some are even gigantic.

Owing to the present unsatisfactory condition of the terminology employed for the various parts of a Pycnogonid, the author has a number of changes to propose, which are explained by a diagrammatic figure. Great care has obviously been taken with the determination of the species, and those now given as new, of which there are eleven, have already been noticed in brief preliminary descriptions.

The general systematic classification of the group is in an unsatisfactory condition, for now that it is recognized that the Pycnogonidea are neither Crustacea nor Arachnids, it is necessary to try and group the

* Comptes Rendus, cxi. (1890) pp. 891–2.

† 'Den Norske Nordhavs-Expedition 1876–78. XX. Pycnogoniden,' by G. O. Sars. Christiania, 1891, 163 pp., 15 pls. and 1 map.

families in larger divisions; Prof. Sars recognizes eight or nine families. In regarding the interrelations of these he has made use of the chelifori. In one group they are entirely wanting, except in the larva; in a second group they are always well developed, and in the third they are present in young post-larval stages, but afterwards disappear more or less completely. The following classification is proposed:—

Order I. ACHELATA.

Fam. 1. Pycnogonidæ. Gen. 1. *Pycnogonum.*
„ 2. Phoxichilidæ. Gen. 2. *Phoxichilus.*

Order II. EUCHELATA.

„ 1. Phoxichilidiidæ. Gen. 1. *Phoxichilidium.* Gen. 2. *Anoplodactylus.*
„ 2. Pallenidæ. Gen. 3. *Pallene*, Gen. 4. *Pseudopallene*, Gen. 5. *Cordylochele.*
„ 3. Nymphonidæ. Gen. 6. *Nymphon*, Gen. 7. *Chætonymphon*, Gen. 8. *Boreonymphon.*

Order III. CRYPTOCHELATA.

Fam. 1. Ammotheidæ. Gen. 1. *Ammothea.*
„ 2. Eurycydidæ. Gen. 2. *Eurycyde*, Gen. 3. *Ascorhynchus.*
„ 3. Pasithoidæ. Gen. 4. *Colossendeis.*

ε. Crustacea.

Eyes in Blind Crayfishes.*—Mr. G. H. Parker has examined the eyes of *Cambarus setosus*, a blind crayfish from caves in Missouri, and has compared them with those of *C. pellucidus* from the Mammoth Cave. He finds that both species still have the optic ganglion and nerve; the latter ends in the hypodermis of the retinal region, but the mode of its termination has not yet been discovered. In *C. setosus* the retinal region is represented only by undifferentiated hypodermis, composed of somewhat crowded cells, but in *C. pellucidus* there is a lenticular thickening, in which there are multinuclear granulated bodies; these appear to be degenerated clusters of cone-cells. The author confirms the results of Leydig, so far as they go, but is led to doubt the accuracy of Packard's observations.

Cirolanidæ and other Isopods.†—Herr H. T. Hansen gives an account of the Cirolanidæ, Corallanidæ, and Alcironidæ, and refers briefly to the Barybrotidæ, Ægidæ, and Cymothoidæ. He has studied thirty-four species, of which twenty-four are new. Perhaps the most important part of his memoir is the description of the mouth organs, their forms and movements, and their adaptation to various modes of life, e. g. in connection with incubation in many females. It is on the nature of these organs that he bases his classification, with this advantage among others that the great distinctions can be readily recognized with

* Bull. Mus. Comp. Zool., xx. (1890) pp. 153–62.
† Skrift. K. Danske Vid. Selsk., v. (1890) pp. 239–426 (10 pls.).

the lens. We can give an illustration only of how the classification is worked out:—

Palp of the maxillipedes is free; the margins of the last two joints are more or less setose, never with hooks. The lacinia of the third joint of the first maxilla at least towards the middle is rather broad.	Palp of the maxillipedes surrounds a cone formed from the distal portions of the other mouth-parts; the intero-superior margin and apex are never setose, the apex and sometimes the intero-superior margin at least in the males and young females bear curved hooks. The lacinia of the third joint of the first maxilla is always narrow.
Cirolanidæ, Corallanidæ, Alcironidæ.	Barybrotidæ, Ægidæ, Cymothoidæ.

Oviposition and Fertilization in Asellus aquaticus.*—Herr G. Leichmann finds that Rosenstadt is not right in thinking that the oviposition of the Asellina is exactly similar to that of the Oniscidæ, as described by Schöbl and Friedrich. The ecdysis which takes place immediately after fertilization does not cause the disappearance of the genital orifices: they are merely hidden by the now developed brood-lamellæ. The brood-plates appear very early as short delicate processes at the base of the first four pairs of legs. They do not arise as mere thickenings but are evaginations of the hypodermis, and consequently inclose a cavity which is in free communication with the body-cavity; in the interior of the larger processes the hypodermis becomes converted by numerous foldings into brood-lamellæ. Fertilization is not effected, as Sars supposed, in the brood-space, but in the ovary; before it is effected the middle part of the oviduct swells out into a large receptaculum seminis, into which the sperm-mass is received. After oviposition the oviducts shrink down again to their original form.

Care of Young in Isopoda.†—Herr G. Leichmann makes a contribution to our knowledge of this subject by an account of his observations on *Sphæroma rugicauda;* the transparent embryos are not inclosed in the brood-cavity but in sacculcs with delicate membranes which lie in the interior of the body of the mother.

Dimorphism of male Amphipoda.‡—M. J. Bonnier records some observations on this subject. Some years since Fritz Müller described the dimorphic males of *Orchestia Darwini*, and other cases have since been described; these have been explained by Faxon, who points out that there is no true dimorphism, but rather a succession of forms, one of which is and the other of which is not adapted for copulation.

M. Bonnier has been able to confirm the truth of this explanation by a study of *Orchestia littorea* and *Bathyporeia pilosa.* The presence of matured testes in the non-copulatory form of the former is not a sufficient argument against this explanation, for other Crustacea are known in

* Zool. Anzeig., xiii. (1890) pp. 715–6. † T. c., pp. 688–91.
‡ Comptes Rendus, cxi. (1890) pp. 987–9.

which one or more ecdyses are required after the maturation of the testes before copulation is possible; here one ecdysis is all that is needed. *Bathyporeia pelagica* is the female, and the form described as *B. Robertsoni* is the copulatory male of *B. pilosa*. It follows that the so called dimorphism of male *Amphipoda* is really a case of progenesis as in some other Crustaceans.

Maturation of the Ova of Cyclops.*—Dr. V. Hæcker has studied the ova of various species of *Cyclops*, in order to determine the precise moment at which a reduction of chromatin elements takes place. Differing from Boveri, who refers the reduction to a period in the history of the germinal vesicle antecedent to the expulsion of the polar bodies, Hæcker finds by careful observation that the reduction takes place in the expulsion of the first.

Movements in the Brain of Leptodora.†—Prof. R. Wiedersheim describes a remarkable region in the brain of *Leptodora hyalina*, in which granules and cells and vacuoles appear to be very mobile, changing their form or position while examined. The mobile zone is that with which the main nerves are connected, and must therefore be of great morphological and physiological importance. Instead of being rigid the central nervous substance has the power of active movement, but what this precisely means has yet to be discovered.

Hermaphroditism of Apodidæ.‡—The Rev. H. Bernard has investigated the structure of *Apus cancriformis*, the reproduction of which has been the cause of so much speculation. As is well known, this species is remarkable for the rarity of its males, and Mr. Bernard now shows that it is really hermaphrodite. The discovery commenced with a study of *Lepidurus glacialis*, which was found to be hermaphrodite. *A. cancriformis* and *L. productus* were then investigated, and in both it was found that the sperm-forming centres are scattered here and there among the rich branchings of the segmental diverticula of the genital tube. They occur either at the tips of such branches, where the eggs ordinarily develope, or as slight lateral bulgings of the same. Further details and drawings are promised.

The origin of this secondary hermaphroditism is to be found in the manner of life of these animals, which are always in danger of being cut off from their kind. The males of the Apodidæ seem to be generally smaller than the hermaphrodites, and this is the only point of sexual dimorphism which they exhibit; on the other hand it will be remembered that in the Cirripedia this sexual dimorphism is much more marked.

Development of Ascidicolous Copepoda.§—M. E. Canu remarks that circumstances have led to a remarkable condensation of the embryogeny of these Crustacea. In the Notodelphyidæ the first *Nauplius* has, in addition to the three pairs of characteristic appendages, the indications of two pairs of maxillæ and two pairs of thoracic legs. The endoderm forms a compact cellular mass; on its dorsal surface there are

* Zool. Anzeig., xiii (1890) pp. 551-8 (1 fig.).

† Anat. Anzeig., v. (1890) pp. 673-9 (5 figs.).

‡ Nature, xliii. (1891) pp. 343-4. Jenaische Zeitschr. f. Naturwiss., xxv. (1891) pp. 337-8.

§ Comptes Rendus, cxi. (1890) pp. 919-20.

attached the double muscles which move the naupliar appendages. The embryo undergoes several ecdyses before ceasing to have the form of the typical *Nauplius*. It becomes converted into the *Metanauplius* by the appearance of a rigid seta at the tip of the tegumentary fold which forms the first maxilla. The tripartite eye of the adult and the third thoracic somite, with its pair of appendicular thickenings, now appear. The next stage is the first cyclopoid stage, in which the body consists of six segments and a furca. In the second cyclopoid stage there are seven segments; the embryos swim actively towards light, and their musculature is well developed. In the next stage the young Copepods enter the Tunicate which shelters them. In the Enterocolidæ the metamorphoses are now abbreviated, and the author has not seen the *Metanauplius*-stage.

Dendrogaster, a new form of Ascothoracida.*—Herr N. Knipowitsch describes *Dendrogaster astericola* g. et sp. n., a remarkable Crustacean parasite, previously found by Prof. N. Wagner in *Echinaster sarsii* and by Prof. W. Schimkewitsch in *Solaster papposus*. Knipowitsch discovered it again in the body-cavity of *Echinaster sarsii*, and found it filled with *Cypris*-like-larvæ, which lived for some time in the aquarium. The parasite is about 9 mm. in length, 10–11 mm. in breadth; the colour is orange-red; the shape is that of a double-lobed sac, the right and left halves of which are connected by a bridge, raised like a cone and bearing a dorsal aperture. The organs of the body lie for the most part in this conical region, the rest is a mantle with branched prolongations from the stomach. On the ventral surface lie a pair of four-jointed antennæ with strong hooks, a large oral cone with a strong lip, a pair of maxillæ, and some doubtful rudiments. A roundish region, which bears the opening of the vas deferens on a terminal papilla, corresponds to the abdomen. The gullet is lined by chitin, the stomach is much branched, there is no hind-gut nor anus. Round the gullet lies the nervous system, with supraœsophageal ganglion, subœsophageal ganglion, commissures connecting them, and a reduced rounded ventral chain. Paired testes lie ventrally in the abdomen; the lobed ovary lies in front of and above them. The larvæ were certainly *Cypris*-like, but Knipowitsch found that they differed in several respects from those of Cirripedes. As to the position of this strange animal, he ranks it with *Laura gerardiæ* (Lacaze-Duthiers), *Synagoga mira* (Norman), *Petrarca bathyacthidis* (Fowler), in the group Ascothoracida, as a subdivision of Cirripedia. The geographical distribution of the group is remarkable, for *Laura* occurs in the Mediterranean towards the African coast, *Synagoga* in the Gulf of Naples, *Petrarca* at a depth of 2300 fathoms (lat. 35° 41′ N., long. 157° 42′ E.), and *Dendrogaster* in the White Sea at a depth of a few fathoms.

Monstrilla and the Cymbasomatidæ.†—Mr. I. C. Thompson urges reasons against the view of Mr. G. C. Bourne, that the Cymbasomatidæ should be regarded as a subfamily of the Corycæidæ, and he places their distinctive characters in a clear way before us. He urges that they should be kept distinct, and suggests that the natural position of the family is close to the Artotrogidæ.

* Biol. Centralbl., x. (1891) pp. 707-11 (3 figs.).
† Trans. Biol. Soc. Liverpool, iv. (1890) pp. 115-24 (1 pl.).

Vermes.

a. Annelida.

Origin of Mesoblast-Bands in Annelids.*—Mr. E. B. Wilson has long been seeking to reconcile the observations of those who, following Salensky, have described the mesoblast-bands of Annelids as arising in some cases by direct proliferation from the ventral ectoblast, with those of such as Kowalevsky, who have demonstrated that in some cases the mesoblast first appears in the form of large cells (teloblasts), by the proliferations of which the paired mesoblastic bands arise. He hopes that the study of the early stages of *Nereis limbata* and *N. megalops* will help to clear the way. The eggs of these worms are extraordinarily favourable for investigation, as they are transparent, of comparatively large size, and can be procured in abundance. As in *Lopadorhynchus* and other types, the trochophore seems to consist at first of two layers only. The mesoblast, like the neural foundations and those of the seta-sacs, arises directly from a thickened bilobed ventral plate; that is, it seems to arise from the ectoblast. But closer examination shows that the cells of this ventral plate differ from the remaining cells of the outer layer; they are larger, differently granulated, and, with certain reagents, assume a brownish colour that marks them off very sharply. It is possible, therefore, to trace their origin, and it may be found that the mesoblast is completely segregated in the anterior part of the plate, while the posterior part alone gives rise to ectoblastic structures. Each of the two divisions of the ventral plate may be traced back to a single cell (pro-teloblast) which is obviously homologous to a corresponding cell in the early embryo of *Clepsine*. These two cells the author calls X and Y, and he tells us that from the latter arise the mesoblast-bands, and from the former the neural plates, the seta-sacs and other structures still undetermined. After tracing the fate of each of these cells through several stages, Mr. Wilson proceeds to compare the history with that of *Clepsine* and *Lopadorhynchus*. In *Clepsine* the large posterior macromere first separates off a single micromere (as in *Nereis*), and then divides into two large cells. The upper right-hand cell (neuro-nephroblast of Whitman) has precisely the same relation to the rest of the embryo as the first pro-teloblast of *Nereis*. In *Clepsine* this cell breaks up into eight teloblasts, but in *Nereis* into four only; the succeeding history of each shows, however, that it is practically certain that the first pro-teloblast of *Nereis* is the homologue of the "neuro-nephroblast" of *Clepsine*, while the second pro-teloblast of *Nereis* is the homologue of the common primary mesoblast of *Clepsine*. These two forms agree in all essential points; and they differ only in secondary details—in the ultimate number and arrangement of the teloblasts, and in the temporary position of the products.

Mr. Wilson thinks that the bilobed ventral plate of *Lopadorhynchus* must be regarded as the homologue of the ventral plate of *Nereis*. They differ only in the earlier segregation and differentiation of the mesoblastic material in *Nereis*, which leads to the formation of a pair of transitory telobasts, which, however, form part of the ventral plate.

The author then raises the question whether the secondary mesoblasts

* Journal of Morphology, iv. (1890) pp. 205–19 (6 figs.).

of Annelids can be shown in all cases to arise from a single pair of teloblasts; at any rate, the case of *Nereis* shows that such may be present only in very early stages, and so be easily overlooked. In *Polygordius* it seems to be certain that no teloblasts of any kind are present, even in the youngest stages. On the other hand, the case of *Nereis* shows that it is not safe to assume the absence of teloblasts without following the development, cell by cell, from the very beginning, and that, whenever it is possible to make such a detailed study, we may pretty confidently expect to find teloblasts. In Mr. Wilson's opinion it is not rash to predict that the secondary mesoblast bands even of *Lopadorhynchus* will yet be shown to arise by teloblastic development.

In a footnote the author informs us that, by a study of *Hydroides dianthus*, he has been able to discover that the head-kidney opens posteriorly into the proctodæum. Under a high power the canal can easily be followed from its beginning near the front end of the organ and along its outer dorsal border into the anterolateral part of the proctodæum. This fact serves to remove all doubt as to the homology of the head-kidney of the trochophore with the nephridia of the Rotifera.

Development of the Earthworm.*—Prof. R. S. Bergh gives a critical account of the different conclusions which have been maintained in regard to the differentiation of the germinal layers in *Lumbricus* and other Annelids, and relates his own observations. From the most median of the four rows of cells described by Wilson the nerve-chain is formed, but in its development an epidermic nervous plexus of yet earlier origin takes part. The three lateral rows of cells form the circular musculature, while the longitudinal muscles arise from internal muscle-plates. As to the nephridia, funnel and coil and terminal portion differentiate from a common rudiment which arises in the internal muscle-plates without any help from the epidermis. Nor do the successive nephridia have any connection with one another. Bergh is as strongly opposed as ever to the theory that Annelid nephridia are homologous with the excretory tubules of Platyhelminthes and Rotifers. The last part of Bergh's memoir, which is characteristically critical, is devoted to maintaining that the entire germinal streak of Annelids is a unity fundamentally ectodermic.

Cutaneous and Muscular Systems of Earthworm.†—Dr. P. Cerfontaine has an elaborate paper on the cutaneous and muscular systems of *Lumbricus agricola*. The body-wall is discussed under the heads of (1) cuticle, (2) hypodermis, (3) muscular layers, (4) peritoneal membrane, and in the discussion of the second of these the hypodermis strictly so called is considered separately from the clitellum and parts connected therewith.

It is very probable that the cuticle is merely the result of the transformation of the superficial protoplasm of the hypodermic cells; it is very regular in structure, and it may be supposed that the bundles of the cuticle result from a sort of keratinization of the interfibrillar substance of the protoplasm; the striæ would then be the result of the more or less complete disappearance of the protoplasmic network; this is the more probable, as swellings are often found at the intercrossings

* Zeitschr. f. Wiss. Zool., l. (1890) pp. 469-526 (3 pls.)
† Arch. de Biol., x. (1890) pp. 327-428 (4 pls.).

of the striæ, which are altogether similar to those which are to be seen at the intersections of the filaments of the network. The cuticle can be regenerated when it has been accidentally removed from any part of the body.

The hypodermis is a true cylindrical epithelium formed of three sets of cells—superficial, intermediate, and basal; they inclose a number of unicellular glands, which are of two kinds, varying with the character of the secretion which they pour out on to the surface of the body by means of the small canals which perforate the cuticle. The substance secreted by the glands has certainly the function of stopping evaporation and maintaining humidity, while the mucus serves as a kind of cement for the walls of the galleries which these worms excavate.

The clitellum is a complicated organ, and in the ventral part, which should be distinguished from the dorsal, the genital groove and the pads of the groove should be noted; each of these last is divisible into an anterior and a posterior portion. A great deal of observation might profitably be devoted to this organ, the function of which is almost unknown. It is very probable that the pads of the groove become more prominent at the time of copulation, in consequence of the contraction of the arciform muscles; the genital groove would then become deeper; and as in copulation worms lie with the pads applied to one another, the grooves of the pair would form a canal through which the sperm might run.

The muscular system is divisible into the muscular layer of the wall of the body, that of the wall of the digestive tract, the muscles of the intersegmental septa, and the muscular envelope of the central nervous system. But all these parts are connected among themselves. In the first set we find, in addition to the circular and longitudinal muscles, the arciform muscles which lie only between the sexual orifices and the hinder end of the clitellum, and the muscles of the setæ. The characters of the muscular element of the earthworm, which are always the same, can be best studied in a piece of the gizzard. It exhibits a longitudinal striation, and at certain points one can distinguish a transverse striation; the striæ are not simple lines, but are moniliform, being due to a number of swellings connected with one another by more delicate parts. The author deals in a very detailed manner with the muscular system.

The peritoneal membrane, seen from the surface, has the appearance of a pavement epithelium; the cells which form it are polygonal; in section they are flattened; those near the longitudinal muscles have their protoplasm fusing insensibly with the intercolumnar granulated substance. Nuclei of various sizes are seen, and some nuclei had several smaller nucleoli in addition to the large one.

The appearances seen justify the belief that direct nuclear division was going on in these cells; there were no certain indications of pathological degeneration or of processes of fusion. In more than twenty cases which were examined essentially similar phenomena were observed. Further investigations, however, are necessary, and fresh specimens will have to be studied.

Megascolex cæruleus.*—Prof. A. G. Bourne gives an account of this earthworm from Ceylon, and proposes a theory of the course of the

* Quart. Journ. Micr. Sci., xxxii. (1891) pp. 47–87 (4 pls.).

blood in earthworms. He does not give any account of its general appearance but gives a figure which appears to be excellent. After some considerable additions to the details of our knowledge of various organs, the author proceeds to propound his new theory of the circulation.

According to this, so long as the modified anterior extremity (of about the first twenty segments) remains intact, it is possible to remove any of the posterior segments without interfering at all with the circulation, in other words, there are signs of a metamerically segmented character of the vascular system, in all but the "cephalized" anterior region. The blood appears to enter the dorsal vessel in each posterior segment through dorso-intestinal, and to leave it by dorso-tegumentary vessels; the latter are always small as compared with the former (of which, indeed, there are in many worms two pairs in a number of segments), and it is probable, therefore, that more blood enters the dorsal vessel than leaves it in each posterior segment. This excess is passed forward to be sent out in the cephalized region. With regard to the supply in the ventral vessel, all the blood which enters it comes from the hearts, and all the ventro-tegumentary branches appear to be efferent vessels. Contrary to the ordinarily received opinion that all the blood in the ventral vessel flows backwards, Prof. Bourne is of opinion that in front of the heart the direction of flow is forwards.

As to the capillary networks, it seems that the afferent vessels of the peripheral networks are in all cases branches of the dorsal and ventral vessels, while their efferent vessels are branches of intestino-tegumentary vessels, and the afferent branches of the intestinal networks are branches of the intestino-tegumentary trunks; the efferent vessels of this last system are branches of either the typhlosolar, the supra-intestinal, or the dorsal vessel, so that blood coming from them is driven either into the hearts or into the dorsal vessel at its anterior extremity, in either case into peripheral networks; from these the blood passes into the intestino-tegumentary system, and once more into the intestinal capillaries. Prof. Bourne points out that a merit of this theory is that it exhibits the vascular system as a perfectly metamerically segmented organ, the portion of it which is contained in the cephalized region representing, as a whole, almost exactly the portion contained in any other segment of the body; it has undergone a synthesis, and certain additional structures, the hearts, have become developed in its region.

New Genus of Earthworms.*—Dr. R. Horst has a preliminary note on a new earthworm brought by Prof. Max Weber from the Malay Archipelago. The genus is to be called *Glyphidrilus* (*G. Weberi*) on account of the clitellum being provided on each side with a folded, crenulated ridge. One to three pairs of spermathecæ are to be found in each segment from xiv. to xix., and all were densely filled with spermatozoa. The new genus is specially characterized by the backward position of the male genital pores, the situation of the spermathecæ behind the other genital organs, and by the presence of more than one pair of them in each segment. The male pores are between segments xxvi. and xxvii., and their position in the intersegmental groove is also of rare occurrence.

* Zool. Anzeig., xiv. (1890) pp. 11–12.

Structure of the Oligochæta.*—Mr. F. E. Beddard, referring to Dr. W. B. Benham's division of the Lumbricomorpha into Microdrili and Megadrili, points out that the presence or absence of a capillary network upon the nephridia is not the only character by which these two orders might be distinguished. There are in addition—

Microdrili.	Megadrili.
(1) Sexual maturity at a fixed period.	(1) Sexual maturity more or less continuous.
(2) Clitellum consisting of a single layer of modified cells only.	(2) Clitellum consisting of two distinct layers of cells.
(3) Ova large and few.	(3) Ova small and numerous.

Ocnerodrilus, however, presents such an admixture of these characters that the proposed division seems almost impossible. Mr. Beddard is inclined for the present to revert to Vejdovsky's arrangement into families only, and he points out that, in discussing the affinities of any particular type of Oligochæta, it is necessary to compare it with a particular family.

Pelodrilus is the name proposed for a new generic type of Annelid collected, in New Zealand, from wet soil near the margin of a swamp. Among other points of interest this new worm has specially thickened intersegmental septa in some of the anterior segments; this tends to show that the medium in which the worm lives has some relation to the presence of these thick septa; for it does not, like its immediate allies, swim in water or burrow in naturally soft mud.

Phreodrilus is another new New Zealand worm in which the general arrangement of the sperm-duct is quite unique, unless it resembles that of *Eclipidrilus*. The atrium commences as a sinuous tube which widens out to form a large thin-walled sac with muscular walls; this sac is nearly filled by a much coiled continuation of the atrium and vas deferens. This genus has highly characteristic setæ; the dorsal rows consist each of a single capilliform seta, not unlike those of the Tubificidæ; the ventral setæ are not quite similar to those of any known Oligochæte. Mr. Beddard concludes with a note on the zone of growth in *Urochæta*, and a brief description of a new species of *Pontodrilus* from Bermuda, in which the gizzard is very feebly developed.

Homology between Genital Ducts and Nephridia in Oligochæta.†—Mr. F. E. Beddard has studied the development of *Acanthodrilus multiporus*. In the young embryos each segment is furnished with a pair of nephridia, each opening by a ciliated funnel internally. Later on, the funnels degenerate and that portion of the tube which immediately surrounds the funnel becomes solid. At the same time the nephridium branches and communicates with the exterior by numerous pores. At a rather early stage four pairs of gonads are developed in segments x.–xiii., each on the posterior wall of its segment; the funnels in close contact with them increase greatly in size and become the funnels of the vasa deferentia and oviducts; subsequently the gonads and commencing oviducts of segment xii. atrophy.

The author can only explain these and other facts which he brings

* Ann. and Mag. Nat. Hist., vii. (1891) pp. 88–96 (2 figs.).
† Proc. Roy. Soc., xlviii. (1891) pp. 452–5.

forward by the supposition that in *Acanthodrilus multiporus* the genital funnels and a portion at least of the ducts are formed out of nephridia. This mode of development confirms the suggestion of the late Prof. Balfour that in the Oligochæta the nephridium is broken up into a genital and an excretory portion.

Reproduction of Autolyteæ.*—M. A. Malaquin has studied the formation of the stolons in *Autolytus*, *Myrianida*, and *Procerastea*. Some species of *Autolytus* exhibit merely fission, while in others there is fission and budding. In *Myrianida* there is budding without fission. When there is budding the somite which proliferates is the pre-anal in *Myrianida* and certain species of *Autolytus*; the anal segment is, from the first, too differentiated to take part in the formation of new zoonites. The "formative zoonite" has no appendages; it is filled by embryonic tissue; when it exists it gives rise, when there is a free proximal surface, to a new head (centrifugal budding), or when the free surface is distal to a new pygidium (centripetal budding). If the formative zoonite is in contact with a stolon, a pygidium is formed on the dorsal surface; the anal segment plays, so to speak, the part of an isolator; it separates two individualities which are becoming more and more marked. The zone of new formation is colourless and transparent: the formative zoonite is larger than the zoonites which precede it. On this segment, which is at first undivided, there appear two lateral grooves which converge and meet on the median line; the rudiments of feet, cirri, setæ, are successively differentiated. In *Myrianida* the author observed a stem of sixty-six segments, followed by twenty-nine male stolons, containing about four hundred and fifty segments, and thirty actively proliferating zones.

Reproduction has also been observed in *Procerastea Halleziana* sp. n.; here the phenomenon of fission is complicated by a median budding before the appearance of the head. The proliferating bud only gives off segments anteriorly.

The growth of the stolons is described in *Polybostrichus* and *Sacconereis*. In the former the formative zoonite immediately gives rise to the two most differentiated segments—the segment which buds off the head and the pygidium; the segments next to be formed are those which contain the genital organs. The head of *Sacconereis* is formed in the same way as that of *Polybostrichus*. Dimorphism is much more marked in this genus.

β. Nemathelminthes.

Filariæ of Birds.†—Dr. T. L. Bancroft has investigated the hæmatentozoa of Australian birds, and, as he was fortunate enough to find them in the Blue-Mountain Parrot, which eats only honey, he was able to trace the cycle of changes. This parrot harbours, as most birds do, a blood-sucking louse. The author, therefore, believes himself justified in assuming that the lice of birds are the intermediate hosts in the life-history of the *Filariæ* of birds, and that birds infect themselves by picking lice from an infected bird, and afterwards re-infect themselves by picking their own lice; this would account for the immense number of hæmatentozoa

* Comptes Rendus, cxi. (1890) pp. 989-91.
† Proc. Roy. Soc. Queensland, vi. (1889) pp. 58-62.

in some birds. In examining birds for embryonic *Filariæ*, it is best to cut out the heart and press it gently against a slide so as to leave thereon a little blood, for the blood in the heart often contains worms when they are not to be found elsewhere in the body. The blood should be examined immediately after death; if a period of thirty hours has passed it is impossible to find them.

Atlantonema rigidum.*—M. R. Moniez has some observations on this Nematode, which is parasitic in various coprophagous Coleoptera. The worm loses most of its organs, and particularly its digestive tube, so that it has merely the character of a long sac filled with embryos of all degrees of development. These break through the wall of the maternal body and spread in large numbers among the viscera of their host. A certain degree of development is possible within the body; regarding the further stages of their history, the author can only as yet surmise as to their relation to the Rhabditis-like forms which are found on the backs of these Beetles.

Development of Gordius.†—Dr. L. Camerano finds that the principal phenomena of maturation and fertilization in the ova of *Gordius tolosanus*, *G. villoti*, &c., are like those of *Ascaris megalocephala*. The segmentation is total but irregular, and results in a two-layered "sterroblastula," which is transformed into a "cœlogastrula." He maintains that the resemblance between the development of *Gordius* and that of other Nematodes justifies the retention of the Gordiidæ as a distinct order within the class.

Histology of Echinorhynchus.‡—Herr J. Kaiser begins an account of the Acanthocephala, which, so far as yet published, deals mainly with their histology. Of the nine species which served as material for his researches, two are new, *E. uncinatus* and *E. spinosus*, both from Florida. The cuticle, the felt-like subcuticula, the radial fibrils of the hypodermis, the lemnisci are described at great length, and a summary is given of what is known in regard to the absorption of food. So far, almost all the results reached corroborate those of previous investigators.

γ. Platyhelminthes.

Rhabdocœle Turbellaria.§—Dr. L. Böhmig, in his second memoir, deals in a very detailed manner with the Plagiostomina and Cylindrostomina of Graffs. We have only space to notice a few of the many points discussed by the author. The reactions of the rhabdites and pseudorhabdites to colouring matters are so very various that we may conclude that their chemical composition varies considerably, and that, perhaps, their function does so also. The parenchyme of the Turbellaria primitively consists of individualized cells, and the manner in which they fuse varies considerably. In the Alloiocœla and in some of the Rhabdocœla there is in each cell a differentiation into supporting and sap-plasma, and the cell-walls of the cells fuse with one another. In the two divisions of the Dendrocœla and perhaps in some Rhabdocœls fusion

* Comptes Rendus, cxii. (1891) pp. 60–2.
† Mem. R. Accad. Sci. Torino, xl. (1890) pp. 1–18 (2 pls.).
‡ Bibliotheca Zoologica, Heft 7 (1891) pp. 1–40 (6 pls.).
§ Zeitschr. f. Wiss. Zool., xli. (1890) pp. 167–479 (11 pls., 21 figs).

of the cells is accompanied by the formation of vacuoles. Some of these at least are intercellular in Triclads, but they are always intracellular in Polyclads. The division of the parenchymal tissue into connective bars and connective cells must be given up.

These Turbellaria always have a large number of glands in their body, and most of them are dermal. Some open into the pharynx and these may be regarded as salivary glands. The pharynx itself is very elaborately constructed. The form of the enteron is greatly influenced by the degree of development of the generative organs, and there is no doubt that in young animals, where these parts only exist in rudiment, the form of the enteron is much more regular and straight. Respiration appears to be effected through the walls of the enteron and of the body as well as by means of the water-vascular system.

With regard to the structure of the nervous system the author agrees with Leydig and Nansen in regarding the substance which fills Haller's plexus as the hyaloplasm of Leydig and as the true nervous substance, but he differs from Nansen in so far that he believes that the fibres and fibrils of this nervous substance form a network and anastomose with one another.

In the eyes of all alloiocœlous Turbellaria we may distinguish a pigment layer or pigment cup, refractive media or lens-cells, and perceptive media or a retina. In the last the layer of rods must be distinguished from the optic nerve. There is much in common between the eyes of Alloiocœla, Triclads, and Polyclads, but the two last most resemble one another in the structure of the retina. The complete absence of lens-cells in Polyclads and Planarians is to be noted.

In treating of tactile organs Dr. Böhmig points out that at the base of the tentacle there are numerous ganglionic cells, the processes of which form a small accumulation of dotted substance, whence fibres pass into the tentacles. He does not know whether the central part of these tentacles is filled by nerve-fibres or whether parenchymatous tissue is also there present. In the epithelium of a comparatively well-extended tentacle peculiar bodies were found just beneath the cuticle; these possibly represent nerve-end-organs, but no connections with nerve-fibres were detected. These bodies are exceedingly small and have the form of lenses; in the middle of the more convex surface there is a small round spherule from the surface of which fine striæ radiate; these striæ appear to be continued into minute and fine hairs.

Some considerable space is devoted to the generative organs.

In the second portion of his paper Dr. Böhmig deals with the anatomical characters of *Plagiostoma Girardi*, both large and small varieties, the latter of which is new, *P. reticulatum*, *P. siphonophorum*, *P. maculatum*, *P. bimaculatum*, *P. dioicum*, *P. lemani*; *Vorticeros auriculatum* is next considered. Among the Cylindrostomina we find a new genus *Monoophorum* for *M. striatum* sp. n.; the genus is defined as belonging to the Cylindrostomina and as having a common oral and genital orifice which is situated near the hinder end of the body; the pharynx is directed backwards and the penis forwards; the bursa seminalis communicates with the genital atrium; the rudiments of the two yolk-glands are fused in the median plane on the dorsal side. In it as in *Cylindrostoma* the testes are situated more anteriorly than in Plagiostomina, and have, consequently, well-developed and long vasa deferentia, which are wanting in the other group. The species of *Cylindrostoma* described are *C. quadrioculatum* and *C. Klostermanni*.

Turbellaria of the Coasts of France.* — In the present memoir Dr. L. Joubin confines himself to an account of French Nemertinea; his chief object is to give an "aperçu" of the fauna and he notes as much as possible the habitat of the worms and the external details which are often so difficult to see. Thirteen species were found to be peculiar to the Atlantic, seventeen to the Mediterranean, and twenty-eight were common to the two areas. *Carinella banyulensis* sp. n. was first thought to be the young of *C. annulata*, but its maturity was proved by its being discovered reproducing itself; *C. aragoi* is a new species also from Banyuls. In describing *Polia curta* the author, which he rarely does, enters into some anatomical details. The new genus *Poliopsis* is suggested for *P. lacazei* sp. n., but the author does not distinguish between what he regards as the generic and what as the specific characters. The names *marionis* and *rustica* are applied to new species of *Tetrastemma*. The only new species of *Nemertes* is *N. duoni*.

Asexual Reproduction of Microstoma.†—Dr. F. von Wagner has made a study of the asexual reproduction of this worm. He is not able to confirm v. Graff's statement that the length of proliferating specimens is from 0·7 to 1·5 mm., as he has observed examples 2 mm. long in which there was no indication of the reproductive process. The law of Hallez that rudiments of new zooids always appear in the last third or fourth is not universally true. There are great variations in the rhythm of asexual propagation, and v. Graff's formula is rather a theoretical generalization from special cases than the result of comparative observation. Hallez's "temps de formation" does not so much fix a definite developmental stage of the developing zooid as represent a special stage of the mother; the isolated hinder piece is not a localized growth-product of the animal which is known as the mother, but is merely a part of it; the constancy in size of the most anterior animal of a chain, which v. Graff supposes to continue for the whole period of asexual propagation, does not really obtain. The internal processes which accompany asexual reproduction may be considered under two heads:—

A. *Formation of septa and separation.*—The enteric tract becomes constricted in the septal plane, and is, consequently, in a state of latent tension of high degree; the process of separation happens at a period characterized by the growth-energy of the epithelial circular groove having reached a stage in which it is superior to the tension of the constricted enteron.

B. *The processes of regeneration* are discussed in eight brief chapters they chiefly consist of changes in and differentiations of the formative cells belonging to the parenchyma. If what happens in *Microstoma* is compared with what is known to occur in other Turbellaria, we are led to the generalization that in the Turbellaria regenerations take their origin from the parenchyma (mesoderm); in other words, the regene-

* Arch. Zool. Expér. et Gén., viii. (1890) pp. 461–602 (7 pls.).
† Zool. Jahrb. (Abth. f. Anat. u. Ontog.), iv. (1890) pp. 349–423 (4 pls.).

rative activity of these animals appears to be connected with the formative capacity of the parenchyma.

The author proceeds to some general remarks on division and budding in the Animal Kingdom. He draws a sharp distinction between the two processes, and comes to the conclusion that asexual reproductions in different phyla of Animals have arisen independently of one another.

Helminthological Studies.*—Prof. M. Braun has a notice of some recent work on parasites done under his direction. Herr C. Dieckhoff has investigated the ectoparasitic Trematodes; he finds the vitello-intestinal canal in *Octobothrium merlangi*, *O. lanceolatum*, and *Axine belones*. The canal appears to be wanting in the Tristomeæ and in the Temnocephala.

Herr F. Matz has investigated the Bothriocephalidæ with the object of finding in the topographical relations of the generative apparatus better means for discriminating the species than we have had hitherto. A series of specific differences have, as was expected, been discovered; the generative orifices are ventral or marginal; differences, though not very considerable, have been seen in the number and size of the testicular vesicles, and there are some points in the vitelline follicles. The number of uterine loops may be greater or less than in *Bothriocephalus latus*.

The Genus Vallisia.†—Sigg. C. Parona and A. Perugia described as a new genus of Trematode, under the title *Vallisia striata*, an ectoparasite on the gills of *Lichia amia;* the body consisted of two parts in different planes, and was covered with fine transverse striæ; there were two minute ventral and eight caudal suckers. But Dr. P. Sonsino has denied the validity of this new genus, and described the same worm under the title *Octocotyle arenata* sp. n. Parona and Perugia vindicate the claims of their genus.

Morphology of Cestoda.‡—Dr. T. Pintner first discusses the vexed question of the act of fertilization in the Cestoda. He has been so fortunate as to have found in a *Mustela lævis* two free proglottids of an *Anthobothrium Musteli* which appeared to be in copulâ. These two joints, which seemed to be of much the same age, showed no signs of any separation-wound; the uterus was full of eggs, though not overcrowded by them. Both joints had their anterior ends pointing in the same direction, but the ventral face of one ring looked in the same way as the dorsal face of the other. It is very possible that their long axes slightly crossed one another. There was true cross-fertilization, for the penis of one individual was fixed in the vagina of the other; each reached only so far as the point where the vagina begins to narrow, but as this is not always the case, the author supposes that copulation was nearly finished when the preparation was fixed. The penis is able to extend itself into a retort-form, and to considerably alter its diameter.

This fortunate accident makes it certain that typical cross-fertilization of the kind that is seen in Snails obtains in the Cestoda; it would hardly seem to be a hasty generalization that this is the rule in all

* Centralbl. f. Bakteriol. u. Parasitenk., ix. (1890 [1]) pp. 52–6.
† Zool. Anzeig,, xiv. (1891) pp. 17–9.
‡ Arbeit. Zool. Inst. Wien, ix. (1890) pp. 57–84 (2 pls.).

cases where a number of sexually mature joints are retained in the host, whether in the chain-form or in free proglottids.

Soon after the discovery of these joints Dr. Pintner had the great good fortune to examine another proglottid of the same worm and of about the same age as the others, which, superficially, exhibited nothing remarkable, but which, when a series of sections were made, revealed the astonishing fact that the penis of this proglottid had entered deeply into the vagina of the same joint. The most remarkable point in this case was the extraordinary depth to which the penis had entered the vagina, for it had passed the loop and reached as far as the level of the generative orifice.

These observations justify the assertion of the existence of typical cross-fertilization in the Cestoda, and, at the same time, confirm the much-discussed observations of Van Beneden and Leuckart on self-fertilization. They, further, strongly support the views of Zeller as to cross-fertilization in the Trematoda; as the same process has been observed in Turbellarians, it may be said to be common to all the Platyhelminthes.

The author has made some observations on the female generative organs of the Tetrabothriidæ, which may be thus summed up. In many, and probably in all Cestoda there is, at the commencement of the oviduct, and at the spot where it takes its origin from the membrane of the ovary, a muscular apparatus which has the function of pumping out the ova from the ovary or driving them on. This apparatus is well developed in the Tetrabothriidæ and Echinobothriidæ, but very feebly in the Tetrarhynchidæ, Tæniidæ, Bothriocephalidæ, and Ligulidæ; it appears to be derived from the similar arrangements which are so well developed in the Trematoda.

δ. Incertæ Sedis.

Heterogenesis in Rotifers.*—Dr. E. v. Daday has made some studies of *Asplanchna Sieboldi* which have shown him that the fertilized ova with thick membranes develope into tubular females, which in the course of their parthenogenesis give rise to an indefinite number of tubular and male-like females as well as males; after copulating with the last they lay fertilized ova, with thick membranes. The parthenogenetically developed male-like females give rise, by parthenogenesis, to other male-like and also to tubular females as well as to males; with the last they, finally, copulate and give rise to ova as before. In other words, *A. Sieboldi*, both parthenogenetically and after impregnation, gives rise to dimorphous females and to males, and after copulation to fertilized eggs. The author gives descriptions of the three forms of the progeny. It is difficult to compare this case exactly with any known mode of heterogenesis. It is probable that many of the forms described as distinct species are really heterogenetic representatives of other, already described species.

List of Queensland Rotifera.†—Mr. V. Gunson Thorpe gives a list of thirty-two species of Rotifera found on the Queensland coast. He hopes, at a later date, to publish descriptions of the new species which are not here enumerated.

* Math. u. Naturwiss. Berichte aus Ungarn, vii. (1890) pp. 140–56 (1 pl.).
† Proc. Roy. Soc. Queensland, vii. (1889) pp. 70–5.

Vibratile Tags of Asplanchna amphora.*—Mr. C. Rousselet states that there are about forty vibratile tags on each side; in shape they are like elongated and compressed cups; the cup is closed by a very delicate spongy protoplasm, probably quite open enough to allow part of the fluid of the body-cavity to pass through.

Notes on Rotifers.†—Mr. G. Western calls attention to a free-swimming *Lacinularia* which he calls *L. natans*, and to a new form resembling an *Asplanchnopus*, but apparently the type of a new genus, which he found in the river at Guildford.

Dinops longipes.‡—Mr. C. Rousselet applies this name to a Rotifer which has hitherto been placed with *Asplanchna*, but it has a distinct intestine and cloaca, and among the jaw-parts are the manubrium and uncus which are wanting in *Asplanchna*.

Organization of Cephalodiscus dodecalophus.§—Prof. A. Lang regards *Cephalodiscus* as, with *Balanoglossus*, a member of the Enteropneusta. He looks on the organization of the latter as adapted to a limicolous and limivorous mode of life, and that of the former to a tubicolous and semi-sedentary one. Moreover, the organization of *Cephalodiscus* rests at a point which corresponds to an early stage of *Balanoglossus*. He does not, however, regard the form as a primitive one, but rather as an altered and simplified *Balanoglossus* which has been affected by its mode of life. The absence of the blood-vascular system may be connected with the small size of the body. Less weight is to be laid on the number of gill-clefts and gonads.

The resemblance of *Cephalodiscus* to the Bryozoa and to *Phoronis* is merely a convergence-phenomenon, due to adaptation to a similar mode of life. The presence of gill-clefts is a great obstacle to any thought of affinity, for even if the Bryozoa were regarded as being descended from *Cephalodiscus*-like forms, the disappearance of the gill-clefts would remain unexplained.

Anatomy and Histology of Phoronis.||—Dr. C. J. Cori gives a long account of the structure of this animal, the systematic position of which has been so long a matter of doubt. He points out that the Phoronida and Bryozoa agree in the possession of a true cœlom; both have, at the anterior end of their bodies, a horseshoe-shaped crown of tentacles within which is set the mouth; this last may be closed by a lip-like process, the epistome; and, lastly, the anus always lies near the mouth.

The cœlom of both is divided into an upper and a lower portion by a partition stretched across in a direction transverse to the axis of the œsophagus. The upper cavity may be called the tentacular-coronal cavity, the lower the body-cavity; the former is made up of the cavities of the lophophore and epistome and of the tentacles. The body-cavity of the Bryozoa is an undivided space, but that of *Phoronis* is broken up by a number of enteric mesenteries. In the tentacular cavity there is on the anal side the ganglion, and from the same side there arises the

* Journ. Quek. Micr. Club, iv. (1891) pp. 241–2 (3 figs.).
† T. c., pp. 254–8 (1 pl.). ‡ T. c., p. 263.
§ Jenaische Zeitschr. f. Naturwiss., xxv. (1890) pp. 1–12.
|| Zeitschr. f. Wiss. Zool., xli. (1890) pp. 480–568 (7 pls.).

epistome; the body-cavity, on the other hand, contains a pair of renal organs and the generative organs. The renal organs of both *Phoronis* and the Bryozoa agree in being short, ciliated tubes, with a retro-peritoneal course, which are, on the one hand, connected with the body-cavity by an infundibular orifice, placed anally of the œsophagus, and open to the exterior by an outer pore.

With regard to the differences between the Bryozoa and *Phoronis*, the phylactolæmatous division of the former has lophophoral arms; to this statement, however, *Fredericella* is an exception. Another difference, which appears to be important, is the absence of a blood-vascular system in the Bryozoa. This, however, may not be significant, as its absence is probably due to loss during phylogenetic development. In a young *Phoronis* the difference in the arrangement of the mesenteries is less unlike what obtains in Bryozoa than is the case with the adult. Although the author points out the resemblances between *Phoronis* and the Bryozoa, he does not go so far as those who regard the former as merely an aberrant Bryozoon; his object is merely to point out the genetic relations which appear to obtain between these two classes of animals.

Echinodermata.

Morphology of Bilateral Ciliated Bands of Echinoderm Larvæ.*—Dr. R. Semon is of opinion that the dipleural larvæ and *Tornaria* offer well-marked differences from the ciliated larvæ of higher and lower Worms, as well as of Molluscs. It would seem, therefore, impossible to homologize the circumoral ciliated band of Echinoderm-larvæ with the ciliated apparatus of other larval types. The structures have probably been acquired independently.

To make our judgment satisfactory we require, however, a better knowledge of the larval nervous systems than we have at present; it is certain that so highly differentiated a larva as *Bipinnaria*, with its rich and complicated muscular apparatus, must have a well-developed and, relatively speaking, highly developed nervous system. And of this we yet know but little.

Calamocrinus Diomedæ.†—Prof. A. Agassiz has a preliminary note on a new stalked Crinoid from the Galapagos. At first sight this new form might readily pass as a living representative of the fossil *Apiocrinus*, but it has also points of resemblance to *Millericrinus*, *Hyocrinus*, *Rhizocrinus*. Like these last, it has only five arms, but these are not simple, but send off from the main stem of the arm three branches to one side and two to the other. The system of interradial plates is highly developed, as in *Apiocrinus* and *Millericrinus*, six rows of solid polygonal imperforate plates being closely joined together, and uniting the arms into a stiff calyx as far as the sixth or seventh radial. These solid plates extend over the prominent anal proboscis; the oral plates are small. The stem is somewhat curved at the upper extremity; it tapers very gradually, and in its general appearance recalls that of *Apiocrinus;* it is cylindrical and has no cirri. There are five distinct basals in one specimen, in another the sutures can be recognized, and

* Jenaische Zeitschr. f. Naturwiss., xxv. (1890) pp. 16–25 (1 pl.).
† Bull. Mus. Comp. Zool., xx. (1890) pp. 165–7.

in the third the basals were completely ankylosed. The stem must have been 26 to 27 in. long, the arms about 8 in.; the height of the calyx to the interradials is 7/16 in.

Cœlenterata.

Development of Scyphostoma of Cotylorhiza, Aurelia, and Chrysaora.*—Prof. C. Claus deals with the developmental history of the three just-mentioned forms of Scyphomedusæ. In some important points Prof. Claus confirms the results of Goette, but in others he disagrees with him.

He finds that in *Cotylorhiza* embryonic development proceeds as far as the swarming Gastrula-stage within the egg-membrane. There is no irregular immigration of ectodermal cells into the blastula-cavity, but, as A. Kowalevsky has already described, the Gastrula is formed by invagination. Intermediate stages are presented by *Aurelia* between this mode and the ingrowth of a solid cell-mass which only later acquires a central cavity such as is seen in *Chrysaora.* The young Scyphostoma forms the proboscis at a very early stage; this organ is developed from the ectodermal invagination in such a way that the internal lining of the proboscis is permanently ectodermal. Some of the organs described by Goette are not developed either in *Cotylorhiza* or in *Chrysaora.*

In contradistinction to the Hydroid Polyps the young Scyphopolyp is characterized not only by the ectodermal nature of the lining of the proboscis, but by the appearance of four diverticula on the oral portion of the gastric cavity, which gives rise to the tentacles, as well as by the alternating rudiments of tæniolæ. In *Cotylorhiza* the tænioles remain rudiments, situated below the oral disc, and do not extend as longitudinal ridges over the whole length of the gastric space. The four septal muscles do not arise as in the Anthozoa, but as ingrowths of ectodermal cell-growths at the peristome, and they have only a secondary relation to the tæniolæ. The so-called septal funnels are cavities in the upper portion of these ectodermal growths, which may be continued into the septal muscles; in *Cotylorhiza*, however, they are not developed. They disappear on the conversion of the Scyphostoma-disc into the Ephyra. The development of the tentacles from the four-armed to the sixteen-armed form is irregular and essentially the same as that already described by the author. The sixteen-armed Scyphostoma appears as the normal form, although in *Aurelia* and other genera the number of tentacles, before the appearance of strobilation, may be as much as 24 or 32.

The conversion of the polyp-like tetrameral Scyphostoma into the octomeral Scyphomedusa commences with the formation of the circular series, of the lobed and intermediate pouches in the periphery of the same. The sensory knobs arise at the base of the eight radial tentacles. Prof. Claus is of opinion that reproduction by strobilation is a form of alternation of generation.

Hydra turned inside out.† — Prof. A. Weismann vindicates Ischikawa's experiments against Nussbaum's criticisms. When a *Hydra* is turned inside out and fixed by a bristle, it gradually rights itself.

* Arbeit. Zool. Inst. Wien, ix. (1890) pp. 85–128 (3 pls.).
† Arch. f. Mikr. Anat., xxxvi. (1890) pp. 627–38 (8 figs.).

Nussbaum and Ischikawa agree that ectoderm never becomes endoderm nor *vice versâ*. But Nussbaum seems to have explained the restitution of the everted polyp by an active migration of ectoderm cells; while Ischikawa showed that the *Hydra* righted itself after eversion by a genuine turning outside in. Ischikawa also demonstrated that endoderm cells were essential to the regeneration of a *Hydra* from a fragment, for the intermediary or interstitial cells cannot become endoderm. Weismann believes that the reason why an excised tentacle usually dies, and does not regenerate an organism, is not the absence of this or that kind of cell, but rather the small size of the fragment.

Spongicola and Nausithoë.*—Signor Lo Bianco and Dr. P. Mayer have been able to demonstrate by following out the development of the larva the correctness of Metschnikoff's suggestion that *Nausithoë* is a stage in the life-history of *Spongicola fistularis.* The Spongicolidæ are shown, therefore, to have nothing to do with the Hydroida, but to belong to the Acalephæ.

Porifera.

Comparative Anatomy of Sponges.†—In the third of his studies on the comparative anatomy of Sponges, Mr. A. Dendy deals with the anatomy of *Grantia labyrinthica* Carter and the so-called family Teichonidæ. Mr. Dendy is convinced that in the present transitional state of our knowledge of the Sponges anatomical investigation must precede systematic work; the greater the number of types investigated the greater will be the value of the ultimate scheme of classification. One great reason for this is that polymorphism and homoplasy occur so generally and to such an extraordinary degree among the Porifera that a careful examination of the internal anatomy is above all things necessary.

The structure of *G. labyrinthica* is described in detail and fully illustrated. It was first called *Teichonia* by Mr. Carter, and the family of which it is the representative the Teichonellidæ, which was altered by Poléjaeff to Teichonidæ; in it that writer put his genus *Eilhardia.* As a matter of fact *Eilhardia Schulzei* Pol. and *Teichonella prolifera* Cart. are Leuconidæ and *G. labyrinthica* is one of the Syconidæ.

In his fourth study‡ Mr. Dendy deals with the flagellated chambers and ova of the common British Sponge, *Halichondria panicea.* The canal system is of the lacunar type, the lacunæ being so irregular as hardly to deserve the name of canals; the inhalant and exhalant lacunæ are precisely similar and interdigitate with one another in the most complicated and irregular manner. The flagellated chambers, which lie wedged in between one lacuna of each kind, are in a general way subspherical in form; their exhalant opening is very wide, and their diameter is about 0·047 mm.

The collared cells, when the chamber is seen in section, may be observed to stand some little distance apart from one another in the gelatinous ground-substance surrounding the chamber. Each cell has a short nucleated body, indistinguishable from the neck, and surmounted

* Zool. Anzeig., xiii. (1890) pp. 687–8.
† Quart. Journ. Micr. Sci., xxxii. (1891) pp. 1–39 (4 pls.).
‡ T. c., pp. 41–8 (1 pl.).

by the delicate funnel-shaped collar. These collars have extremely fine outlines, but all are connected at their margins by a very distinct membrane (Sollas' membrane). Neither Prof. Sollas nor Mr. Dendy have till now been able to see flagella in concrescent choanocytes, but Mr. Dendy has now been so fortunate as to see them plainly projecting from the bodies of the collared cells; he has thus decided the question of the coexistence of Sollas' membrane and the flagella of the collared cells. Bidder has already forestalled the author in a suggestion he was about to make—that this membrane serves to filter food-particles from the current of water flowing through the Sponge.

The ova are remarkable for their great complexity of structure. In *Grantia labyrinthica* the mature ova migrate through the walls of the inhalant lacunæ and remain suspended therefrom; each has its distinct peduncle and awaits the spermatozoa brought in by a stream of water. It is probable, though it has not been proved, that the lacunæ of *H. panicea*, in which the ova are found suspended, are also inhalant. The adult ovum has a total diameter of about 0·067 mm. The outermost portion forms a distinct envelope, which is fairly thick. Within this envelope the ovum proper is suspended as in a bag; it is spherical, uniformly and rather coarsely granular; the spherical nucleus has a very thick and distinct membrane, and the substance is finely granular, it stains lightly, whereas the substance of the single spherical nucleolus stains very deeply.

Protozoa.

Stentor cæruleus.*—Dr. A. Schuberg finds much to correct in previous descriptions of the structure of *Stentor cæruleus*. He gives his own observations on the superficial stripes, and their "ramifying zone," on the so-called "peristome" and its insunk oral region or "gullet," on the frontal region, and on the adoral membranellæ. In regard to the blue pigment, of which so little is known, he tells how some five-year-old preparations of this species had acquired the dark purple-red colouring of *St. igneus*, and how three living specimens which he isolated lost their pigment entirely and afterwards regained it. Schuberg has also discovered some new facts in regard to the process of division, and this especially, that the whole constriction is from the first connected with a rupture of the pellicle in a definite direction. In discussing the comparative morphology of *Stentor*, he maintains that the so-called peristome is not *in toto* homologous with that of other Infusorians, indeed that it is homologous with the "frontal region" of the Hypotricha and other Heterotricha, and should be renamed as such.

The Life of Difflugia.†—Dr. M. Verworn has found in *Difflugia lobostoma* an interesting object of study. In the specimens examined, the shell had no sand particles, but consisted of irregular plates made by the animal itself and of organic débris. It seems that the little plates arise from peculiar grains which lie round the nucleus and are probably formed as a secretion under nuclear influence. When an individual divides, these grains are exposed on the surface of the separated cell, unite firmly with one another, and form a connected case

* Zool. Jahrb., iv. (1890) pp. 197–238 (1 pl.).
† Zeitschr. f. Wiss. Zool., l. (1890) pp. 443–68 (1 pl. and 3 figs.).

of plates or scales. Verworn is strongly disinclined to believe that *Difflugia* exercises any "choice" in regard to the particles used in forming the extrinsic part of the shell. Thus in the basin whence his specimens of *D. lobostoma* were obtained, there were no sand particles, and consequently none on the shells. Moreover, he was able to see specimens clothing themselves with powdered glass when that was the only available material. The character of the shell depends mainly on what material can be most conveniently obtained, and on the mechanical conditions of architecture.

In studying the conjugation of *Difflugia*, unions of three and even four were repeatedly observed. The process is characterized by the appearance of a small, peculiarly shaped accessory nucleus beside the usual one, and during conjugation the small nuclei of two individuals come into close relations—facts evidently suggestive of what obtains in ciliate Infusorians. By numerous experiments on artificially divided specimens, Verworn has convinced himself that the nucleus is not a "psychical centre" of the cell, that normal movements persist for a time in portions without nuclei, and that these eventually cease because of molecular disturbances resulting from the absence of the nucleus, which has therefore an indirect but not a direct influence on movement.

Cytophagus Tritonis.*—Under this name Herr J. Steinhaus gives an account of a Coccidium which lives parasitically in the cells of the enteric epithelium of a Triton. The creature has the form of a small rounded cell which incloses a vesicular nucleus with a small nucleolus and some small pigment-grains. The diameter of the body varies from 2 to 9 μ. Proliferation commences with mitotic changes in the nucleus. After cell-division the products become sickle-shaped corpuscles, 6 to 7μ long; they become grouped in the cavity caused by the parasite in the body of the epithelial cell; they next take on an amœboid form, and wander from the cells in which they were produced. There is no cyst during any part of the period of proliferation.

In this last point *Cytophagus* agrees with the *Karyophagus Salamandræ* already described by the author, but the differences between them are such as to necessitate the establishment of a new genus for the parasite of the Triton.

Foraminifera collected off the South-west of Ireland.†—Mr. J. Wright gives a report on the Foraminifera collected in 1888 by the expedition sent out by the Royal Irish Academy, and concludes with a table of distribution of the 216 species of Foraminifera known from the south-west coast of Ireland.

* Centralbl. f. Bakteriol. u. Parasitenk., ix. (1890 [1]) pp. 50–2.
† Proc. Roy. Irish Acad., i. (1891) pp. 460–502 (1 pl.).

BOTANY.

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

a. Anatomy.

Tschirch's Text-book of Anatomy.*—This volume, which serves as an introduction to a general work on Economical Vegetable Anatomy, embraces a discussion of the following subjects:—Structure of the cell, cell-contents, and reagents, including aleurone, chlorophyll, chromoplasts, fatty oils, starch and starch-generators, calcium oxalate, tannins, alkaloids, essential oils and resins, glucosides, &c.; formation and growth of the cell-wall, including a discussion of the so-called "intercellular substance"; different tissue-systems, adopting Haberlandt's classification; and a detailed account of secretion-receptacles.

(1) Cell-structure and Protoplasm.

Elementary Structures and Growth of the Vegetable Cell.†—Prof. J. Wiesner maintains that, since the cell-contents, such as chlorophyll-grains, &c., assimilate, grow, and multiply by division, the cell cannot be the ultimate elementary structure of the plant; it must inclose a number of simpler living structures, and may possibly consist of an organic combination of such structures. It is exceedingly probable that the protoplasm is itself made up of such elementary structures; it is itself organized, and, with its organized contents, nucleus, chlorophyll-grains, &c., can only multiply by division. For these living elements of the protoplasm which he formerly called plasmatosomes,‡ the author now proposes the simpler term *plasomes*.

Among the different kinds of plasome are to be reckoned the protoplasmic rudiments from which originate the chlorophyll-grains, the starch-grains, the vacuoles, the tannin-vesicles, and other similar structures, as well as the rudimentary structures from which the dermatosomes of the cell-wall are formed. The plasomes differ from one another as the cells of a tissue differ from one another; and they bear the same relation to the cell as the cells do to the tissue. Like certain cells, the plasomes appear to possess the property of uniting with one another, or of elongating into fibrils; or they may disappear by absorption.

In the lowest known organisms, such as the lower Schizophyta, the plasomes do not develope into separable products; in the lower Fungi, such as *Saccharomyces*, there are formed within the cell, from the plasomes, simply vacuoles and rudimentary nuclei, and the plasomes which constitute the cell-wall are so small that they cannot be recognized as dermatosomes. From the Algæ upwards the most various substances are formed out of the plasomes, but even in the highest plants all the

* 'Angewandte Pflanzen-anatomie: Bd. 1, Grundriss d. Anatomie,' 8vo, Wien u. Leipzig, 1890, xii. and 548 pp., 614 figs.

† SB. K. Akad. Wiss. Wien, xcix. (1890) pp. 383–9, and Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 196–201.

‡ Cf. this Journal, 1886, p. 818.

plasomes of certain cells are ultimately employed only in the formation of cell-wall.

The functions of the plasomes are very various, and are not confined to the formation of the contents and of the cell-wall; their extreme minuteness and consequent large superficies greatly promote metastasis. They must be assumed to form a connected whole, which probably has a reticulate or scalariforn framework, the interstices of which are filled with fluid, as is shown by the behaviour of protoplasts under the pressure of gases. Whether the plasomes are the ultimate organic structures of the cell cannot at present be determined; if they are so, they must be regarded as the carriers of all inherited characters, or the "pangens" of de Vries.*

The mode of growth of the plasomes differs, however, from that of protoplasm; the plasome increases simply by the growth of its mass, protoplasm by the fresh formation of growing plasomes.

Nuclear Origin of Protoplasm.†—M. C. Degagny, in a previous note on this subject, specially described the perforations which are produced across the nucellus, while in the present paper he deals with the consecutive formation of soluble ferments and of coagulable protoplasmic matters in the cell. The author takes as an example *Helleborus niger* (Christmas rose), and shows that these soluble ferments are the product of the cells in process of disorganization; a full understanding of the phenomenon is furnished by attentive observation of the tissues of the nucellus. In the Christmas rose there are certain nucelli where there are no perforations, and others where there are; there are certain nucelli where the embryo-sac in its growth assimilates the whole of the tissues which are in contact with it, without leaving any residue, and others where these tissues are not consumed by the sac. The author then carefully traces the formation of the soluble ferments, and states that these are not the only trace of liquid matter, but that in the perforations of the nucellus newly coagulated protoplasmic matter is also found. Several examples are then successively described which show clearly the actual course of the phenomena which the author describes; *Lilium candidum* is a favourable example.

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

Distribution of the Organic Acids in Succulent Plants.‡—According to observations made by M. E. Aubert, chiefly on *Sedum dendroideum*, *Crassula arborescens*, and *Sempervivum tectorum*, malic acid is the only acid found in the free state in succulent plants, except occasional faint traces of tartaric. The quantity of malic acid varies greatly in different leaves of the same rosette (in the house-leek), and in the same rosette at different ages, being most abundant in the outer leaves. In the stem and leaves, the quantity is greatest at an early age, decreasing as the plants grow older; and as regards the distribution of the acid in the leaf itself, its proportion is least where the part receives most light, both

* Cf. this Journal, 1889, p. 547.

† Bull. Soc. Bot. France, xxxvii. (1890) pp. 180-8. Cf. this Journal, 1890, p. 196.

‡ Rev. Gén. de Bot. (Bonnier), ii. (1890) pp. 369-84 (5 figs.); and Bull. Soc. Bot. France, xxxvii. (1890) pp. 135-7.

heat and light causing its destruction. As a general rule, the maximum of acid corresponds to a minimum of aqueous vapour transpired, and *vice versâ.*

Tannin in the Compositæ.*—According to M. L. Daniel the organ in the Compositæ which contains the largest quantity of tannin is the leaf, next the capitulum, next the stem, and lastly, the root. The root is richest in tannin when young, while the reverse is the case with the stem and the leaves. Etiolation decreases the amount of tannin. The Cynaraceæ contain, as a rule, a larger quantity of tannin than the Cichoriaceæ. The above facts lead the author to the conclusion that, in the Compositæ, the tannins cannot play the part of reserve-substance like inulin.

Localization of the Essential Oil in the Tissue of the Onion.†—M. Voigt finds in various species of *Allium* that the essential oil of onion is found throughout the epiderm or the external layers of all parts of the plant, in the envelopes of the fruit and seed, in the layer of endosperm which surrounds the embryo, and in the sheaths of the vascular bundles. He believes its function to be to protect the plant in general against herbivorous animals, and especially the parts which conduct water and sap.

Occurrence and Function of Phloroglucin.‡—Herr T. Waage has detected the presence of this substance in about 135 species of plants. It is the symmetrical trioxybenzol, and occurs not only free, but forms also complex compounds, especially bodies of the nature of ethers, corresponding to the glucosides, such as phloroglucides (hesperetin, naringenin, phloretin, quercetin, rhamnetin, &c.), or phloroglucosides (aurantiin, glycyphyllin, hesperidin, phloridzin, rhamnin, rutin, &c.).

Phloroglucin is found chiefly in the following parts of the axis,—the epiderm, phellogen, phelloderm, cortical parenchyme, sclerenchyme, medullary rays (in Angiosperms), cambium, pith, aerial and root-hairs, endoderm, pericambium, root-cap, underground stems and roots, but not, or only to a much smaller extent, in the cork, bast-fibres, sieve-tubes, cambiform vessels, and wood-vessels; it was found also in the leaves, sepals, petals, stamens, and carpels. The proportion of phloroglucin varies greatly in different plants; as a general rule it is most abundant in Vascular Cryptogams, Gymnosperms, and dialypetalous Dicotyledons; least so in Monocotyledons and sympetalous Dicotyledons.

Phloroglucin $C_6H_6O_3$ may be formed, like the carbo-hydrates, by the mutual decomposition of carbon dioxide and water, with elimination of oxygen. It was never detected in the chlorophyll-grains or in the protoplasm of mature cells; only in the cell-sap. It is probably formed as the result of a splitting-up of sugar into phloroglucin and water. It appears not to be used up again to any extent in the vital processes of the plant, but to be a secondary product of metastasis.

* Rev. Gén. de Bot. (Bonnier), ii. (1890) pp. 391–403.

† Jahrb. Hamburgischer Wiss. Anlage, 1890. See Bonnier's Rev. Gén. de Bot., ii. (1890) p. 365.

‡ Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 250–92.

(3) Structure of Tissues.

Apical Tissue in the Stem of Phanerogams.*—M. H. Douliot finds, from an examination of the stems of species belonging to about 20 genera of Gymnosperms (Abietineæ, Cupressineæ, Taxineæ, and Gnetaceæ), that the stem always grows, like that of Vascular Cryptogams, by means of a single apical cell, which is sometimes pyramidal, sometimes prismatic. It differs also from that of Monocotyledons and Dicotyledons in the absence of an independent epiderm. Among the 23 Monocotyledons examined, he finds two types, viz. (1) three distinct initial cells (Gramineæ, Commelynaceæ, Scitamineæ, Liliaceæ); (2) two distinct initials (Naiadaceæ, Juncaceæ, Alismaceæ, Hydrocharideæ). Among Dicotyledons, the existence of three initials is most frequent, occurring in two cases in Apetalæ, ten in Dialypetalæ Superiores, three in Dialypetalæ Inferiores, and almost universally in Gamopetalæ; while apical growth by two initial cells was observed in four cases among Apetalæ, five among Dialypetalæ Superiores, and in only one among Gamopetalæ.

Increase in Thickness of the Stem of Cucurbitaceæ.†—Mr. M. C. Potter finds that the stem of the woody genera of Cucurbitaceæ—*Cephalandra* and *Trichosanthes*—increases in the normal way by a well-marked interfascicular cambium. In the herbaceous climbers belonging to the order with annual stems, the stem is strengthened by a ring of sclerenchymatous tissue situated in the cortical tissue between the epiderm and the vascular bundles. The woody perennial climbers, on the other hand, have no ring of sclerenchyme, and derive their support mainly from the xylem, which is constantly being renewed from a cambium ring.

Morphological Origin of the Internal Liber.‡—M. Lamounette has investigated this subject chiefly in connection with the hypocotyl (tigellum), cotyledons, terminal bud, and leaves. With regard to the root and hypocotyl he finds that those plants examined which have an internal liber (phloem) in their stem, may be divided into two classes, viz. those in which this structure occurs in the hypocotyl, and those in which it does not; it never occurs in the root. The internal phloem of the hypocotyl is independent both of the phloem of the root and of the external phloem of the vascular bundles of the hypocotyl; its formation is always later than that of the external phloem, and of the xylem-elements of the vascular bundles in conjunction with it; it originates in the cells of the central medullary parenchyme. In the cotyledons the internal (upper) phloem is also always of later origin than the other elements of the vascular bundles, and originates in the procambial cells which have furnished these latter elements. Its period of formation and its origin are the same in the leaves.

Since therefore the formation of an internal phloem is abnormal, and is due to a special evolution of certain parenchymatous cells, and is independent of the formation of the fibro-vascular bundle with which it is associated, the author considers that the term "bicollateral," usually

* Ann. Sci. Nat. (Bot.), xi. (1890) pp. 283–350 (7 pls. and 5 figs.).
† Proc. Cambridge Phil. Soc., vii. (1890) 5 pp. and 2 pls.
‡ Ann. Sci. Nat. (Bot.), xi. (1890) pp. 193–282 (3 pls.).

applied to such bundles, ought to be disused, from the point of view of the origin of the internal phloem.

Formation of Duramen.*—According to Herr K. v. Tubeuf the excretion of gum or the formation of thyllæ in the vessels of dicotyledonous trees affords no analogy to the excretion of resin in Conifers. The purpose of the formation of duramen as a consequence of injury to the stem is the prevention in the interior of the plant of differences in air-pressure, in the proportion of oxygen, and in that of moisture, between the air within the plant and the external atmosphere. The substances which cause the hardening always arise from living cells, and the walls of the duramen are always impregnated with tannin.

Medullary Rays.†—Herr L. Kny has investigated the histological structure of the medullary rays of dicotyledonous woody plants. He finds them to be composed essentially, in the majority of cases, of two kinds of cell, which he calls medullary palisade-cells and medullary merenchyme-cells, and describes in detail their character in the case of *Salix fragilis*. The former are usually greatly elongated in their longitudinal diameter, and lie close together without intercellular spaces; the latter are usually elongated radially, and have narrow intercellular spaces lying transversely between their layers. In the case described, the innermost portion of the rays which lies in the region of the spiral vessels consists exclusively of palisade-cells. The two kinds of cell differ also in the mode of their punctation. The walls of the merenchyme-cells which are in contact with vessels are destitute of pits, while pits occur abundantly on their upper and under walls. Where, on the other hand, palisade-cells lie in contact with vessels, the intervening walls are provided with large polygonal slightly bordered pits, which are wanting in the palisade-cells of other parts of the medullary rays. Even in later rings belonging to branches several years old the merenchyme-cells are sometimes entirely wanting. Medullary rays consisting exclusively of merenchyme-cells were never seen by the author.

Function of the Sieve-portion of Vascular Bundles.‡—Dr. J. Blass adduces further arguments in favour of his view that the chief function of the sieve-tubes is the supply of food-material to the wood-elements and to the formative cambium. In many trees—*Tilia*, *Quercus*, *Syringa*, *Fraxinus*, *Populus*, *Betula*—as well as in herbaceous plants, he finds the sieve-cells in the immediate proximity of the cambium. By ringing the stems of both woody and herbaceous plants, it can be shown that no copious flow of albuminoids takes place out of the sieve-tubes.

M. H. Lecomte § criticizes very unfavourably Dr. Blass's theory that the sieve-tubes are the locality of the formation, and not merely the conducting tissue, for albuminoid substances. He asserts that the theory rests on assumptions rather than on proved facts, and points out that it is opposed to other facts which have been established with regard to these vessels.

M. Lecomte further states that Dr. Blass does not pay sufficient

* Zeitschr. f. Forst- u. Jagdwesen, 1889, pp. 385–403. See Bot. Centralbl., xliv. (1890) p. 232.
† Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 176–88 (1 pl.).
‡ Jahrb. f. Wiss. Bot. (Pringsheim), xxii. (1890) pp. 253–92. Cf. this Journal, 1890, p. 622.
§ Journ. de Bot. (Morot), iv. (1890) pp. 299–300, 400–4.

attention, in describing transverse sections, to the distinction of the elements, or to the heterogeneous nature of their contents. Dr. Blass asserts that after decortication the contents of the sieve-tubes are identical above and below the decorticated portion. His critic, however, deems the observations on this subject to be incomplete.

Laticiferous System of Fumariaceæ.*—One of the characters hitherto relied on as separating the Fumariaceæ from the nearly allied Papaveraceæ is the absence of the laticiferous system so characteristic of the latter order. M. L. J. Léger shows that this distinction can no longer be maintained, although the nature of the latex is in general different from that of the Papaveraceæ. The laticiferous elements, which were found in all species of Fumariaceæ examined, take the form either of cells indistinguishable from those which surround them, or of more elongated cells, or of cylindrical or prismatic tubes with walls of their own, but never septated or branched. They occur in all organs of the plant,—in the root, hypocotyl, stem, leaves, bracts, calyx, corolla, and ovary; in the medullary parenchyme, the phloem of the vascular bundles, the cortical parenchyme, &c. The latex is usually limpid, without granules or globules, and of a gooseberry-red colour; but, in some species, as *Fumaria capreolata* and *speciosa*, it becomes yellow in the adult plant. On the other hand, some species of Papaveraceæ, e. g. *Eschscholtzia californica* and *tenuifolia*, as well as *Hypecoum procumbens*, intermediate between the two orders, have a red limpid latex resembling that of the Fumariaceæ.

Reserve-receptacles in the Buds of the Ash.†—From the structure of the bud-scales of *Fraxinus excelsior*, Herr F. Schaar draws the conclusion that they serve not merely for protection, but also as a supply of reserve food-material. The tissue which serves this purpose is a thick-walled parenchyme, the thickening-layers of which are absorbed, as the buds unfold, in the same way as a thick-walled endosperm-tissue. A similar nutritive tissue is found also at the point of insertion of the bud; and beneath the bud, in the pith of the branch, a local reservoir of starch, which disappears in the spring. The same is probably true of all buds the scales of which contain a thick-walled parenchyme.

(4) Structure of Organs.

Morphology of the Coniferæ.‡—Dr. M. T. Masters reviews in detail some points in the comparative morphology, anatomy, and life-history of the Coniferæ. The forms which have been described as constituting a distinct genus under the name *Retinospora* are only stages in the life-history of certain species of *Chamæcyparis*, *Thuja*, and *Juniperus*, and may possibly be the origin of new species. The number of cotyledons varies between two and as many as eighteen, and is inconstant, not only in some genera, but even in different individuals of the same species. Their usual form is linear or linear-oblong; the stomates on the cotyledons vary greatly in number; they are usually oval, with

* Comptes Rendus, cxi. (1890) pp. 843–6.
† SB. K. Akad. Wiss. Wien, xcix. (1890) pp. 291–300 (1 pl.).
‡ Journ. Linn. Soc. (Bot.), xxvii. (1890) pp. 226–332 (29 figs.).

two guard-cells. Primordial or primary leaves often intervene between the cotyledons and the adult foliage-leaves; and the adult leaves may vary in different stages of the plant's growth or on different parts of its branches. The leaves not unfrequently exhibit movements, the purpose of which is apparently to secure the exposure of the stomatiferous surface to light and heat. The "needles" of *Pinus* are regarded by the author as true leaves. The "needles" of *Sciadopitys*, on the other hand, may probably be axial structures.

Dr. Masters adopts the gymnospermous view of the flowers of the Coniferæ, and also the hypothesis that each male "catkin" is a single flower. The number of pollen-sacs in an anther (microsporange) varies between two and as many as twenty. The form of the pollen-grain, whether winged or not, cannot be used as an absolutely certain character to distinguish between the Cupressineæ and the Abietineæ. In the female flower the fruit-scale is almost invariably present as something superadded to the bract; it may arise as an enation either from the base of the bract or apparently from the axis just within or above it: its structure is neither that of a leaf proper nor that of an ordinary shoot, but bears more resemblance to that of a cladode.

Theory of Pseudanthy.*—Prof. F. Delpino argues that organogeny by itself is a very untrustworthy test for determining the morphological nature of organs. It is only the comparative morphology of the mature organ that can determine this. Applying the theory of pseudanthy, and in harmony with the evidence afforded by the course of the fibro-vascular bundles, as is well shown in *Alcæa rosea*, he traces the descent of the Malvaceæ from a type allied to *Ricinus*, the staminiferous bodies of this latter genus having become converted into the staminiferous tube of the Malvaceæ, Bombaceæ, and Sterculiaceæ. The Hypericaceæ agree with the Malvaceæ in being pseudanthic, and in all other essential points, differing from them only in characters of secondary importance.

Staminodes of Parnassia.†—From an examination of abnormal flowers of *Parnassia palustris*, Dr. R. von Wettstein draws the conclusion that each staminode or nectary represents not a bundle of stamens, but a single stamen, the central branch corresponding to the filament, and all the branches on each side to an anther-lobe. This conclusion supports the view that the Parnassiaceæ are related to the Saxifragaceæ rather than to the Hypericaceæ.

Pollen-grains.‡—Herr H. Fischer has examined the structure of the pollen-grains in 2214 species of plants. In 1180 of these he finds the extine to present three parallel folds. The most complicated structure of the extine occurs in the Compositæ; it is much simpler in the Monocotyledones than in most Dicotyledones. The author could in no case detect the existence of a third membrane.

Tendrils of the Passifloraceæ.§—M. W. Russell states that there is great difference of opinion amongst botanists as to the nature of the

* Malpighia, iv. (1890) pp. 302–12 (1 pl.). Cf. this Journal, 1890, p. 623.
† Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 304–9 (1 pl.).
‡ Beitr. z. vergleich. Anat. d. Pollen-körner, Breslau, 1890, 69 pp. and 3 pls.
§ Bull. Soc. Bot. France, xxxvii. (1890) pp. 189–91.

tendrils of the Passifloraceæ. The brothers Bravais considered the tendril to be an accessory bud; Masters held that it was the result of the partition of the floral peduncle; while Eichler described the tendril as an axillary branch of the leaf. The author has made most of his observations on *Passiflora holosericea*, and draws the conclusion that the tendril of the Passifloraceæ represents a modified axillary branch.

Protection of Foliage against Transpiration.*—Prof. A. F. W. Schimper has studied this subject, especially in relation to the flora of Java. The protection against excessive transpiration afforded by the reduction of the surface and of the intercellular system, by a coating of resin or wax, by a thick cuticle, &c., is required not only by plants which grow in very dry situations, but also by halophytes, by Alpine plants, and in the colder temperate zones, by evergreen woody plants. This xerophilous character of the foliage is exhibited by the coast vegetation of Java—consisting of the mangrove, *Nipa fruticans*, *Casuarina*, *Cycas circinalis*, species of *Pandanus*, *Ipomæa pes-capræ*, &c., even when the soil on which they grow is frequently flooded. This structure is rendered necessary by the fact that the presence of salt in the substratum hinders the absorption of water, and that concentrated saline solutions in the green cells retard assimilation.

The same xerophilous character is presented by the alpine flora of Java, although the mountain-tops are never covered with snow, and the temperature is throughout the year favourable for vegetation. The principal determining causes appear to be here the rarity of the air and the powerful insolation, both of which have a tendency to promote transpiration. The evergreen trees and shrubs of temperate climates, such as the box, holly, ivy, conifers, &c., exhibit similar protective adaptation against excessive transpiration (and not against cold), in the thick cuticle, depressed stomates, &c.

Abnormal Leaves of Vicia sepium.†—M. W. Russell describes a modification in the structure of the leaves of *Vicia sepium* in consequence of the puncture of an insect, causing the transformation of the leaflets into ascidia. The puncture brings about an inequality in the growth of the cells of the two surfaces of the leaf, causing a folding of the leaflets on its median vein as on an axis.

Influence of the Moisture of the Air on the Production of Spines.‡—M. A. Lothelier has studied the causes which accelerate and retard the production of spines in two plants, namely *Berberis vulgaris* and *Cratægus oxyacantha*. The result of his observations is that the hygrometric state of the air exercises a marked influence on the production of spines in both the plants named. Dry air accelerates their production, while humidity retards it; and the internal differences correspond to the exterior. In a section of a spine exposed to moist air the vessels of the xylem are few in number, and the pericycle is not lignified; in dry air the xylem forms a continuous ligneous circle, and the pericyle is also lignified.

* SB. K. Preuss. Akad. Wiss., 1890, pp. 1045–62.
† Rev. Gén. de Bot. (Bonnier), ii. (1890) pp. 481–9 (4 figs.).
‡ Bull. Soc. Bot. France, xxxvii. (1890) pp. 176–8.

Aerial Roots of Orchideæ.*—Herr E. Palla describes the structure of the aerial roots in two species of Orchideæ, *Angræcum ornithorhynchum* and *Polyrhiza* sp.

In the former species the velamen is furnished with multicellular conical papillæ, having thickened walls, between which the velamen often consists of only a single layer of cells, thus greatly increasing the absorbing surface of these roots, which also serve as the assimilating organ. The leaves are very small and narrow, and of simple structure, only three vascular bundles passing into them.

In *Polyrhiza* the aerial roots have generally a triangular section, the velamen being well developed on the side in contact with the substratum, consisting there of several layers of cells, while it is more or less entirely suppressed on the two other sides. The velamen is furnished with hairs, which apparently serve both as absorbing organs and as organs of attachment.

β. Physiology.

(1) Reproduction and Germination.

Anatomical Characters of Hybrids.†—M. M. Brandza has examined the anatomical structure of the following hybrids, viz.:—*Rosa rugosa-fimbriata*, *Cornus tricolor* (*C. alba* + *C. mas*), *Cirsium arvense-lanceolatum*, *Marrubium Vaillantii* (*M. vulgare*+*Leonurus cardiaca*), *Medicago falcato-sativa*, and *Sorbus hybrida* (*S. Aucuparia* + *S. Aria*); and, while the characters are in each case constant, he finds the following remarkable differences between them. In (1) none of the characters of the hybrid are intermediate between those of the parents, but some of the characters are those of one parent, while others are those of the other parent. In (2) the stem, petiole, and principal veins of the leaf are intermediate in character between those of the parents, while the lamina presents some of the characters of each parent side by side. In (3) the stem and floral axis exhibit intermediate characters, while the petiole has some characters of each parent unchanged. In (4), as in (1), there is no blending of characters, but some of those of each parent are presented side by side. In (5) and (6) the structure is intermediate.

Proterandry and Proterogyny.‡—According to observations made by Mr. T. Meehan, the proterandry or proterogyny of a species is a point frequently governed by the conditions in which it grows. Thus, in the case of the hazel, while in this country the male and female flowers mature nearly simultaneously, in America, with sudden high temperature, the male flowers will open long before the female flowers, while with long-continued temperate heat, the female flowers will advance more rapidly than the male.

Flowers and Insects.§—Continuing his observations on the mode of fertilization and the fertilizers of American plants, Mr. C. Robertson

* SB. K. Akad. Wiss. Wien, xcviii. (1889) pp. 200–7 (2 pls.).
† Rev. Gén. de Bot. (Bonnier), ii. (1890) pp. 433–45, 471–9 (39 figs.).
‡ Proc. Acad. Nat. Sci. Philad., 1890, pp. 268–70.
§ Bot. Gazette, xv. (1890) pp. 199–204. Cf. this Journal, 1890, p. 628.

now describes in this respect several species of Papilionaceæ, the visitors being chiefly Hymenoptera and Diptera, with, in one case, a humming-bird. Several species have extra-floral nectaries.

Self-fertilized Flowers.*—Mr. T. Meehan records the following native or naturalized American plants as self-fertilized:—*Trichostema dichotomum*, *Buddlea curviflora*, *Vitex Agnus-castus*, *Hypericum mutilum*, *H. canadense*, *Phytolacca decandra*, *Lycopersicon esculentum*, *Lycopus virginicus*, *Hamamelis virginica*. He states that whenever a plant is unusually productive, he finds, as a rule, arrangements for self-fertilization.

Pollination of the Mistletoe.†—Dr. C. A. M. Lindman confirms the statement of Loew that the mistletoe is pollinized by insects; besides bees, he believes that flies are also attracted by the scent of the flowers, which he compares to that of apples, and which is strongest in the male flowers. Although the flowers themselves are inconspicuous, the yellow colour of the tips of the perianth-leaves, and of the thick internode beneath the flowers, makes the inflorescence visible for a considerable distance. In the male inflorescence, in addition to the normal terminal flowers, there are solitary flowers, which are larger than the normal ones, in the axils of the small bracts at the base of the inflorescence.

Pollination of Aristolochia, Salvia, and Calceolaria.‡—Herr C. Correns describes in detail the biological anatomy of the flowers of a number of species belonging to these three genera. In *Aristolochia Clematitis* he enters minutely into the structure and origin of the "wicker-hairs" (Reusenhaare) within the perianth-chambers, and the part played by them in insuring pollination. Similar hairs occur in other species of the genus, but are wanting in *A. sipho*, where the perianth-tube is curved, instead of being straight, as in the other species described. The exact mode of pollination in this species must remain undetermined until its insect-visitors have been observed in its native country.

In the different species of *Salvia* there are two mechanical contrivances for assisting pollination by insects, the lever-apparatus of the stamens, and the motility of the upper lip of the corolla. In those in which the latter contrivance is found, the stamens are entirely concealed in the upper lip, and the ordinary are frequently accompanied by cleistogamous flowers. In *S. pratensis* and its allies we have also, in addition to the hermaphrodite, smaller female flowers. The lever-apparatus in the larger flowers is described in detail. In the opinion of the author the viscid glands found on the corolla, stamens, &c., of many species, cannot serve, as Delpino thinks, the purpose of more firmly fastening the pollen-grains to one another.

In some species of *Calceolaria* we find a motile connective and a lever-apparatus somewhat resembling that of *Salvia*. On the outer side of the incurved margin of the lower lip of the corolla, are a number of hairs with glandular apical cells, and the pedicel-cells filled, in some species, with very brightly coloured chlorophyll-grains, but no starch.

* Proc. Acad. Nat. Sci. Philadelphia, 1890, pp. 270–4.
† Bot. Centralbl., 1890, pp. 241–4. Cf. this Journal, 1890, p. 745.
‡ Jahrb. f. Wiss. Bot. (Pringsheim), xxii. (1890) pp. 161–252 (5 pls. and 2 figs.).

Pollination of Crambe maritima.*—Dr. P. Knuth describes the structure and arrangement of the male and female organs in the wild sea-kail, and the arrangements for pollination. Although slightly proterogynous, he considers that, as a rule, the stigma is self-pollinated by the aid of small Coleoptera attracted by the abundant and strongly scented nectar contained in the honey-glands at the base of the stamens.

Change in Colour of the Flower of the Horse-chestnut.†—The inflorescence of the horse-chestnut consists of flowers, some of which are hermaphrodite, but the greater number male from the abortion of the style. On the upper petals are patches which are at first pale yellow and comparatively inconspicuous, but which, when the flower begins to wither, become bright red and much more conspicuous. Herr W. O. Focke has investigated the object of this change of colour, and has come to the conclusion that it is of no advantage to the individual flower, the small insects which are attracted by it taking no part in the process of pollination; its sole purpose seems to be to render the entire inflorescence more conspicuous to the humble-bees which are the principal fertilizers of the flowers.

Oospores formed by Union of Multinucleated Sexual Elements.‡—M. P. A. Dangeard finds that the young oogone of *Cystopus candidus* contains several nuclei; these do not fuse into one with the nuclei of the antherid, and there is no fusion of male and female nuclei. The so-called nucleus is an oily globule, completely soluble in chloroform, and it is surrounded by a layer of protoplasm which contains numerous nuclei. As the author has made similar observations on *Ancylistes*, *Saprolegnia*, *Pythium*, and *Peronospora*, he thinks his results may be generalized; the theory, therefore, of Fisch, that there is a fusion of nuclei in oospores formed by the union of multinucleated sexual elements, must be given up.

Germination of Seed of Castor-oil Plant.§—Prof. J. R. Green has been led by his study of *Ricinus communis* to the following conclusions:—The reserve-materials in the endosperm consist of oil and proteid matters, the latter being a mixture of globulin and albumose. The changes in germination are partly due to ferment action, and there are three ferments in the germinating seed; one is proteolytic and resembles trypsin, one is a glyceride, and splits the oil into fatty acid and glycerin, while the third is a rennet ferment. Two, if not all three, are in a zymogen condition in the resting seed, and become active in consequence of the metabolic activity stirred up in the cells by the conditions which lead to germination. The changes caused by the ferment action are followed by others, which are due to the metabolism of the cells, and on these the embryo exercises some influence by setting up, as it developes, a stimulus which is probably physiological. The result of the various processes is to bring about the conversion of the proteids into peptone, and, later, into asparagin, and the splitting of the oil into fatty acid and glycerin;

* Bot. Centralbl., xliv. (1890) pp. 305–8 (2 figs.).
† Abhandl. Bot. Ver. Brandenburg, xxxi. (1890) pp. 108–12.
‡ Comptes Rendus, cxi. (1890) pp. 382–4.
§ Proc. Roy. Soc. Lond., xlviii. (1890) pp. 370–92.

the latter gives rise to sugar, and the former to a form of vegetable acid which is soluble in water and in ether, is crystalline, and has the power of dialysis.

Germination of Seeds of Papilionaceæ.*— According to Sigg. O. Mattirolo and L. Buscalioni, when the seeds of Papilionaceæ (*Phaseolus multiflorus*, *Vicia Faba*, *Pisum sativum*, *Lupinus albus*) germinate, or are brought into contact with water, the process can be divided into three periods, viz. :—(1) The seed increases in size, causing a wrinkling of the integument, the absorption of water by which is the cause of the increase; cavities are formed between the integument and the cotyledons, and in the intercellular spaces of the integument itself, in which the air necessarily becomes rarefied. (2) A period of decrease in size due to the absorption of the air in the intercellular spaces. (3) This is followed by a second period of increase in size due in part to decomposition. The micropyle, which can open or close according to the hygrometric conditions, is the natural channel through which air enters the seed; and the integument of the seed plays a most important part in the respiration which is essential to its germination.

Germination of the Sugar-cane.†—Dr. Fressanges describes and figures an instance of germination of the grain of the sugar-cane while still within the panicle. The mode of germination has never been accurately described.

Temperature of Tubercles during Germination.‡—M. H. Devaux gives the results of some observations on the temperature of a mass of germinating potatoes. At the height of 30 cm. from the bottom of the heap the temperature was little in excess of that of the surrounding air; at 60 cm. the temperature was 23° C., the air being 20° C. At 130 cm. it was 29° C., while at the top of the mass, at about 2 metres, it was 39° C.

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

Absorption of Nitrogen.§—From experiments made in cultivating poppies and wheat in sterilized sand, M. Pagnoul concludes that ammoniacal nitrogen can be assimilated by plants when the nitric fermentation is deficient; but that it is notably inferior in this form to nitric nitrogen from the point of view of the nutrition of the plant.

Assimilation of Nitrogen by Robinia.‖ — By causing seeds of *Robinia Pseudacacia* to germinate in a soil and a nutrient fluid entirely destitute of nitrogen-compounds, Herr B. Frank convinced himself that this leguminous tree possesses the same property as the herbaceous plants belonging to the order, of extracting nitrogen directly from the atmosphere. Tubercles were abundantly formed on the root, and, during the first summer, the seedling had obtained an amount of nitrogen 38-fold greater than that contained in the seed, nearly the whole of which must have been derived from the nitrogen of the atmosphere.

* Malpighia, iv. (1890) pp. 313–30 (6 pls.). Cf. this Journal, 1890, p. 625.
† Rev. Hist. et Litt. de l'Ile Maurice, April 23, 1890 (1 pl.). See Journ. of Bot., xxviii. (1890) p. 303.
‡ Bull. Soc. Bot. France, xxxvii. (1890) pp. 168–70.
§ Comptes Rendus, cxi. (1890) pp. 507–9.
‖ Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 292–4.

Conduction of Water.*—Pursuing his investigations on this subject, Herr T. Bokorny finds that, in the case of *Myriophyllum proserpinacoides*, air and water are always present in the scalariform and spiral vessels of the vascular bundles. In addition to the vessels, the conduction of water appears to take place mainly through the outer and collenchymatous portion of the bast, but chiefly through the former. Experiments with iron-salts show that in this case the course of the ascent of water is through the wall of the vessels.

By the same method of investigation the same author † demonstrates that in *Rumex longifolius* and other species of the order, the transpiration-current passes through the cell-walls of the collenchymatous tissue of the leaf-stalk to the transpiring lamina of the leaf, and with a rapidity of not less than 1 metre per hour. The collenchymatous tissue is here distinguished by the great elongation of its cells.

Herr Bokorny ‡ further defends himself from the charge that he does not assign to plants any tissue with the special function of conducting water; what he does maintain is that there is no tissue which has always and exclusively this function in all plants.

(3) Irritability.

Sensitiveness of Plants to certain Salts.§—M. G. Ville points out that the sensitiveness of plants to certain salts may be used as a test for the presence of these latter. That the test is a delicate one may be easily inferred from the results obtained by the author in various plants with phosphate of lime.

Beer yeast gave very astonishing results, the presence of 0·0005 gr, dissolved in 1 litre being easily seen from its results on the growth of the yeast. Analogous results were obtained from experiments made with peas and wheat.

The experiments show the value of phosphate of lime as a manure or a necessary nutriment for perfect development, but their use as a test for this salt seems rather doubtful.

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

Physiology of Woody Plants.||—Dr. A. Fischer finds that in summer the vessels of many dicotyledonous and monocotyledonous trees and the tracheids of conifers exhibit a decided glucose-reaction, while in about the same number the reaction is very slight or altogether wanting; the glucose does not occur in the wood-fibres. Dwarf shrubs and herbs contain no glucose in their stem, root, or leaf-stalks. In the winter the quantity of glucose sensibly diminishes, increasing again in the spring during the period of blossoming. The quantity of starch in trees shows one maximum in the autumn when the leaves begin to fall; after the fall of the leaves it decreases, reaching a minimum in the winter; it is formed again in the early spring, reaching a maximum about April, and then again decreasing, to be stored up again in the summer. In the

* Jahrb. f. Wiss. Bot. (Pringsheim), xxi. (1890) pp. 505–19. Cf. this Journal, 1890, p. 484.
† Biol. Centralbl., x. (1890) pp. 321–3.
‡ Bot. Ztg., xlviii. (1890) pp. 493–5.
§ Comptes Rendus, cxi. (1890) pp. 158–61.
|| Jahrb. f. Wiss. Bot. (Pringsheim), xxii. (1890) pp. 73–160.

buds also important changes take place in the amount of starch stored up in them in the winter. In most dicotyledonous and monocotyledonous trees, especially those with hard wood, the reserve-starch remains unchanged in the wood and pith from the autumn till May; while in conifers and soft-wooded trees, such as the lime and birch, either the whole or the greater part of the starch is transformed into a fatty oil, or a portion of it in the bark into glucose. The carbohydrates formed in the leaves descend only through the cortex.

Physiological Researches on the Floral Envelopes.*—M. G. Curtel states that he has noticed that the flower, and the corolla in particular, carries on in darkness, or in a feeble light, a more active transpiration than does the leaf. This the author proves by experiments with *Cobæa scandens.* The intensity of the respiration is in like manner greater than that of the leaf, the quantity of oxygen absorbed being considerably in excess of the carbon dioxide given off. A great number of flowers contain chlorophyll in their perianth; sometimes the process of assimilation may be noted by the disengagement of oxygen, but more often the assimilatory process is masked by the respiration. It will be seen then that the general result is an energetic oxidization of the floral perianth, one of the consequences of this being that coloured substances are formed from the chlorophyll, which give to the floral envelopes their characteristic brilliancy.

Formation of Calcium Oxalate.†—Dr. F. G. Kohl supports the view of Palladin ‡ that oxalic acid must be regarded as a secondary product in the synthesis of albumen from amides and carbohydrates. Although it has not yet been detected in all cases, it is probable that all Algæ and Fungi, as well as Flowering Plants, produce oxalic acid or an organic acid that can physiologically replace it. Since the cells of fungi absorb very little, if any, lime, they cannot, of course yield crystals of calcium oxalate.

The production of oxalic acid by *Saccharomyces Hansenii*, already recorded by Zopf, may be regarded as an oxalic fermentation comparable to the acetic fermentation in being a process of oxidation. Dr. Kohl distinguishes two kinds of fermentation:—(1) oxidizing fermentation which results in the formation of acetic acid in the Schizomycetes, of oxalic and carbonic acid in Fungi, Algæ, Muscineæ, Vascular Cryptogams, and Phanerogams, and of tartaric and malic acids in the higher plants; and (2) reducing fermentation, resulting in the production of alcohol by Schizomycetes and Fungi, and of lactic and butyric acids by Schizomycetes.

Reduction of Nitrates to Nitrites by Plants.§—M. E. Laurent states that many other organs of growing plants have the same property as that already known in the case of germinating seeds, of reducing nitrates to nitrites. This was determined in the case of tubers, roots, petioles, stems, peduncles, and young fruits. The purpose of this function appears to be to furnish the living cells with oxygen for the

* Comptes Rendus, cxi. (1890) pp. 539–41.
† Bot. Centralbl., xliv. (1890) pp. 337–44 (3 figs.). Cf. this Journal, 1890, p. 476.
‡ Cf. this Journal, 1888, p. 247.
§ Bull. Acad. R. Sci. Belgique, xix. (1890) pp. 478–85.

purpose of respiration. The most satisfactory test for the presence of nitrites was found to be the reaction with chloride of naphthylamin in the presence of hydrochloric and sulphanilic acids.

Influence of Anæsthetics on Respiration.*—Sig. A. Mori has investigated the effects of anæsthetics on the respiration of green plants in light and darkness. Light and the anæsthetic favoured, darkness and the anæsthetic hindered, the emission of carbon dioxide. He inclines to believe that the anæsthetic, acting in sunlight, suspends the synthetic function with which the chlorophyll is associated, and thus increases the amount of carbon dioxide liberated. In darkness the anæsthetic certainly hindered the general respiration, for the amount of carbon dioxide liberated was less than the normal.

Presence of a Diastatic Enzyme in Plants.†—Herr J. Wortmann is unable to accept the statement of Mayer and others, that a diastatic ferment is universally present in all parts of plants, and that this substance is as widely distributed as starch itself, and indispensable to its absorption. He maintains that not only can starch be absorbed without the assistance of diastase, but that diastase may occur where it can have no physiological function in connection with the absorption of starch.

For the demonstration of the presence of diastase, the author recommends that the part of the plant in question be extracted, after being thoroughly crushed, with an equal volume of water, and that, except where large quantities of starch, mucilage, or albuminoids are present, the extraction should not last over more than from two to three hours in the cold. The presence of diastase is then shown by its action on starch.

As the result of a very large number of experiments, Wortmann finds that in reserve-receptacles where great quantities of starch are stored up, such as seeds, tubers, and rhizomes, diastase is also present in considerable quantities; while, on the other hand, it is not present in assimilating leaves, the disappearance of starch from these organs not being in any way dependent on the action of diastase. In opposition to Krabbe,‡ he states that protoplasm can disintegrate starch-grains in precisely the same way as diastase, by the formation of pore-canals.

Oil-decomposing Ferment in Plants.§—From experiments made by Herr W. Sigmund, chiefly on the seeds of *Brassica* and *Ricinus*, he concludes that there exists in plants a ferment capable of decomposing the fatty oils, the fatty acid resulting from the decomposition being principally oleic acid. The operation of the ferment is very much slower and less energetic than that of the pancreatic secretion of animals.

Fermentation of Bread.‖—According to experiments made by Miss Katherine E. Golden with German yeast, both yeast and bacteria can separately raise bread, the yeast sometimes better than the bacteria; while in the ordinary making of bread they act together.

* Atti e Rend. Accad. Med. Chirurg. Perugia, ii. (1890) pp. 135–41.
† Bot. Ztg., xlviii. (1890) pp. 581–94, 597–607, 617–27, 633–54, 657–69.
‡ Cf. this Journal, 1890, p. 749.
§ SB. K. Akad. Wiss. Wien, xcix. (1890) pp. 407–11.
‖ Bot. Gazette, xv. (1890) pp. 204–9.

Fermentation of Cider.*—M. E. Kayser, in studying the fermentation of cider, directed his attention in the first place to the chemical aspect of the different French ciders. Although these showed obvious differences of alcohol, tannin, sugar, glycerin, acids, &c., no results sufficiently definite for practical purposes were obtainable. Another object in view was to examine the various forms of fermentation-fungi. For this purpose 120 Pasteur's flasks containing apple-juice were inoculated with single cells from pure cultivations. In the end the number was reduced to eleven species. In this examination the following points were taken into consideration: the form and size of the cells, the surface scum and the bottom deposit, the sensibility of the vegetation to acid and alkaline sugar solutions. The clearness, taste, and odour of the resulting liquid were also noted. In examining the various kinds of *Saccharomyces* the author adopted a modification of the method introduced by Hansen; that is, noting the temperature-curves during spore-formation. This method is stated to have furnished excellent results. In another series of experiments the author made use of seven kinds of yeast, either alone or in mixtures, and, as far as possible, under conditions similar to those adopted in the commercial manufacture of cider. The results, as might be expected, were various, some being good, others indifferent, and others bad. The addition of *Saccharomyces apiculatus* imparted a perfumed bouquet.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Selaginella lepidophylla.†—Herr W. P. Wojinowic describes the phenomena connected with the closing up and opening out of this plant under the influence of drought and moisture. It is a purely mechanical process, depending on its hygroscopic properties, and on the form of the primary axis of the plant, which is sympodial, forming a corkscrew-like spiral.

Vascular Bundles of Isoëtes.‡—Sig. O. Kruch describes in detail the histology and development of the conducting bundle in the leaves of *Isoëtes*. It is collateral, and its phloem-portion consists of sieve-tubes and parenchymatous or cambiform elements, which generally become transformed, except at the base of the leaf, into mechanical elements. The grouping of the sieve-tubes differs in the different species. Their longitudinal walls are distinctly thickened and punctated. The sieve-plate is covered by a substance which gives the reactions of callus. The xylem consists, in the limb of the leaf, of a system of canals bounded by cells of a special character, and of a parenchyme, in which some annular or spiral tracheids are dispersed. The bounding cells are of considerable width, and have very thin radial walls. As regards the

* Annal. de l'Institut Pasteur, iv. (1890) p. 321. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 726–7.

† Beitr. z. Morph. Anat. u. Biol. d. Selaginella lepidophylla, Breslau, 1890. See Flora, lxxiii. (1890) p. 501.

‡ Nuov. Giorn. Bot. Ital., xxii. (1890) pp. 396–402; and Malpighia, iv. (1890) pp. 56–82 (4 pls.).

development of the bundles, the first elements to become differentiated are sieve-tubes, followed by the central tracheid of the xylem. The tracheids which are first differentiated are prismatic, with polygonal section, and are terminated by horizontal septa.

In all the species examined, in the portion of the leaf which runs from the glossopode to its insertion in the rhizome, the sieve-tubes are united into a single zone, and constitute the greater part of the phloem-arc. In the section of the ligule and in that of the sporange, the xylem consists simply of tracheids of irregular thickness, constituting a network, the meshes of which are occupied by very thin-walled cells.

Lycopodiaceæ.*—Prof. F. O. Bower gives a sketch of the structure of this order of Vascular Cryptogams, and of its relationship to the extinct *Lepidodendra*. He states that while the latter, which varied among themselves to a considerable extent as regards details, correspond in their most important characters to the *Lycopodium* of the present day, they yet differed greatly from them in several respects, of which the most notable are their size, the presence of secondary thickenings in the stem, and the greater sexual differentiation as shown by the presence of two kinds of spore, male and female.

Hymenophyllaceæ.†—Herr C. Giesenhagen has examined the sexual generation of several species of Hymenophyllaceæ, especially *H. caudiculatum*. The prothallium of several species of *Trichomanes* is distinguished by the formation of gemmæ, spherical cells elevated on the apex of a pedicel, which divide, and finally become detached from the pedicel, and develope into new prothalloid filaments. While the prothallium of *Trichomanes* is diœcious, that of *Hymenophyllum* is frequently monœcious. The prothallium of *T. radicans* may continue to grow for three years without producing antherids or archegones.

In the spore-producing generation, while many species are rootless, others produce adventitious roots. Some species have barren and fertile leaves of different structure; the sterile leaves are always simply pinnate. Most species of *Trichomanes* are distinguished by the occurrence in the stem of "stegmata," flat tabular cells containing a mass of silica in contact with their inner wall. A sclerenchymatous cortex is almost universal in the stem and root. *Trichomanes microphyllum* n. sp. belonging to the section Hemiphlebium, is the smallest known fern, with leaves not more than 7 mm. in length, each of which has a single terminal sorus. The stem is penetrated by a vascular bundle of the simplest possible constitution, consisting of a single tracheid surrounded by four or five cambiform cells. The purpose of the conducting bundle in the Hymenophyllaceæ appears to be to carry the nutrient material to the sori and other parts where it is required. The rootless species have root-like cauline shoots, which attach the plant, and serve for the absorption of nutrient material. While the stem-bundle is completely surrounded by a sclerenchymatous ring, in the leaf-veins the bundle is protected only by a layer of sclerenchyme above and below, and the nutrient material reaches it from the parenchyme of the leaf through the lateral openings.

* Proc. Phil. Soc. Glasgow, xxi. (1890) pp. 158–72.
† Flora, lxxiii. (1890) pp. 411–64 (4 pls.).

The author is of opinion that neither the anatomy nor the morphology of the Hymenophyllaceæ lends itself to the view that they present an archaic form from which all other ferns are derived.

Stem of Ophioglossaceæ.*—In contrast to the statement of other writers, and to his own previous view, M. P. Van Tieghem now regards the stem of all the genera of Ophioglossaceæ as monostelic in the tigellar portion, i. e. below the first leaf, and astelic (i. e. without any central cylinder) in the portion of the stem above the first leaf. The difference which is manifested between the two types of stem in the order—viz. that of *Ophioglossum* on the one hand and that of *Botrychium* and *Helminthostachys* on the other hand—consists really in this, that in the former case the vascular bundles are free or dialydesmic, in the latter case they coalesce laterally, or are gamodesmic. This astelic structure of the stem marks a divergence from the Filicineæ, and brings the Ophioglossaceæ nearer to the Equisetaceæ, where we have also the astelic structure, both dialydesmic and gamodesmic.

Algæ.

Symbiosis of Algæ and Animals.†—Mdme. A. Weber-Van Bosse and Prof. M. Weber describe the following new example of true or apparent symbiosis from the Dutch East Indies.

A filamentous alga, *Trentepohlia spongophila* n. sp., was found in a freshwater lake in Sumatra, imparting a green colour to the sponge *Ephydatia fluviatilis*, and producing zoospores. The alga alone appears to derive benefit from the commensalism, but the sponge does not suffer injury from the perforation of its tissue. This is, therefore, not an example of true parasitism, but is rather a transitional case between true symbiosis and parasitism.

True symbiosis was observed between a marine sponge belonging to the genus *Halichondria* and *Struvea delicatula;* the former growing to a larger size than usual when infested by the alga, which becomes somewhat modified and assumes the appearance of *Spongocladia vaucheriæformis.*

Marchesettia spongioides was found in symbiosis with a *Reniera.*

The authors enumerate the following as true examples of symbiosis:—*Struvea delicatula* with a *Halichondria; Marchesettia spongioides* with *Reniera fibulata; Spongocladia vaucheriæformis* with *Reniera fibulata; Oscillaria spongeliæ* with *Spongelia pallescens* and *Psammoclema ramosum.* The following are doubtful:—*Callithamnion membranaceum* with *Spongelia pallescens, S. spinifera,* and *Aplysilla sulfurea; Scytonema* with *Spongia otaheitica.* The following must be regarded as instances of parasitism:—*Thamnoclonium flabelliforme* on *Reniera fibulata;* the Floridea observed by Lendenfeld on *Dactylochalina australis; Thamnoclonium spongioides* and *Rhodymenia palmetta* on an undetermined sponge; *Trentepohlia spongophila* on *Ephydatia fluviatilis.*

* Journ. de Bot. (Morot), iv. (1890) pp. 405–10.

† 'Zool. Ergebnisse einer Reise nach Niederländisch Ost-Indien,' Heft i. pp. 48–71 (1 pl.) Leiden, 1890. See Bot. Centralbl., xliii. (1890) p. 118; and Ann. Jard. Bot. Buitenzorg, viii. (1890) pp. 79–94 (2 pls.).

Fucoideæ of Scandinavia.*—Herr F. R. Kjellman proposes the following new classification of the Fucoideæ :—

Cl. I. Cyclosporeæ.
 Fam. 1. Fucaceæ (Cystoseireæ, Himanthalieæ, Fuceæ).
Cl. II. Phæosporeæ.
 Order 1. Zoogonieæ.
  Suborder 1. Gynocratæ.
   Fam. 1. Cutleriaceæ.
  Suborder 2. Isogonicæ.
   Fam. 1. Lithodermataceæ, 2. Laminariaceæ, 3. Sporochnaceæ, 4. Ralfsiaceæ, 5. Spermatochnaceæ, 6. Stilophoraceæ, 7. Chordariaceæ, 8. Elachistaceæ, 9. Myriotrichiaceæ, 10. Desmarestiaceæ, 11. Dictyosiphonaceæ, 12. Striariaceæ, 13. Encœliaceæ, 14. Sphacelariaceæ, 15. Ectocarpaceæ.
 Order 2. Acinetæ.
  Fam. 1. Tilopterideæ.

Two new genera are also proposed :—*Phæosphærium* founded on *Linkia punctiformis*, and *Physematoplea* on *Scytosiphon attenuatus*.

Sphacelariaceæ.†—Herr J. Reinke gives a monograph of the species hitherto known of this family of Phæosporeæ, with descriptions of four new genera. He now regards them as a distinct family from the Ectocarpaceæ, the genus *Isthmoplea* belonging to the latter, while *Lithoderma* is the genus of Ectocarpaceæ which exhibits the nearest affinity to the Sphacelariaceæ, and is perhaps their point of departure. A histological character by which the Sphacelariaceæ are distinguished from *Lithoderma*, *Ectocarpus*, *Isthmoplea*, and all other Phæosporeæ, is the black colour imparted to them by eau de Javelle. The growth in length of the axes is effected by the lengthening and transverse septation of the apical cell.

The family consists of ten genera, viz. *Battersia* gen. n. (1 sp.), *Sphacella* gen. n. (1 sp.), *Sphacelaria* (12 sp.), *Chætopteris* (1 sp.), *Cladostephus* (3 sp.), *Halopteris* (1 sp.), *Stypocaulon* (3 sp.), *Phloiocaulon* (2 sp.), *Anisocladus* gen. n. (1 sp.), and *Ptilopogon* gen. n. (1 sp.). *Battersia* forms a distinct section of the family, distinguished by its crustaceous habit, the fertile branches springing directly from the relatively very large basal disc, and these branches ending in unilocular sporanges. The only species, *Battersia mirabilis*, is at present known only from Berwick. *Sphacella subtilissima*, from the Balearic Islands, forms small dense cushions on *Carpomitra*, on which it is parasitic; on the erect slightly branched uniseriate branches are numerous unilocular sporanges. In *Anisocladus*, from South Africa and New Zealand, the normal branches are always barren, and the fructification is confined to short branched adventitious branches, in the axils of which are both plurilocular and unilocular sporanges. *Ptilopogon*, from New Zealand, also has both kinds of sporange, which are found only in the axils of the branches of tufted adventitious shoots. The plant is of

* 'Handbok i Skand. Hafsalgflora,' Th. 1, Fucoideæ, Stockholm, 1890, 103 pp. See Bot. Centralbl., xliv. (1890) p. 148.

† Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 201–15 (3 figs.).

large size, and is differentiated into primary and secondary axes, and branched leaves.

New Genera of Algæ.*—In his monograph of the Algæ of South Georgia, Dr. P. F. Reinsch describes four new genera, one freshwater and three marine, viz.:—*Dermatomeris*, belonging to the Ulvaceæ, with a coriaceous-gelatinous thallus; *Stegastrum*, belonging to the Chordariaceæ, and near to *Myrionema*, epiphytic on *Porphyra; Melastictis*, doubtfully placed among the Chordariaceæ, a true parasite; and *Hydrurites*, probably allied to *Hydrurus*. In none of them were the organs of reproduction made out with certainty.

Conjugation of Spirogyra.†—According to Prof. G. Haberlandt the two corresponding conjugation tubes do not begin to be formed at the same time in *Spirogyra quinina;* it is sometimes the tube of the male cell, sometimes that of the female cell, that is first formed; and the place of formation of the later one is in all probability determined by the chemical excitation exerted by a substance exuded from the apex of the older tube. As the two tubes are not always formed exactly opposite to one another, one or the other has to bend in order that they may meet, and this curvature is also probably of a chemotropic character. The contraction of the protoplast of the female cell, and its conversion into a gamete are also the result of a direct excitation by the male cell.

Trentepohlia.‡—M. E. de Wildeman describes the species of *Trentepohlia* natives of the Dutch East Indies, including the following new species:—*T. Bossei*, *T. luteo-fusca*, *T. procumbens*. The classification of the species is that adopted in his previous papers.

Enteromorpha.§—M. E. de Wildeman has followed out the mode of growth of *Enteromorpha intestinalis*, and especially the formation of the branches. In addition to the larger branches which spring from the base of the plant, there are often a large number of small branches springing from its upper region. Each of these originates in a rounded cell larger than those which surround it, which divides by a succession of transverse divisions to form a row of cells, and these finally, at least in the apical portion, also divide longitudinally. These branches may then become detached, and grow into new plants.

Volvox and Eudorina.‖—Continuing his observations on *Volvox*, Dr. L. Klein states that the colonies of *V. globator* are exclusively nonsexual and monœcious (almost invariably proterogynous), while in *V. aureus* as many as twenty-one different combinations are possible, and actually exist. The oospheres, which can be distinguished with certainty from the parthenogonids only by their deeper colour before maturity, may, in certain cases, develope into daughter-colonies without impregnation. The author distinguishes two kinds of "*Sphærosira*-form" of *V. aureus*—the normal form in which the division of the

* 'Die Deutschen Polarexpeditionen,' vi. (1890) pp. 329–449 (19 pls.). See Hedwigia, xxix. (1890) p. 285.

† SB. K. Akad. Wiss. Wien, xcix. (1890) pp. 390–400 (1 pl.).

‡ Ann. Jard. Bot. Buitenzorg, ix. (1890) pp. 124–42 (3 pls.). Cf. this Journal, 1890, p. 490.

§ Notarisia, v. (1890) pp. 1115–21 (1 pl.).

‖ Ber. Naturf. Gesell. Freiburg, v. (1890) 92 pp. and 5 pls. See Bot. Centralbl., xliv. (1890) p. 319. Cf. this Journal, 1889, p. 558.

antherozoids begins only after leaving the mother-colony, and the *Endosphærosiræ*, which are always smaller, and in which mature bundles of antherozoids are formed before their escape. Of *Eudorina elegans* the author observed both tabular and spherical daughter-colonies, but was unable to determine whether they were male or non-sexual. The bundles of antherozoids he regards as male colonies.

Reproduction of Hydrodictyon.*—Dr. G. Klebs gives further details of his experiments on the conditions which determine the production of zoospores or of gametes in *Hydrodictyon utriculatum*. The nutrient solution employed imparts to all cells the most active tendency to the production of zoospores. In the dependence of the production of zoospores on light, *Hydrodictyon* presents a marked contrast to *Œdogonium* and other Algæ; but recalls the similar phenomenon in the growth and production of cellulose in *Zygnema*. The presence of oxygen is also essential to the formation of zoospores. The power of non-sexual multiplication which lies latent in every cell is dependent on the presence of a definite material element which the author terms the rudiment. The conditions for its perfect development are the presence of warmth, oxygen, organic nutrient substances, nutrient salts, light, and fresh water. Of these the nutrient salts are the most important.

Gametes can also be formed in all mature nets; the determining factors being not internal causes but external conditions. The most favourable is a 5 per cent. solution of cane-sugar, with absence of nutrient salts; glycerin produces the same effect; also glucose, milk-sugar, mannite, and erythrite; a moderately high temperature is also essential; but the formation of gametes appears to be almost independent of light.

By varying the conditions, as above indicated, one and the same net may be induced to form zoospores in one part, gametes in another part. The conditions under which one or the other tendency predominates are given in detail. While an interruption of growth tends to induce the formation of zoospores, and the suppression of the production of zoospores induces a tendency to the formation of gametes, the experiments afford no support to the hypothesis that the maturity of the cell is by itself favourable to the production of sexual elements.

New Genus of Siphoneæ.†—Prof. J. G. Agardh thus describes a new genus *Callipsyma*, belonging to the Udoteaceæ:—But slightly encrusted, and having the filaments which compose the entire frond constricted into oblong joints; those of the laminæ which proceed from the margin of the rachis dichotomous and laterally agglutinated; those of the stem slightly flexuose.

Fungi.

Behaviour of the lower Fungi towards inorganic nitrogen-compounds.‡ — According to Herr O. Loew formic aldehyde CH_2O is poisonous to fungi and other organisms, but some of its unstable compounds are not. Only such inorganic compounds of nitrogen can supply

* Flora, lxxiii. (1890) pp. 351–410. Cf. this Journal, 1890, p. 206.
† 'Till Algernas Systematik,' Lund, 1887, p. 65. Cf. this Journal, 1887, p. 998.
‡ Biol. Centralbl., x. (1890) pp. 577–91.

nutriment as are easily transformed in the cells into ammonia. The nearly related hydroxylamin, NH_2OH, is, on the other hand, highly poisonous. This substance has not the least effect upon ordinary dissolved albumen; while, even when dilute, it immediately kills living protoplasm. In the same way the diamids entirely prevent the formation and growth of Schizomycetes. While a 1 per mil. solution of sulphate, phosphate, or nitrate of ammonia kills *Spirogyra* in twenty-four hours, even a 10 per cent. solution has no injurious effect on the lower fungi. The elimination of free oxygen during putrefaction takes place only when the putrefying substance contains nitrates.

Trehalose in Fungi.*—M. E. Bourquelot states that among the saccharine substances met with in fungi there is one, namely trehalose, which attracts particular attention. The author has analysed two examples of young *Lactarius piperatus*; the first was treated with boiling water and the second was desiccated in the air. In the former trehalose was exclusively found and in the latter mannite. The disappearance of the trehalose had therefore taken place during the desiccation.

Saprolegniaceæ parasitic on Algæ.†—M. E. de Wildeman records the following species of Saprolegniaceæ parasitic on different Algæ:—*Aphanomyces phycophilus*, *Lagenidium Rabenhorstii*, and *L. entophytum* on *Spirogyra*, *Ancylistes Closterii* on *Closterium acerosum*, and *Lagenidium Zopfii* n. sp., allied to *L. entophytum*, on a species of *Œdogonium*.

Devœa, a new marine genus of Saprolegniaceæ.‡—After explaining the life-history of *Saprolegnia* and *Dictyuchus*, Dr. S. Lockwood describes, under the name *Devœa infundibuliformis*, a new type of Saprolegniaceæ parasitic on the scales of *Hippocampus heptagonus*. The thallus has the form of a funnel or cornucopia surmounted by a lid or opercule. Within this funnel are produced the zoospores, which appear to escape by a fissure in the side. The following is given as a diagnosis of the new genus:—Thallus an infundibuloid capsule or sporangial cell, the basal end an imperforate point, often a little curved, constricted or inflected at the rim, making the aperture about 4/5 of the diameter across the face. Fitting to this is a membranous cap or opercule, very variable in length and in the form of the posterior part. Inside the capsule is a hollow core of somewhat wavy or irregular parallel planes, their inner edges making a well in the middle of the capsule. The zoospores from these hymeneal lamellæ issuing into the well, and there swelling, the mass rises and lifts off the opercule, flows over the rim, and thus swarms from the mother-cell. Neither hyphæ nor mycele were observed.

Gymnoascaceæ and Ascomycetes.§—Prof. H. Zukal describes new species of *Gymnoascus* and *Microascus*, and two new genera allied to *Gymnoascus*, viz.:—*Aphanoascus*, in which the envelope of the fructification resembles that of *Gymnoascus* only until the spores are ripe, developing later into a close pseudo-parenchyme; the mode of origin of the asci, spores, and intermediate hyphæ corresponds closely to that in

* Comptes Rendus, cxi. (1890) pp. 534–6.
† Bull. Soc. Belge Microscopie, 1890, pp. 134–9.
‡ Journ. New York Microscop. Soc., vi. (1890) pp. 67–85 (3 pls.).
§ Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 295–303 (1 pl.). Cf. this Journal, 1890, p. 366.

Gymnoascus. *A. cinnabarinus*, found on alligator's excrement, presents a connecting link between *Gymnoascus* and *Eurotium*. In *Chætotheca* the peritheces are depressed and hemispherical, thick-walled and not coiled, and are surrounded by long slender blackish thick-walled hairs; the pear-shaped or nearly spherical asci arise laterally or at the end of very delicate much-branched hyphæ; the spores are eight in an ascus, smooth, and lens-shaped.

Prof. Zukal holds there is no real analogy between the mode of formation of the ascus of the Gymnoascaceæ and that of the archicarp of *Eurotium*, &c. Its origin is simply an accumulation of protoplasm in a hypha, the apex of which then becomes coiled by circumnutation. He believes that the basal portion of the slender sterile hyphæ in the fructification of the Gymnoascaceæ serves for the conveyance of nutrient material to the ascogenous branches; and that the corresponding hyphæ in *Penicillium* perform the same function. The true Gymnoascaceæ—*Endomyces*, *Gymnoascus*, *Ctenomyces*, and *Penicillium* — excluding *Eremascus*, are in fact nearly allied to *Eurotium*, *Aphanoascus*, *Cephalotheca*, *Chætotheca*, and *Microascus*.

Disease of the Beetroot.*—M. E. Prillieux has been able to follow the various phases of a beetroot disease, the chief characteristic of which is that it causes the young leaves to dry up and become black. The disease has been attributed to a fungus named by Fuckel *Sporidesmium putrefaciens*. As, however, the figure published by Fuckel does not correspond to any of the forms observed by the author on the small black leaves at the heart of the beetroot, he deems these to be due to a fungus for which he proposes the name of *Phyllosticta tabifica*, which causes white spots on the petioles.

Black-rot of Grapes.† — In reference to the alleged identity of *Phyllosticta Labruscæ* and *P. Ampelopsidis* with *Lastadia Bidwellii*, Mr. B. T. Galloway finds that inoculation of either the berry or leaf of *Vitis* and *Ampelopsis* with pycnid-spores from berries or leaves of the grape infected with the black-rot gives no result; while inoculation of *Ampelopsis* or *Vitis*-leaves with ascospores from infected grape-berries resulted in the formation of pycnids and spores of *Phyllosticta Ampelopsidis*.

Fungi parasitic on Forest-trees.‡—Herr E. Rostrup gives a summary of his observations during the years 1883–1888 on the fungi which cause diseases on forest trees in Denmark. They relate chiefly to the following species:—

Melampsora pinitorqua (*Cæoma pinitorquum*), on *Pinus excelsa* and *Mughus*, connected genetically with the *Melampsora* on *Populus tremula*; *M. betulina*, much more injurious to *Betula odorata* than to *B. verrucosa*; *Peridermium Pini* includes three distinct species, *Coleosporium Senecionis* on various species of *Senecio*, and apparently also on *Campanula*, with its æcidio-form *P. Wolfii* on the leaves of various species of *Pinus* of the group *Pinaster*, *Cronartium asclepiadeum* on *Vincetoxicum officinale*, with

* Comptes Rendus, cxi. (1890) pp. 614–6.
† Bot. Gazette., xv. (1890) pp. 255–9.
‡ Tidsskr. f. Skovbrug, xii. (1890) pp. 175–238 (11 figs.). See Bot. Centralbl., xliii (1890) p. 353.

its æcidio-form *P. Cornui* on the stems and branches of *Pinus sylvestris*, and *C. ribicola* on the leaves of species of *Ribes*, with its æcidio-form on the stems and branches of *P. Strobus; Trametes radiciperda*, one of the most destructive parasites on pines and beeches; *Peziza calycina*, a saprophyte, and apparently not injurious; *Lophodermium Abietis* sp. n., on *Pinus excelsa; Nectria ditissima*, one of the most destructive parasites on beeches, ashes, and apple-trees; *Nectria cucurbitula* on pines; *N. cinnabarina*, a destructive parasite on limes, sycamores, maples, horse-chestnuts, and hawthorns; *Rossellinia quercina* on ashes, beeches, and maples; *Herpotrichia parasitica* (*Trichosphæria parasitica*) on *Pinus excelsa; Cryptospora suffusa* on alders; *Pestalozzia Hartigii* on seedling conifers and beeches; *Phoma pithya* (*P. abietina*) on *Pinus Douglasii* and *Abies excelsa*.

Development of the Hypogæi.*—Dr. R. Hesse completes his account of the development of the fructification of the Tuberaceæ, Elaphomycetes, and Hymenogastreæ, out of "swarmers." Both the envelope (peridium) and glebe are formed out of minute motile bodies, which gradually come to rest and become agglomerated into smaller or larger colonies, the septated hyphæ round which they group themselves being probably derived from similar elements. The so-called rhizines, and all other hypha-like structures which spring from the older peridia, are always formed by the union into chains of similar motile bodies. The "swarmers," of which glebe and peridium are alike composed, can be readily isolated by pressing in water; but can only be detected by an amplification of 1000 or more; the author believes them to be provided with a cilium at each extremity. The asci are also formed out of structures endowed with an amœboid motion which result from the conjugation of bodies of the same kind; they are not formed from the so-called "ascogenous hyphæ," but become attached to these hyphæ after their formation, and subsequently increase in size at the expense of the paraphyses which surround them. The real mode in which the spores are formed will be described in a future monograph of the order.

Classification of Lichens.†—In his monograph of the Lichens of Brazil, M. E. Wainio describes a number of new genera, and as many as 240 new species. He considers all the systems of classification of Lichens at present proposed to be founded on uncertain characters, especially that of the stromatic structure of the exciple; and regards the nature of the gonids as the character of the greatest importance in the establishment of primary groups; while the paraphyses afford excellent characters for the discrimination of genera and species. M. Wainio divides Lichens first of all into Discolichenes corresponding to the Discomycetes, and Pyrenolichenes corresponding to the Pyrenomycetes, the former of these being again divided into Cyclocarpeæ, Graphideæ, and Coniocarpeæ.

Preparing Wine-Ferments.‡—M. A. Rommier prepares his wine-ferments in the following manner. Grapes carefully chosen are crushed

* Bot. Centralbl., xliv. (1890) pp. 308–15, 344–51 (2 pls. and 2 figs.). Cf. this Journal, 1890, p. 649.

† Acta Soc. pro Fauna et Flora Fennica, vii. (1890). See Morot's Journ. de Bot., iv. (1890), Bull. Bibl., p. xcv.

‡ Comptes Rendus, cx. (1890) pp. 1341–3.

and placed in little flasks. It is advisable to prepare more flasks than are absolutely needed, in order to have a greater chance of obtaining one free from bacteria or mycoderm. When fermentation has been fairly started, the flasks are lightly shaken up, and one or two drops removed to inoculate flasks filled with clear and sterilized grape-juice. After repeating this several times in grape-juice the cultivations are made in water mixed with sugar and suitable salts. In this way the less vigorous ferments are eliminated, and finally *Saccharomyces ellipsoideus* only remains. The ferment is then preserved in small or large flasks containing grape-juice, or in infusions made from sterilized raisins. The flasks are closed by means of stoppered tubes, the ends of which are plunged in water. The stoppers are carefully sterilized.

In order to preserve some ferment after it is quite fermented, it is separated by decantation from the alcoholic liquid, and is then introduced into glass bulbs, which are afterwards closed with a spirit-lamp. To ordinary wines devoid of bouquet there may, by this method, be imparted quite an agreeable flavour or bouquet.

Uredineæ and their Hosts.*—M. G. Poirault gives a complete list of the plants natives of France, Belgium, and Switzerland, with the Uredineæ known to be parasitic upon them, whether in the uredo-, teleutospore-, or æcidio-form, distinguishing also whether the teleutospores germinate immediately, or only after a period of repose. The host-plants are arranged under their natural orders.

Himalayan Uredineæ.†—Completing his Descriptive List of the Uredineæ of the neighbourhood of Simla, Dr. A. Barclay describes the following new species:—*Uromyces Vossiæ* on *Vossia speciosa*, *U. Strobilanthis* on *Strobilanthes Dalhousianus*, *U. McIntirianus* on *Hemigraphis latebrosa*, *Phragmidium quinqueloculare on Rubus biflorus*, *P. incompletum* on *R. paniculatus*, *Melampsora Sancti-Johannis* on *Hypericum cernuum*, *M. Leptodermis* on *Leptodermis lanceolata*, *Coleosporium Plectranthi* on *Plectranthus Gerardianus*, *C. Clematidis* on *Clematis montana*, *Chrysomyxa Piceæ* on *Picea Morinda*, *Cæoma Mori* on *Morus alba*, and also a number of new isolated uredo- and æcidio-forms.

Herr P. Dietel ‡ describes a new genus of Himalayan Uredineæ, *Barclayella*, with the following diagnosis:—Teleutosporæ series pluri-v. multicellulares formantes, promyceliis germinantes divisione transversali in sporidia quatuor disrumpentibus. Uredosporæ et æcidiosporæ ignotæ. The typical species *B. deformans* grows on the leaves of the young shoots of *Picea Morinda* (*Abies Smithiana*). The genus differs from the nearly allied *Chrysomyxa* and *Coleosporium* in the mode of formation of the sporids.

Uredo Vialæ.§—Prof. G. von Lagerheim describes in detail this new parasite of the vine in Jamaica. It attacks the under side of the leaves, but the spots attacked retain their green colour longer than the healthy parts. The uredospores are ovoid or pyriform, 20–27 μ long by 15–18 μ

* Journ. de Bot. (Morot), iv. (1890) pp. 229–34, 245–51, 307–15, 342–8.

† Journn. Asiatic Soc. Bengal, lix. (1890) pp. 75–112 (4 pls.). Cf. this Journal, 1890, p. 648.

‡ Hedwigia, xxix. (1890) pp. 259–70 (1 pl.).

§ Rev. Gén. de Bot. (Bonnier), ii. (1890) pp. 385–90 (1 pl.). Cf. this Journal, 1890, p. 495.

broad; their membrane is thin and colourless, and is closely covered with minute elevations. Each group of uredospores is surrounded by a circle of cylindrical paraphyses swollen at the base. A variety or very nearly allied species, *U. Cissi*, attacks *Cissus rhombifolia*.

Æcidium esculentum.*—Under this name Dr. A. Barclay describes a fungus belonging to the Uredineæ which grows on the flowering shoots of *Acacia eburnea* in India, causing hypertrophy and other malformations; its æcidia are largely eaten by the natives.

Mycetozoa.

Development of Myxomycetes and new Species.†—Mr. G. A. Rex points out that, although the sporange of many mature species of Myxomycetes exhibits remarkable variation in form, colour, and structure, no such tendency to variation exists in the plasmodial stage, the plasmode itself being unvarying in colour and in other physical characters. The variations in the sporangial stage the author believes to be due to local external influences, especially to differences in the temperature and moisture of the atmosphere. The above remarks are illustrated especially in the case of *Tubulina cylindrica*.

The same author ‡ describes the following new American species of Myxomycetes:—*Physarum tenerum*, *Trichia subfusca*, and *T. erecta*.

Protophyta.

α. Schizophyceæ.

Vegetation of Hot Springs.§—Mr. W. H. Weed enumerates the Algæ found in the hot springs on the American continent. Of these there are no less than 3500 in the Yellowstone district, the temperature of which reaches 85° C., while in the Brewer-spring in California it rises as high as 93° C. They consist of peculiar species of Protococcaceæ, Oscillariaceæ, and Confervaceæ, with a comparatively small number of Desmidiaceæ and Diatomaceæ, generally the same species as in cold waters. They thrive best when the water is somewhat alkaline; their colour is often a bright red and green, and varies with the temperature of the water. They are always eventually encrusted by siliceous or calcareous sediment.

Zoochlorellæ and Lichen-gonids.‖—Herr M. W. Beyerinck gives further details of his pure culture of some of the lowest Algæ (Protophyta) Since the organism known as *Chlorococcum protogenitum* Rbh. does not appear to produce zoospores under any conditions, he proposes to establish it as the type of a new genus under the name *Chlorella vulgaris*. The cultures of this and of the new species *Raphidium naviculare* were made by introducing a drop of the water containing them into a nutrient fluid consisting of ordinary ditch-water boiled with 10 per cent. gelatin. *Scenedesmus acutus* cultivated in this way was found also to

* Journ. Bombay Nat. Hist. Soc., v. (1890) pp. 1–4 (1 pl.). See Bot. Centralbl., xliv. (1890) p. 322.

† Bot. Gazette, xv. (1890) pp. 315–20.

‡ Proc. Acad. Nat. Sci. Philadelphia, 1890, pp. 192–6.

§ Amer. Naturalist, xxiii. (1889) pp. 394–400.

‖ Bot. Ztg., xlviii. (1890) pp. 725–39, 741–54, 757–68, 782–5 (1 pl.). Cf. this Journal, 1890, p. 757.

liquefy gelatin, though more slowly than bacteria. The effect of this and other similar organisms on other nutrient substances is described in detail. *Chlorella* the author regards as belonging to the Pleurococcaceæ, and as presenting the lowest form from which the green algæ are derived; it belongs to the same type as *Eremosphæra*. Its identity was again demonstrated with the Zoochlorellæ of *Hydra viridis*, the green variety of *Stentor polymorphus*, *Paramecium aurelia*, and *Spongilla fluviatilis*; but the author's observations tend to show that *Raphidium* and *Scenedesmus* are perfectly distinct organisms from these. The genus *Chlorella* is defined as consisting of unicellular green algæ, with spherical, elliptical, or flattened cells, from 1–6 μ in diameter, usually with only one chromatophore, and no or only an inconspicuous pyrenoid; usually only one nucleus, or sometimes two, consisting only of chromatin; multiplication by free cell-formation from successive bipartitions; zoospores altogether wanting. It occurs in both fresh and salt water, and probably also on the soil. Four species are described:—*C. vulgaris* (*Chlorococcum protogenitum* Rbh.), *C. infusionum* (*Chlorococcum infusionum* Rbh.), *C.* (*Zoochlorella*) *parasitica* Brandt, and *C.* (*Zoochlorella*) *conductrix* Brandt.

Another form produced under similar circumstances is *Chorosphæra limicola*, which differs from those already described in readily producing zoospores; it bears a strong resemblance to *Chlamydomonas pulvisculus* in its structure and mode of life.

The gonids of the lichen *Physcia parietina* are identical with *Cystococcus humicola* Näg. They multiply by a series of bipartitions, or, under certain circumstances, produce zoospores closely resembling those of *Chlorosphæra*; no conjugation between these was observed.

Diplocolon and Nostoc.*—Pursuing his investigations on the metamorphoses which *Scytonema clavatum* undergoes when grown on a nidus of Hepaticæ, Herr H. Zukal found that filaments, when moistened after being accidentally desiccated, had become, as well as their enveloping sheath, distinctly shorter and thicker. These filaments eventually passed over entirely into the *Nostoc*-condition; or the trichomes became enveloped in thick yellow secondary sheaths, very often consisting of two distinct layers, and coiled in a loop-like fashion. In this condition they agree altogether with the characters of *Diplocolon*, which must be regarded as a condition of development connecting *Scytonema* with *Nostoc*. The *Diplocolon*-filaments finally passed over into *Nostoc microscopicum*.

Oscillariaceæ.†—M. M. Gomont gives a revision of the genera of the Homocystous Nostocaceæ (Oscillariaceæ) founded on the same principles as that of Bornet and Flahault for the Heterocystous Nostocaceæ,‡ and based on an examination of living and dried specimens, and of published descriptions. In accordance with these writers he uses the term *trichome* for the string of cells, and *filament* for the filament inclosed in its sheath, and proposes *cap* (coiffe) for the thickening often produced in the upper part of the membrane of the apical cell, and furnishing an

* Notarisia, v. (1890) pp. 1106–15 (1 pl.). Cf. this Journal, 1890, p. 222.
† Journ. de Bot. (Morot), iv. (1890) pp. 349–57.
‡ Cf. this Journal, 1890, p. 103.

organ of protection. It is wanting in the Heterocystous Nostocaceæ, and in the Homocystous genera protected by a thick sheath, as *Schizothrix* and some species of *Lyngbya*. Its structure is, however, often manifested only in the mature trichome before the formation of the hormogones. As a general rule the characters used for the discrimination of the genera are the number of trichomes, whether one or more, in the sheath, the form and consistency of the latter, and the grouping of the filaments among one another; while the anatomical characters of the trichome are chiefly employed for the distinction of species. The fourteen genera are thus classified:—

Tribe I. VAGINARIEÆ. Trichomes two or more in each sheath when the filaments are completely developed (with one exception); sheath yellow, red, or blue.

A. Sheath inclosing several trichomes. 1. *Schizothrix* (subgenera Inactis, Hypheotrix, Symphyosiphon, Chromosiphon). 2. *Dasyglœa*. 3. *Microcoleus*. 4. *Hydrocoleum*.

B. Sheath red, inclosing only a single trichome. 5. *Porphyrosiphon*.

Tribe II. LYNGBYEÆ. Trichomes solitary in the sheath; sheath yellow, never red or blue.

Subtribe 1. Lyngbyoideæ. Trichomes naked and mobile only for a short time; hormogones secreting a new sheath when emerging from the one in which they were inclosed. 6. *Plectonema*. 7. *Symploca*. 8. *Lyngbya* (subgenera *Leibleinia*, *Eulyngbya*). 9. *Phormidium*.

Subtribe 2. Oscillarioïdeæ. Trichomes naked and mobile for the greater part of their existence; sheath delicate, fragile, not coloured, in some species wanting or not yet detected. 10. *Trichodesmium*. 11. *Oscillaria*. 12. *Borzia*. 13. *Arthrospira*. 14. *Spirulina*.

Classification of Diatoms.*—Sig. M. Lanzi proposes the following classification of the Diatomaceæ:—

SERIES I. Frustula axi infravalvari sæpius brevi, cingulo angusto et patente sculptura carente.

A. Valvæ absque linea longitudinali mediana.

α. Valvis rotundatis.

a. Sculptura simplice isomorpha (Melosireæ, Coscinodisceæ, Eupodisceæ, Chætocereæ).

b. Sculptura heteromorpha (Asterolampreæ, Heliopelteæ).

β. Valvis oblongis.

a. Frustula cingulo et valvis asymmetricis (Meridioneæ, Licmophoreæ, Surirelleæ).

b. Frustula et cingulo symmetricis, valvis asymmetricis (Eunotieæ).

c. Frustula cingulo valvisque symmetricis (Nitzschieæ, Fragilarieæ, Tabellarieæ).

B. Valvis linea et nodulo mediano præditis.

α. Frustula asymmetrica, cingulo recurvo dorsiventrali,

* Atti Acc. Pont. Nuovi Lincei, xliii. (1890) pp. 53–7. Cf. this Journal, 1890, p. 496.

valvis dissimilibus, una tantum lineam et nodulum medianum habens (Cocconeideæ, Achnantheæ).

β. Frustula symmetrica, valvis similibus (Gomphonemeæ, Cymbelleæ, Naviculeæ).

Series II. Frustula latere aucta, axi infravalvari longitudinalem æquante vel sæpius exsuperante, cingulo plerumque lato et patente sculptura prædito.

α. Cingulo simplice haud tesselato (Hemiaulideæ, Biddulphieæ).

β. Frustula cingulo late extenso, partibus pluribus prætextis composito (Striatelleæ, Rhizosolenieæ).

Nutrition and Movements of Diatoms.*—Dr. J. D. Cox adopts Van Heurck's view of the alveolation of the siliceous coat of diatoms, and believes that it is by endosmose through the alveolæ that they receive their nutriment. On the other hand he considers that the chief locomotive organ of diatoms is the raphe, when present, and that the habit of the species depends on the presence or absence, and on the position and form, of this organ. Thus, for example, the symmetrical *Naviculæ* are furnished with a well-developed raphe along the median line of each valve; *Cocconeis*, with its raphe situated on one side only of its large and flat disc, is adapted to an epiphytic life on the stems of other Algæ; the curved species of *Surirella* have no proper movement, except a slight rolling from time to time; their raphe is found on the border of the wings. Other Pseudo-raphideæ or Cryptoraphideæ are carried without resistance by waves and currents, or vegetate quietly in a bed of mucus, following a mode of existence in accord with the conditions by which they are surrounded.

β. Schizomycetes.

Prof. R. Koch on Bacteriological Research.†—In an address on bacteriological research, Prof. R. Koch gives a rapid sketch of the history of Bacteriology, the age of which is computed to be about fifteen years. After acknowledging that our present knowledge is in great measure due to, and in fact has been rendered possible by, the great improvements in Microscope objectives and in the methods of technique (preparation, preservation, cultivation, &c.), the author lays it down as being incontrovertible that all species of bacteria are constant, but admits that within certain limits they may deviate from the normal type, the pathogenic being most prone to variability. The confusion which has frequently arisen with regard to the species of bacteria is ascribed to the undue prominence given by some writers to certain characteristics, and it is held by the author that the proper method of determining the specific position of micro-organisms is to very carefully consider every characteristic, morphological and biological. And even when this has been done there are numerous difficulties to be overcome; for example, to isolate and identify the typhoid bacillus from the contents of the intestine, from the soil or water, is difficult even for the experienced observer.

* Journ. de Micrographie, xiv. (1890) pp. 207–12, 245–7.

† 'Vortrag gehalten in der 1. allgemeinen Sitzung des X. Internat. Med. Congresses 1890,' Berlin, Hirschwald, 1890, 8vo, 15 pp.

Yet with a few bacteria more certainty can be attained; cholera vibrios and tubercle bacilli possess specific characteristics by which they can be easily identified. But even in the case of tubercle bacilli a caution is necessary, for the author notes that the bacillus of fowl tuberculosis is obviously a distinct though closely allied species.

The next point discussed is the relation of bacteria to disease. The proof of a direct relation is perfectly clear with regard to a certain number of infectious diseases—anthrax, tuberculosis, erysipelas, &c. And as to some others, such as typhoid, cholera, diphtheria, relapsing fever, leprosy, there is little doubt, although the attempts at artificial infection have hitherto failed.

After alluding to the importance of the metabolic products of bacteria and the recently discovered toxalbumins, the author expresses his opinion that the question of immunity can only be answered by the aid of bacteriology, and then passes on to consider some of the biological phenomena of bacteria.

After this the numerous failures of bacteriology are touched on, as in measles, scarlet fever, typhus, small-pox, rabies, influenza, and numerous other infectious disorders.

The address concludes with a consideration of the methods at our disposal for combating pathogenic micro-organisms, either directly, as by disinfection, or indirectly, by the application of certain substances to the body which might render the bacteria inert, without injury to the organism.

Germicidal Action of Blood-serum.*—For ascertaining the action of the blood-serum of sick or vaccinated animals, MM. Charrin and Roger passed carotid blood of the rabbit into iced sterilized vessels, and inoculated the serum obtained after coagulation with *B. pyocyaneus.* This microbe has, according to Buchner, a marked resistance to the germicidal action of blood-serum. From comparative experiments between the serum of normal animals and those which 24 hours previously had received an intravenous injection of *B. pyocyaneus*, and which were moribund, when the blood was withdrawn it was found that the serum of the latter was more resistant. After 24 hours the tubes were no more cloudy than previously, and microscopically only a few isolated bacilli were found, while the normal serum had become turbid and contained numerous bacilli.

A resistance of intermediate intensity was shown by the serum of rabbits which had been repeatedly infected by the subcutaneous injection of *B. pyocyaneus.* Plate cultivations of the three kinds of serum showed great differences in the number of germs they contained.

The germicidal action, accordingly, is intensified in the serum of sick and vaccinated animals. The authors consider, however, that immunity is the result of manifold conditions, and do not intend to throw any doubt on phagocytosis.

The same authors † have recently extended their researches on the germicidal action of blood-serum to the bacillus of symptomatic anthrax

* Comptes Rendus, cix. (1889) pp. 710–3. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 283–4.

† CR. Soc. Biol., 1890, No. 14. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) p. 283.

("Rauschbrand"). As is well known, guinea-pigs are extremely sensitive to Rauschbrand, while rabbits are almost completely refractory. Yet these bacilli develope better in the blood-serum of rabbits than in that of guinea-pigs. By vaccination the blood-serum of both animals is found to have received increased germicidal properties; nor is this a transitory condition, for the authors observed it for seventy days. Hence for Rauschbrand no parallel can be drawn between the natural resistance of these animals and the germicidal property of their blood-serum.

Germicidal Action of Blood.*—Prof. J. von Fodor, after alluding to his first researches on the germicidal action of blood, the experiments and inferences of others on the exact value to be given to the plasma, the corpuscles, or the tissues in destroying bacteria, and therefore producing immunity for the organism, gives an account of some lengthy researches he has recently carried out on the same subject.

The bacterium employed was anthrax, and the blood of living animals was passed, with the usual precautions, into flasks containing glass beads. The blood was then defibrinated by shaking and afterwards inoculated with anthrax disseminated equally throughout the blood by means of the beads. At certain intervals some of this blood was inoculated on pepton-gelatin.

Only some of the results of the more important experiments can be mentioned. These were that arterial blood is more germicidal than venous; and fresh blood more so than that which has stood.

The germicidal action increases with the temperature, being strongest from 38°–40°, after which it rapidly diminishes.

Individual disposition to infectious diseases seems to be in exact proportion to the germicidal action of the blood.

By artificial modification of the blood, in other words by increasing its alkalinity, it was found that the germicidal properties would be considerably augmented. It therefore immediately followed that it might be possible, by increasing the alkalinity of the organism, to inhibit the growth of anthrax after inoculation, and experiments were made on rabbits with this intent, by injecting them with bicarbonate of soda. The results were sufficiently satisfactory to warrant a further and more prolonged investigation.

Certain Conditions that modify the Virulence of Tubercle-Bacillus.†—Dr. A. Ransome has made some experiments that go to show that fresh air, light, and a dry sandy soil have a distinct influence in arresting the virulence of the tubercle-bacillus; mere exposure to light in otherwise bad sanitary conditions does not destroy the virus.

Cure for Tetanus and Hydrophobia.‡—Mr. E. H. Hankin has a notice of a recent memoir by Behring and Kitasato, two workers in Prof. Koch's laboratory, who have not only succeeded in producing immunity against diphtheria and tetanus, but also in curing animals affected by these diseases. The most remarkable part of their discovery is the fact that the blood of an animal that has been made immune

* Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 753–66.
† Proc. Roy. Soc. Lond., xlix. (1891) pp. 66–73.
‡ Nature, xliii. (1890) pp. 121–3.

against diphtheria or tetanus possesses the extraordinary power of destroying the poison caused by the microbe of this disease. As this power is also possessed by the serum of such an immune animal, the serum can be used as a curative means on other animals that are suffering from the disease.

After reviewing the work lately done by various investigators into immunity, Mr. Hankin tells us that the essential new proposition is this:—"The immunity of rabbits and mice against tetanus depends on the power possessed by the fluid part of their blood of rendering harmless the poisonous substances produced by the tetanus bacilli." This is a completely new theory of the nature of immunity; for, hitherto, it has been supposed that immunity must depend either on the voracious activity of the phagocytes, or on a bacteria-killing power possessed by the blood, or on an acquired tolerance against the poison.

The authors' experiments show that the blood of rabbits which have been made immune against tetanus can destroy the tetanus poison; this character is possessed by the blood both before and after it has left the vessels, and by the cell-free blood-serum obtained from it. This character is so permanent that it is still manifested by such serum after it has been injected into other animals. Various experiments are described which support these statements.

Bacillus developing a Green Pigment.*—Herren F. Winkler and H. von Schrötter isolated from the excrement of the caterpillar infesting an apple (*Carpocapsa pomonella* L.) a bacillus from 2–2·5 μ long, easily stainable with anilin dyes, and which, when cultivated on gelatin plates, liquefies the medium, causing the development of a greenish-yellow colour and a peculiar smell. In test-tube cultivations these characteristics are more pronounced, especially the liquefaction and the pigment production.

The pigment is very soluble in water, but insoluble in alcohol and chloroform. It is destroyed by acid, and restored by the application of alkalies. When cultivated on plover's-egg albumen, it developes with the production of a fine emerald green colour, while the liquefaction is delayed. On potato there was formed a reddish-yellow greasy-looking overlay, the result of confluence of the colonies.

The pathogenic effect of this bacillus was tried on rabbits, some being injected in the vena jugularis externa and others in the peritoneal sac. The former were unaffected, while the latter succumbed from peritonitis and gangrene of the intestine.

The authors propose to call this micro-organism *Bacillus melochloros*.

Bacillus producing an Indigo-blue Pigment.†—Herr H. Claessen found in Spree water a chromogenous micro-organism, the rod-elements of which corresponded approximately in length and breadth with those of *B. typh. abdominalis*. These rodlets were usually separate, but sometimes two or three were found together, and occasionally groups united by a cement. The outline of the rodlets was clearer than the centre of the bacilli, which by staining showed that they were enveloped

* Mittheil. aus d. Embryol. Institute d. K. K. Universität Wien, 1890, pp. 60–5.

† Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 13–17. Cf. Bot. Centralbl., xlii. (1890) p. 146.

in a delicate sheath. Cultivated on gelatin at 15° C. they form white colonies for the first three days, but on the fourth a blue pigment appears at the margin of deep-lying colonies, and at the edge of the superficial ones. The pigment, which is in very fine granules, does not penetrate the gelatin. The bacillus is aerobic and does not liquefy gelatin. When cultivated in meat-broth it did not thrive, and no pigment was formed, and incubation temperatures either diminished or prevented growth.

On agar there developes an indigo-blue deposit, which appears as a coloured band from 2–3 mm. wide around the edge, and resembling the iridescent shimmer of a saturated solution of gentian-violet. Potato cultivations have the same appearance as those on agar, but the pigment only appears with an acid reaction of the potato. If this be alkaline there developes only a dirty green tuft, but without any detectable morphological difference of the bacilli.

Neither spore-formation nor filamentous outgrowths were observed.

When distilled water was inoculated with bacillous material, a distinct milky clouding was observable in twenty-four hours, and a dark-blue, almost black, granular sediment was formed on the bottom of the vessel. The indigo-blue pigment was formed in the various media even in the dark.

The pigment is insoluble in hot and cold water, absolute alcohol, and in a mixture of equal parts of ether and alcohol, is slightly soluble in caustic potash, in hot sulphuric acid, and in cold hydrochloric acid.

Peculiar Disease of Bread.*—In the interior of loaves of Graham bread, one or more patches of variable size, forming brownish, sticky, viscid masses with a peculiar smell, are sometimes found. This degeneration has been found by Herren Kratschmer and Niemilowicz to be due to the action of *Bacillus mesentericus vulgatus*, which, when inoculated on healthy bread, infects it as soon as it shows a slightly alkaline reaction.

It is therefore inadvisable to bake large loaves, as the interior of the loaves is not sufficiently heated to kill the germs.

Growth of Bacillus of Symptomatic Anthrax on solid nutrient media.†—Mr. S. Kitasato has obtained anaerobic cultivations of "Rauschbrand" bacillus on agar and gelatin to which sugar, glycerin, and reducing media had been added. In solid media the bacilli retained their virulence, which was not the case in cultivations of guinea-pig broth. The most favourable temperature was from 36°–38°. Grown in gelatin under hydrogen, spheroidal colonies are formed which liquefy their adjacent medium. The bacilli are straight rods with rounded ends and possessing characteristic movements. In gelatin at the ordinary temperature they form spores only slowly, but quite quickly at incubation temperatures. The spores are oval, and the sporogenous bacilli are immobile. The spores are resistant to drying for several months; heating to 80° for one hour does not kill them.

Contrary to the statement of Metschnikoff, the author finds that

* Wiener Klin. Wochenschr., 1890, No. 30. See Bot. Centralbl., xliii. (1890) pp. 401–2.

† Zeitschr. f. Hygiene, viii. p. 55. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 15–6.

this bacillus does not form spores in the living body, true spores being produced 24–48 hours after death. The corpuscles which have been mistaken for spores do not possess the morphological, the biological, nor the tinctorial characters of resting forms.

The author also disputes the assertion of Roux that guinea-pigs inoculated with "Rauschbrand" are protected from malignant œdema.

Studies on Immunity.*—In a second memoir, E. Metschnikoff again takes up his parable on immunity, this time taking as his text anthrax in pigeons, and preaches against Baumgarten and others, who see in this affection objections to the doctrine of phagocytosis.

While admitting that pigeons when infected in the usual manner are very insusceptible to anthrax, the author states that this is not the case if the inoculation be made in the anterior chamber of the eye or if the anthrax have already passed through a previous pigeon; and it was further found that such virus was more dangerous to mammalia than that which had not been passed through a series of pigeons.

The author also found that the aqueous humour could by itself be used as a nutrient medium for anthrax bacilli, the spores of which, when injected into the anterior chamber, developed; their appearance being followed by the immigration of leucocytes and the simultaneous disappearance of the bacilli. Similar observations were made after subcutaneous or intramuscular inoculation; the conclusion being that the bacilli were devoured by the microcytes and macrocytes. The fate of the bacilli within the pigeons was followed out by making plate-cultivations from the exudation at the inoculation place. As a rule they were found to be still alive after twenty-four hours; in one case they were living after six days, but usually they died much earlier. They retained their virulence as well as their viability, and only occasional involution forms were found. In order to show that the bacteria were swallowed alive, some of the phagocytophorous exudate was mixed with a drop of bouillon. By this the phagocyte is killed, and the bacteria set free were observed developing under the Microscope. Besides this the author further showed that the bacteria which had been swallowed retained their virulence. This was done by isolating three phagocytes which contained bacteria by means of a fine glass pipette and transferring them to bouillon. Positive results were obtained with mice, guinea-pigs, and rabbits.

In a further communication on the relations between anthrax and white rats, the author shows that these animals do not possess perfect immunity to anthrax. The bacilli always develope, although usually the inoculation is followed by recovery, in which the phagocytes play an important part.

Mucous Fermentation.†—Herr E. Kramer finds that the process of mucous fermentation, which may happen to various substances, is excited by at least three species of bacteria, the nature and the reaction of the

* Annal. de l'Institut Pasteur, 1890, pp. 65 and 193. Cf. Centralbl. f. Bakteriol. u. Parasitenk., vii. (1890) pp. 545–7; viii. (1890) pp. 58–9.

† SB. K. K. Akad. Wiss. Wien, x. (1889) pp. 467–505. See Bot. Centralbl., xliii. (1890) p. 298.

fluid being of importance to the result. Fluids containing glucose with neutral or slightly alkaline reaction are decomposed by *Bacillus viscosus sacchari*. This is 1 μ thick, 2·5 to 4 μ long, motionless, forming filaments, liquefying gelatin, and being aerobic. Acid glucose solutions become mucous from the action of *B. viscosus vini*. This bacillus is 2–6 μ long, 0·6–0·8 μ thick, is anaerobic, and grows only in acid solutions. Solutions containing milk-sugar become mucous from the action of a coccus 1 μ in diameter. The mucus is a carbohydrate having the formula $C_6H_{10}O_5$, and is apparently derived from the external membrane.

Bacteria in Water.*—Dr. W. Migula, who has examined 400 different kinds of water taken from Silesia and Baden during the years 1888 and 1889, lays it down as an axiom that the harmfulness of water depends rather on its impregnation with different kinds of bacteria than upon the number of colonies. Hence a bacteriological examination of drinking water should be directed towards enumerating the different kinds of micro-organisms, instead of merely counting up the absolute number of colonies present in a cubic centimetre of water. In his article he gives five different tables, the results of which may be summed up as follows:—

(1) The results obtained from counting the colonies of bacteria in 1 ccm. of water are no criterion of its value as a drinking water. (2) Putrefaction bacteria are almost completely absent from drinking water. (3) Putrefaction bacteria are most frequent when water contains 1000–10,000 germs to 1 ccm., but are still present when it contains less than 50 germs, but if there be more than 10,000 germs they are not so numerous. (4) Putrefaction bacteria attain their greatest frequency when the number of different species present in water is greatest. (5) The relation between the number of kinds and the number of colonies is very indefinite.

Bacteria of Chemnitz Potable Water.†—Herr O. E. R. Zimmermann describes the following new species found in the Chemnitz water supply:—*Bacillus fluorescens aureus*, *B. fluorescens tenuis*, *B. fluorescens albus*, *B. fluorescens longus*, *B. rubefaciens*, *B. implexus*, *B. punctatus*, *B. vermiculosus*, *B. constrictus*, *B. fulvus*, *B. miniaceus*, *B. devorans*, *B. gracilis*, *B. helvolus*, *B. plicatus*, *B. guttatus*, *B. radiatus*, *B ochraceus*, *B. subflavus*, *Micrococcus rosettaceus*, *M. cremoides*, *M. carneus*, *M. sulphureus*, *M. concentricus*. Taken all together, 40 species of bacteria are enumerated, and their specific differences described.

Chemical Products of Growth of Bacillus anthracis.‡—Dr. S. Martin grew bacilli in a solution of pure alkali-albumin and of mineral salts of the composition of the salts of the serum. The anthrax bacillus, in digesting the alkali-albumin, forms proto-albumose, deutero-albumose, and an alkaloid. The alkalinity of the albumoses may explain their toxic properties; the bacillus forms the alkaloid from the albumose, and it is possible that the living tissues have a similar action when the albumose is introduced into a living animal.

* Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 353–61.
† 11 Bericht d. Naturwiss. Gesell. zu Chemnitz, 1890. See Bot. Centralbl., xliii. (1890) p. 272.
‡ Proc. Roy. Soc. Lond., xlviii. (1890) pp. 78–80.

Influence of Physical Conditions on the Life of Micro-organisms.*— Drs. E. Bonardi and G. G. Gerosa have made a series of experiments on the susceptibility of micro-organisms to environmental influence. They start with a useful summary of the results already reached by others, and then expound their own. In solutions of flesh-extract and peptone the density of the fluid has no effect on form; in gelatin the microspores are found only in the denser solutions; in flesh-extract the multiplication is more abundant and rapid in the less dense solutions, in gelatin the reverse is true; in flesh-extract of whatever density only Schizomycetes develope, in gelatin *Penicillium* predominates, in peptones both occur equally. The minimum temperature at which microbes will develope varies with the quality and density of the organic solution; in flesh-extract of slight density they multiplied for eleven days at 5°, but when the density was increased the temperature had to be raised to 10°, while in gelatin they remained sterile for months at 25°. A solution of flesh-extract of slight density was sterilized at 50°, but a denser solution required 60°. After three days at 79°, granulations appear which are not absolutely distinguishable from the indubitable organisms. In all the solutions, *Bacillus subtilis* prevails at higher temperatures above 30°, *B termo* at lower, but both show themselves in manifold instable forms. In favourable solutions of flesh and peptone, *B. subtilis* resisted for twenty-four hours temperatures of 79° and even 100°. Heating flesh-extract for two or three hours in a Papin's stove at 120°-130° did not hinder the appearance of spherical organized bodies. Carbonic acid gas and nitrogen only retard development, magnetic and electric influences have likewise a retarding influence, and this is very markedly the case with sunlight.

Red Nitro-indol Reaction as a Test for Cholera Bacilli.†—Herr R. J. Petri considers that the red nitro-indol reaction is of diagnostic value for ascertaining the presence of cholera bacteria. It would appear, however, from his experiments that this value is rather scientific than practical, inasmuch as the test must be used in combination with plate-cultivations and other suitable methods for recognizing the micro-organisms, and also that it is essential that pure cultivations only should be employed, contents of the intestinal canal and the like being unsuitable.

The reaction in question is the production of a red colour in the cholera vibrio after the addition of sulphuric acid; a reaction which results in the formation of indol and nitrite. The author confirms the original observation that the reaction takes place on media containing pepton. After the addition of the acid, 10 drops to 6 ccm. of the nutrient medium, the red reaction begins to appear after four hours' incubation, attaining its maximum in twenty-four to forty-eight hours, after which it dies away.

A similar red colour was obtained by the reagents used with other bacteria, a fact which, as alluded to above, seems to deprive this test of much of its so-called value.

Tumours in Animals.‡—M. A. F. Plieque, in discussing the ætiology of tumours, lays it down that it is of great importance to

* Atti R. Accad. Lincei—Mem., v. (1888) pp. 332–73.

† Arbeiten a. d. Kais. Ges.-Amte, vi. p. 1. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 152–3.

‡ Rev. de Chirurgie, ii. (1890) No. 7. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 148–9.

ascertain if these be of parasitic origin. Actinomycosis may be safely quoted as an instance of parasitic disease, while a similar origin for other tumours, such as melanosis in horses, may be more than suspected. After alluding to the transmissibility of actinomycosis from man to animals and *vice versâ*, the method of infection, the immunity of Carnivora, the author turns to other tumours, the existence of which depends on the immigration of micro-organisms.

Botryomyces and *Discomyces*, two fungi closely allied to *Actinomyces*, are found in those large fungous tumours which frequently develope in horses after gelding. In the numerous small abscesses which appear in the new growth are found bright points resembling the grains of *Actinomyces*, only somewhat smaller.

To melanosis, a common disease of horses, the author attributes a parasitic origin, the black granules besetting the tumour probably containing the parasite, which is, perhaps, a protozoon. Cultivations made with the granules have, however, hitherto failed. A parasitic origin is also claimed by Dominic for the papillomata of oxen (*Bacterium porri*), by Czokor for *Epithelioma contagiosum* of birds (a Gregarinid), and by Perroncito for the cyst-formations on the mesentery and pleura of birds (*Aspergillus nigrescens*).

Frequently too the tumours of plants have a parasitic origin; such tumours may be induced by infusoria (on the roots of Leguminosæ), by bacteria (tumours on fir and olive trees), and by higher fungi (the tumours on maize). The *Plasmodiophora brassicæ*, the cause of the tumours on cabbages, may belong to the group of Actinomyces fungi.

Although the parasitic theory of tumour formation is very seductive, the author cautions against general conclusions, on the ground that the vast majority of inoculation and transplantation experiments have been negative. The ill success of these experiments is declared by the author to be due to the neglect of certain important factors influencing tumour formation, in the choice of the inoculated animals. For example, no account is taken of age, an important factor in tumour formation, nor of the kind of animal to be inoculated, those usually operated on being rabbits and guinea-pigs, animals little prone to be affected by tumours; nor of the tissue to be selected for the experiment, that usually chosen being the subcutaneous tissue, a part in which tumours rarely develope spontaneously. Better results would possibly be obtained by attending to such conditions.

Osteomyelitis and Streptococci.*—MM. Lannelongue and Achard find from experiments that pyogenic Streptococci can produce in bone-marrow changes similar to those brought about by Staphylococci. The osteomyelitis induced by Streptococci is rarer than that caused by Staphylococci.

Microbes of Acute Infectious Osteomyelitis.†—MM. Courmont and Jaboulay find from intravenous injection of rabbits that suppuration of bone can be induced by several kinds of micro-organisms. The osseous

* CR. Soc. Biologie, 1890, No. 19. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) p. 731.

† CR. Soc. Biologie, 1890, No. 18. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) p. 731.

tissue is directly affected by Staphylococci, while the bone-marrow is principally affected by Streptococci.

Controversy on Phagocytosis.*—One of the last passages at arms between the supporters and opponents of the theory of phagocytosis as it is called by the inventor, Metschnikoff, is that of Hueppe and Petruschky. The former opines that natural immunity is closely connected with the cell-element of the body, although the extra-cellular influence possibly possesses some protective effect. Petruschky, however, points to the experiments of Nuttall, Buchner, himself, and many others, as showing that immunity is the result of biochemical processes going on in the body. And he even denies the efficacy of any co-operative assistance afforded by the phagocytes. To this Hueppe replies that no doubt the body juices do exert some chemical action on bacteria; but that this action is insufficient to explain the different behaviour of different species of animals towards bacteria, and that therefore cell action must be admitted to possess an important influence, and he further emphasizes his position by reasserting that there is no doubt that phagocytes do pick up living and virulent bacteria, and that recent biochemical researches teach us anew that we are led astray by chemical theory if we lose sight of the cell.

In response to this, Petruschky addresses himself merely to the particular point about the vitality of the bacteria when picked up by the leucocytes. Living anthrax bacilli, he says, are endowed with a kind of stickiness, which causes them to adhere to the corpuscle. Of course, the chief argument against the theory of phagocytosis is that bacteria are disposed of by blood-serum, both under artificial and natural conditions.

Bacteria in Wort and in Beer.†—Herr A. Zeidler examined three kinds of bacteria occurring in wort and in beer. One of these presented some resemblance to *Bacterium termo*, but formed also chains and filaments. The wort had a celery-like odour. The two other sorts set up acetous fermentation; one of them was identical with *B. aceti*, while the third did not agree with the descriptions of *B. aceti pasteurianum* or *xylinum*.

Pure cultivations of these bacteria were inoculated on sterilized wort, wort in various stages of alcoholic fermentation, and on compressed pure cultivations of yeast. It was found that the termo-like bacterium died as soon as the alcoholic fermentation set in, and when cultivated on the compressed yeast the latter was rapidly decomposed.

One of the acetic acid bacteria, especially at certain temperatures, set up a mucoid change in the beer, but the other had no such effect.

Günther's Bacteriology.‡—The recently published manual of Dr. C. Günther chiefly appeals to students of medicine, offering to them, in a compact form, the science and practice of Bacteriology, and specially

* Fortschritte d. Medicin, viii. (1890) Nos. 12, 13, and 15. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 29–31.

† Wochenschrift f. Brauerei, 1890, Nos. 47, 48. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 10–11.

‡ Leipzig, 1890, 244 pp. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 11–12.

dealing with the technique required for the microscopical examination of micro-organisms.

In the general portion of the work the author treats of the morphology, biology, and classification of bacteria, and then describes the means for their prevention, their observation, and their cultivation.

In the special part are discussed the most important of the pathogenic bacteria, and also a certain number of saprophytic organisms.

Bacteriology for Farmers.*—The object of this work, written by Dr. W. Migula, is to disseminate the results of bacteriological investigations in so far as they may have practical bearings, and consequently it does not present any novel features. It is apparently chiefly intended for persons engaged in agricultural pursuits, and to these at any rate it may be recommended.

DAVID, TH.—**Les microbes de la bouche.** (The Microbes of the Mouth.) Paris, 1890, 8vo, 113 figs.

DESPEIGNES, V.—**Etude expérimentale sur les microbes des eaux.** (Experimental Study on the Microbes of Water.) Paris, 1891, 8vo.

KECK, E.—**Ueber das Verhalten der Bakterien im Grundwasser Dorpats, nebst Beschreibung von 10 am häufigsten in demselben vorkommenden Bakterienarten.** (On the Bacteria in the ground-water of Dorpat, with description of ten of the commonest species found therein.) Dorpat, 1890, large 8vo, 66 pp.

LEWANDOWSKI, A.—**Ueber Indol und Phenolbildung durch Bakterien.** (On the Formation of Indol and Phenol by Bacteria.) *Deutsche Med. Wochenschr.*, 1890, No. 51, p. 1186.

NUTTALL, G. H. F.—**Beiträge zur Kenntniss der Immunität.** (Contributions to our knowledge of Immunity) Göttingen, 1891, large 8vo, 55 pp.

POTTER, T.—**Some of the Problems of Bacteriology.** *Indiana Med. Journ.*, 1890–1, pp. 28–30.

PRUDDEN, T. M.—**Bacillus versicolor.** *Proc. New York Pathol. Soc.* (1889) 1890, p. 103.

RUBNER.—**Beiträge zur Lehre von den Wasserbakterien.** (On Water-Bacteria.) *Arch. f. Hygiene*, XI. (1890) Heft 4, pp. 365-95.

SMITH, T.—**Observations on the Variability of Disease Germs.** *New York Med. Journ.*, II. (1890) No. 18, pp. 485-7.

TILS, J.—**Bakteriologische Untersuchung der Freiburger Leitungswässer.** (Bacteriological Examination of the Water of Freiburg.) *Zeitschr. f. Hygiene*, IX. (1890) Heft 2, pp. 282–322.

TURINA, V. A.—**Ricerche sui germi dall' aria e della polvere degli ambienti abitati.** (Researches on the Germs of the Air and Dust of Inhabited Regions.) *Giorn. d. Reale Soc. Ital. d'Igiene*, 1890, Nos. 8–10, pp. 452-66.

* Berlin, 1890, 8vo, 144 pp. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) p. 361.

MICROSCOPY.

a. Instruments, Accessories, &c.*

(2) Eye-pieces and Objectives.

"On a new System of Erecting and Long Focus Objectives."†—M. L. Malassez, after referring to the advantage of erect images and long focal lengths, when delicate dissections have to be made, exact measurements determined, &c., writes:—

"For these purposes we have already at our disposal the simple lens or the doublet, the Brücke lens, and the ordinary compound Microscope furnished with erecting apparatus. These instruments are excellent in certain cases, but are certainly unsatisfactory in many others. Thus, the simple lens and the doublet do not give sufficiently strong magnifications with foci sufficiently long, and, in making use of them, it is necessary to bend over the object to be examined in a very uncomfortable way. The Brücke lens possesses the advantage of having a very long focus, but the magnification which it affords is not very considerable. The Microscope itself gives all the magnification desired, but as soon as this becomes at all considerable, the focus is very short, and there is no room for manipulation.

I have devised a new system of objectives, which gives the best results. Adapted to the ordinary Microscope, the objective gives at once, without erecting apparatus, an erect image of the object examined. Its focus is very long, as long as could be wished. One of them has a focus of 7 cm., while it gives a true magnification of 30 diameters with a No. 2 eye-piece of Vérick, and a tube-length of 16 cm. I have made some which had foci much longer, reckoned by metres instead of centimetres. With these it was possible to see with the Microscope objects placed at the other end of the work-room, or even objects more distant still, such as houses and monuments at a distance from the window. However, as we lose in magnification and light what we gain in length of focus, it is of advantage to limit this as much as possible.

These new objectives possess the further advantage of considerable penetrating power, i. e. it is possible to vary the focus without losing the object. The one mentioned above has, for instance, a penetration of 2 to 3 millimetres. It is possible to get more, but it is necessary to limit it, for it would be at the expense of the defining power, i. e. at the expense of the clearness of the images.

The field of view is sufficiently large; that of the objective already taken as an example is from 8–10 mm. in diameter. With it microscopic images are obtained perfectly plane. The field is, of course, enlarged as the magnification is reduced. The device by which I have obtained the two principal properties characteristic of this new system of objectives, viz. the erection of the images and the indefinite length of the foci, is as follows:—

The different lenses composing the objectives really form two distinct

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

† Arch. de Méd. Expér., i. (1889) pp. 449-54.

optical systems, each acting as a single convergent lens. One, called for convenience of description the first lens, occupies the lower part of the objective next the object to be examined; while the other, called the second lens, occupies the upper part in connection with the Microscope-tube.

Matters are so disposed that the first lens gives behind it and in front of the second an inverted image of the object, and the second then gives behind it an inverted image of this first. It follows from this that this second image, inverted in relation to the first, is really erect in respect to the object. As this is the image examined by the eye-piece which does not invert, it accordingly remains erect with respect to the object. In other words, the aim of the first lens is to give an inverted image of the object; while the second acts as an ordinary objective, and with the eye-piece constitutes a compound Microscope; so that we examine with this Microscope, not the object itself, but an inverted image of it produced by a lens placed in front of the objective, between it and the object. The Microscope, as it inverts anew this inverted image, gives a final image, which is erect with respect to the object examined.

The possibility of obtaining with these new objectives very long foci, and of any length desired, is explained very easily. With convergent lenses, the farther the object seen, the nearer to the principal focus is the image on the other side of the lens; so that if it is wished to receive it on a screen or examine it with an optical apparatus, it is necessary to approach the nearer to the principal focus. Reciprocally, when very near the lens, it is only possible to see the images of very distant objects; and, on the other hand, when receding from it, only those of objects very near. Similarly, with this new system of objectives, if the second lens is brought near the first, only very distant objects can be seen, and accordingly the focal length of the whole system will be augmented; while by separating the lenses the focal length will be diminished, and only nearer objects can be seen. I have made one of these objectives in which the two lenses can be approached or separated at will, so as to vary at pleasure the length of the foci, and to see with the Microscope objects more or less distant. In practice, however, I think that it is better to use objectives with fixed focus.

The idea of erecting microscopic images by means of the objective is not new. Strauss-Durkheim says, in his treatise on Comparative Anatomy (I. p. 81), published in 1842, that he succeeded twenty-five years previously in erecting the images of compound Microscopes by placing an additional objective below the ordinary objective, and he describes and figures the arrangement which he adopted. He would seem to have shown this improvement to Trécourt and Oberhauser, and it was probably their Microscope thus modified which they presented in 1839 to the Academy of Sciences (ix. p. 322, "Microscope achromatique à tous grossissements"). It gave very variable magnifications, had foci greater as the magnification was weaker, and gave erect images. Fischer de Waldheim, of Moscow, had the same idea about the same time, and constructed a Microscope to which he gave the name of pancratic.

These Microscopes did not appear to have any success. Robin, in his 'Traité du Microscope' (1871, p. 162), states that their images were wanting in clearness, and that for a long time he had given up their use "pour quelque genre de travail que ce soit." Now they are forgotten, very few treatises on the Microscope mention them, nor are they referred to in catalogues of makers.

In my preliminary trials I contented myself with adding an objective to the existing one, thus making unconsciously a pancratic Microscope. But although by this arrangement very curious optical effects could be obtained, it was not advantageous for the special end in view, viz. convenience of manipulation under the Microscope; for that purpose what could be the use of these foci of indefinite length, or these high magnifications which are only obtained by reducing the working distance and losing light? I then conceived the idea of replacing the single lens system, giving by simple changes of position all kinds of foci and magnification by a series of special systems, each composed of fixed lenses, and consequently giving a definite focal length and magnification, each system being specially combined in order to produce a definite optical effect, and presumably giving more perfect results. Thence followed the erecting objectives of long focal length described above. If the principle on which they depend is already known, they may at least be considered as a new and more practical application.

The first of these new objectives was constructed by me eleven years ago, and was shown then to many persons, amongst whom was M. Vérick, who undertook to make similar ones. He did not do so, but his successor has been engaged under my direction in this new work. Any maker will be able easily to do the same after some trials."

The New Apochromatic Objective.*—Dr. J. D. Cox writes:—"In the February number of the Royal Microscopical Society's Journal we find a synopsis of work done with the new apochromatic objective of 1·63 N.A. by Dr. Van Heurck, the distinguished director of the Antwerp Botanical Garden. Some references to the same appear in a late bulletin of the Belgian Microscopical Society. The results mark a positive advance in the perfection of objectives, though, as Prof. Abbe warned us when announcing the apochromatic lenses which the new Jena glass made possible, each step must be a small one in the present state of the art, and there are apparently but few more within the range of the knowledge and the means possessed by us.

Now, as heretofore, the study of the diatoms gives the means of testing the progress in lens making, and gives the chief stimulus to scientific opticians. Dr. Abbe, who has become personally interested in the Zeiss optical establishment at Jena, is uniting all the resources of scientific formulæ with the skill of an almost perfect mechanical *atelier* to produce wider angled objectives; whilst Dr. Van Heurck, stepping into the place so long occupied in the microscopical world by our lamented Dr. Woodward, of the Army Medical Museum, is, with his dark-room and heliostat, demonstrating what the new lenses will do upon the old familiar tests of *Pleurosigma angulatum*, the small *Navicula rhomboides* (*Frustulia saxonica*), and *Amphipleura pellucida*. When, under his skilful manipulation, real progress is recorded, the improved lens quickly finds its way into the hands of the enthusiasts of the school

* Microscope, x. (1890) pp. 164-8.

of Koch in the rival department of investigation of the infinitely little, to determine what it can tell us in regard to the structure and growth of bacteria.

The photographs which illustrate Dr. Van Heurck's latest work with the new lens seem to show two things: first, that he exhibits the areolation on the valve of *Amphipleura* with a distinctness of definite resolution beyond anything heretofore published; second, that in regard to the less finely marked shells, no perceptible advance upon work done with glasses of narrower angle is apparent. A word further as to each of these points.

In the resolution of *Amphipleura*, as in regard to other tests, there has been a regular progress, partly dependent on real improvement in lenses, and partly upon the use of better methods of manipulation. The mounting of the specimen has also been an element of no small importance. Everybody knows that a diatom mounted dry is much more boldly visible than one mounted in balsam. Striæ are shown, in this case, with much less oblique light, and may be resolved by a glass which quite breaks down when used on the balsam mounted specimen. This is consistent with the fundamental principle that the angle of aperture of a lens determines the possibilities of its work in the resolution of fine details in all microscopic objects. A well corrected glass will do more than a badly corrected one made on the same formula and with the same aperture. No glass of high power has ever been made so perfect as to perform all the theoretic possibilities for a glass of its angle. But however well made the lens may be, it is a mere waste of time and eye-sight to try to make it show details too fine for the theoretic capability of its angle of aperture.

The average fineness of striation of *Amphipleura pellucida* is for the transverse lines about 90,000 to the inch, and of the longitudinal (by Dr. Van Heurck's measurement) about 125,000. But the finest of these are (by the R. M. S. tables) theoretically resolvable in photography by a dry glass of 180° aperture, by a water-immersion glass of 100° water angle, or by a homogeneous immersion glass of 83° balsam angle, all being of a numerical aperture 1, substantially. It thus appears that the angle of 1·63 N.A. is ·63 in excess of what is theoretically required to do the work which Dr. Van Heurck has accomplished with it, or, in other words, that our high power glasses do less than two-thirds of what perfect glasses of their aperture might do, if the tables are correct. Here, then, is a large margin for the improvement of the whole series of immersion lenses, since almost any lenses of first class makers found in the market, have angle enough, in the high powers, to do all that the new apochromatic has done.

But before we can decide how far the new lens is superior to older ones of less aperture, we must have the latter tested under equal conditions, and it is to be hoped that Dr. Van Heurck will add this to his useful labours. The new photographs are from objects mounted in a medium of refractive index 2·4, with both slide and cover-glass closely approximating the same index. They are also taken with monochromatic sunlight. Ever since Prof. H. L. Smith introduced the highly refractive media, it has been well known to microscopists that a very thin and finely areolated shell like *Amphipleura pellucida* is so much more easily resolved in them that the test when so mounted loses very much of its difficulty. If we make the slide and cover-glass nearly or quite homogeneous with the medium, and in addition to this increase considerably the aperture of the substage condenser, and connect it with the slide by a highly refractive immersion medium, it needs no telling that the difficulties of resolution have been still further and very greatly diminished. Prof. Abbe and Dr. Van Heurck deserve great praise for devising and putting to use the means of effecting such favourable conditions; but the difference between these and the conditions under which other glasses are used must be eliminated before we can tell how much of the improvement in work is due to the lens, and how much to the conditions.

In regard to my second point, viz. that as to the less finely marked shells, no perceptible advance in the character of work is apparent, I will only say that Dr. Woodward's photographs, exhibited at the Centennial Exposition at Philadelphia in 1876, must remain the standard of comparison when the work of the older lenses is brought into question. He worked with a Powell and Lealand water-immersion of 1/16 in. of 1869, and Tolles's 1/10 and 1/18 of similar construction. A little later he used also Spencer's glycerin immersion 1/6 and 1/10, Zeiss's homogeneous immersion 1/8 and 1/12, and a homogeneous 1/10 by Tolles. I think none of these glasses had an aperture greater than 1·25 N.A. Whilst writing this paper I have examined those photographs afresh, and am entirely sure that for the exhibition of the areolation and structure of *Navicula rhomboides*, both the coarser and finer forms (including *Frustulia saxonica* or *Navicula crassinervis*) *Surirella gemma*, *Amphipleura Lindheimerii*, *Pleurosigma angulatum*, and for the transverse striation of *Amphipleura pellucida*, they are fully equal to anything that has been done with the most recent and widest angled glasses, not merely as photographs, but as conclusive evidence of the quality of the glasses he used and their satisfactory work within the limits named.

Dr. Van Heurck has taken one step in advance (and it is a real one), which shows with what labour each step is now gained. The new glass has cost Prof. Abbe months of labour, as is reported; and no inconsiderable expense in money, as well as time, has been lavished upon it. The result, to put it in its most general form, is that where we could distinguish objects in the approximate form of circles or squares of a diameter of 1/100,000 in., we may now (under exceptional conditions) distinguish them if 125,000 to the inch. Yet this may make the difference between tracing definitely some part of the life-history of a bacillus or failing to trace it.

The apochromatic system is by no means synonymous with increase of angular aperture, though it adapts itself readily to the widening of angles. It is distinctively a step in the reduction of the conflict between the chromatic and spherical corrections, by the aid of the wider range in refraction and dispersion which the newly-invented Jena glass possesses. It is therefore directly aimed at the problem stated before, viz. the bringing of the practical performance of our lenses more nearly to the standard of their theoretic possibilities. The effort to do this by using material of higher refractive index for lenses is an old one. Even diamonds have been used for experiment in this direction. The solution of the problem has been sought also in the identical direction in which Dr. Abbe is working. More than a dozen years ago Charles A. Spencer told me of his own efforts, in the earlier part of his life, to manufacture new varieties of glass with the qualities now found in the Jena glass, but abandoned it because his pecuniary means were wholly inadequate to that sort of experiment. The liberality of the German Government, backing up the combination of high scientific acquirements of Dr. Abbe and his associates in the directions of physics and chemistry, has produced the valuable results we see. A single consideration still holds back many investigators on this side the ocean from giving implicit faith to the new system, and that is the fear as to the durability and chemical stability of the new glass. There is, whether rightly or not, a strong impression that a too large proportion of the apochromatic lenses have been short lived, and some of the failures have been in the hands of such careful and skilful manipulators that careless handling cannot be assumed. To have a costly lens fail on one's hands when the maker, who alone can be properly trusted to repair it, is on the other side of the globe, and custom house regulations are a practical veto on sending it back and forth, makes an earnest student of Nature pause. The same doubt seems to make American opticians cautious in using the new material, and it is hardly to be regretted that they should first exhaust the means of perfecting objectives made of the "old reliable" flint and crown glass. In the hands of the average manipulator the new lenses do not show superiority over high-class American ones. The art of manipulating them (for it is an art) may well occupy some of the hours of the student, with the assurance that till he has acquired some skill in that way, he will not be able to detect the difference between tools having so nice shades of merit. And even then he may console himself that many experts agree with the opinion of Dr. Detmers, that, angle for angle, it cannot yet be said that the best European lenses excel the best American."

Ancient Lenses.*—Mr. Henry G. Hanks calls attention to a very old reference to lenses, or magnifying glasses, which he recently found in an old work, 'The Vanity of Arts and Sciences,' by Henry Cornelius Agrippa. The edition shown was an English translation, published in 1676, from the original Latin edition, published in 1527. The reference alluded to reads thus:—

"So we read, as Celius in his ancient writings relates, that one Hostius, a person of an obscene life, made a sort of glasses, that made the object seem greater than it was, so that one finger should seem to exceed the whole arm, both in bigness and thickness."

It was found that Cælius Antipater (to whom Agrippa probably refers) was a Roman historian who lived 125 years B.C. He wrote a history of the first Punic War, only parts of which were extant. So far as known, this was the first account of magnifying glasses in history. Henry Cornelius Agrippa, the author of this curious old book, was born at Cologne in 1486, and was a man of talents, learning, and eccentricity. In his youth he was secretary to the Emperor Maximilian, and was knighted for bravery in Italy. On quitting the army he devoted himself

* Amer. Mon. Micr. Journ., xi. (1890) p. 243.

to science, and made pretensions to an acquaintance with magic. In 1530 he wrote his treatise 'On the Vanity of the Sciences,' which was a caustic satire upon the inefficiency of the common modes of instruction. After an active, varied, and eventful life, he died at Grenoble in 1539.

(3) Illuminating and other Apparatus.

New Measuring Apparatus for Microscopical Purposes.*—Dr. G. Lindau remarks that of all the pieces of apparatus which have been proposed for the measurement of small objects under the Microscope, the screw and glass micrometer in combination with objective or eye-piece has proved the best. Of these the eye-piece micrometer is by far the most convenient, and is to be preferred to all other micrometers, especially where a mean of several observations is taken. Cases however occur in which the eye-piece micrometer fails to be of service, as in the measurement of thin membranes or threads and in physical investigations on wave-lengths of light, &c. A micrometer constructed by Dr. V. Wellmann may replace it with advantage in these cases. It was originally intended for astronomical purposes, but forms a very useful micrometer for the Microscope. It is especially serviceable for measuring very small objects not exceeding a few μ in size. It differs in principle from all other micrometers in depending on the double refraction of light in certain crystals. It is well known that on looking at a point through a prism of rock-crystal two images, the ordinary and the extraordinary, are seen. As the prism is rotated about the optic axis, the extraordinary image rotates about the ordinary. Consequently, if such a prism is fitted over a microscopic eye-piece in whose focus a thread is stretched, two images of the thread are seen. On rotating the prism the apparent distance of these two images for a certain position becomes zero (the images coincide), and on rotating through 90° from this position it reaches a maximum. On continuing the rotation up to 180° the images again coincide. In the rotation from 180° to 360° the images behave in a similar way, except that the movable one changes over to the other side.

In the new micrometer these two images are used in precisely the same way as the threads of a screw micrometer, for by suitable rotation of the prism their distance is made equal to the image of the object to be measured. The distance of the two images is given by

$$\Delta = m \sin \phi,$$

where ϕ is the angle through which the prism is rotated, and m is the apparent maximum distance of the images for a given magnification v. This constant m is easily determined by measuring objects of known size.

Now the apparent magnitude of an object, of which the actual size d is to be determined, is given by

$$\Delta' = d \,.\, v.$$

Consequently, when by rotating the prism

$$\Delta' \text{ is made} = \Delta = m \sin \phi,$$

* Naturwissensch. Wochenschr., iv. (1889) pp. 185–6 (1 fig.).

we have

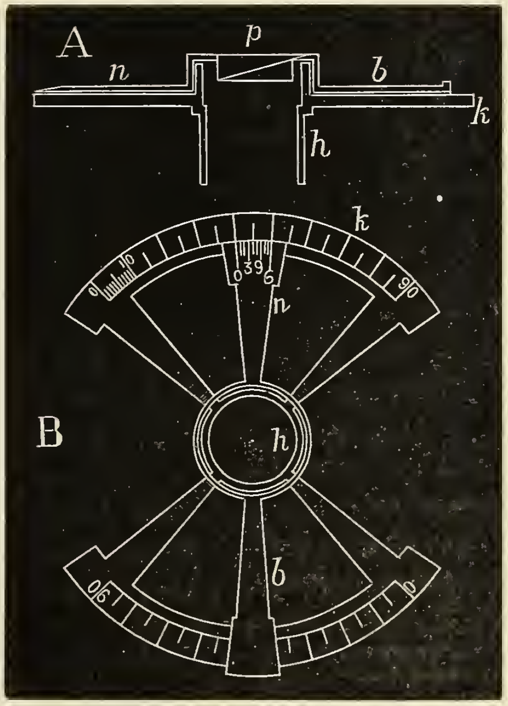
$$d = \frac{m \sin \phi}{v}.$$

To avoid calculations during the observation, Dr. Wellmann has prepared tables of the value of d for different values of ϕ and v.

$\frac{m}{v}$ is usually a very small quantity, which for the prism and lenses used by the author amounted only to 9 μ. Accordingly, to pass from 0 μ to 9 μ the prism must be turned through 90°, so that great exactness is obtained for even a comparatively rough reading. Thus a reading of 1/10 degree on the circle gives an exactness of

$$\frac{9}{90 \cdot 10} = 0 \cdot 01\ \mu.$$

Fig. 15.



The apparatus itself, as constructed by Schmidt and Hänsch, consists of two parts (fig. 15 A and B). The divided circle k is, by means of the socket h, passed over the body-tube of the Microscope, and is fastened by three screws. Only two opposite quadrants are used, and the rest of the circle, together with the middle portion of the quadrants, is cut away to diminish the weight of the apparatus. The eye-piece is then inserted in the body-tube. Above the socket of the divided circle, which projects upwards, another is fitted which easily turns about it. This carries in its upper part the prism p of rock-crystal, with refracting angle of 70°. Beneath are two projecting arms, one of which n serves as vernier reading to 1/10 degree, and the other b to balance and turn the apparatus.

Polarizing Prisms.*—Dr. W. Grosse calls attention to the important part played by calc-spar prisms in so many physical instruments, and regrets the high price of the material and the great loss which takes place in the course of preparation of the prisms. The various forms of prism are classified as follows:—

I. Prisms in which both rays wholly or partially occupy the field of view. Besides the older well-known forms of Wollaston, Senarmont, and Rochon, there are the more recent prisms of Dove and Abbe, the latter of which consists of an equilateral prism of calc-spar, with wedges of crown glass on the sides.

II. Prisms in which the central zone of the field of view is occupied only by one ray (the extraordinary).

* Zeitschr. f. Instrumentenk., x. (1890) p. 445.

1. With one diagonal slit, and between the two faces
   a. Canada balsam or linseed oil;
   b. Air.
2. With two diagonal slits intersecting
   a. In the middle of a basal plane (Ahrens);
   b. In the middle of the prism (Bertrand).

III. Prisms which contain only the lamella of a doubly refracting medium.

The requirements of an ideal prism are:—Plane polarized field, largest possible field of view, slightest possible refraction of the ray, smallest possible ratio of length and breadth, and least possible waste of material.

In the following table the numbers 1 to 5 serve to estimate the value of the prism for the specific property indicated in each of the horizontal rows. The last column gives for each of these properties the most advantageous forms—viz. those marked with 4 or 5.

	Nicol Group.					Air Prisms.		Double Slit.				
	Nicol.	Hartnack.	Thompson.	Dove.	Abbe.	Glan.	Foucault.	Bertrand.	Ahrens.	Double Slit Air Prism.	Plate Prisms.	Advantageous Form.
1. Plane polarized field	3	4	5	2	2	2	2	2	3 (1)	2	1	Thompson, Hartnack.
2. Field of view ..	3	3	3	2	2	1	1	4	4	1	5	Plate prism, Bertrand, Ahrens.
3. Loss of light ..	4	5	5	5	3	2	2	3	5	2	1	Dove, Hartnack, Thompson, Ahrens.
4. Displacement of ray	2	5	5	5 (1)	5	3	1	3	5	3	4	Hartnack, Thompson, Ahrens (Dove).
5. Ratio of length and breadth..	1	1	1	3	3	4	4	1	3	5	2	Air-prism with double slit, Glan, Foucault.
6. Waste of material	4 (3)	2	1	4	4	2	4	3	3	4	5	Plate-prism, Dove, Abbe, air-prism.
Total.. ..	17 (16)	22	20	17(+4)	19	14	14	17	21 (+2)	17	18	

At the author's suggestion, Herr Halle, of Potsdam, has undertaken the preparation of the air-prism with double slit, referred to in the above table. It is not half so thick as broad and long, and would be useful as a polarizer. Another form suggested by the author may be described as a Bertrand prism with air slit. It is rather thicker than broad and long; but as the field of view amounts to 15° it would be very serviceable as an analyser.

A new Camera Lucida.*—Herr G. Govi describes a new camera lucida, which consists of two rectangular equal-sided prisms of the same glass, one of which is smaller than the other. The hypothenuse face of the smaller, which is coated with thin gold-leaf, must be as large as the side face of the larger, on which it is fastened with Canada balsam or some other substance with refractive index as near as possible to that of the glass.

The hypothenuse face of the larger prism is turned at 45° to the

* Central-Ztg. f. Optik u. Mechanik, x. No. 22, p. 260.

horizontal, and lies above the eye-piece of the Microscope. The eye sees from above through one side face, at the same time, the microscopic object and the paper on which the drawing is to be made. The rays proceeding from the latter fall on the other side face of the small prism, are refracted into this, and so reflected on the gold-leaf that they reach the eye in the direction of the rays coming from the Microscope.

A new Ocular Diaphragm.*—Prof. Wm. Lighton writes:—In a paper read before the American Society of Microscopists at Indianapolis in 1878, I described a new dark-field eye-piece which was the result of experiments begun in 1863, and which was also described and illustrated in the first number of the 'American Quarterly Microscopical Journal,' published in 1878 by Prof. Romyn Hitchcock.

There also appeared in the 'American Monthly Microscopical Journal' for June 1887 a description of an analysing diaphragm for an eye-piece, to be used with the polariscope.

These two pieces of apparatus were to be used above the eye-piece, and were designed for a special kind of work. That now to be described is also to be used above the ocular, but for work of another sort. Its aim is to intensify the image of a certain class of objects, notably the Diatomaceæ, and its construction is shown in the accompanying figures, fig. 16 being a top view, fig. 17 an end view, fig. 18 an inside view, and fig. 19 is a sectional side view of the cap. The same letters in the different figures always refer to the same parts.

A, fig. 19, represents the axis of the Microscope; B, the eye-piece. G, fig. 16, the top of the eye-piece in which is a groove J. D is a sliding diaphragm moving in the groove from right to left and the reverse, by means of the screw F and spring I. Fig. 17 shows the manner of fitting the diaphragm in the groove.

To the under side of the diaphragm is fastened a square post H, by means of the screw L. This post gives motion to the diaphragm by the use of the screw F, and in the opposite direction by the spring I, which is supported by studs K.

It is very important that a proper adjustment of the diaphragm be made.

C, fig. 19, is the image of the mirror brought to a focal point through the eye-lens. It is at this point that the knife-edge of the diaphragm should be placed; the field will then have a subdued tint, and the object an exceedingly clear definition. Covering the point C with the diaphragm gives a *brilliant image of the object on a dark field*, and withdrawing the diaphragm from all contact with this point, the object will appear as ordinarily seen in the Microscope. I have obtained the best resolution of diatoms by the use of an achromatic eye-piece. I have also used Steinheil's 1 in. and 1/2 in. lenses as eye-pieces with good results.

The field under these eye-pieces assumes a soft grey tint the instant the diaphragm touches the point C. I do not find the use of the Huyghenian eye-piece to be satisfactory. I would strongly advise the use of the Nelson ocular.

* Microscope, x. (1890) pp. 8–10.

When using oblique light it is important that the diaphragm be placed on the side of the eye-piece nearest the mirror. For example, if the mirror is placed at the left of the stage, the screw F should be at

Fig. 18.

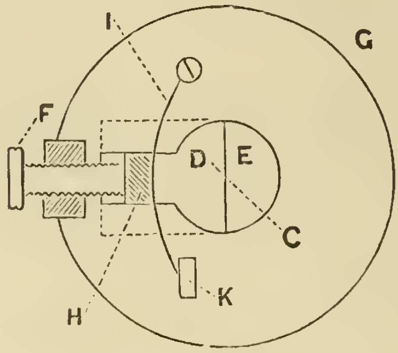
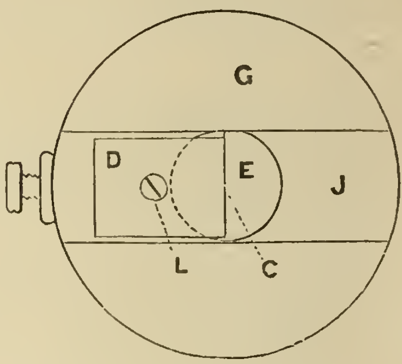


Fig. 16.



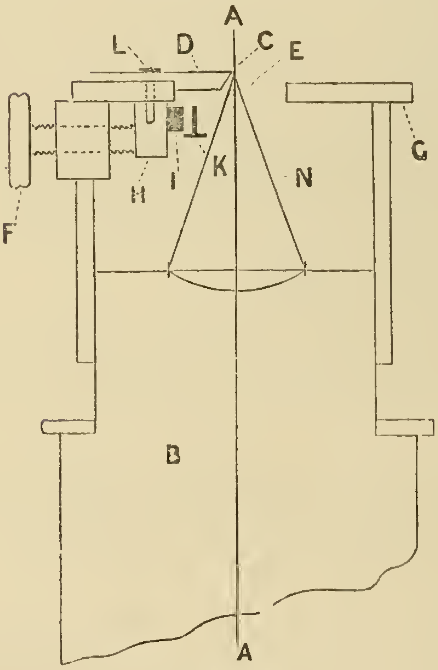


Fig. 19.

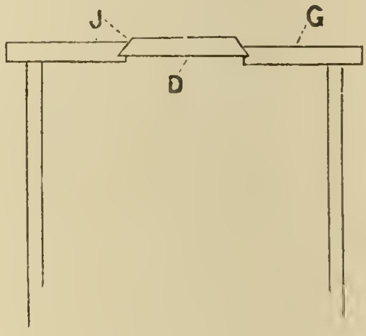


Fig. 17.

the left of the Microscope-tube. The eye-piece can be revolved to bring the diaphragm into the required position, and this revolving motion will also give a variety of beautiful effects.

The diaphragm works equally well with all objectives which I have used, and will, I think, repay all workers with the Microscope for the practice necessary to become familiar with its use.

Substage Condenser.*—Mr. Hyatt stated that the condenser which he exhibited to the New York Microscopical Society was constructed by himself on the principle announced some time since by Prof. Alfred M. Mayer—three plano-convex lenses, the largest one, of 2 in. focal distance, with a central stop, placed below, and two smaller lenses, paired, with their convex surfaces opposed to each other, and placed

* Journ. New York Micr. Soc., vii. (1891) p. 54.

near the under surface of the stage. The combination gives an excellent dark-ground illumination.

New cheap Centering Substage.—Mr. E. M. Nelson's substage, exhibited at the last November meeting,* is made thus:—The substage tube is made 1/4 in. larger in diameter than usual; a smaller tube, which holds the condenser, fits in this; this second tube has a large flange on the top, which prevents it passing through the large substage tube. A screw is cut on the bottom of the inner tube, and a flange similar to the upper one screws on. Obviously, therefore, by screwing the lower flange tight, the inner tube may be secured in any desired position.

(4) Photomicrography.

Handy Photomicrographic Camera.†—Mr. W. H. Walmsley writes:—Although photography in conjunction with ordinary microscopical observations (in other words, photomicrography) has undoubtedly grown in usefulness and popularity among workers with the Microscope during the past five years, there can be no doubt that its aid is very sparingly employed—a fact greatly to be regretted. For it is quite self-evident that the value of any microscopical research would be greatly enhanced, not only to the observer himself, but to his readers (in the event of his work being published), by full and accurate illustrations. Very few microscopists are competent draughtsmen, or capable of making drawings of objects under the lens at all correctly, or even presentable as illustrations thereof. And a drawing thus made is always permeated more or less by the imagination of the artist; so that the greater his skill in that direction the more likely is he to introduce features, not as rendered by the tube, but as he thinks he sees them. To be sure, photographic reproductions of microscopic objects are in a majority of cases not by any means perfect, or what one could desire, but they are vastly superior to almost any drawings in their accurate delineation of the various features of the specimen. The saving of time is another most important feature, as a dozen negatives may be taken in less time than that required to make a single careful drawing.

In the days of the old "wet-plate," the comparative insensitiveness of which precluded the use of a lamp as the illuminator, only those possessing a well-filled pocket-book or having access to the resources of a governmental or college laboratory could avail themselves of the aid of photography in connection with the Microscope. But the modern gelatin "dry plate" has placed in the hands of every one a cheap and efficient means of doing the highest class of work readily and perfectly. The very highest powers may be used with the light from an ordinary petroleum lamp. I have a print from a negative of *Pleurosigma angulatum* magnified 2400 diameters, by Spencer's 1/10 homogeneous objective; the illuminant being an ordinary single wick coal-oil lamp. It is the work of Dr. J. E. Baker, of Wyoming, Ohio, and is fully equal to the best work given to the microscopic world during the past six months.

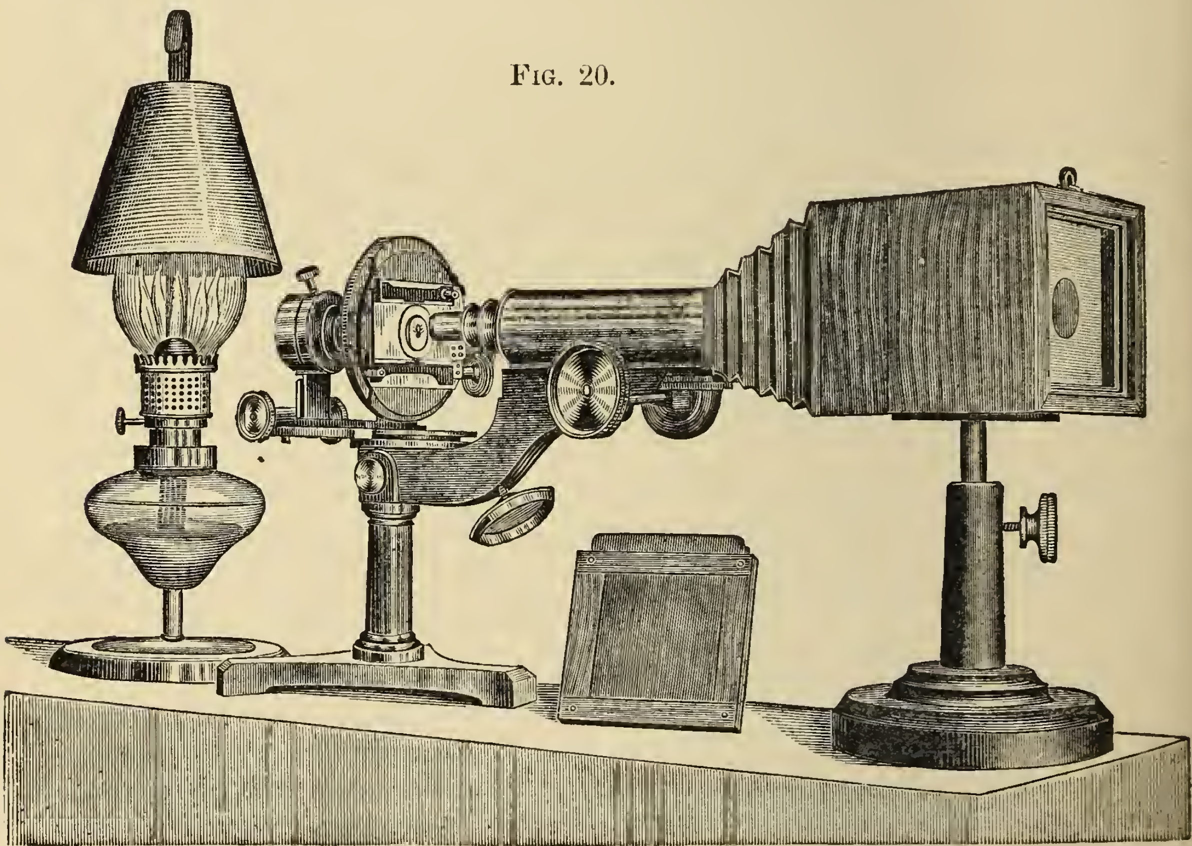
Why, then, has the use of photography not become more general

* See this Journal, 1890, p. 838.

† Amer. Mon. Micr. Journ., xi. (1890) pp. 257-61; and Proc. Amer. Soc. Micr., xii. (1890) pp. 69-74.

among microscopists? Simply from the fancied difficulties of the necessary but simple manipulations required; and from the real one of the absence of any form of camera which could find a regular and permanent home upon the work-table, occupying no more space than the Microscope itself, and always ready for immediate use. The latter is a most important requisite. How frequently does the student find in the course of his observations upon living and other tissues, features that are vital toward proving the truth of his researches, but so evanescent that the lapse of even a few minutes may suffice to obliterate them? If, then, there be at his elbow a small, simple camera which can be at once applied to the Microscope without the slightest alteration of the latter, save placing the body in a horizontal position, using the same source of illumination, be it diffused daylight or that of the ordinary lamp, has he not a boon within his reach, which a few years since would

Fig. 20.



have been deemed impossible? And are not his thanks due to the fellow-worker, whose own wants found expression in the original of the "Handy" photomicro camera?

My friend Mr. H. Wingate, of Philadelphia, has long been an ardent worker with the Microscope, his studies being almost exclusively confined to the minute fungi belonging to the family of Myxogastres. He is exceedingly skilful with the pencil, and his drawings of these minute organisms, their spores, &c., are at least equal to any that have ever come under my observation. But, being actively engaged in business, the time wasted in making these drawings was a large tax, and he determined upon calling in the aid of photography; and there being absolutely no camera in the market to meet his requirements, he proceeded to construct one. Procuring a plate-holder of the proper size, he built the camera to suit it after the plan of the man who carried the bung-hole to a cooper shop to have a barrel made for it. His material was some heavy blackened cardboard, and an old piece of a steam-fitting some 4 in. long; his tools, a pocket-knife and a glue-pot, with the brains to use them. With these crude appliances he produced a camera, adapted to his Microscope, and capable of doing the highest class of work. He uses a Zeiss's 1/18 homogeneous lens constantly; and frequently makes a dozen or more negatives of an evening therewith.

Upon seeing this little affair, I was at once struck with the conviction that if it could be produced in a form adaptable to any Microscope, it would fully meet the long-felt want of just such an instrument. The result was the construction of the "Handy" camera, which has already been supplied to many institutions of learning and to private workers.

The camera consists of a mahogany box about 2⅝ in. square, corrugated and blackened on the inside to prevent any reflections of light. A solid cone of some 4 in. in length, tapering to receive the tube of the Microscope, is attached to the front of the box. Preferably, this cone front should be in a bellows form, as in the sample sent, but this being rather more costly than the solid cone, many will be satisfied with the latter. In one case the bellows responds readily to the movements of the Microscope tube in focusing; in the other the tube must slide readily into and out of the solid cone. At the opposite end of the box is a groove, in which the plate-holder and frame containing the focusing screen slide. The former carries two plates 2½ in. square, amply large for all ordinary illustrations. Should larger sized pictures be required they can be made by enlarging upon bromide paper.

The focusing screen is made of very thin crystal glass, most carefully ground by hand, presenting the smoothest surface obtainable by this means, but still quite too coarse for the exact focusing of delicately marked objects. In fact the focusing screen is mainly useful in procuring even and full illumination of the field, and in properly centering the object. The final fixing of the exact focus is done by means of a focusing glass used in conjunction with a disc of thin cover-glass attached to the ground surface of the screen by means of Canada balsam.

The camera is mounted upon a stout metal rod, which slides into the upright shaft of a very heavy japanned base, and can be secured at any height to suit that of the Microscope (when the latter is placed in a horizontal position) by means of a milled head. The base is shod with thick felt cloth, so that it may be placed upon any polished table-top without scratching the latter, and at the same time remain firmly fixed in the position it may be placed in.

And this is all there is of it: simple, compact, always ready for immediate service, and occupying no appreciable space upon the work-table. Although primarily intended for use with the Microscope-body inclined in a horizontal position, it may be as readily adapted to the latter in a vertical one, when the character of the objects (as those mounted in fluids) may require. My own method has been to remove the camera from its base and mount it upon the top of an open box containing the Microscope. An opening in the top of the box allows the cone to be slipped over the tube of the Microscope, and in this manner I have made very successful negatives of blood-corpuscles in rouleaux in their own serum, yeast spores in fluid, &c. A correspondent in Boston writes me that he has mounted the camera upon a firm retort-stand for the same purpose. Many methods of using the instrument in an upright position will doubtless present themselves to the worker therewith.

The illumination may be by reflection from the mirror as in ordinary work, or by removing the latter and placing the lamp behind the stage in a direct line with the optic axis. It must be carefully centered in order to illuminate alike in all portions. Condensers of various kinds, bull's-eye, achromatic, Abbe, &c., can be used as desired, but only with moderate powers. The best results will be obtained by the employment of simple diaphragms of various sizes to suit, and so placed as to come as close as possible to the under surface of the slide upon which the object is mounted. All extraneous light should be excluded and none be allowed to enter the objective other than the rays which illuminate the specimen. Opaque objects may be photographed quite as successfully as transparent ones, but the time of exposure would be very greatly shortened by employing direct sunlight.

The eye-piece may be removed or not, as the observer may elect. Following the teachings and practice of the late Dr. J. J. Woodward, I have almost invariably worked without it, using an amplifier where sufficient magnification could not be obtained with the objective alone. In using medium and high powers, I have not found the eye-piece objectionable, but with low powers it certainly detracts from sharpness of definition, so that my preference is decidedly in favour of the amplifier where an increase of power beyond that obtainable with the unaided objective becomes necessary. If possible, however, always use the latter alone. The short tube-length, alone possible (when using the "Handy" camera), renders the employment of amplifier or ocular necessary, if enlargement beyond three or four hundred diameters is to be made, since the limit of a 1/18 used direct is less than 350°.

The corrections of most modern objectives as to visual and actinic foci, are so nearly identical that no difficulty will be experienced in obtaining sharp definition of any subject if a little care be used. But it may not be amiss to say the student's series of Bausch and Lomb are the best, by all odds, of any I have ever seen or used at all approaching them in moderation of cost. I have numerous remarkable examples of their work which I have never seen excelled by lenses of equal powers, no matter what their cost. It certainly is not necessary to go abroad in these latter days to get the best in the optical as well as in many other directions.

The dry plates for the "Handy" camera are furnished by the makers in two degrees of sensitiveness to suit every variety of subject. They are readily developed by any of the methods used for gelatin plates, my own preference being given to hydroquinone or a mixture of that with cikonogen, as giving the clearest results, clearest details, and sharpest contrasts with any desired amount of density. Their cost is but 25 cents per dozen, certainly cheap enough to tempt any one to their use.

In conclusion, a few words upon various printing methods. Presuming that every microscopist who ventures into the realms of photography will do his own printing, a few hints may prove useful. There can be no doubt of the beauty and perfection of a good, properly toned, and finished print upon albumenized paper. This is conceded. But comparatively few amateurs will ever succeed perfectly in the operation of sensitizing the paper and toning the print, whilst most of the "ready sensitized" papers on the market are an abomination and a snare. Therefore avoid this method of printing, unless prepared to do first class work.

Passing by platinum as being both expensive and uncertain, excepting in the hands of an expert (although its beauty and perfection cannof be too highly extolled), let us consider for a moment the decided claim of bromide paper, as being the best material for printing in our class of work. Using the smooth surface paper and developing with ferrous oxalate, we get a perfect print rendering the most delicate details with the crispness and clearness of a steel plate engraving, which indeed it most closely resembles in very many instances. The exposure is made by lamplight, so that one is entirely independent of time or weather, and the finished print is quite permanent; as much so, it is reasonable to believe, as a carbon print. If the sheet be allowed to dry by itself, it will present the appearance of an ordinary plate engraving. If a polished surface be desired, all that is necessary will be to float the paper, print side down, upon a sheet of polished hard rubber; to squeeze it into optical contact, removing all superfluous moisture, and when quite dry it will peel off the rubber plate with a beautful polished surface, greatly increasing the delicacy of detail in many subjects, especially diatoms. Most decidedly my preference is given to this form of printing.

But there is another method which, at the risk of being laughed at, I am inclined to gently urge. I refer to the ferro-prussiate, or more commonly named "blue prints." This method of printing is tabooed in many instance, "blue prints" being rigorously proscribed in the albums of the Postal Photographic Club, but for all that it has decided advantages and merits for the work we are considering. It is cheap, as the paper may be purchased ready sensitized, at very trifling cost, and it requires no skill or experience in the using. It is merely necessary to expose to bright sunlight until sufficiently printed (a few experiments will determine this), and then to wash in several changes of water; the result being a bright permanent blue print upon a clear white ground, with excellent detail, excepting in the most delicate structures.

The negatives made with the "Handy" camera are of a convenient size for printing lantern-slides by contact. A print on glass is certainly the most perfect of any that possibly can be made, and the importance of this method of demonstration has long since been conceded. Gelatin plates coated on thin glass with special slow emulsions are furnished by several makers, and microscopists can readily make their own lantern slides with a little expenditure of time and patience.

On some Processes of Photomicrography.*—Dr. S. Capranica gives an account of the processes and apparatus which he employed to establish the results given in this Journal, 1888, p. 651.

* Zeitschr. f. Wiss. Mikr., vi. (1889) pp. 1–18.

(1) Apparatus for instantaneous photomicrography.—The author strongly recommends the use of the finder, with which it is possible to view simultaneously the preparation on the stage of the Microscope, and the projection of the image on the ground glass of the camera. The apparatus employed is a modified form of the Bourmans system. The camera is of wood, 30 cm. by 30 cm. and 12 cm. deep. On the front is a board, sliding in grooves, on which a metal flange with circular aperture of 5 cm. is screwed. A short tube carrying a shutter is attached to the flange. On this tube is screwed a totally reflecting prism in a circular metal box, having a right-angled tube of less diameter, to which is applied a stereoscopic binocular eye-piece of Abbe-Zeiss. The two eye-pieces of the latter are unscrewed and replaced by two other tubes. The tube replacing the straight eye-piece is of the same length, and can be fitted with slight friction into the socket of the vertical tube of the prism-box. The other tube replacing the inclined eye-piece has a rack and pinion motion, and can be lengthened by the addition of other pieces of tube of the same diameter. The finder having been arranged, the tube of the stereoscopic eye-piece is placed in that of the Microscope, and by a strong binding screw the foot of the instrument is fixed to the work-table. A special slide, which serves the triple purpose of plate-holder, support for the ground glass, and shutter, consists of a square box, provided with two cylinders, on which is rolled a band of black sheet indiarubber completely light-proof. A screw button presses on the spring, which by a pneumatic release sets the cylinders in motion. On drawing a silk thread, the indiarubber sheet unrolls itself on the cylinders and, traversing with great rapidity the free surface of the slide where the sensitive plate is exposed, returns instantly to its first position. The maximum rate of passage of the indiarubber band was 1/20 of a second. Since the shutter is placed at the back of the camera, the shock of its release can only very slightly affect the Microscope.

The author in all his experiments made use of the large Microscope of Koritska, and considers that the apochromatic objectives supplied to him by this maker are in many respects superior to those of Zeiss. The polarization apparatus is disposed as in the Nachet petrographical model. The micrometer screw has a divided head and reads to the 500th mm. with great exactness. For very delicate work the author used the stand (large model) of Powell and Lealand, or a Ross stand with swinging tail-piece for oblique light. When powerful condensing systems were used, a special cell containing a saturated solution of alum was placed beneath the stage, and the rise of temperature was noted by a thermometer.

The indispensable condition for success with a high-power objective, as e.g. a 1/25 immersion, is to have a sufficiently strong illumination. To a bad illumination of the image the author attributes most of the faults usually noticeable in photomicrographs.

(2) Apparatus for the reproduction of consecutive movements of microscopic creatures.—Experiments made by the author with one of the first photographic cameras of Stirn succeeded sufficiently well to induce him to make it the basis of the apparatus which he subsequently employed. This camera consists of a circular box, 2 cm. thick,

having a shutter, with a continuously intermittent release, each movement of which simultaneously caused a circular sensitive plate to advance by a sector. Of this camera only the shutter in the front of the apparatus was retained. This was fixed to the plate of a camera similar to that described in (1). The two special slides designed by the author have a clockwork movement. The one for use with a glass sensitive plate consists of a rectangular box 20 cm. by 20 cm. and 5 cm. deep. At the centre of the box is a metal wheel, put in motion by a clockwork arrangement at the back of the slide, which is provided with an escapement pneumatically regulated. In the metal wheel are fixed the sensitive plates, of the same size as those used in the Stirn camera. This part of the slide is protected from light by a screen, which is placed on a frame in such a way as not to interfere with the movement of the wheel. The screen is pierced with a circular aperture of 5 cm., placed in a line with the aperture of the shutter. The focusing is effected either by Moitessier's method, or by the substitution of a ground glass for the slide. When the slide has been placed in position, the finder, previously described, is fixed by a screw tube in the shutter. As soon as focusing is finished, the slide is charged with the sensitive plate, and successive photographs are taken of the movements of the object on the stage, while it is kept under observation the whole time with the finder. The disadvantage of this slide is that with it only a very limited number of proofs can be obtained. The apparatus devised by the author to remedy this defect can give theoretically 250 impressions of 9 cm. by 9 cm. in a minute. This second slide is a modified form of that of Eastman.* A band of very sensitive negative paper is rolled in turn on two cylinders. A powerful clockwork arrangement placed at the top of the slide effects the movement of the sensitive paper. A lever, pneumatically regulated by a caoutchouc ball, communicates with the spring which sets the clockwork in motion. The rest of the apparatus is in all respects similar to that first described.

The first of the two slides was constructed at Milan by Mr. Oscar Pettozzi, and the second at Genoa by Mr. Ettore Guelfi.

New Flash-light for Photography.†—Dr. Thomas Taylor made an exhibition of his new discovery before the Washington Chemical Society, which, it is believed, will supersede several now in use for photographing at night. The composition consists largely of charcoal made from the silky down of the milk-weed—a form of carbon which he prefers to all others, because of its freedom from ash. A few grains being placed on tissue paper and ignited by a punk match, produces a prompt and blinding flash, while it was observed that the paper on which the powder rested was not even scorched, thus demonstrating the greater security from accidents.

Notes on Photomicrographic Prints exhibited at Meeting of R.M.S. on 19th November, 1890.—Mr. A. Pringle writes as follows regarding the remarks made on his prints by Dr. Dallinger and Mr. E. M. Nelson.‡

(1) Photographs of *B. termo*.—Mr. G. F. Dowdeswell, F.R.M.S., is

* M. A. Londe's 'La Photographie Moderne,' 1888, p. 22.
† Microscope, x. (1890) p. 190.
‡ See this Journal, 1890, pp. 836-7.

responsible for the nomenclature *B. termo*. The organism corresponds with sufficient accuracy—allowance being made for the somewhat vigorous treatment in staining—with the measurements, and also with the behaviour in cultivation, of Cohn. The staining was effected by the method of Loeffler—modified, I understand, by Mr. Dowdeswell—tannin and iron sulphate being used as a mordant. The photographs exhibited, and about ten others not shown, were obtained with an apochromatic 2 mm. glass by Zeiss, projection ocular, and a dry condenser, nominally of N.A. 1, also by Zeiss.

The preparation viewed with the named objective and compensating oculars Nos. 8 and 12, shows the flagella apparently as long and almost as wide as they are shown in the photographs. That is to say, that the flagellum so viewed varies from twice to six times as long as the "body" of the organism, and in some cases the flagella seem to be even longer in proportion to the bodies than six times.

I agree with Dr. Dallinger that, as a rule, *B. termo*, unstained, or slightly stained, or stained without the use of Loeffler's mordant, shows a flagellum about one and a half times the length of the body. Until I saw late preparations by Mr. Dowdeswell, I had never seen flagella nearly so long attached to *B. termo*.

Dr. Dallinger appears to attribute the great prolongation as well as an "extremely rotten" appearance, or "imperfectly defined edge" to imperfections inherent in, or frequently found in, photographic representations of microscopic images. It is difficult to conceive the operations or the optics concerned in photomicrography producing such a very remarkable prolongation of a flagellum as that with which we are dealing. But in respect of the width of the flagellum, much may be said on a certain shortcoming of photography. The phenomenon known as "lateral development" has a marked bearing on photographic images of very minute objects, such as the case in point. The silver is not reduced, I believe, precisely at right angles to the surface of the vehicle-film, there is a certain amount, varying no doubt with the nature and properties of the vehicle, of "spreading" of the silver image through the menstruum containing it, hence (among other reasons) a negative image is never quite so "sharp" as the image projected on the film. This action of lateral development takes place twice in the production of a print; first, in the production of a negative; second, in the operation of printing. Further, I believe that this lateral reduction takes place to a greater extent in printing processes where the image is revealed by development, and I believe that the gelatin processes of photography are more apt to favour this phenomenon than, for instance, albumen processes.

The negatives and the prints exhibited were produced by development processes on gelatin films, and, moreover, the prints were left with surfaces more or less "matt"; and it is probably not stretching any point to say that the fact of the width of the flagellum on the print being at least 50 per cent. greater than if accurately represented it would be, is accounted for by the photographic imperfections I have named. The inaccuracy in the length of the flagella due to these causes is so slight as to be negligible.

Photomicrography in Space.—Dr. Fayel, President of the Société Linnéenne de Normandie, communicated to that Society * a note on this subject which we translate:—"Under the designation of *Photography in space*, Dr. Fayel records a process of his invention which facilitates the observation of opaque objects by the Microscope, even with powerful objectives, and which he thinks will hence render important service. Instead of focusing directly upon the object, Dr. Fayel allows the image to be projected on the ground glass of the photographic camera, and then removes the ground glass and examines the aerial image with a Microscope. In order to reduce the labour of adjusting the Microscope, it should first be focused very near the plane of the ground glass. The image appears so sharp that the minutest relief-forms of the opaque object may be observed by manipulating with the fine-adjustment screw."

(6) Miscellaneous.

Liquid Crystals.†—Prof. O. Lehmann has been able to demonstrate the remarkable fact that three organic substances at certain temperatures, although actually in a liquid state, show strong doubly refracting power, and may therefore be regarded as anisotropic crystals.

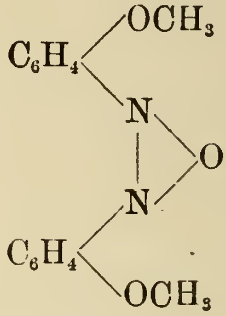
All crystals hitherto known consist of solid aggregates. The author has previously shown, however,‡ that some crystals can be made to flow when subjected to pressure exceeding the limit of elasticity. This has been long known with respect to amorphous bodies like sealing-wax and soft glass. Bodies like these pass, by increase of temperature, continuously out of the solid into the liquid state, i. e. the limit of elasticity gradually diminishes until at a certain critical temperature its value is zero. Beyond this temperature the body is liquid, and the smallest force is capable of causing it to flow. If a crystal then possesses a very low limit of elasticity, it can be made to flow, just as a liquid can, by means of a very slight force. The question therefore arises whether a crystal could not have an elasticity limit zero, and thus be referred no longer to solid but to liquid bodies.

According to the prevailing ideas, which receive their most perfect development in the theory of Soncke, this should be impossible; for this theory supposes that the molecules of crystals form regular point systems, held in position by the elastic force. The author, however, considers that this theory is unsatisfactory when the physical instead of the purely geometrical relations of crystals are considered. If the existence of a crystal as such depend on a regular distribution of the molecules, long continued deformation should at length lead to the production of a body not possessing this regular arrangement, i. e. to an amorphous substance. Experiments, however, made by the author showed that no amount of deformation was capable of converting a crystal into anything resembling in any way an amorphous body. Having regard to this slight correspondence of the theory with fact, the idea of a liquid crystal appeared to be justifiable. One distinction between crystalline and amorphous bodies is the capacity possessed by the former alone of growth in a supersatu-

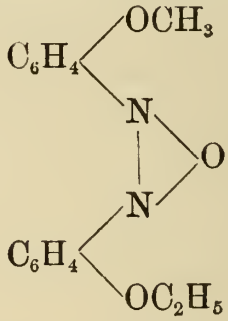
* Bull. Soc. Linnéenne de Normandie, iii. (1888–9), p. 13.
† Pogg. Ann., xl. (1890) No. 7, pp. 401–23.
‡ Zeitschr. f. Phys. Chem., iv. (1889) p. 462.

rated solution. Now almost all known liquids possess this property, so that, to be consistent, they should be considered as crystallized, and, since they are isotropic, as belonging to the regular system. The three organic substances which form the subject of the paper are examples (at present the only ones known) of liquid crystals which are anisotropic. They are:—

1. Azoxyphenetol.
2. Azoxyanisol.



3. Compound of the composition



The following observations apply to all three alike.

The normal form of crystal drops —Crystals of the substance under examination, placed on the stage of the Microscope under a cover-glass, were melted and then allowed to cool again to the point of crystallization. On again warming and examining between crossed nicols, at a certain temperature (134° for azoxyphenetol, 116° for azoxyanisol, and 87° for the third substance), a sudden transformation into strongly doubly refracting crystals took place. These newly formed crystals preserved the same form as the first, but were seen by pressing down the cover-glass to be not really solid, but liquid. By warming still further, at a definite temperature (165° for azoxyphenetol, 134° for azoxyanisol, and 140° for the third substance), they passed into the ordinary isotropic liquid modification. In order to isolate the liquid crystals a solvent in the shape of Canada balsam was used. By then heating to a temperature above their point of fusion, and subsequently cooling, the crystal drops separated out from the solvent in perfect spheres, which in ordinary light showed peculiar shading effects, most of them like fig. 1 or fig. 2 (Plate V.). These figures really represent the same object in different positions. The shading effect is due to irregularities of refraction, like the "Schlieren" seen in amorphous bodies when examined under oblique illumination by Töpler's "Schlieren-apparatus." *

* Pogg. Ann., 127 (1866) p. 556.

Between crossed nicols fig. 1 appears as fig. 3 * with a black cross, fig. 2 as fig. 4*a* or 4*b*, dark or clear, according as the long " Schliere " is parallel or inclined to one of the directions of vibration of the nicols.

The distribution of the directions of extinction for the individual points of the drop is given by the curves represented in figs. 5 and 6. They correspond to the electric level surfaces and lines of flow in a conducting sphere in which the current enters and emerges at the extremities of a diameter. Regarding a drop as composed of uniaxial crystal particles, the optic axes must be considered as arranged in positions corresponding to the lines of flow, and the equatorial planes as representing the level surfaces. An optically uniaxial crystal in which the limit of elasticity is zero must assume such a form. For the surface tension between crystal and liquid will possess different values on the different crystal faces; but since there is no counteracting elastic force, the molecules will change their positions until the surface tension has everywhere the same value, and that the smallest possible, since the potential surface energy tends to a minimum. The molecules will accordingly arrange themselves so that they all present the same side outwards.

By the use of the polarizer alone indications of dichroism are obtained. Thus, when the long " Schliere " is parallel to the short diagonal of the nicol, the crystals appear colourless and with faint outline; when at right angles, yellow and sharply defined.

Deformation of crystal drops.—By pressing the drop between stage and cover-glass the principal form (fig. 1) changes to that shown in fig. 7. In this the " Schlieren " have given place to a sharp nucleus at the centre and another around the circumference of the disc. Between crossed nicols the appearance is the same as before, except that the quadrants show colour differences. By suitable pressure on the cover-glass the central nucleus can be made to approach the edge and finally to take up a position between the broken ends of the marginal nucleus (fig. 8). By further deformation the two nuclei pass through various transitions until the symmetrical form of fig. 9 is obtained. By then diminishing the pressure until the drop once more assumes the spherical shape, the simple form of fig. 2 is obtained. Thus the total effect of the series of changes has been to turn the drop through 90° about a horizontal axis.

More exact observation with greater magnifying power showed the peculiarity in the spaces between the two nuclei seen in fig. 10. This was found to be due to a rotation of the whole drop in a direction contrary to the hands of a watch. The rotation was so much more rapid, the greater the difference in temperature between stage and cover-glass. On account of the friction of the glass and because the rotating force mainly affected the circumference, the outer layers became distorted with respect to the inner. Fig. 11 represents a much twisted drop produced in this way. Between crossed nicols it showed concentric dark rings with alternating white and yellow ones.

With very rapid rotation the ends of the nuclei bend towards the

* The punctuation in the figures denotes, according to thickness, pale to dark yellow.

centre (fig. 12), and finally a double spiral filling the whole space may result (fig. 13).

Another effect of heat is the production of local rotations about horizontal axes. A portion of the marginal nucleus may thus be drawn into the interior of the drop (fig. 14); a fresh nucleus then forms on the edge, and may follow the first, and so on until the whole surface becomes covered with parallel nuclei (fig. 15).

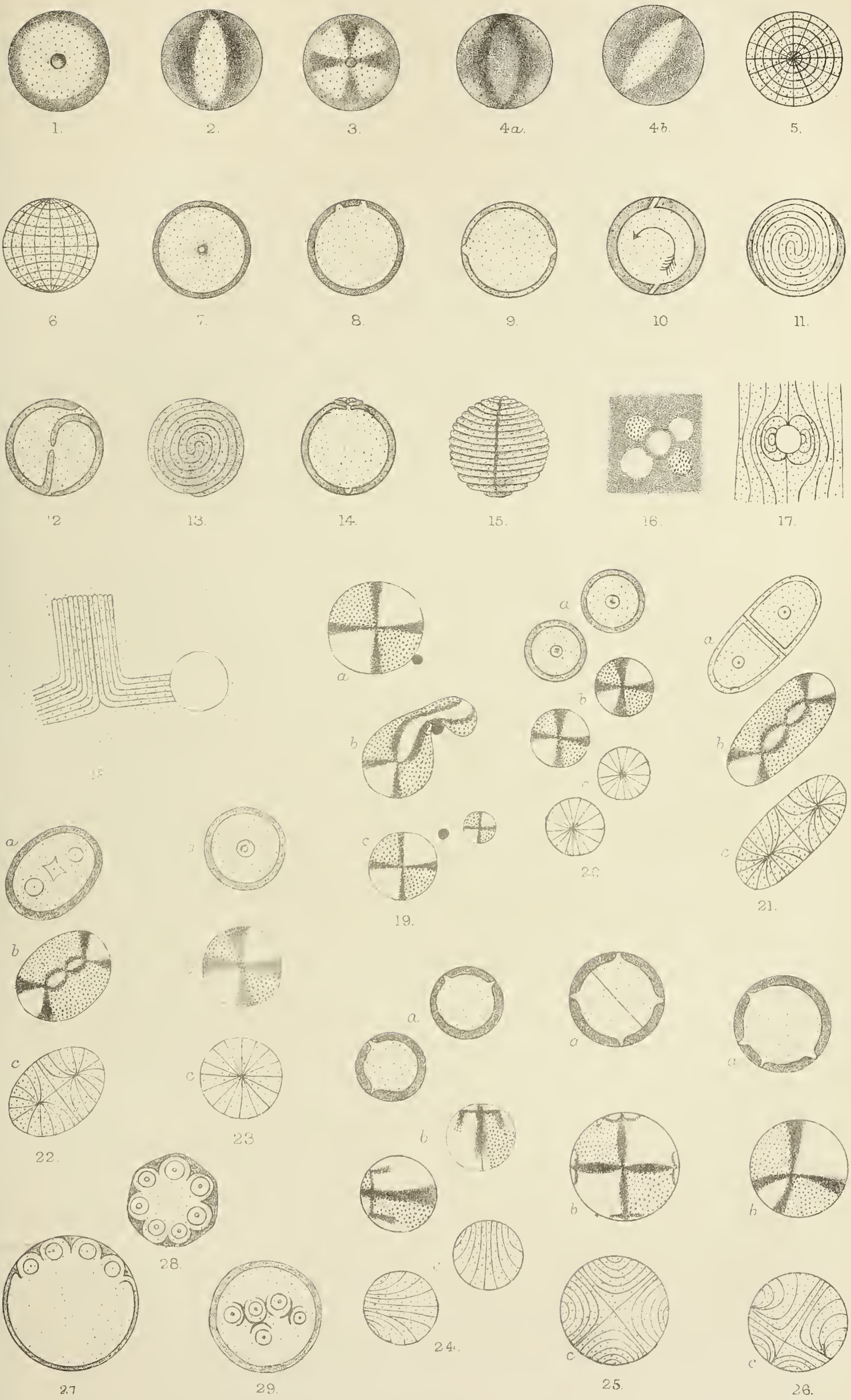
When a flattened-out drop is very strongly heated, it is gradually dissolved, and, in consequence of the above movements, the thickness diminishes most quickly at the centre. Accordingly a hole is soon formed, and the drop is changed into a ring. At the moment of production of the hole, one or two nuclei form on its edge. The same thing happens when there is an air-bubble in the interior of the mass (fig. 16). For this case the structure lines are represented in fig. 17. They correspond exactly to the electric lines of force in a dielectric, into which an insulated conducting sphere is brought. Effects similar to those produced by heat can be brought about by mechanical means. Fig. 18 represents the effect of the passage of an air-bubble into a large mass, by which the nuclei are drawn out into parallel threads, like the "oligen Streifen" observed with cholesteryl benzoate.

Division of crystal drops.—When an ordinary liquid crystal is cut into two parts, each part forms a new individual with spherical form and nucleus like the original. Fig. 19 *a*, *b*, *c*, shows the division of a crystal by means of an air-bubble; the crystal is first deformed, and then cut into two parts.

Copulation of crystal drops.—In the case of two drops with central nuclei the union of two into one may take place in two ways, either by the two nuclei closing up to the double nucleus in the centre of the compound drop, or by one nucleus being driven off to the edge, while the one-half of the compound drop grows at the expense of the other. The first process is represented in figs. 20 *a*, *b*, *c*, to 23 *a*, *b*, *c*. One of the processes by which two drops with marginal nuclei may unite is explained by figs. 24 *a*, *b*, *c*, 25 *a*, *b*, *c*, and 26 *a*, *b*, *c*. The ultimate form taken by the complete union of two drops need not be the only possible stable one. Quite stable intermediate forms may occur, especially where several drops are united. Figs. 27, 28, and 29 show some examples of the copulation of drops with central nuclei.

With regard to the copulation of *dissimilar* crystals, it was found that any one of the three organic substances could unite with any other. Their properties, however, were so similar that no striking result was obtained.

In support of the contention that optically isotropic liquids should be considered as liquid crystals belonging to the regular system, the author brings forward the following considerations. In the conversion of a substance into an allotropic modification the newly formed crystals generally occur regularly orientated with respect to the earlier ones. Now suppose that in a fused mass of regular crystals this orientating effect acts upon the crystallized modification resulting from solidification, and the latter upon the liquid crystals formed by the fusion. Then by repeated fusion and solidification the visible solid crystals, as well as the invisible liquid ones, should always occupy the same positions,



R. Morgan lith.

West, Newman, imp.

Liquid Crystals.

and be of the same size, provided that internal currents are guarded against.

Some such effect the author obtained, not, however, by conversion of a fused mass into a solid modification, but into a liquid crystallized one. To avoid currents in the fused mass, special care was taken to have everything perfectly clean, and only very slight thickness was given to the liquid layer between stage and cover-glass. In this capillary space one of the three substances was heated until the solid crystals were converted into the doubly refracting liquid modification. This occurred in regular orientation with respect to the solid crystals, i.e. a copy of each in its outline was obtained, but with other interference colours and different directions of extinction. On heating still further, until the doubly refracting liquid was converted into the singly refracting, the field of view between crossed nicols became dark by the widening out of dark circular spots which formed in the doubly refracting mass. The fused mass was then cooled down again, when the doubly refracting liquid crystals again appeared with precisely the same outline and directions of extinction as before. The author considers that this experiment serves to strongly support the idea that non-doubly refracting fused masses are regularly crystallized enantiotropic modifications. That doubly refracting liquids are so rare as to have hitherto escaped discovery, receives some explanation from the fact that with substances having many enantiotropic modifications, the crystal system, with increased temperature, tends to a higher degree of symmetry, and thus finally to the regular system.

On the History of the Invention of Spectacles, Microscope, and Telescope.*—Herr C. Landsberg shows on what uncertain grounds it was that the year 1890 was regarded as the 600th anniversary of the invention of spectacles, and the 300th of that of the Microscope. It is impossible either to fix a precise date for these inventions, or to give with certainty the names of the inventors. The art of cutting and polishing precious stones was known to the ancients, and among the relics of this art we posses lenses, both convex and concave, which are at least 3000 years old, e. g. the plano-convex lens of rock-crystal discovered by Layard in the ruins of Nineveh. It can scarcely be doubted that the men who made these lenses were acquainted with their magnifying power, and in fact made use of it in the execution of those delicate engravings on gems which have been handed down to us. An exact description of the effect of spherically-cut glass is, however, not to be found in ancient literature; but Pliny mentions that the near-sighted Nero looked at the gladiatorial games through a smaragd. The Arabian physician Alhazen (about 1100 A.D.), who was the first to give an exact anatomical description of the eye, showed by his writings that he knew the magnifying effect of a segment of a sphere made of a denser material than the air. Later writers on optics refer to the observations of Alhazen, but add nothing to them. To Roger Bacon (1216–1294), however, much more extensive knowledge is ascribed. He is often credited with the invention of eye-glasses and the telescope. All that can be gathered from his writings

* Central-Ztg. f. Optik u. Mechanik, xi. (1890) pp. 265, 277.

is that he possessed plano-convex lenses and knew their magnifying power; that he attributed this power to the fact that the lenses made it possible to see objects under a greater angle; and that he perceived how useful such lenses might be for people with weak sight. There is no evidence, however, to show that he was actually the inventor of spectacles. That honour, it appears, must be divided between Alexander de Spina of Pisa, and Salvino degli Armati of Florence, for an old chronicle of the monastery of St. Katharina, in Pisa, ascribes it to the first, while an inscription discovered on a tombstone in the church of Maria Maggiore, in Florence, gives it to the second. The first authenticated notice of the use of glasses for weak sight is contained in a letter dated 1299, and Jordan di Rivalto, in a speech made in the year 1305, refers to the invention of spectacles as being then scarcely twenty years old. Thus the date of the invention was close at the end of the thirteenth century, but no precise year can be given. For the next three centuries no advance in the theory of optics appears to have been made, and it was not until the beginning of the 17th century that the Microscope and telescope were invented. Italy and Holland both claim the honour of the invention, and each of these nations brings forward different names. There is very little doubt that the honour belongs to Hans and Zacharias Jansen, father and son, glass-cutters of Middelburg. Evidence in support of their claim by the son and sister of Zacharias Jansen, and by Wilh. Borell his friend, is contained in a paper by Pet. Borelius on the invention of the telescope which appeared in 1655. According to the description given by Borell, the short-tube telescopes (Microscopes) made by the Jansens were about $1\frac{1}{2}$ ft. long. The tube, which was about 2 in. in diameter, was supported by three brass dolphins, and had a base of ebony on which the small objects to be examined were laid. The long telescope, or telescope proper, was not made by the Jansens until some time after the Microscope. A rival claimant for the honour of this invention is Lepreg, or Lipperstey, or Lipperheim, another glass-cutter of Middelburg. He certainly did construct a telescope, and was able to exhibit it to a stranger who came to Middelburg (probably about 1608) in order to make inquiries about the new invention; but whether his instrument was made independently or only in imitation of that of the Jansens it is impossible to say. In Italy, Galileo is generally accepted as the inventor of the telescope, but, as he himself allows, it was not until after he had heard of the Dutch invention that he attempted to construct an instrument for himself. To him is due the credit of being the first to direct the telescope to the heavens; and with its aid in 1610 he made the discovery of Jupiter's satellites. Although the earlier discovered, the Microscope was almost unknown beyond its birthplace at the time when the telescope was in all hands. Thus Cornelius Drebbel, who exhibited an instrument in London in 1621, was looked upon as the inventor, and is so described by Huyghens and many others.

Similarly, in Italy, the Microscope was unknown until about 1624. One explanation of this may be found in the fact that the instruments were then very incomplete. For the long series of improvements, both in the optical and mechanical parts, which has led to the perfection of the instruments of to-day, the present century is mainly responsible.

Microscopes, Microtomes, and Accessory Apparatus exhibited at the Tenth International Medical Congress at Berlin.*—At this exhibition there appears to have been a very fair show of instruments specially adapted for medical and pathological work. Most of the chief firms were represented, the greater number, of course, being German. Novelties were apparently conspicuous by their absence, the exhibitors' claims to inspection being chiefly for thoroughness and effectiveness, such as a Microscope with movable stage and nose-piece with four objectives, and a similar instrument fitted with Mayall's stage.

Microtomes were in full force: besides the commonly used sliding microtomes and freezers, the less known instruments for cutting under water, automatic microtomes, and Altmann's "Support-Mikrotom," were exhibited.

International Exhibition at Antwerp.—A circular letter has been issued regarding the "Exposition de Microscopie Générale et Rétrospective," to be held at Antwerp in August and September next.

The Executive Committee consists of M. Charles de Bosschere, President, Dr. Henri Van Heurck, Vice-President, MM. Edmond Grandgaignage and Gustave Royers; M. Charles Van Geert, junr., is General Secretary, and M. Ferdinand Van Heurck is Secretary.

The Honorary Presidents are Prof. Abbe, Mr. F. Crisp, and M. Nachet. Among others of the Honorary Committee are Prof. Strassburger, Dr. W. J. Behrens, Dr. E. Hartnack, Dr. Rod. Zeiss, and Dr. Sieg. Czapski, from Germany; Sir Joseph D. Hooker, Mr. John Mayall, junr., Mr. Julien Deby, Dr. Maddox, and the Rev. Dr. Dallinger, from England; Dr. Cox, Dr. H. Ward, and Prof. Hamilton L. Smith, from the United States; Dr. J. Pelletan and Dr. P. Miquel, from France; Dr. Engelmann, from Holland; the Abbé de Castracane, from Italy; and Dr. P. T. Clève, from Sweden.

The following is the "Programme de l'Exposition de Microscopie":—

Classe I. *Microscopes pour toutes les recherches courantes.*—A. Microscopes à platine et à sous-platine (" substage ") à mouvements mécaniques. Modèles à tube anglais et à tube continental. Microscopes ordinaires pour recherches usuelles. Microscopes à bon marché pour les études élémentaires. B. *Microscopes spéciaux.* — Microscopes binoculaires. Microscopes pour la minéralogie et la pétrographie. Microscopes comparateurs. Microscopes spéciaux pour la photographie. Microscopes renversés. Microscopes de voyage. Microscopes de poche. Microscopes de démonstration. Microscopes à deux ou plusieurs corps. Microscopes pour musées à platine portant de nombreuses préparations etc. Microscopes de projection. Objectifs et oculaires. Objectifs achromatiques et apochromatiques. Objectifs à sec, à immersion dans l'eau, à immersion homogène, etc. Oculaires: de Huygens, de Ramsden, holostériques, compensateurs, à projection. Appareils optiques pour l'éclairage. Condenseurs achromatiques et non-achromatiques.

Classe II. *Appareils d'éclairage.*—Lampes à pétrole. Lampes à gaz. Appareils pour la lumière oxyhydrique. Appareils pour l'éclairage électrique à arc, à incandescence. Piles électriques spéciales.

* Central-Ztg. f. Optik u Mechanik, Oct. 15, 1890.

Classe III. *Appareils pour la photomicrographie.*— Microscopes spéciaux. Chambres photographiques diverses. Photomicrogrammes.

Classe IV. *Appareils divers.*—Appareils binoculaires ajustables à volonté sur des microscopes quelconques. Revolvers; adapteurs; spectroscopes-microspectromètres. Appareils de polarisation. Chambres claires: pour microscope vertical, pour microscope incliné, pour microscope horizontal. Goniomètres, hématimètres, chromomètres. Chambres de culture (" Growing-cells"). Compresseurs. Platines à chariot indépendantes du microscope. Prismes redresseurs, oculaires redresseurs, oculaires binoculaires, oculaires stéréoscopiques. Plaque de diffraction d'Abbe. Appareil à échauffer l'objet sous le microscope. Appareils divers non mentionnés.

Classe V. *Appareils de mensuration* pour l'oculaire, pour la platine; appareils de mensuration pour les couvre-objet.

Classe VI. *Microtomes.*—A mouvements mécaniques, à main. Appareil à diviser pour tracer les micromètres et les tests dites de Nobert.

Classe VII. *Appareils et accessoires pour les préparations microscopiques et les dissections.*—Microscopes simples, doublets, loupes montées.

Classe VIII. *Préparations microscopiques.*—Préparations de toute espèce. Préparations simples. Préparations systématiques. Typen-Platten et Test-Platten.

Classe IX. *Appareils pour la bactériologie.*—Étuves à culture. Étuves à températures basses et constantes. Étuves à stériliser par l'air sec et par la vapeur. Appareils pour la coagulation du sang. Appareils pour la stérilisation des sérums. Boîtes pour désinfecter les instruments et pour stériliser les plaques à gélatine. Régulateurs pour la pression du gaz. Lampes inextinguibles et lampes se fermant automatiquement lorsque la flamme s'éteint. Appareils pour les recherches des microbes dans l'air et dans l'eau. Verrerie pour bactériologie (ballons, tubes, billots, plaques, entonnoirs à eau chaude, crochets, etc.).

Classe X. *Ouvrages de microscopie.*—Traités de micrographie. Ouvrages traitant de toutes les applications du microscope.

Prof. Gilberto Govi.—He was born at Mantua in 1834, and was educated at Turin and Florence, subsequently taking the professorship of physics at the University of Naples. He died on 29th June, 1889. At his funeral the President Brioschi, of the Accademia Reale dei Lincei, referred in high terms to the great capacity of Govi, and to his ardour in historical research in difficult points connected with scientific discovery. He was a frequent contributor to the transactions of the learned societies of Italy, and was particularly versed in the literature of electricity and optics. He made a special study of the labours of Volta, and threw much new light on the varied attainments of Leonardo da Vinci, to whose manuscripts he had access at the Biblioteca Ambrosiana of Milan. Govi's contributions to microscopy, theoretical, practical, and historical, were numerous. Most of his devices were carried out in conjunction with M. Alfred Nachet, the optician, of Paris. His latest historical research was an elaborate paper communicated to the Reale Accademia dei Lincei, in which he sought to establish the invention of the compound Microscope by Galileo; this paper we translated and published in this Journal, 1889. Govi was elected an Honorary Fellow in 1888.

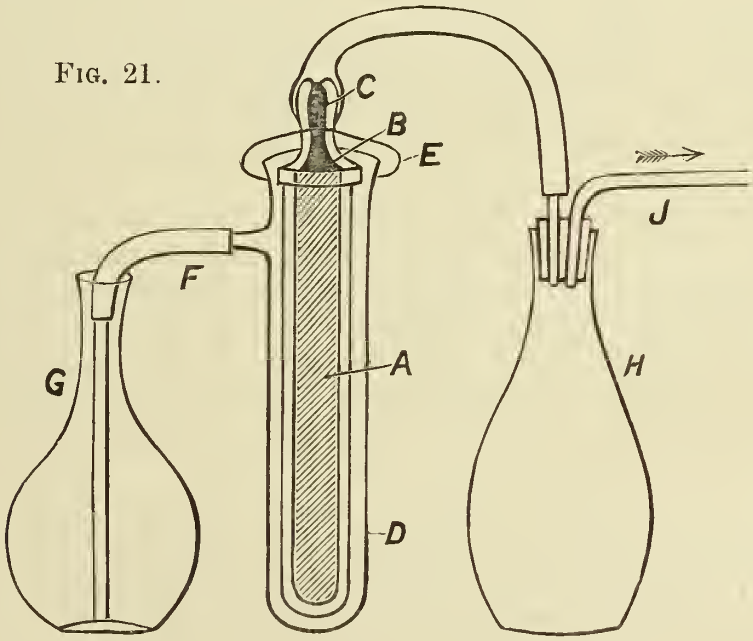
Mr. A. P. Schulze.*—Our readers will regret to see the announcement of the death of Mr. Adolf Paul Schulze, F.R.S.E. and F.R.M.S. Mr. Schulze was a yarn merchant in Glasgow, and made the study of microphotography, microscopy, and optics, the special pleasure of his spare time. Born in 1840 at Crimmitschau, Saxony, he was educated at the Polytechnic of Chemnitz, where he studied engineering, and came to England in 1864, ultimately settling in Glasgow in 1869. He made the subjects above named his special study, and was known from his scientific work to the leading men in all that is comprised in the term "optics," Prof. Abbe, of Jena, being in regular correspondence with him. Perhaps it would be too much to say that Adolf Schulze's life was lived in the wrong place; but for a busy man, in the commercial sense, he did much in the interests of science—so much as to give an idea of what he might have done had it been possible for him to have devoted himself to research.

β. Technique.†

(1) Collecting Objects, including Culture Processes.

Simple Apparatus for filtering Sterilized Fluids.‡—The apparatus invented by Dr. O. Bujwid consists of a Chamberland bougie A, about

Fig. 21.



15 cm. long and 2–3 cm. thick. Upon the top is placed a sort of cover B, through which runs a hole C. These two parts are very easily sterilized with steam or hot air. When required for use, the arrange-

* Engl. Mech., lii. (1891) p. 440.

† This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

‡ Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 4–5 (1 fig.).

ment is as seen in the illustration. The filter is placed in a test-tube D, and the air therefrom is exhausted by means of an air-pump. Hence the fluid to be filtered flows from the flask G, through D and C to H. Between the bottom of the porcelain filter and the test-tube, a piece of cotton-wool is placed.

Apparatus for cultivating Anaerobic Microbes.*—Dr. C. Brantz has invented an apparatus for the better cultivation of anaerobic micro-organisms. The apparatus, which is depicted but not described, consists of a holder or receiver for the solution of pyrogallic acid. It is placed beneath the slide and has two apertures, one of which opens into the chamber where the organisms are being cultivated in hanging drops, while the other is for connection by means of a caoutchouc tube with an apparatus for developing hydrogen gas. The receiver is capable of containing 5 grm. of the pyrogallic acid solution.

(2) Preparing Objects.

Method of investigating Development of Limax maximus.†—Miss Annie P. Henchman found that the best way of obtaining embryos was to keep adults, say twenty-five or thirty, in a large tin pail, the cover of which was perforated with small holes. It is best to feed them on cabbage, which affords them a sufficient protection against desiccation, and a place where they may lay their eggs. Care must be taken to keep the vessel clean. Eggs were generally found in the morning, in bunches of from thirty to forty. As they are more abundant in the early stages of confinement, it is better to obtain a few slugs often than many at once. The eggs must be carefully protected from drying. In a moderately warm room hatching occurs between the twenty-second and the twenty-seventh day.

The best agents for killing embryos are either 0·33 per cent. chromic acid or Perenyi's fluid. The chromic material, when well stained with alcoholic borax-carmine, shows the differentiation of nerve-cells and nuclei excellently. Good results for the study of cell-division have also been obtained by staining with Czokor's cochineal. Picro-carminate of lithium is valuable in later stages, as it brings out nerve-fibres, which are stained yellow, while the ganglionic cells are coloured red.

It is best to remove only the outer envelope before killing the embryos, as they are thus less likely to be injured. The inner membrane may be removed with needles after the eggs have been dropped into water to which a few drops of acid have been added. The embryos will be found to be very delicate, and must be handled with great care through every step of the process. Miss Henchman employed only the chloroform method of imbedding in paraffin. The embryo should be carried through the period of heating as quickly as possible, for the embryos are very apt to become brittle if subjected to the heat too long. They should be imbedded within an hour, or an hour and a half, from the time they are first put upon the bath in the chloroform. Paraffin

* Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 520–1 (1 fig.).
† Bull. Mus. Comp. Zool., xx. (1890) pp. 171–5.

which melts between 50° and 52° C. is better for imbedding than that which is harder, for in the latter the embryo may be cracked.

Sections from 10 to 15 μ thick, and in the oldest stages even thicker, are better than those that are very thin.

Method of observing Asexual Reproduction of Microstoma.*— Dr. F. von Wagner kept his living specimens of *Microstoma* in small breeding aquaria, 15 cm. long, 10 cm. broad, and 6 cm. high; and he did his best to reproduce the natural conditions of their existence without diminishing the opportunities for observation. A thin layer of mud was spread on the floors of the vessels, and food was provided in the shape of abundance of Daphnids of various sizes. Only a few plants were admitted, and they were, therefore, renewed completely every week. Care was taken to prevent the entrance of any other animals. Notwithstanding all this care, the specimens did not live for more than two or three weeks.

The animals, when required for measurement, must be carefully drawn out with a pipette, placed in a small watch-glass, and measured with an eye-piece micrometer. Great patience is needed.

Various preservative reagents were tried, and a concentrated watery solution of sublimate was found the best. Lang's fluid and a half per cent. osmic acid solution often gave good results. Weigert's picro-carmine was used for staining, and sections 1/100 to 1/500 mm. in thickness were cut.

Examining Bone Marrow for developing Red Corpuscles†— Herr E. Neumann says that phases of the development of the red blood-corpuscles may be observed by obtaining bone marrow in the following manner:—The marrow is squeezed out of some cancellated bone by means of a vice, and a small quantity of this taken up in a capillary tube and placed on a slide. Having been covered, it is examined directly without any addition. By this means good results can be obtained from ribs of human bodies which have been dead for some days.

Study of Contraction of Living Muscular Fibres.‡—M. L. Ranvier studied the appearances of living striated muscular fibres during stimulation by an electric current in the following manner:—The retrolingual membrane of the frog is stretched over the platinum ring devised by the author, and placed in some indifferent fluid in a moist chamber. Before putting on the cover-glass and closing it down with paraffin, two strips of tinfoil are placed on the slide in such a way that they may serve as electrodes. These movable electrodes receive the current from a bichromate battery, the ends of the wires of which are surrounded by flat lumps of lead. These rest on the tinfoil.

Observations carried out in this way show that when a striated muscular fibre is stimulated, the striation is present during all stages of contraction, and that the contractility of muscle is invariably associated with the contraction of the thick discs, which assume a somewhat spheroidal shape, the thin discs on the clear spaces being unaffected.

In a similar way the contraction of unstriped muscular fibre is observed.

* Zool. Jahrb., iv. (Abth. f. Anat. u. Ontog.) pp. 420–1.

† Virchow's Archiv, cxix. (1890) pp. 385–98. See Zeitschr. f. Wiss. Mikr., vii. (1890) p. 364.

‡ Comptes Rendus, cx. (1890) pp. 613–7 (2 figs.).

And for this purpose the mesentery of *Triton cristatus* is recommended. The smooth fibre requires a greater stimulus than the striated muscle. The difference between the contraction of the two varieties of muscle is merely one of manner and not of kind; the striated muscle contracts quickly, the unstriped slowly.

Examining the Endbulbs of the Frog.*—M. J. Fajerstajn demonstrates the termination of the nerves in the tongue and palate of the frog as follows.

The fixatives used were chromic acid 1 to 400, sublimate 5 to 100, Kleinenberg's solution, Flemming's chrom-osmium-acetic acid, and Carnoy's fluid (alcohol 6 vols., glacial acetic acid 1 vol., chloroform 3 vols.). The sublimate and Flemming's and Carnoy's fluids were the best. The preparations were hardened in alcohol, and imbedded in celloidin or paraffin.

For isolating the cylinder-cells the following method gave the best results: a mixture of 4 per cent. bichromate of potash and 1 per cent. chloral hydrate is made, and in it is placed either a piece of the palate mucosa, or the whole tongue, for 12 to 60 hours. The preparation is then placed under a dissecting Microscope, and teased out in a very weak solution of iodine-green.

For staining sections, several procedures were followed, e. g. sublimate 5 per cent., alcohol, paraffin, alum-carmine, with acetic acid and anilin-blue; or Flemming's mixture, alcohol, paraffin, methyl-green, metanil-yellow or the latter, preceded by safranin, Carnoy's fluid, alcohol, paraffin, dahlia.

Methylen-blue was used very satisfactorily for demonstrating the course of nerves. For this purpose it is advised to inject through the abdominal veins, as thereby the circulation is least interfered with. The injection must be done slowly, after paralysing with curara or anæsthetizing with ether. The solution used by the author was 1 part methylen-blue to 800 parts of a 0·6 per cent. chloride of soda solution.

Preparing Retrolingual Membrane of the Frog to show the junction of Muscular and Elastic Elements, and the natural termination of Muscle Fibre.†—M. L. Ranvier was enabled to demonstrate the connection between the elastic and the muscular elements of the retrolingual membrane in frogs by the following method. It was thereby found that the elastic fibres are attached to the sarcolemma, the two structures being welded together so intimately that mechanical means fail to break the continuity.

The membrane taken from a pithed or decapitated frog is placed for 24 to 48 hours in one-third alcohol. The epi- and endothelia are then removed with a brush; after this the membrane is immersed for 24 hours in a weak solution of methyl-violet, 5B. The preparation is again washed and then mounted and examined in glycerin.

Another histological problem was also resolved from this membrane. What is the natural termination of a muscular fibre? Does it end in a thick disc, a thin disc, or in a clear space? By means of the following

* Arch. de Zool. Expér. et Gén., vii. (1889) pp. 705–50 (1 pl.). See Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 357–9. † Comptes Rendus, cx. (1890) pp. 504–8.

method, the author demonstrated that the ending was in the thick disc. A frog is curarized. The lymphatic sacs are injected to distension with 2 per cent. bichromate of potash or ammonia. Eight or ten days afterwards, the retrolingual membrane is detached, and placed in water until it is decolorized. The epithelium is removed with a brush, and the preparation then stained with fresh hæmatoxylin and alcoholic eosin. The membrane is then dehydrated in alcohol, cleared up in oil of cloves, and mounted in balsam. Thus prepared, the thick discs are stained a bright red, the thin discs present a yellowish-rose colour, while the clear spaces are absolutely uncoloured.

In this way the succession of discs and clear spaces is easily followed right up into the tendon, where the muscle is seen to end as a rose-coloured hemispherical mass, which seems to correspond with a thick disc.

Hence, the author concludes that muscle fibrillæ end at the thick disc.

Examining the histolytic phenomena occurring in the tail of Batrachian Larvæ.*—For paralysing batrachian larvæ, Herr A. Looss prefers the use of an electric current (see this Journal, 1886, p. 700) to curara solutions, or to the pressure of a cover-glass. This method does not affect the histolytic processes which are taking place in the tail of the larva, and the only impediment to observation is the increasing pigmentation. The best fixative was found to be a mixture of sublimate and acetic acid (saturated aqueous solution of sublimate 150 ccm., distilled water 150 ccm., acetic acid 3–4 ccm.). After long washing in water, and having been tested with iodine alcohol to detect any remains of sublimate, the preparations are carefully hardened. For this, Fol's modification of Flemming's chrom-osmium acetic acid is recommended, but Müller's fluid, chromic acid, picric acid, and the mixture of chromic acid and platinum chloride are condemned. Staining was done in toto, in order to avoid damaging the preparation. Picrocarmine gave the best results, but acid-borax, alum and indigo-carmine, hæmatoxylin and anilin dyes were also employed. The paraffin imbedded sections (0·01 to 0·0075 mm. thick) were stuck on with glycerin albumen, and finally mounted in balsam.

For examining the so-called sarcolytes, decomposition-derivatives of striated muscle, Paneth's method was used. This consists in overstaining with picrocarmine, and then, after extraction of the excess of pigment, with hæmatoxylin and then dehydrating. After the sections have been freed from paraffin and stuck on the slide, they are washed with undiluted alcohol (96 per cent. spirit and 2·5 to 3 per cent. HCl). This leaves the hæmatoxylin only in the nucleus, and after thoroughly washing with slightly ammoniacal spirit, in order to remove all trace of acid, the nuclei are seen clearly defined, of a pure blue colour, and lying in a more or less red mass of protoplasm.

Examining the Blood for the Hæmatozoon of Malaria.†—M. Laveran states that the best time for examining malarious blood is

* Preisschr. d. Fürstl. Jablonowski'schen Gesellschaft zu Leipzig . . . d. Math.-Naturw. Section, 1889, 116 pp. and 4 pls. See Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 352–4.

† La Semaine Méd., x. (1890) No. 53. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1890) pp. 15–6.

during the height of the paroxysm, and the patient should not have taken any quinine for some time. The tip of the finger, having been properly cleaned, is pricked with a lancet, and the drop of blood is then placed between two cover-glasses. Fresh blood is best examined by daylight and with high dry powers. The flagella will be seen most frequently on the edges of the pigmented round free corpuscles. If a dry preparation is to be examined, the cover-glasses are drawn apart, the blood allowed to dry, and then the cover-glass is drawn thrice through the flame.

The preparations may be examined unstained, but the author prefers to stain with a saturated aqueous solution of methylen-blue, before using which the cover-glass must be washed with equal parts of alcohol and ether. In this way the nuclei of the white corpuscles are stained dark blue, while the round bodies, either free or adhering to the red corpuscles, are pale blue, and the growing corpuscles scarcely at all coloured.

Hydroxylamin as a Paralysing Agent, or Prefixative, for small animals.*—Dr. B. Hofer recommends hydroxylamin for paralysing small animals, as this substance and its hydrochlorate or sulphate possess a well-marked paralysing action on contractile elements.

In commerce it is obtained as the crystalline hydrochlorate; of this a 1 per cent. solution in water is made, and this is then rendered neutral by the addition of carbonate of soda. For dissolving the salt, spring, pond, or sea water must be used, and not distilled water. It is not advisable to have excess of the carbonate of soda, as this renders the solution too strongly basic and also less stable.

The animals having been palsied in this neutral solution of hydroxylamin, the next step is to fix them: for this purpose alcohol, picric and acetic acid, or a mixture of these acids, are recommended, as osmic and chromic acid, sublimate, the chlorides of gold and platinum are too easily reduced. The author gives several special examples of the action of this fluid. It is sufficient to state that it is used in 0·1 to 1 per cent. solution, the most useful strength being 0·25 per cent. From the examples quoted, e. g. *Stentor cæruleus*, *Spirostomum teres*, *Carchesium polypinum*, *Hydra grisea*, *Bunodes gemmacea*, *Dendrocœlum lacteum*, *Hirudo medicinalis*, Rotatoria and Mollusca, it is obvious that this reagent possesses a specific paralysing action on the contractile elements of the lower animals, and that its use as a preliminary to the permanent fixative is a distinct advantage. The length of time needed to produce the paralysing action of course varies with the size of the animal and the strength of the solution.

Preparation of Aleurone-grains.†—M. V. A. Poulsen calls attention to Overton's method of preparing and fixing the aleurone-grains in the endosperm of *Ricinus*. By plunging an absolute alcohol section in an aqueous solution of gallo-tannic acid, crystalloids are made to imbibe the acid and take a brown colour; they are then placed in a 1 per cent. solution of osmic acid, washed in distilled water, and preserved in glycerin. This method depends on the production of metallic osmium

* Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 318–26.
† Rev. Gén. de Bot. (Bonnier), ii. (1890) pp. 547–8.

in the crystalloids. M. Poulsen recommends also the two following processes:—

(1) Very thin sections of the endosperm are first placed in absolute alcohol for twenty-four hours, and, as soon as they are hard, transferred for an hour to a 25 per cent. aqueous solution of tannic acid, and then washed with distilled water. They are then plunged in an aqueous solution of potassium bichromate until they become brown or yellow. The sections thus made are preserved in glycerin, and show the transparent aleurone-grains with great clearness.

(2) After being hardened as before, the sections are made to imbibe tannin and washed; they are then placed for an hour or less in a 10–20 per cent. aqueous solution of iron sulphate, which brings out a very dark-blue or almost black colour. The sections are then washed and dehydrated in absolute alcohol; and the preparations thus made are placed first of all in essence of clove, and finally in Canada balsam. They are beautifully clear, and very durable.

Reference Tables for Microscopical Work.*—The following continues Prof. A. B. Aubert's reference tables: †—

Gum with chloral hydrate:—Gum arabic, chloral hydrate, water. A cylinder, 60 ccm. contents, is filled two-thirds with gum arabic in pieces; to this is added a solution of chloral hydrate (several per cent.) containing 5–10 per cent. of glycerin; shake often; in a few days the gum will dissolve; the syrupy liquid is filtered. Carmine and hæmatoxylin stained objects can be mounted in this medium.

Gum and acetate of potash or of ammonia:—Gum arabic, acetate of potash or of ammonia, glycerin, water. Made as the preceding medium, only a solution of potassic or ammonic acetate is used instead of a solution of chloral. Anilin-stained objects can be mounted in this.

Iodized serum, artificial (Ranvier):—(1) distilled water, 135 grm.; (2) egg albumen, 15 grm.; (3) common salt, 0·2 grm.; (4) tincture of iodine, 3 grm. Mix 1, 2, and 3, and filter; add 4, and filter again. Used for examinations, not for mounting.

Potassio-mercuric iodide (Stephenson):—Biniodide of mercury, iodide of potassium, water. To the water add an excess of each salt, and filter. This gives a very dense liquid of high refractive index (3·02). For diatoms, &c., may be used diluted.

Monobromide of naphthalin.—High refractive index; for diatoms, &c.

Monobromide balsam:—Solution of hardened Canada balsam in monobromide of naphthalin. Refractive index high, 1·6; shows finer structure of diatoms, &c.

Monobromide tolu. Weir's medium:—Solution of balsam tolu in monobromide of naphthalin. Refractive index, 1·73; may prove very valuable as a medium for diatoms. *Preparation.*—Dissolve 3 oz. of balsam of tolu in 4 fluid drams of benzol, add 4 fluid oz. carbon disulphide; renew this treatment with more carbon disulphide; pour it off again; evaporate the benzol from the balsam tolu. The tolu will now be free from cinnamic acid; put 1 fluid dram of monobromide of naphthalin in 1/2 oz. vial; add enough of the purified tolu to make a stiff mixture or solution when cold. Heat to 104° or 122° F. when using.

* Microscope, xi. (1891) pp. 12–14.

† See *ante*, p. 142.

Pacini's solution:—Sodium chloride, 1 part; corrosive sublimate, 2 parts; water, 113 parts; glycerin, 13 parts. Let it stand three months, then use 1 part with 3 of water; filter before using. Recommended as a preservative of delicate tissues.

Phosphorus (Stephenson):—Concentrated solution in carbon disulphide. High refractive index; difficult and dangerous to use; takes fire spontaneously in the air.

Ripart's solution:—Camphor water, 75 parts; distilled water, 75 parts; glacial acetic acid, 1 part; copper acetate, 0·3 part; copper chloride, 0·3 part. Useful for delicate vegetable tissues, desmids, Confervæ, &c.

Styrax:—Chloroform solution. For diatoms; high refractive index.

American styrax:—Chloroform solution filtered and hardened, Colour as light as that of good balsam; high refractive index; for diatoms and fine tissues.

Harting's corrosive sublimate solution:—Corrosive sublimate, 1 part; water 200 to 500 parts. For blood-corpuscles, &c.

Williams' solution:—Saltpetre, 2 oz.; sal-ammoniac, 2 drams; corrosive sublimate, 1 dram; glycerin, 2 oz.; alcohol, 1 pint; water, 2 quarts. Let stand for several days; filter. More properly a preservative for large anatomical and other specimens.

Wickersheim's solution:—Alum, 100 grm.; saltpetre, 12 grm.; potash, 60 grm.; arsenious oxide, 20 grm.; boiled water, 3000 grm. A preservative of large anatomical and other specimens.

Virodtzeff's solution:—Glycerin, 2160 parts; water, 1080 parts; alcohol, 45 parts; thymol, 5 parts. A preservative of large anatomical and other specimens.

Use of Gelatin in fixing Museum Specimens.*—Herr E. Schmidt recommends the use of gelatin- instead of glass-plates as a basis on which to fix small animals for demonstration. The spirit-specimen is laid on a moistened portion of the gelatin-plate, and is fixed as the gelatin dries, or it is attached by silver thread. Herr E. Weltner describes how small and delicate specimens may be attached to glass plates by means of concentrated (aqueous) solution of fine French gelatin. The spirit-specimens are as far as possible dried from the involved alcohol, and then fixed by the gelatin on a warm glass plate. Sponges, Hydroids, Anthozoa, Ctenophores, Bryozoa, Tunicates, and such delicate animals as *Salpa*, *Ophrydium*, and *Collozoum*, are in this way successfully prepared. The gelatin solution must be concentrated, else it turns white when put into alcohol. For Medusæ and similar organisms, Weltner has adopted the glycerin and gelatin method recommended by List. Gelatin is dissolved in equal parts of glycerin and water; the cold mixture is again dissolved by boiling with about three times as much glycerin and water (again in equal parts); the almost cooled result is spread on a glass plate; on this the spirit-specimen with the alcohol dried off is then laid. A douche of absolute alcohol will hasten the fixing. The objection to the method seems to be that the cementing material turns white when the specimen is returned to alcohol. For the closure of glass vessels, Herr Weltner finds the use of gutta-percha most effective.

* SB. Gesell. Naturf. Freunde, 1890, pp. 95–8.

(3) Cutting, including Imbedding and Microtomes.

Strasser's Ribbon Microtome for Serial Sections.* — Prof. H. Strasser describes a microtome upon which he appears to have expended considerable pains in order to make the sections adhere to the under surface of a specially prepared roll of paper. Hence he calls it the "Schnitt-Aufklebe" microtome.

In the microtome proper there does not appear to be anything new,

FIG. 22.

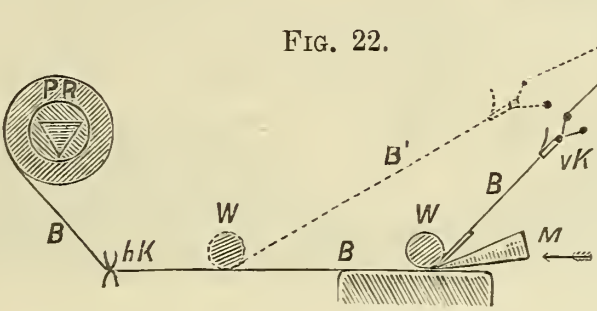
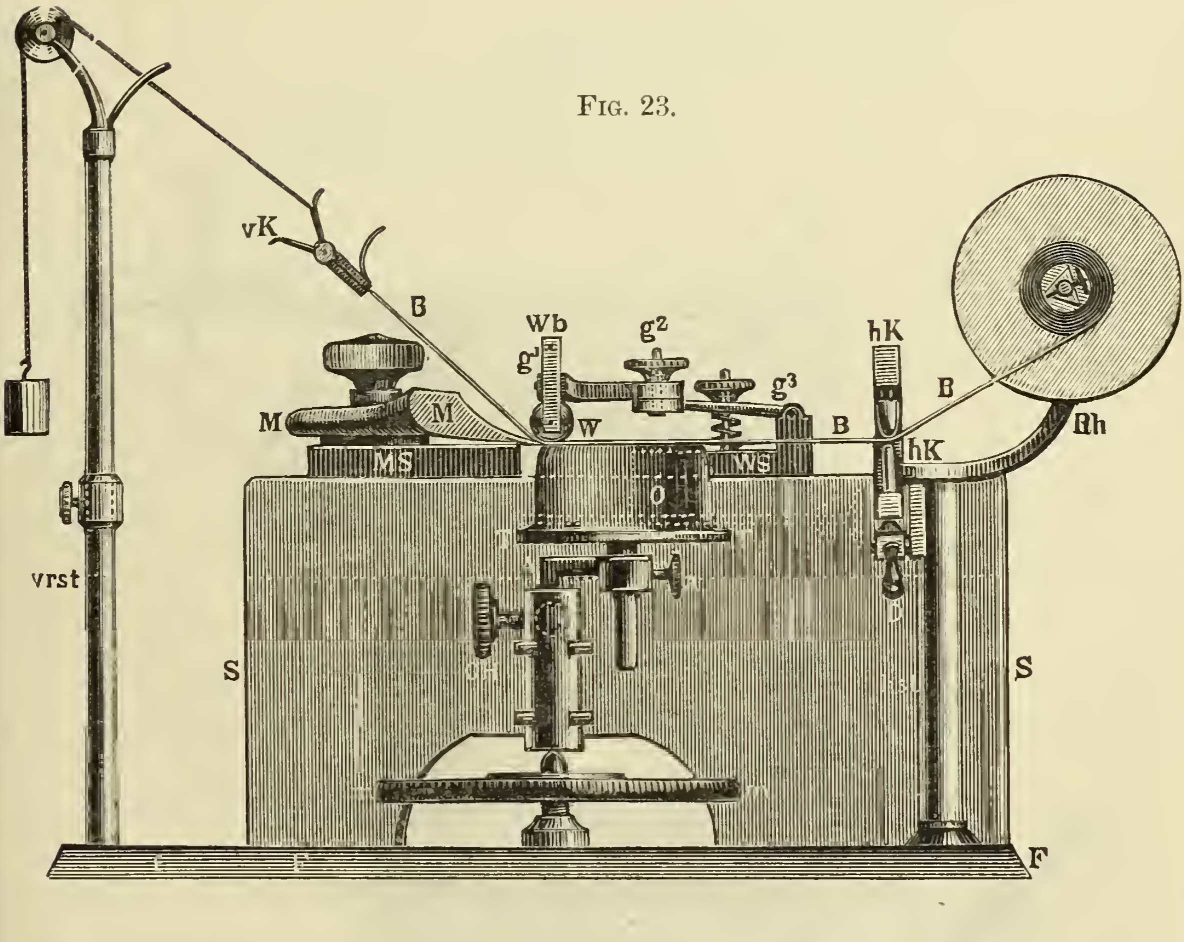


FIG. 23.



as it merely consists of the usual arrangements; that is, there is an object-holder raised by the micrometer-screw, and a knife-holder running on a heavy block in a V-shaped slide-way. The novel details consist in the apparatus for receiving the sections as they are cut off, and the

* Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 289–304 (5 figs.).

Fig. 24.

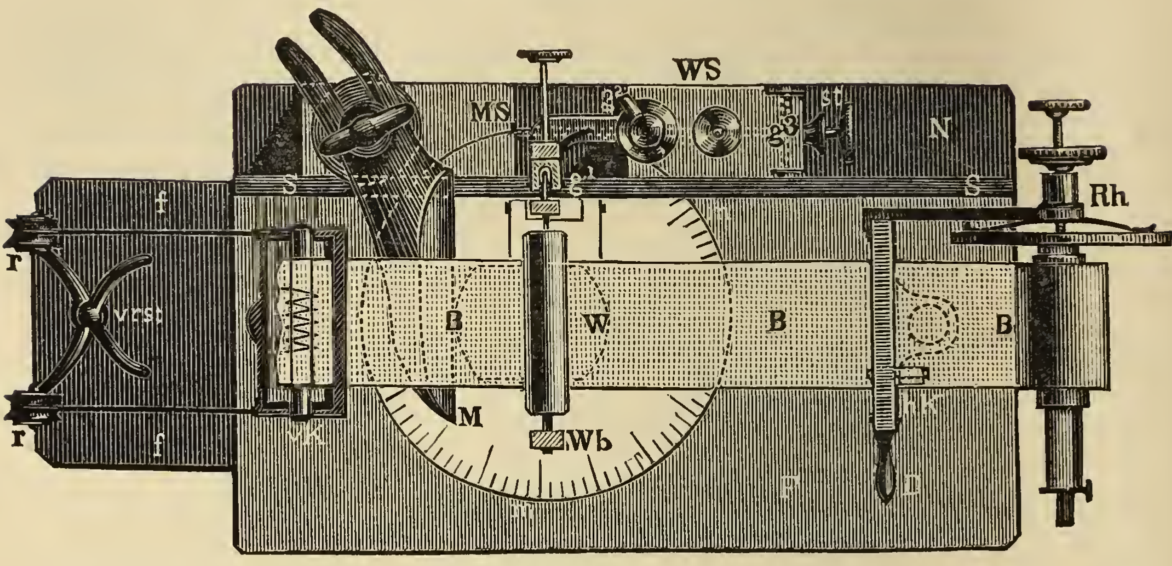

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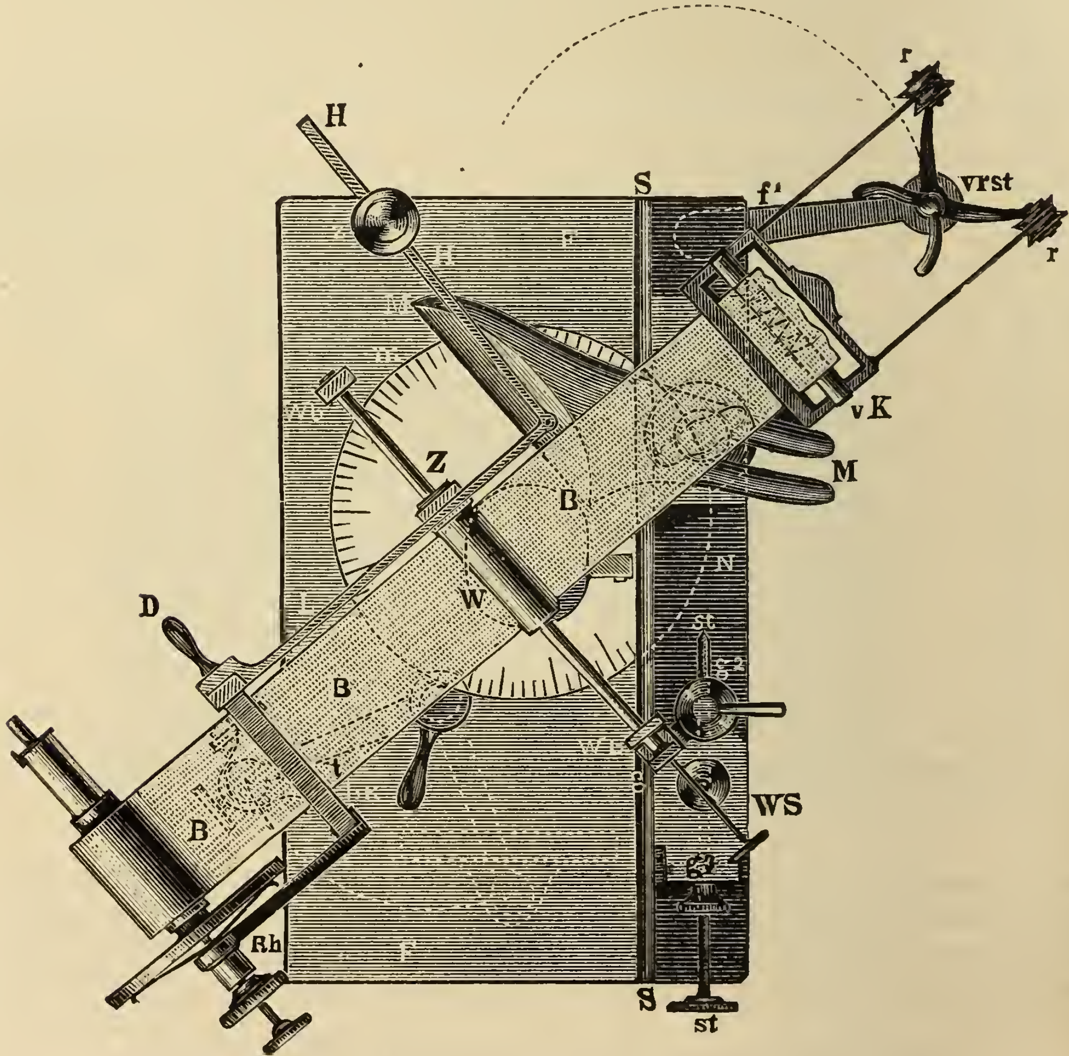
Fig. 25.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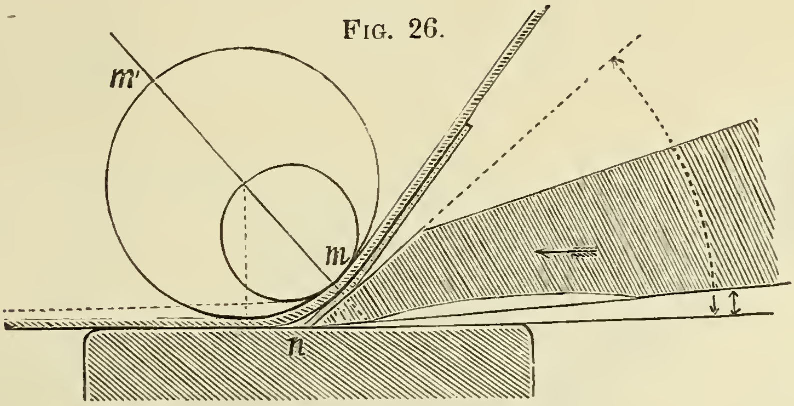
knife. The band arrangement is a roll of paper kept taut (figs. 22–25), and passing close to the edge of the knife. The roll P R passes first through a guiding loop *h* K, which gives it its direction parallel to the object. It is kept in this position, and at the same time applied to the edge of the knife M, by the roller W, the diameter of which is 8 mm. The band, after leaving the space between roller and knife-edge, is directed upwards to the clamp *v* K, and there passes over another roller *r*, and to its end is attached a weight for the purpose of keeping the whole quite taut (fig. 23). In order to reduce the friction between the knife, the roller, and the paper band to the practical minimum, the roller W is made as small as possible (8 mm.), and the upper surface of the knife-

Fig. 26.



edge is ground to an angle of 20°–25°. (See fig. 26.) The desired effect is thus obtained, and by using a paraffin of medium softness for imbedding the specimen, the sections show little tendency to break or curl up.

When in actual use, the paper band requires to be removed from the surface of the paraffin block in order to let the knife be put into position for cutting again. (See figs. 22 and 23.) This done, the roller is replaced, and receives after each alteration the necessary tension from a spring. As the sections are cut they adhere to the under-surface of the band. The adhesion is effected by smearing the block surface after every section with a mixture of castor oil 3 parts, and 1 part collodion of double strength. The microtome is made in two forms, as shown in figs. 23, 24, and 25.

In fig. 24 is seen a view from above of the simple construction for the cross position of the knife. In fig. 25 is a similar view of the more complicated apparatus, which allows the knife to be used in any position.

Miehe's Improved Lever Microtome.*—The lever microtome of Gustav Miehe, so called because the knife-carrier is fitted with a handle so that this piece may be easily worked, has been improved by the addition of a spring catch to the microtome screw-plate, so that every division of the plate, and therefore, of course, the rising or descent of the screw, is audibly clicked.

The mechanism of the recent addition is simple. It consists in a catch *m*, held in its place by the spring *n*, which is fitted on the end of an arm *o*, locking in the teeth of the microtome plate. As the pitch of the

* Preis-Verzeichniss von G. Miehe, 1889; Miehe's Catalogue of Microtomes.

microtome screw is 0·5 mm., and as there are 100 teeth on the edge of the plate, one turn equals 0·005 mm. If a section-thickness of 0·03 mm. be desired, the screw *l* is undone, and the circle segment *c* pushed back until the mark 3 corresponds with that on the vernier, after which it is tightened up. The handle *a* is then pushed from the upright *b* to the upright *d*. By this action the catch *m* pushes the micrometer

Fig. 27.

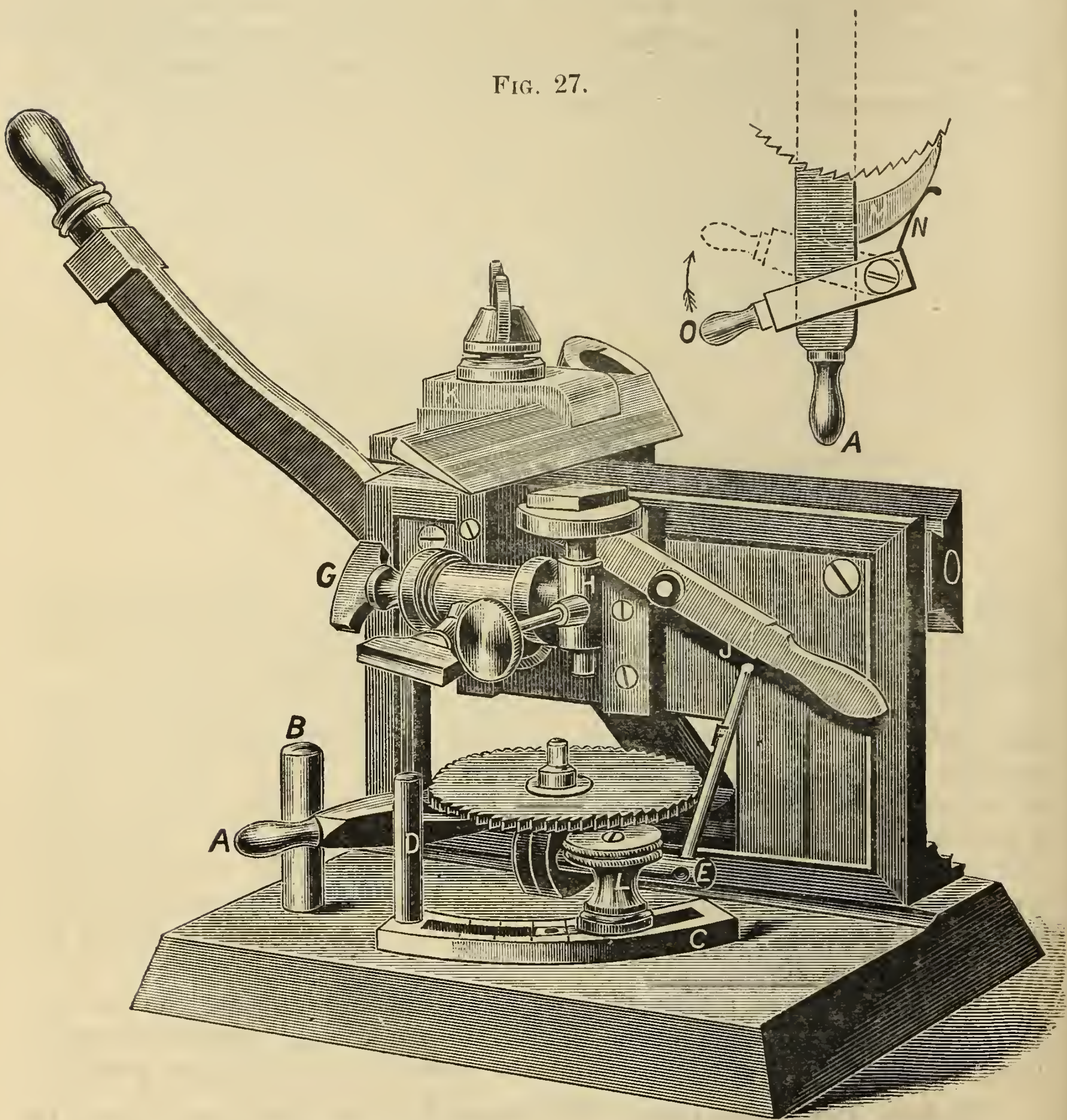


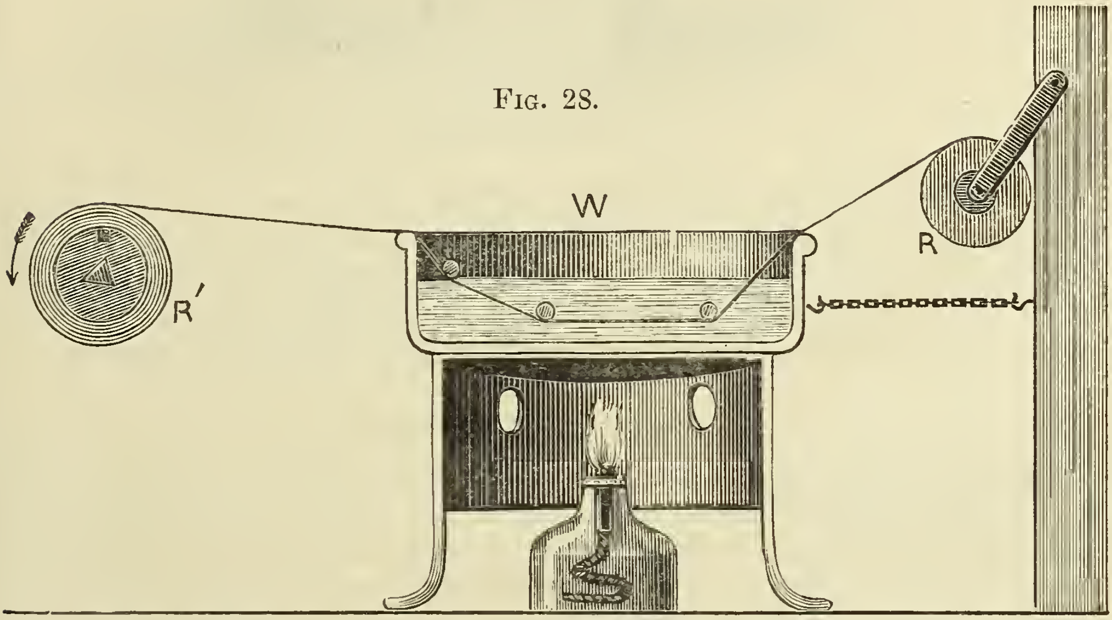
plate round, and the object-holder is thereby raised 0·03 mm. The handle is then pushed back again to *b* and the section made.

If the preparation has been raised too high, the object-holder is lowered in the following manner:—The screw *e* is unloosed by means of the rod *f*, and then the handle *o* is pushed in the direction of the arrow. This action sets free the catch *m*, so that the preparation-holder is easily lowered by screwing down the micrometer plate, and then pushing down the preparation-holder until its lowest part is in contact with the uppermost part of the micrometer screw. The screw *e* is then tightened up.

With this instrument the knife may be used either in the cross or in the oblique position. The latter is shown in the illustration; the object-holder is moved to either position by means of the screw *g*.

Treatment and Manipulation of Paraffin-imbedded Sections.*— The principal advantage that celloidin possesses over paraffin is that it is more suitable for the manipulation of large sections. Prof. Strasser has laid himself out to devise means whereby this reproach may be

Fig. 28.



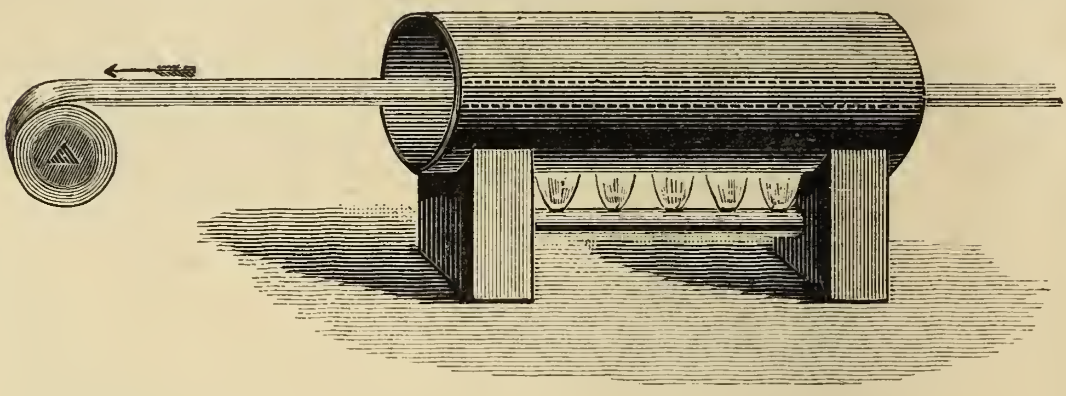
taken away from paraffin. This end may be attained by the adoption of the provisional slide (paper), by using a special form of microtome in which the sections are made to adhere to the provisional slide at the time of sectioning, and by leaving the sections on the provisional slide as long as possible. The provisional slide, which must necessarily be a roll of paper, is prepared either with wax or gum. In fig. 28 is shown the method of saturating the roll with Japanese wax. The illustration perfectly explains the method, and it is only necessary to point out that the roller R′ is so far from the immersion tank that the wax is dry in the band before it reaches the roller. The rolls of gummed paper are made by passing the roll through a tank containing in solution gum arabic 50, glycerin 20, and water 100 parts, and then the band is dried by passing it through a tube heated underneath by a series of gas-jets (fig. 29).

The sections are then stuck on by means of an adhesive made of collodion and castor oil. This procedure is facilitated by the use of Strasser's "Schnitt-Aufklebe" microtome. After the bands or sections have been carefully numbered, they are covered with an adhesive composed of 2 parts collodion and 1 part castor oil, after which they are deposited in a turpentine bath, in order to dissolve the paraffin, and at

* Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 304–17 (2 figs.).

the same time to harden the collodion. From this point we found it somewhat difficult to follow accurately the author's diffuse directions,

Fig. 29.



but it seems that the continuation of the procedure is as follows:—Immersion in pure benzin, then in 95 per cent. spirit, then in thick collodion. After this they are stained, and thereupon cleared up, first in 70–80 per cent. spirit, and finally in carbolxylol. The sections are in the end mounted definitely in balsam, or provisionally in paraffin.

(4) Staining and Injecting.

Metallic Impregnation of the Cornea.*—Prof. F. Tartuferi says that the fixed cells of the cornea, even to their most delicate prolongations, may be deeply stained by immersing the cornea of some adult animal (ox) in a solution of hyposulphite of soda (15 grm. to 100 of distilled water) for three days or longer, and keeping it at a temperature of about 26°. The preparation is then placed in a vessel containing finely powdered chloride of silver and a little pure water, for two days or longer.

If the adult cornea be treated in this manner for a still longer period, or if the cornea of a young animal be used, these fixed elements are but imperfectly visible, but other details are brought out, for example, numerous elastic fibrillæ; while by further variations of the foregoing method the isolated elastic fibrillæ of the cornea may be obtained. The preparations are quite permanent.

Staining Medullated Nerve-fibres with Hæmatoxylin and Carmine.†—Prof. N. Kultschitzky now gives more complete details of his method for staining sections of the central nervous system.‡ The material is hardened in Erlitzki's fluid for one or two months, and is then placed in running water for one or two days. It is next hardened in alcohol and imbedded in celloidin. The sections obtained in this way are stained with the hæmatoxylin solution (1 grm. hæmatoxylin dissolved in a small quantity of C_2H_6O and 100 grm. of 2 per cent. acetic acid). The staining is effected in from one to three hours. The sections are then placed in a mixture of 100 ccm. of saturated solution of lithium carbonate, and 10 ccm. of 1 per cent. solution of red prussiate of potash.

* Anat. Anzeig., v. (1890) pp. 524-6. † T. c., pp. 519-24.
‡ See this Journal, 1890, p. 115.

When sufficiently decolorized (two to three hours) the sections are thoroughly washed and then mounted in balsam.

For staining sections with carmine, the author uses a stain made as follows:—Powdered carmine is boiled for two to four hours in 10 per cent. acetic acid; for every 100 ccm. of acetic acid, 2 grm. of carmine are required. After cooling, the solution is filtered. In this acetic carmine the sections are immersed for twenty-four hours, after which they are decolorized in the lithium and prussiate of potash solution. As this is rapidly effected, the sections must be, at the proper moment, removed to distilled water and thoroughly washed therein, after which they are mounted in the usual manner.

Kultschitzky's Nerve-stain.*—Dr. J. Schaffer relates his experience of this method and his improvement thereon. This consisted in removing some of the stain from sections over-coloured in acetic-hæmatoxylin by means of borax-ferridcyanide of potassium solution. As to the previous preparation of the tissue by means of chromic acid, Erlicki's or Müller's fluid, Schaffer explains that the myelin of the medullary nerves has the strongest affinity for chromic acid and its salts, that in washing out there is a stage at which the chromic acid or salt has been removed from all the tissnes except the medullary sheaths of the nerves, and that this is the moment for staining with hæmatoxylin.

Staining the Motor Nerve-cells of Torpedo.†—G. Magini, in studying the different positions of the caryoplasma and of the nucleolus in motor nerve-cells, obtained the best results in an examination of the electric lobes of the Torpedo by staining with Weigert's hæmatoxylin, after-staining with safranin, and then decolorizing with ferrocyanide of potash, and also by staining with methylen-blue in 1/10,000 KHO, and after-staining with safranin. The latter method produced especially fine preparations, the body of the cell being violet, the caryoplasma red, and the nucleolus blue.

Fixing and Staining Glands of Triton helveticus.‡—M. Heidenhain, in studying the histology of the cloaca and its glandular adnexa in the Triton, proceeded as follows:—Fixing was best done in picric acid or concentrated sublimate solution. For hardening, alcohol gradually increasing in strength until it became absolute. The specimens were stained with alum carmine, and then treated with picric acid-alcohol, or aqueous solution of pure hæmatoxylin, and then mordanted with 1/2 to 1 per cent. alum solution.

When stained in sections stuck on with alcohol, or by Schällibaum's method, anilin dyes, acid fuchsin, methyl-green, orange were used, and these combinations with sublimate fixation produced excellent results.

Fixing, Staining, and Preserving the Cell-elements of Blood.§—Dr. H. Griesbach deals chiefly with the blood of Mollusca, although a few remarks are devoted to the blood-corpuscles of Vertebrata. As a fixative, the author has the highest opinion of the value of osmic acid.

* Anat. Anzeig., v. (1890) pp. 643–5.

† Atti R. Accad. dei Lincei Roma, vi. (1890) pp. 466–7 (2 figs.). See Zeitschr. f. Wiss. Mikr., vii. (1890) p. 356.

‡ Arch. f. Mikr. Anat., xxxv. (1890) pp. 173–274 (4 pls.). See Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 356–7. § Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 326–32.

The blood on the cover-glass may be exposed to the action of the vapour, or the acid (1 per cent. solution) may be mixed with it thereon, or it may be dropped into a watch-glass full of the acid. If the last method be adopted, the procedure may further be improved and simplified by mixing some pigment with it, so that the blood is at once stained and fixed. For this purpose the most useful dyes are methyl-green, methyl-violet, crystal violet, safranin, eosin, acid fuchsin, and rhodanin. In all cases a saturated aqueous solution of the pigment is mixed with a 1 per cent. solution of osmic acid.

For fixing and imparting a double stain good results were obtained from rhodanin and methyl-green. These pigments are to be dissolved separately and then added to the osmic acid. A blue-red fluid results, which stains the cell-body red and the nucleus green. Besides osmic acid, picrosulphuric acid, chrom-osmium-acetic acid, and gold chloride are favourably alluded to as fixatives.

For preserving specimens of fixed molluscan blood, resinous media are not suitable, the best material for the purpose being glycerin, which mixes easily with the before-mentioned fluids, and also keeps the colour fairly well. Permanent preparations are made by running a thin border to the cover-glass with some oil-colour (Cremser white), so as to prevent any pressure on the cell-elements, and also to keep the glycerin from exuding. Some glycerin is placed on the middle of the cover-glass, and to this is added the mixture of the blood and fixative and the whole carefully mixed. The cover-glass is then carefully laid upon a slide and ringed round.

Staining Terminations of Tracheæ and Nerves in Insect Wing Muscles by Golgi's Method.*—By the application of Golgi's method to the muscles of insects, Prof. S. R. Cajal obtained some unexpected results. It was found that the tracheæ in the feet and wings (the non-dissociable muscles) terminate in two horizontal networks, while in the dissociable muscles only one such network was demonstrable. The method also showed the termination of the nerves in the muscle-fibres as a system of delicate filaments, some of which were disposed upon and others beneath the sarcolemma. The technique is as follows:—Pieces 3–4 mm. thick are cut from the wing muscles and immersed for 12–24 hours in a mixture of osmic acid and potassium bichromate (1 per cent. osmic acid 5 parts, 3 per cent. bichromate of potash 20 parts). They are next placed for 24 hours in 0·75 per cent. nitrate of silver solution, after which they are treated with 40 per cent. alcohol. Thus prepared, the pieces are teased out and then again washed several times in spirit; after this they are cleared up in oil of cloves, passed through oil of turpentine, and then mounted in the usual way. For obtaining transverse sections, the muscle may be placed in elder-pith and so cut up, or it may be imbedded in paraffin and sectioned.

The black reaction in the tracheæ is always constant, but the staining of the nervous tissue is less certain, so that it is advisable to make a good number of preparations.

* Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 332–42 (1 pl. and 3 figs.).

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

Can mounting media be improved for high powers by increasing the index of refraction?*—In answer to this question, Mr. J. D. Beck writes:—"It has been the aim of the microscopist to increase the refractive power of mounting media for diatoms, bacteria, biological and other specimens requiring a high amplification and the best resolution. Whether better results are attainable in this direction I am unable to say. All my diatoms, slides from J. D. Möller and others, are mounted dry or in balsam; I have never tried Prof. Smith's medium. If the increase in refraction is an improvement, would it not be a desideratum to attain still more satisfactory results, which perhaps might be accomplished by increasing the index of refraction of mounting media? The desideratum is to see what exists, and to secure for that the most favourable means, bearing in mind that we must not expect too much from the best lenses under unfavourable conditions or circumstances. A certain quack condemned my Beck's 1/6 in. objective because with it and a Beck's No. 2 ocular he could not see bacteria in spring water, when in fact the water, which was cold as ice, came out of a mountain of rocks so free of vegetable and organic matter that no organisms could live in it, while a drop of water from a rivulet showed thousands of bacteria under the same lens.

Insomuch as a large majority of microscopists cannot afford to buy the new Zeiss apochromatic objectives, they may perhaps increase the resolving or defining powers of the lenses of a cheap grade by improving the refractive properties of mounting media. While the philosophy of the Irishman, that "if a little is good, more is better," when he imbibed the second glass, may be rather extravagant in such cases, yet it may be solid philosophy for practical purposes in other directions; so then, may we not continue to experiment on media to increase the refractive power until we find still more satisfactory results?

A friend of mine copied and sent me a list of refractive indices. The highest index of fifty substances given is that of chromate of lead at 2·50 to 2·97. It would appear that all the salts of lead and zinc have a high index of refraction, which seems to be very much increased by the action of chromic acid, which probably exists in the metal chromium in a higher degree than in lead or zinc. I do not believe that nitre, which combines with chromium to form chromate of potassium, afterwards changed to bichromate of potassium through the action of sulphuric acid when exposed to acetate of lead, really increases the refraction of chromate of lead. I have my doubts whether the acetate of lead adds any refractive power to the bichromate of potassium. Native sulphur is given at 2·115, but when distilled with charcoal and reduced to a volatile spirit by adding one atom of carbon to two atoms of sulphur, forming bisulphide of carbon, the index is reduced from 2·115 to 1·678. This is what the carbon has done, and yet diamond, which is carbon crystallized, is way up to 2·47 to 2·75. I suppose it would be impossible to bleach and to reduce the chromate of lead to a colourless medium without destroying its high refraction. We might expose colourless linseed oil to the action of chromate of lead by heat,

* Microscope, x. (1891) pp. 18–20.

and when well settled filter a number of times, or clarify it as varnish is clarified. This would become a rapid drying medium *per se*. Resins might be treated with chromate of lead in the same manner. Whether this suggestion is practical I will leave for others to decide who have more experience and skill in chemistry than I.

What can be done with sulphur and phosphorus? Can we dissolve sulphur in oil and make a transparent medium of it?

There are phosphorus, 2·224; carbonate of lead, 1·866; oil of anise seed, 1·111; bisulphide of carbon, 1·678—all pretty high—what can be done with them? There may be other substances higher and better than those mentioned. How many will act in this important matter?"

Useful Mounting Menstruum.*—Dr. Alfred C. Stokes writes:—"In a recent number of 'Malpighia' M. Aser Poli called attention to the oil of cajeput as a valuable medium in which to place objects before their permanent mounting in Canada balsam, it being used as a clearing agent instead of the oil of cloves. He states that it is soluble in dilute alcohol, and thus permits of the direct transfer of the object to it, thereby avoiding the use of absolute alcohol. He also remarks that trials with the oil have been followed by beautiful results, the preparations being perfectly clear, and that delicate objects such as the marine Algæ, which are among the most difficult to preserve in a satisfactory way, are, when treated with the oil of cajeput, almost entirely free from the ordinary obnoxious shrinkage.

These qualities are all excellent ones, and by the microscopist that does but little work in mounting, the chance to simplify the operation should be hailed with joy. To do away with one of the processes that modern methods seem to consider necessary will be a boon. By the use of the oil of cajeput the worker can simplify his methods by discarding the absolute alcohol, and thus not only save himself considerable trouble and some time, but some expense, as an object cleared or soaked in oil of cloves cannot well be transferred from it to balsam without the intervention of absolute alcohol.

After having been cleared or soaked in the cajeput oil, the object may at once be mounted in the ordinary balsam, or in that dissolved in benzol or in chloroform. Absolute alcohol must be kept in a specially prepared bottle, as it evaporates rapidly and absorbs water greedily. To avoid its use is pleasant indeed.

Since reading M. Poli's account of the action of the oil I have been making a few experiments, and refer to them here in the hope that some that in their microscopical work have more need of mounting than I, will take the subject, continue the experiments, and report the results.

In my limited experience I have been pleased with the oil. It has a pleasantly aromatic odour and pale-green colour that are in no way objectionable.

Placed on a glass slip it evaporates, but not with such haste that the microscopist must hurry his movement to do as he would before it is gone; it evaporates somewhat slowly, and leaves no trace on the glass.

* Microscope, xi. (1891) pp. 4–6.

It is soluble in carbolic acid, or the commercial liquid acid as obtained of the druggist is soluble in it. With old benzol balsam that had become so hard and so nearly dry in the bottle that it had to be dug out with a knife in a stringy mass, the oil mixed perfectly, making the old material fluid and easily worked. What its action would be with benzol itself I can only infer from this experiment. In dilute alcohol it is, as M. Poli has said, perfectly soluble.

After evaporating Canada balsam to glassy hardness in the ordinary way before dissolving it in benzol or in chloroform, I dissolved it in the oil of cajeput, to learn what would be the result. This I found to be excellent. The hard balsam dissolves readily in the oil, and makes as thick or as thin a fluid as may be wanted. The solution, however, although readily effected, appears to take place with rather less facility than with benzol or chloroform. Still, it is accomplished by leaving the mixture to itself, the solution being made without attention on the part of the microscopist.

The results of mounting in the cajeput balsam justify all the good words that M. Poli has spoken of the oil as a clearing medium. After the object has been soaked in dilute alcohol for a convenient time, it is transferred to the oil of cajeput for as long as the microscopist may wish, and thence to the cajeput balsam in which it is to be mounted.

Under the cover-glass drying seems to be as rapid as with benzol balsam ; the little that is unavoidably spread on the slip appears, however, to harden rather more slowly, yet I have made no comparative test. The effects of the mounting medium are excellent; as far as I can perceive, quite as good as those from benzol or chloroform balsam; and the simplifying of the process should be greatly in its favour with those that are not professional preparers, and are therefore not ready to give any amount of time and attention to their special work.

I have not tried it with staining fluids. This I must leave to others. M. Poli, however, in the note already referred to, says that objects treated with it, stained green and then mounted in Canada balsam, retain their colour. Further than that nothing is known about this part of the subject.

The reader will perceive that my experiments have been few and of little importance. I mention the matter only because I believe the menstruum will prove to be an exceedingly useful one, especially to the amateur, to whom the simplifying of the process and the avoidance of the use of absolute alcohol should certainly make it acceptable. The suggestion is not original with M. Poli, as the oil has been used by others and referred to in print, but has never come into general use as it should.

(6) Miscellaneous.

Desk for Microscopical Drawing.*—Dr. Giesenhagen has devised a desk or framework for microscopical drawing which is very easy to manage. The construction of the apparatus is easily understood

* Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 169–72 (2 figs.).

from the accompanying illustrations. It is made of wood, and the drawing surface can be altered to and fixed in any desired position with ease. It is scarcely necessary to observe that it is intended for camera drawing.

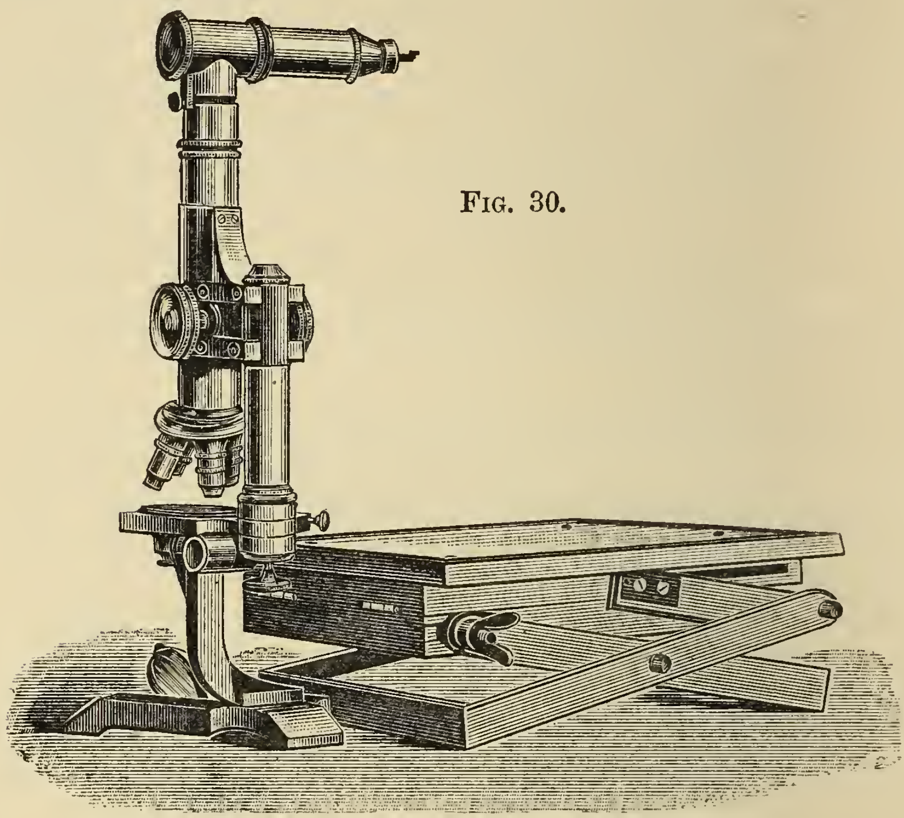


Fig. 30.

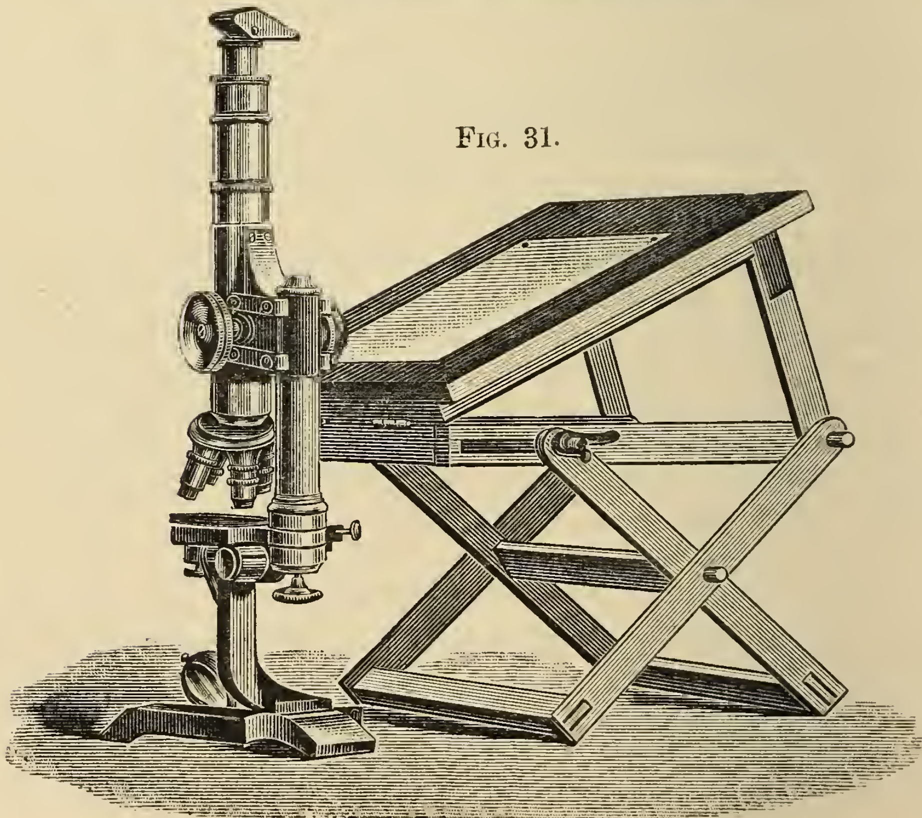


Fig. 31.

PROCEEDINGS OF THE SOCIETY.

Meeting of 18th February, 1891, at 20, Hanover Square, W., the President (Dr. R. Braithwaite, F.L.S.) in the Chair.

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

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

	From
Micrometer for recording the thickness of cover-glass, &c. ..	*Mr. E. Bausch.*
Slides (6) of Recent and Fossil Diatoms	*Miss M. A. Booth.*
Photomicrographs (12)	*Mr. E. G. Love.*
do. (6)	*Mr. W. H. Walmsley.*

Mr. J. Mayall, junr., said that amongst the donations there was (1) a screw-micrometer, devised by Mr. Edward Bausch, of the Bausch and Lomb Optical Company, and sent to them for the purpose of illustrating a paper reprinted in the current number of the Journal, pp. 108–13. The instrument was intended to furnish a ready means of measuring the thickness of cover-glasses to the 1/1000 in. or the 1/100 mm. In addition to this, Mr. Bausch had also sought to make it applicable to the purpose of indicating at the same time the proper length of body-tube necessary to be used with various thicknesses of cover-glass so as to obtain the best results from the use of each of a series of five unadjustable objectives made by the company. The various data which the instrument was intended to record were printed on the cylindrical part of the drum connected with the micrometer screw. He thought, however, that the idea might be a little too ambitious, because it presupposed that there was an absolute uniformity in objectives of the same denomination, which in practice it would be hardly possible to attain. The idea was, no doubt, good, and the instrument was not only very prettily designed, but was—he was informed—very inexpensive. As illustrating a point which Mr. Bausch believed to be important in practical microscopy, the Society would feel greatly interested in being able to add this instrument to their collection. (2) They had received from Mr. Walmsley, successor to Messrs. Beck, in Philadelphia, some specimens of the photographs produced with a simple form of small photomicrographic camera, which were very clear and sharp. The idea of making photographs on such small plates was first brought out some years ago by a Dublin firm, who made a camera in the form of a little box to fit on the end of the draw-tube. Mr. Walmsley had improved on that by making his with a bellows body, fitting upon an adjustable pillar and stand. (3) Some photomicrographs had also been received from Columbia College, New York. They were chiefly of popular objects, and had been produced with considerable technical skill. The letter by which they were accompanied was read. (4) Six slides of Diatomaceæ had been forwarded from America by Miss M. A. Booth—a Fellow of the Society. They were very neatly mounted, and were exhibited under Microscopes in the room. A letter from the donor was read.

Mr. Andrew Pringle's "Note on Photomicrographs exhibited at the Meeting of the Society in November last, and on Remarks made by Dr. Dallinger and Mr. Nelson," was read. Mr. Mayall said that the fact noted by Mr. Pringle as to the photographic image spreading laterally was a new observation to him. Perhaps Mr. Nelson would say whether he had observed effects such as those mentioned by Mr. Pringle (see *ante*, p. 264).

Mr. E. M. Nelson said he had not observed anything of the kind; but he thought if correct methods were adopted, the object would be correctly represented by the image projected on the prepared plate. The whole difference was made by using small cones of light so as to get density of image. Of course, in that way they could easily get effects of that kind: by shutting up the condenser, for instance, they could double the image.

Mr. Mayall read a translation of a note (see *ante*, p. 265) by M. Fayel, communicated to the Société Linnéenne de Normandie, of which he was president, suggesting a novel method of examining large opaque objects, which he termed "Photomicrography in Space." The plan proposed by M. Fayel was to direct a photographic lens to the object, and focus the image upon the ground glass of the camera; then he removed the ground glass, and viewed the aerial image with a compound Microscope. Mr. Mayall thought it was by no means an easy matter to adapt a compound Microscope so as to be readily movable for inspecting different portions of the aerial image. The compound Microscope when so employed acted merely as an erecting eye-piece, and he thought M. Fayel must be mistaken in suggesting that powerful objectives might thus be employed with advantage.

Mr. T. Charters White said "there was nothing new under the sun"; the description just given of the "new" method of examining large objects recalled to his mind a similar plan devised by the late Dr. J. Matthews for precisely the same purpose, and described and exhibited at the Quekett Club in February 1879, under the name of the Micromegascope. Dr. Matthews used to place the object upon the table and form an image of it by means of an ordinary low-power objective, fitted into the tube of the substage with the front uppermost. This was then looked at through the Microscope in the ordinary way, and for examining flowers and other large objects it was very effective.

Mr. E. M. Nelson said the plan seemed like going all round the bush to get at a very indifferent result, because if they used a 2 in. objective upon the Microscope, they could take in an angle of 30°; whereas the photographic lens had practically no angle at all. This lens acted as a telescope object-glass, and the Microscope was used to magnify and erect just like the terrestrial eye-piece of a telescope. Zeiss did the same thing, only very much more perfectly, with his A* lens, which not only gave a great amount of light, but enabled the effect to be altered from that of a telescope down to that of a 4 in. objective. The other plan was simply ludicrous as turning the Microscope into a very indifferent telescope.

Mr. Mayall said the instrument described by Mr. Charters White was known in the last century as the "Megaloscope," and had been constructed by B. Martin, both as a dioptric instrument and as a catadioptric; in the latter case an ordinary short-focus Gregorian reflecting telescope was so arranged that the distance between the reflectors could be increased so as to enable moderately near objects to be seen magnified. The plan adopted by Dr. Matthews was simply to adjust a low-power Microscope objective or a Kellner eye-piece in the substage, which he directed towards the object, or to a plane mirror in which it was reflected, and then he viewed the aerial image with the compound Microscope above. The difference between Dr. Matthews's plan and that of B. Martin was principally in the employment of achromatic objectives, which he believed had been first used in this way by Charles Chevalier. Mr. Mayall quite agreed with Mr. Nelson that such an arrangement was a very inferior way of building up a telescope for viewing moderately near objects; though it should be remembered that the late Dr. Royston Pigott fully believed he had been able to resolve about the one-millionth of an inch by such an arrangement, the fallacy of which had been conclusively demonstrated by Prof. Abbe in the Journal of the Society. But M. Fayel's arrangement was not open to Mr. Nelson's criticism regarding the angle of aperture, which applied, of course, when the projecting lens—the object-glass of the megaloscope—was a Microscope objective of very small linear aperture. M. Fayel proposed to use as the object-glass of his megaloscope a photographic lens of which the *linear* aperture would doubtless be very much larger than that of any Microscope objective, and the linear aperture would be proportionately more effective when utilised telescopically. The linear aperture of Microscope objectives of even 4 in. or 5 in. focus was practically limited by the diameter of the Society screw to something less than an inch; but many photographic lenses had been constructed of 4 in. to 6 in. focus, with linear apertures of $2\frac{1}{2}$ in. to $3\frac{1}{2}$ in., and these might be employed in the manner suggested by M. Fayel more effectively than Microscope objectives, collecting very much more light. He (Mr. Mayall) did not suppose that M. Fayel proposed this method of observation to supersede the recognized employment of low powers on the Microscope, but rather to meet the case where objects were to be viewed which could not be conveniently examined with an ordinary Microscope.

Prof. Bell gave a résumé of a paper by Dr. W. B. Benham "On *Eminia equatorialis*, a new earthworm from Equatorial Africa," explaining that the specimen described had been found by Emin Pasha, and forwarded to the Natural History Museum, whence, by permission of Dr. Günther, it had been sent to Dr. Benham for examination. Unfortunately, it was the only specimen collected, and its small size and immature condition made it difficult to say exactly what position should be assigned to it. There seemed no doubt as to its being a new genus. Dr. Benham's paper, minutely detailing such observations as it had been possible to make, would be published *in extenso* in the Journal.

On the motion of the President, the thanks of the Society were given to Dr. Benham for his communication.

Prof. Bell said they had also received a paper from Mr. T. B. Rosseter "On the Cysticercus of *Tænia coronula* found in specimens of *Cypris*." Mr. Rosseter had from time to time written to him with regard to his observations, but so far they had not been complete, and he had suggested to him the direction which it was advisable for him to take in order to render them so. Mr. Rosseter for some time failed to make the observations suggested to him, but he had repeatedly visited the field in which was situated the pond which contained the *Cypris*, in the hope of discovering the object of his search amongst the fæces of the animals by which the place was frequented. On one fortunate occasion, however, he found amongst the evacuations of a duck a small whitish ball which turned out to be a mass of seventy or eighty tapeworms. By reference to the work of Dujardin, where eight forms were described, he was able to find that one very closely resembled those he had found, and he came to the conclusion that the cysticercus of the *Cypris* was that of *Tænia coronula*. Unfortunately for Mr. Rosseter, it happened that his observations had been anticipated by those of a Hungarian gentleman, Herr Al. Mrázek, a notice of which appears in the just issued number of the Society's Journal (pp. 45–6), and though this might be a matter for regret, he had at least the satisfaction of knowing that his opinion was confirmed. There seemed to be every probability that Mr. Rosseter was right in determining the species to be *coronula*, and they might reasonably suppose that, living in the same pond, the duck might eat the *Cypris*, and in this way the transference from one host to the other would be effected.

The President said that although it appeared that Mr. Rosseter had been anticipated, he thought they might compliment him upon the perseverance he had shown in following up the matter, and that the thanks of the Society were due to him for his communication.

Mr. Mayall said they had received a preliminary notice of an International Exhibition to be opened this year at Antwerp in connection with the 300th anniversary of the invention of the Microscope. It was intended to exhibit Microscopes of all kinds, from the earliest to the most modern, and to include apparatus of all kinds relating to microscopy. Invitations would, doubtless, be given to the possessors of interesting Microscopes, &c., to contribute to the success of the exhibition by the loan of them (see *ante*, p. 271).

The President said they would probably receive some further communication on the matter later on, and it would no doubt make a pleasant trip for any one who could go over to see what was exhibited at Antwerp.

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

Mr. E. Bausch:—Micrometer for recording the thickness of cover-glass, &c.

Miss M. A. Booth:—Recent and fossil Diatoms.

Mr. E. G. Love:—Photomicrographs.

Mr. T. B. Rosseter:—Slides of Cysticercus of *Tænia coronula* Duj., in illustration of his paper.

Mr. W. H. Walmsley:—Photomicrographs produced with his camera.

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. Horace T. Brown, F.R.S., A. Harrison, F.C.S., James E. Talmage, D.D., E. W. Weis, M.D., and William H. Southon. Prof. Hermann Fol and Prof. Sir Joseph Lister, Bt., F.R.S., were elected *Honorary* Fellows.

Meeting of 18th March, 1891, at 20, Hanover Square, W., the President (Dr. R. Braithwaite, F.L.S.) in the Chair.

The Minutes of the meeting of 18th February last were read and confirmed, and were signed by the President.

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

	From
Brady, H. B., Report on the Foraminifera collected by H.M.S. "Challenger" during the years 1873–76. xxi. and 814 pp., Atlas of 115 pls. (4to, London, 1884)	*Mr. E. W. Burgess.*
Pabst, C., 'Leitfaden der Theoretischen Optik zum Gebrauche auf höheren Unterrichtsanstalten und beim Selbstunterrichte.' vi. and 100 pp., 22 figs. (8vo, Halle a. S., 1888) ..	*Mr. F. Crisp.*
Photographs (2) of *Lophopus crystallinus*	*Mr. J. B. Robinson.*

Letters from Prof. Hermann Fol, of Nice, and Prof. Sir Joseph Lister, Bt., F.R.S., expressing their thanks to the Society for the honour of their election as honorary Fellows, were read to the meeting.

Prof. Bell, in calling special attention to the two volumes presented by Mr. Burgess, remarked that they formed together one of the largest of the reports resulting from the "Challenger" Expedition, and considering the mass of material from which they had been compiled, and the manner in which the work had been done, they not only formed a monument to the memory of their late honorary Fellow, Mr. H. B. Brady, but would also be a most valuable addition to the Society's library.

Mr. Mayall said they had received a letter from a correspondent in America—Mr. J. H. Noblit—asking for information as to working with high powers on opaque objects. He hoped some Fellow who had experience in such matters would undertake to reply to this communication. A letter had also been received from Col. O'Hara, dealing with sundry points connected with photomicrography.

Mr. E. M. Nelson exhibited and described a new design of student's Microscope recently brought out by Mr. Baker, the idea of which was to provide a Microscope of this class fitted with some of the more important accessories usually only supplied to instruments of an expensive character. The one now shown was fitted with all the ordinary movements. It had a good coarse-adjustment, a differential fine-adjustment, a centering substage with rackwork, and a Wright's finder. The stage was of the horseshoe shape, and solid and well made, so that the instrument answered to the description given of it as a cheap Microscope capable of doing all ordinary microscopic work. The production of instruments of this class was a matter in which he had always taken great interest, and he had done what he could of late years to promote their improvement. He believed also that he was the first to put a coarse-adjustment to them, in place of the sliding tube which at one time used to be thought good enough, because the common German Microscopes were made in that way. The cheaper way in which the differential fine-adjustment was now made enabled this also to be introduced without exceeding a reasonable price. He thought Mr. Baker had risen to the times in bringing out this instrument, and deserved great credit for so doing, because English makers generally had not studied to meet the real requirements of students, but had been content to copy inferior Continental models. The consequence was that our schools and colleges were flooded with cheap German Microscopes, and people who went to study at German universities came back with the idea that what was in use there was the best thing of its kind for the purpose for which it was wanted.

Mr. Karop said that he also had advocated for a long time this kind of improvement in the cheaper forms of Microscope, and was therefore very glad to see such a successful attempt made in this direction. There was one thing, however, which he thought required attention, and that was the draw-tube, which was not long enough for use with the higher power English objectives as adjusted to the ordinary English body length; it seemed to want a supplementary draw-tube, like that which was shown by Mr. Nelson at a recent meeting of the Society. The finder would be found a very useful addition to what seemed likely to prove a very useful form of instrument.

Mr. Mayall said this Microscope represented the second serious effort recently made to meet the want of a good, cheap student's Microscope, the first having been made by Mr. Swift, and described some time since by Mr. Karop. In the instrument before them, it seemed to be rather a mistake to make it with such a low base, as there was now scarcely height enough to get at the substage or mirror; a little more room for the hands below the stage would, he thought, be advantageous. The possession of the centering substage would, he need hardly point out, be of great advantage.

The President thought that a greater elevation of the stage would also be an improvement.

Mr. Nelson quite agreed with Mr. Mayall's suggestion as to the desirability of greater height of the base; but then there was a veto against it being made otherwise. The German Microscopes were made of a certain height, and, of course, the English ones must be made the same!

Mr. T. Charters White read his paper "On a new Method of demonstrating Cavities in Dental and Osseous Tissues," which was illustrated by specimens exhibited under the Microscopes in the room.

The President said the Society was much obliged to Mr. White for his paper; certainly his specimens bore out his remarks, and they were most beautifully shown.

Mr. E. M. Nelson exhibted an enlargement of a photomicrograph. He did not approve of that kind of thing; but, as it was done on the Continent, perhaps, if nothing of the kind was produced in England, it might be said that they were unable to make enlargements.

Mr. E. M. Nelson read his paper "On the Optical Principles of Microscope Bull's-eyes," illustrating the subject by drawings on the blackboard.

The President thanked Mr. Nelson for the practical way in which he had dealt with a subject of great importance to all who worked with the Microscope.

Dr. Dallinger said that the remarks and details which had been laid before them by Mr. Nelson might have seemed to be dry and hard; but in reality they were of the most practically useful kind which could be brought under the notice of such a society as theirs. He had not only pointed out defects in optical construction, but also the way in which those defects might be corrected. All who worked much with the Microscope were aware that it was a matter of the utmost importance to get a condenser as far as possible aplanatic, not merely upon the grounds mentioned by Mr. Nelson, but because a condenser so constructed was of the greatest importance in order to bring out the best results of an aplanatic objective. He was very glad, therefore, to find that Mr. Nelson had brought his practical mind to bear upon the subject, and that he had not only shown them the defects of existing forms, but had put into the hands of opticians the means by which those defects might be corrected.

Mr. Mayall thought that, for the honour of their theoretical opticians, it should be mentioned that the theory as to the passage of the rays of light through lenses was dealt with by Herschel in his well-known treatise on light in the 'Encyclopædia Metropolitana,' and in Coddington's 'Treatise on the Reflexion and Refraction of Light' (1829–30) it was gone into in a most complete manner, and the transmission of rays in the case of the meniscus, and every other form of non-achromatic lens, was exhaustively dealt with. This treatise of Coddington's should not be confused with the two editions of his work on 'Optics,' published earlier. The later treatise embodied some of the then most recent investigations in optics by Airy, Herschel, and others, and was still regarded as one of the most important textbooks on the subject. The formula for aplanatic foci, to which Mr. Nelson had referred, was generally assigned to Lagrange. Gauss and Listing had contributed most important general theorems, whence the passage of rays of light through systems of lenses could be determined. In the current number of the Society's Journal was a translation of a paper by the late Prof. G. Govi, in which that distinguished physicist endeavoured to still further simplify computations of that kind. He mentioned these facts because Mr. Nelson seemed rather to suppose the theory had not received the attention it merited, inasmuch as Heath's recently published work on optics dealt with it only partially. He (Mr. Mayall) thought English publishers of scientific works had hitherto been very remiss in not supplying English students with translations of the best German and French works on optics. Gauss's works were still for the most part unknown in England, as also were Listing's. Mr. Adolphe Martin's application of Gauss's theories to optical instruments, and M. Croullebois's development of them in connection with lenses of given thicknesses, ought to appear in English. There was also Verdet's 'Optique Physique,' and many other optical works of great importance, which were, of course, known to professional mathematicians in England; but they were hardly referred to in the textbooks in general use.

Mr. Mayall said that since the last meeting he had received another notification from the authorities of the Antwerp Microscopical Exhibition, giving further details than those which he was able to communicate at the last meeting of the Society. From this it appeared that the exhibition was to be open during August and September next, and the proposed mode of classification was given (see *ante*, p. 271.) It was clear the exhibition was intended to be pretty exhaustive, and if in each class there was only a moderate representation, the whole would be likely to form a very interesting collection.

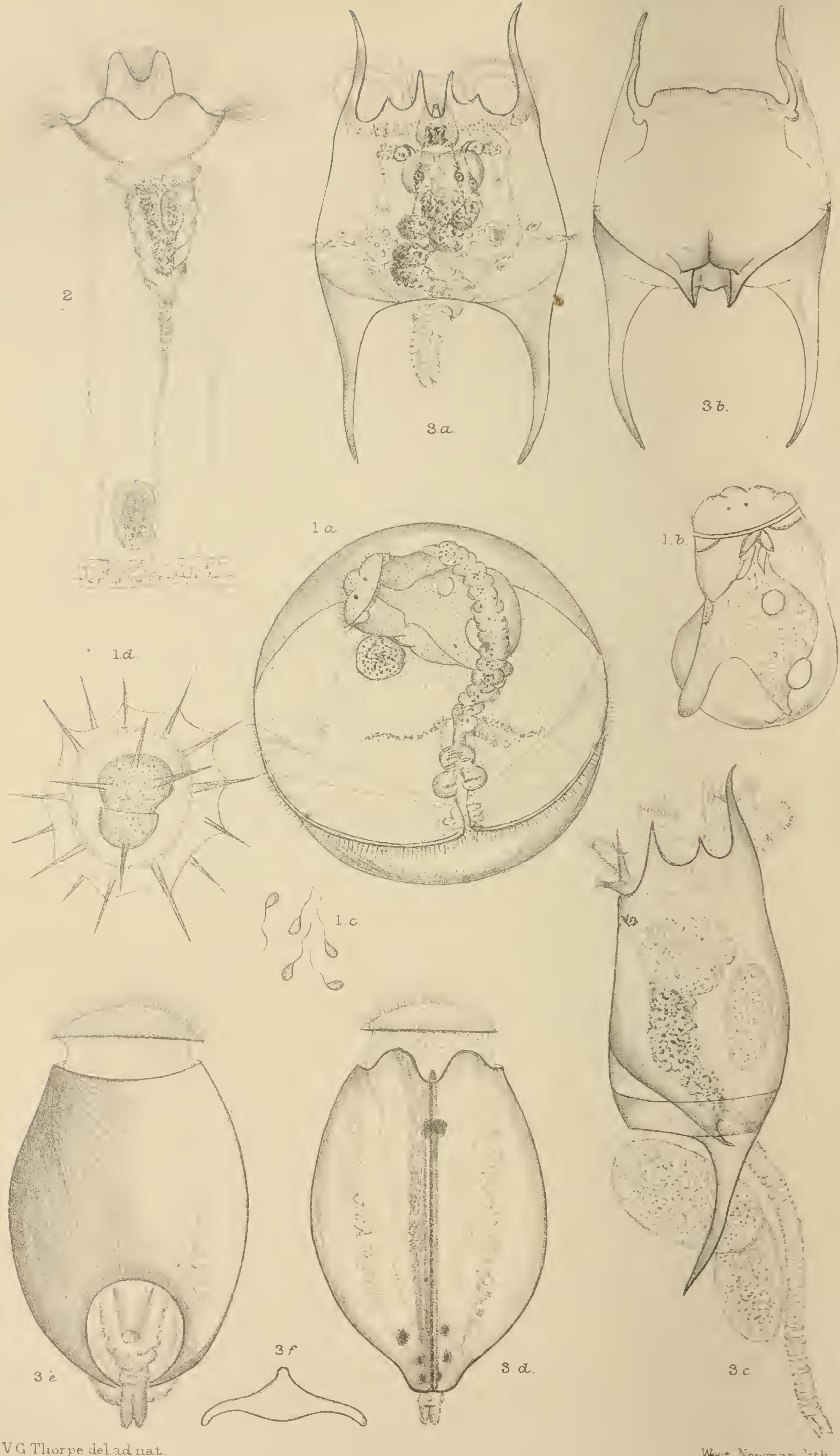
Prof. Bell said they had also received from the General Secretary of the International Congress on Hygiene, to be held in London in August next, an invitation to appoint delegates to represent the Society at the meetings, and thinking it very desirable that they should be so represented, the Council had requested the President and Dr. Dallinger to undertake the duty. This congress, he might mention, was the seventh of a series which had been held in all the great capitals of Europe except Great Britain, and it was expected that the forthcoming gathering would be one of the most important yet held.

The President announced that arrangements had been made to hold an exhibition meeting and conversazione of the Fellows of the Society on the evening of Thursday, April 30th.

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

Mr. C. Baker:—Baker's Improved Student's Microscope.
Mr. J. B. Robinson;—Photographs of *Lophopus crystallinus*.
Mr. C. Rousselet:—*Hydra tuba*, Medusa stage.
Mr. T. Charters White:—Infiltrated sections of Bone and Dentine.

New Fellows.—The following were elected *Ordinary* Fellows:—Messrs. Kay Lees, F.R.C.V.S., Alfred B. Loder, J.P., and Colonel Alexander Ewing.



V G Thorpe del. ad nat.

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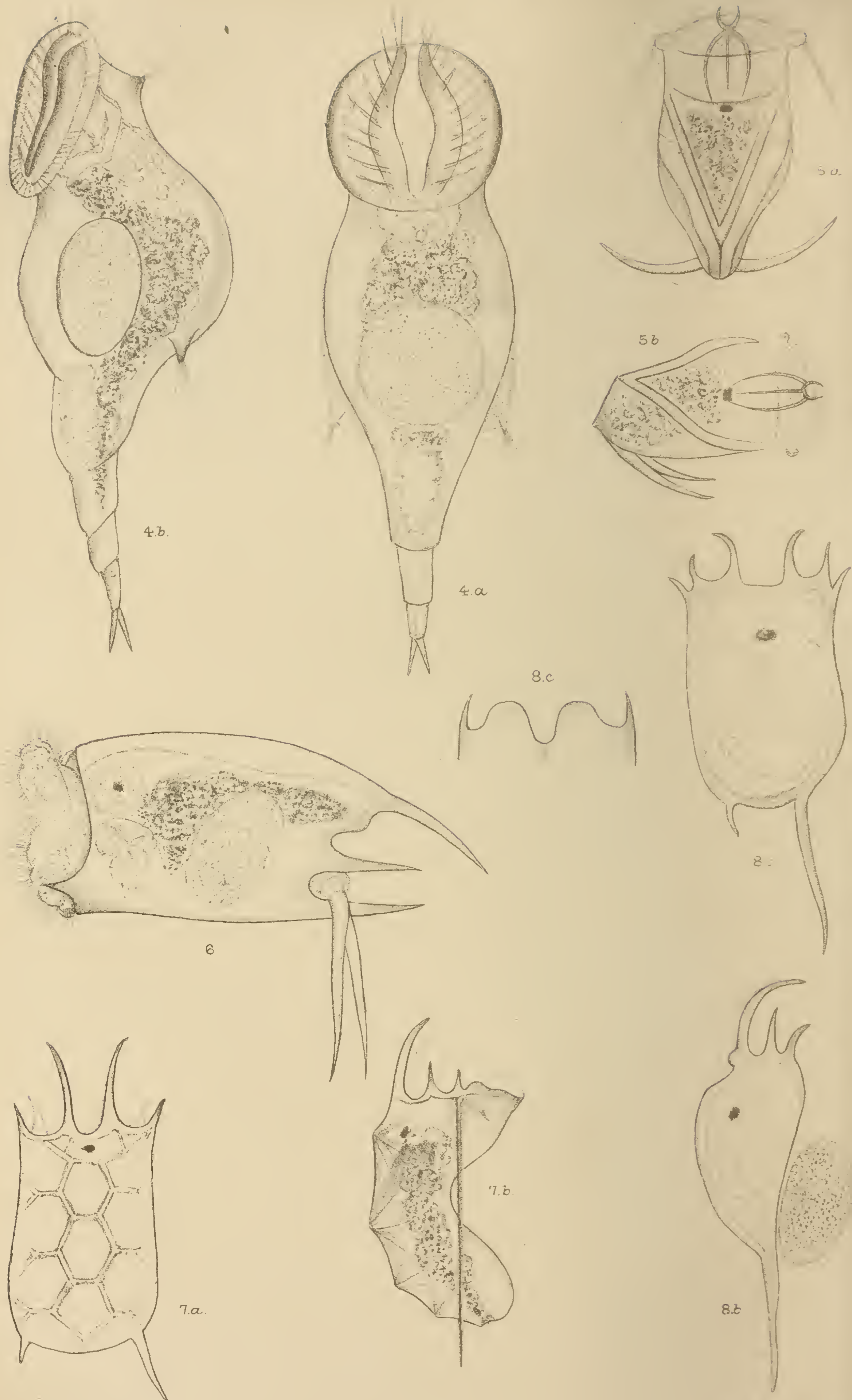
New and Foreign Rotifera



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New and Foreign Rotifera

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

JUNE 1891.

TRANSACTIONS OF THE SOCIETY.

IV.—*New and Foreign Rotifera.*

By Surgeon V. Gunson Thorpe, R.N., F.R.M.S.

(*Read* 15*th April*, 1891.)

The Male of Trochosphæra æquatorialis. Pl. VI. fig. 1.

For more than thirty years this rare rotifer has, I believe, eluded rediscovery since Professor Semper first found it in the Philippine Islands. In January 1889, I had the good fortune to find it once again in the Fern Island pond of the Botanical Gardens, Brisbane, Australia. Here it was in company with enormous numbers of *Volvox globator,* and the resemblance it bore both in shape and size to these algæ, as the spherical rotifers and the moving plants circled in and out amongst each other, irresistibly caused one to consider whether we have not here an instance in the microscopic world of "protective mimicry." The time at my disposal for the examination of this remarkable genus was little more than a week, but during this period I was lucky enough to witness the birth of the hitherto unknown male. The male rotifer appeared to lie free in the body-cavity of the female, partially encircled by the intestinal tract (fig. 1 *a*). Nevertheless it was probably surrounded by the invisible wall of the oviduct. During the progress of labour the mother rotifer was perfectly quiescent, and indeed she never recovered vitality.

EXPLANATION OF PLATES VI. & VII.

Trochosphæra æquatorialis.—Fig. 1 *a*. Unborn male in body of female. 1 *b*. Male of *T. æquatorialis*. 1 *c*. Spermatozoa of male. 1 *d*. Winter egg.

Floscularia torquilobata.—Fig. 2. Ventral view.

Brachionus furculatus.—Fig 3 *a*. Dorsal view of female. 3 *b*. Ventral view of lorica of female. 3 *c*. Side view of female. 3 *d*. Dorsal view of male. 3 *e*. Ventral view of male. 3 *f*. Diagrammatic section of male.

Rhinops orbiculodiscus.—Fig. 4 *a*. Ventral view. 4 *b*. Side view.

Notommata cuneata.—Fig. 5 *a*. Dorsal view. 5 *b*. Dorso-lateral view.

Salpina cortina.—Fig. 6.

Anuræa procurva.—Fig. 7 *a*. Dorsal view. 7 *b*. Side view.

Anuræa scutata.—Fig. 8 *a*. Dorsal view. 8 *b*. Side view. 8 *c*. Anterior mental edge of lorica.

The male is totally unlike the female, resembling in its general characteristics the known males among the Melicertidæ. Its form is sacculated, the narrowest part being the head, which is fringed with a wreath of cilia, and bears two minute red eyes, placed somewhat close together (fig. 1 *b*). The body is, as usual, occupied by a large sperm-sac, in which the spermatozoa could be distinctly seen, as well as two or three large translucent vesicles. There is a large penis, but no foot. The spermatozoa have an oval head, with a flagellum about three times the length of the head attached to it along one side (fig. 1 *c*).

In the body of another female *Trochosphæra*, which was dead, I came across a curious organism, which, I have little doubt, is a winter egg (fig. 1 *d*). It was nearly circular in shape, of a flattened appearance, with a dense central nucleus, which had undergone unequal binary division, the whole being covered with long spines.

Floscularia torquilobata. Pl. VI. fig. 2.

Sp. ch.—Lobes five, broad, without knobs. Dorsal lobe arched towards the ventral surface, so that the setæ point towards the foot.

This large and handsome floscule was found, in May 1888, in a solitary bush pool on the shore of Gloucester Passage, coast of Queensland. It resembles in its general aspect and size *F. longicaudata*. The dorsal lobe, however, is three times as long as the two ventral next in size, and is arched across the mouth of the coronal cup, so that the setæ point downwards towards the foot, on the ventral aspect. In other respects its anatomy follows the usual type. Only a single specimen was seen.

Brachionus furculatus. Pl. VI. fig. 3.

Sp. ch.—Occipital spines six, the outermost ones the longest. Two long *lateral* spines behind; temporary only. Male loricated.

This handsome *Brachionus* I found in a pool near Simon's Bay, Cape of Good Hope, in December 1890. The general shape of the lorica resembles the egg of a skate. The antlers, the outermost of the six occipital spines, are the longest, being three times as long as the innermost, and are fantastically twisted in shape. The intermediate pair are mere saw-like projections. The animal carries two long lateral spines till an early period of adult life, and discards them afterwards. I have obtained many specimens which had no lateral spines behind, and two specimens with but a single spine on one side, and in another specimen there was a distinct constriction at the base of one of the lateral spines, apparently the commencement of self-amputation. The dorsal and ventral plates of the lorica are united at their edges for the upper three-fifths of their length. As this point, where the orifices for the lateral antennæ are situated, the ventral plate leaves the dorsal plate, and suddenly narrows towards the orifice of the foot, which is bounded by two small spines; the floor of the body-cavity, except for this opening, is formed by a triangular basal plate, which meets the dorsal plate on a line joining the orifices of the lateral antennæ (fig. 3, *b*, *c*). Thus there is for the lower two-fifths of the lorica a space left between the basal plate and the lower part of the dorsal plate, and it is in this space that parasitic infusoria, such as species of *Colacium* and *Carchesium*, take up their abode. The pectoral edge is almost straight, with a central notch, and two deep lateral notches, and ends at each extremity in the appearance of a sharp curved spine, about one-third the length of the antler, but not separated from it, forming in fact a strengthening buttress to its base. This pseudo-spine is evidently a transitionary form of the eighth occipital spine, as seen in *B. polycerus*. The animal is able to close the superior orifice of the lorica by bringing the dorsal and ventral edges into mutual contact. The foot can be protruded to a great length, equal to that of the body and antlers together.

The *digestive system* needs no description, as it follows the usual type. There is a large *contractile vesicle* into which the lateral canals can be distinctly traced. There appear to be four vibratile tags on each side. In regard to the *nervous system* there is a large ganglion, in which is imbedded a crimson prism-shaped eye. In one specimen which I examined closely, I found that from the lower edge of the ganglion proceeded three fine nerve-fibres, each of which, whilst crossing the surface of the mastax, expanded into a small nucleated ganglion-cell; then diminishing to their former calibre, they lost themselves on the surface of the stomach and intestinal tract (fig. 3 *a*). Nerve-fibres also supply the dorsal antenna as well as the lateral antennæ, which make their exit, as mentioned before, just above the junction of the dorsal and basal plates. The *ovary* is of a reddish tinge, especially marked when the young ova are in process of formation. The infant female, when in the egg, has the long anterior antlers as well as the posterior spines bent over inwards in such a way that they overlap each other close against the body, so that the whole animal is oval in shape and accurately fits the shell. Immediately after birth these spines are very soft and flexible.

The *male*, many specimens of which I examined, is 1/167 in. in length, and is invested with a distinct lorica. The *dorsal* surface of this lorica is convex, and down its centre runs a high ridge. The occipital edge presents a deep central notch for the protrusion of the dorsal antenna (fig. 3 *d*). The *ventral* surface is deeply concave, and presents at its lower portion a large circular opening, through which a long flexible foot protrudes, as well as a large penis (fig. 3 *e*). There is a large red eye. The male rotifer is extremely active, swimming in a frantic sort of manner through the water, clambering on to the back of a female, and running all over her like a great parasite, frequently squeezing himself into the space between the dorsal and basal plates of the lorica of the female before actual coition takes place. He also secretes a glutinous material from his foot, by which he anchors himself to the body of the female, twirling round on his own axis at a short distance away.

Size :—Total length of female adult rotifer, 1/70 in. Length of body and anterior spines only, 1/90 in. Width, 1/143 in. Length of male, 1/167 in.

Rhinops orbiculodiscus. Pl. VII. fig. 4.

It is difficult to determine in which genus, whether *Hydatina* or *Rhinops*, this new rotifer should be placed. It is evidently a form intermediate between the two, since, in different points of its anatomy, it combines the characters of both. The corona is that of a *Rhinops* with the proboscis and terminal eyes absent, whilst it resembles a *Hydatina* in the fact that it possesses both a dorsal antenna and two lateral antennæ. On account of the structure of the corona, I propose to place it provisionally in the genus *Rhinops*, and to name it *R. orbiculodiscus*.

I found it in October 1889, in great numbers, in water from the peat bogs amongst the mountains of Donegal, behind Moville. In the following year I was unable to obtain a single specimen. In the same pool were *Mastigocerca bicornis*, *Dinocharis detractus*, *Diglena forcipata*, and *Pterodina reflexa*. In another pool nigh to the same place was found *Conochilus volvox*.

The corona is the most characteristic feature in the anatomy of this rotifer. It is a perfect circle in shape, set at an obtuse angle to the ventral surface. It presents a deep cup-like cavity, round the inner edge of which runs the outer ciliary wreath. The inner ciliary wreath consists of large cilia placed on the summit of two tapering cushions which approach each other at the lower part and surround the buccal orifice. The long dorsal proboscis seen in *R. vitrea* is in this species entirely absent, as also are the eye-spots. The corona is in fact that of a *Rhinops* with the dorsal proboscis obliterated.

The ventral surface is flattened, the dorsal surface, on the other hand, swelling out with a fine sweeping curve into a globular form, well seen when the creature is viewed from the side (fig. 4 *b*), and then suddenly diminishing behind to the base of the foot. The foot is about one-third the length of the body, and is terminated by two toes.

The intestinal tract is of the usual type, a mastax, followed by a capacious stomach, and an intestine ending on the dorsal aspect at the base of the foot. Gastric glands are seen on both sides of the stomach. There is a large translucent ovary, and a large contractile vesicle on the ventral side of the base of the foot. The two lateral antennæ are situated, one on each side, at the lower part of the globular dorsal surface. They can be seen distinctly also from the ventral aspect. A single dorsal antenna occupies the mid-line just below the upper border of the corona.

Notommata cuneata. Pl. VII. fig. 5.

This pretty little species I found in considerable numbers in a quarry pool in Bickleigh Vale, Devonshire, in April 1890. Its general shape is that of a wedge, the broader extremity being the head. The pair of *toes* are long and curved, their length being one-third that of the body. There is a pair of *auricles*, the setæ of which are unusually long. The *trophi* are of the usual type; the *stomach* is capacious; a *contractile vesicle* is also present. The crimson *eye* is conspicuous. The little creature secretes a glutinous material from its toes, by which it is in the habit of anchoring itself to surrounding objects. Length 1/300 in.

Salpina cortina. Pl. VII. fig. 6.

This rotifer was found in the ponds of the Acclimatization Gardens, Brisbane, Australia, in January 1887. The *occipital spines* are wanting; the *pectoral* pair short; and the *lumbar* spine is considerably longer than the *alvine* spines. There is a deep notch in the posterior edge of the lorica, uniting the lumbar and alvine spines. The *toes* are two-thirds the length of the whole body. There is a large ganglion, with a conspicuous crimson eye. The rest of the anatomy is of the usual type.

Anuræa procurva. Pl. VII. fig 7.

The only water supply in the desolate volcanic island of Ascension is brought to the town from Green Mountain, an oasis in the midst of ashes and cinders, by an aqueduct of pipes, seven miles in length, broken at regular intervals by covered tanks or reservoirs. The water in the cattle trough in front of one of these tanks, known by the expressive name of "God-be-thanked" Tank, I found this January (1891), to be swarming with *Pedalion mirum*, in company with a species of *Anuræa*, which I believe to be new.

When viewed from the front, one would be inclined to consider *A. procurva* but a variety of *A. aculeata*. When, however, a side view is obtained, it is at once seen that the lorica is considerably curved, so that the ventral surface is deeply concave, and that the anterior and posterior extremities project much beyond the line of the lateral edges. In regard to the occipital spines, six in number, the middle pair (antlers) are by far the longest, and are curved forwards. The two posterior spines are unequal. The lorica is hexagonally tesselated, similarly to *A. aculeata*; the tesselations, however, are not very distinct. A large red *eye* is present. Length 1/200 in.

Anuræa scutata. Pl. VII. fig. 8.

This species, found in the fountain of the Botanical Gardens, Brisbane, in January 1889, is relatively both broader and deeper than *A. aculeata.* The curve of the dorsal surface is sweeping, whilst the ventral surface is comparatively flat. The occipital spines are six, the middle pair long and procurved. The anterior mental edge has a deep notch at its middle. The posterior spines are unequal, the length of one being that of the body; the other is degenerated. A single red *eye* is present. Length about 1/120 in.

V.—*A New Method of Infiltrating Osseous and Dental Tissues.*

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

(*Read* 18*th March*, 1891.)

It is well known to all who are in the habit of mounting osseous or dental tissues in Canada balsam, that great care must be observed in order to keep out this substance from any existing tubular or cavernous elements in these tissues, in order to obviate the inevitable obliteration which would arise in consequence. It therefore occurred to me that if such cavities could be filled by some substance insoluble in the balsam, such obliteration would be prevented, and the minutest features of the section rendered visible. Several methods presented themselves to my mind, but none seemed to have greater advantages than that I wish to introduce to your notice this evening. I do not pretend that this method will demonstrate anything fresh in a known structure, but should abnormal histological elements be present they will be made evident more readily, while the well-known obliteration will be entirely removed. The plan by which for many years I have mounted hard dental tissues answered very well, and it may be of help to recall it as it has proved so useful in the hands of others who have adopted it. It was to grind the dental or osseous sections between two plates of ground glass, with water and pumice powder, till sufficiently thin, finishing them off at last with old and worn-out ground glass and water alone. This, while it allowed the grinding down to proceed more slowly, at the same time polished the section; this being saturated with water only required cleaning and its surfaces dried, when it might be mounted in fairly stiff balsam, *but without heat.* In this manner the internal cavities remained impermeable to the balsam. Thinking over this method with a view to its improvement, the thought occurred to me that if some method of infiltration could be adopted, such as is frequently employed in preparing the soft tissues, an advantage could be gained; and I set to work to carry this thought into execution after this manner. The section may be cut or ground moderately thin and soaked in ether for about 24 hours or more, it is immaterial; it may then be transferred to a thin collodion stained with fuchsin, where it may remain for two or three days to allow the stained collodion to follow the ether into the minutest ramifications of the tissue. In this manner not only the lacunæ of bone are infiltrated, but their radiating canaliculi also, and the dentinal tubuli, equally fine in dimensions, are frequently found filled to their ultimate terminations. The section may now be placed in methylated spirit which will harden the collodion, and it may remain in this till a suitable opportunity arises for grinding it down to its final thinness. The collodion being insoluble in water, no detrimental action can ensue from the grinding down, but especial care should be taken to finish off with *old* *ground glass and water only*, to avoid the adherence of particles of pumice to the collodion or in surface cavities, which would detract from the cleanliness and beauty of the preparation. When sufficiently thin, the section may be mounted, *surface dry*, in stiff Canada balsam, or what may be better, the styrax used for mounting diatoms, but the mounting should by preference be accomplished without the application of heat, or at most only the slightest increase of temperature, to avoid vaporizing the moisture contained in the cavities or tubes of the tissue. If the temperature be raised to a greater extent the mounting medium runs in, leaving the intimate structure filled with the red collodion, a result which may be useful under some circumstances. By this method any unsuspected or abnormal cavities are made very evident by the coloured collodion. Brittle tissues are made less friable by the toughness of the collodion, and the work of grinding down much facilitated. I may here give a useful suggestion in reference to the staining of the collodion with the fuchsin: this dye should be mixed in the methylated spirit used for making the collodion, and the requisite quantity of ether be added and well shaken up, then the pyroxiline added. If the alcoholic solution of fuchsin is added to the collodion after it is mixed the alcohol in this solution precipitates the collodion in a gummy mass, and so toughens it that it fails to permeate the tissue, but prepared in the manner I have just indicated it preserves its fluidity, and should it by evaporation become thickened it can be diluted with a little more ether. I have tried the other anilin dyes such as Bismarck brown, iodine-green, and methyl-violet, but cannot at present get such a satisfactory result as I have with fuchsin.

This method as applied to the osseous and dental tissues is, I believe, new, and might be regarded as something almost too simple to bring before a body of such accomplished microscopists as form the bulk of this Society; yet the suggestion of it may lead to its employment in other directions, and I hope that much benefit may arise to its employers from its underlying possibilities.

VI.—*On Bull's-eyes for the Microscope.*

By E. M. Nelson, F.R.M.S.

(*Read* 18*th March*, 1891.)

Having lately been investigating the optical principles involved in the construction of lantern condensers, I have found some points which are applicable to, and of service in, the cause of microscopy. With regard to the lantern, my aim in the first instance was to construct a condenser which could be used either with lime-light or with a mineral oil lamp. I designed a triple, consisting of two menisci and a plano-convex of crown, the front lens being removable, so that the two remaining lenses formed a double condenser for use with mineral oil.

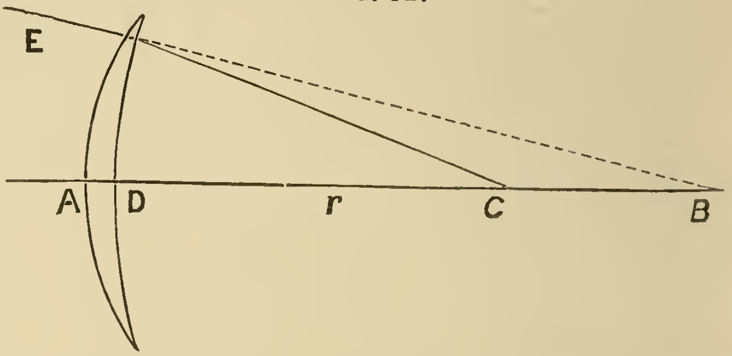
The triple, when tried with lime-light, gave several important results:—

1st. The light secured was about double that given by ordinary forms.

2nd. The definition on the screen was undoubtedly improved. This latter result might have been expected from the former, because of the increase of light that was sent through the darker portion of the picture, but there was also a marked improvement in what is known as the high lights, and this certainly I did not expect. The conclusion that forced itself upon me was that the case was analogous to that of the Microscope—viz. a more perfectly constructed condenser gave a more perfect image. Although my triple greatly reduced the spherical aberration there was still a considerable amount left, owing to the conditions imposed by having the two lenses suited for a mineral oil illuminant. Seeing, however, so much improvement in the definition, I have since computed a quadruple condenser of minimum aberration, which will, I feel confident, yield still better results.

It was this improvement in the definition which led me to turn my attention to Microscope bull's-eyes. These I found were constructed on principles of maximum aberration, or rather on no principles at all. When, some years ago, I adapted the Herschel doublet to the Microscope bull's-eye, thinking that the form was well known, I left it entirely in the hands of the optician, but on more close examination I now find that the combination supplied has no point of resemblance to Herschel's doublet, of which I have found in several old books a description. Many years ago it was discovered, by whom I do not know, that light falling on a dense medium of refractive index μ bounded by a spherical surface, would, under certain conditions, be refracted without aberration to another point. The conditions were, that the distance from the point from which the light issued to the centre of curvature, should be to the radius, as the refractive index was to unity. When those conditions were obtained, then all the light passed without aberration to another point. It is this theorem which makes it possible to construct an aplanatic meniscus. For if, in a converging meniscus, the more convex curve satisfies the above conditions, the shallower curve may be made any radius from the focal point, and therefore the light will pass through that surface without refraction. Fig. 32 makes this abundantly

Fig. 32.



evident. Let the ray E fall on the convex curve A, whose radius is A r, and let B, which is technically known as the focus of E, be the point where E produced will cut the axis, and let μ the refractive index of A D $= 1 \cdot 5$. Then, if A r : r B :: 1 : $1 \cdot 5$, all rays falling on A which have their focus at B will be refracted without aberration to the conjugate focus C. All that is necessary now is, from the centre C to describe the curve D, and the meniscus A D is constructed, for it is quite evident that all the rays refracted by A to C are radii of D, and so pass through without refraction.

The converse problem is also true. If a light is placed at C, all rays falling on the meniscus A D will be refracted aplanatically as if they came from B. So far the books help one, but as r and B are both unknown, it is a tedious business to construct an aplanatic meniscus for purposes of a bull's-eye, &c. I have investigated the problem, and have devised some very simple formulæ which make the construction of an aplanatic meniscus perfectly easy. Let us see what we have given us. We have two things, viz. the refractive index of the medium, and C D, the back focus. Now, we first require the distance A C, or the back focus + the thickness of the lens. The best way of determining the thickness of the lens is by drawing it. Extreme accuracy in this point is not necessary. Having found A C call it P; and A B, P′; A r, r; and let μ = the refractive index. Then

$$r = \frac{\mu P}{\mu + 1}$$

and

$$P' = \mu P.$$

Having found r draw it. It is only necessary to lay off an angle at

C to represent the aperture, by which means the diameter of the lens may be found. This being determined from the centre C, we can draw the curve D, and so the meniscus is constructed. If it is found that the proper amount has not been allowed for A D, the thickness of the lens, it can now be measured, and the curve computed with the new value of A C or P. To complete the doublet it is necessary to place a converging lens of minimum aberration in front of A to parallelize the rays which have their focus at B.

Some care is necessary in doing this, for it is important that the focus for the marginal rays be accurately determined, leaving the aberration to act on the central pencils, as they are of less importance. First, we must decide the form of the lens. In the case of a glass of low refractive index, it would be better, perhaps, to have a crossed lens, but with flint of 1·62 I find that the difference in the coefficients for aberration in the plano and in the crossed lens amounts to only ·006, whilst in glass, whose refractive index is 1·516, it is ·075. Crossing a flint lens is therefore a work of supererogation. Let us, in the first instance, investigate the procedure with a plano-convex flint lens where $\mu = 1 \cdot 62$. The plane side will face A.

Its focal length will obviously be B A + the distance between the lenses + the distance of the nodal point from the plane side + the spherical aberration for the semidiameter of the lens. B A or P′ we already know from the formula $P' = \mu P$. The distance between the lenses may be made small, say 1/20 in.; n the distance of the nodal point from the plane side can be found by the formula $n = \frac{d}{\mu}$ where d = the thickness of the lens.

To determine the spherical aberration is a longer business, and as this paper is intended to be entirely practical and not theoretical I have no intention of giving the formulæ at length, especially as I have done so previously (R. M. J., 1887, p. 928.) It will be sufficient to point out that it consists of the product of two quantities which we will call a and b. The first of these, viz. a, varies principally with the refractive index of the glass used. When $\mu = 1 \cdot 516$, for a crossed lens, $a = 1 \cdot 025$, and for a plano-convex, $a = 1 \cdot 1$. When $\mu = 1 \cdot 62$, for a plano-convex lens, $a = \cdot 804$.

The quantity b is the square of the semidiameter of the lens divided by the focus: thus if y is the semidiameter, $b = \frac{y^2}{f}$. The total spherical aberration is $a\,b$.

If we put in for the value of f the sum of the values already obtained, viz. the distance B A or P′ + the distance between the lenses, say 1/20 in. + the distance of the nodal point from the plane side of the lens, sufficient accuracy will be obtained; if, however, extreme accuracy be required, determine the spherical aberration by this value of f, and by adding it to the above quantities obtain a new value for f by which a true value may be obtained of b.

Having found f the required focus, the radius is easily deduced by the formula $r' = f(\mu - 1)$.

In assigning a value to y we must know the diameter of the lens. It may be found thus:—having drawn the meniscus and found the point B or P′ and having laid off the angle of aperture at C (fig. 32) through the point where the extreme ray from C meets the curve A, draw B E. E being the limiting ray it determines the diameter of the lens and consequently the value of y.

If it is required to further diminish the aberration it can be accomplished by crossing the second lens. As stated above, it is not necessary to do this when the lens is of 1·62 ref. index. A plano flint is however a good deal better than a crossed crown, the difference of the coefficient in favour of the flint being ·22. Therefore if it was a matter of equal cost between a crossed crown and a plano flint, the flint should be chosen, and as the meniscus is aplanatic, whether made of crown or flint, it might be cheaper to make the meniscus of crown and combine it with a plano flint. The combination would yield a result as far as aberration was concerned almost equal to that of a doublet composed wholly of flint. As crown glass has a green tint, where the colour of the light is of importance flint glass only should be used.

To find the radii r and s of a crossed lens of given focus, it is only necessary to multiply the focus by the constants H and K thus:—

$$r = \mathrm{H}f$$
$$s = \mathrm{K}f.$$

For glass of ref. index 1·516; H = ·5935, and K = − 3·944.
For glass of ref. index 1·62; H = ·653, and K = − 12·06.

In a crossed lens the flatter curve always faces the meniscus.

It should be remarked that the formula for the nodal point given above, $n = \frac{d}{\mu}$, is not strictly accurate for a crossed lens, but it is abundantly so for my purpose. The distance n is measured from the flatter curve into the substance of the lens, similar to the plano.

The spherical aberration may be considerably further reduced by placing a second aplanatic meniscus next the first, so making the condenser a triple (fig. 35).

The formulæ for computing the radii of the second meniscus are precisely similar to those of the first.

Let Q and Q′ be the terms of the foci of the second meniscus corresponding to P and P′ of the first.

As far as the second meniscus is concerned we have merely to regard the light as emanating from B and neglect altogether the presence of the first meniscus.

Q will therefore equal the distance A B or P′ + the distance between the menisci + the thickness of the second meniscus. Then

$$r' = \frac{\mu Q}{\mu + 1}.$$

s' will be drawn from centre B to the point where E meets r (fig. 32).

The formula $Q' = \mu Q$ gives Q′ which is the point to be used in determining f for the third lens in the same way as the point B or P′ was used in finding the focus of the plano or crossed lens for the double.

The reason why the aberration is decreased by the insertion of a second meniscus is because of the decrease of the factor b by the increase of the denominator in the fraction $\frac{y^2}{f}$ by the removal of the focus from P′ to Q′. The total spherical aberration $a\,b$ is therefore reduced.

In the triple the light meets the surfaces at no great obliquity, consequently there is not much loss by reflection.

With regard to the diameter and focal length of a combination suitable for a Microscope bull's-eye, if it is required to fill the back lens of any substage condenser 1½ in. would be more than sufficient, but for the illumination of opaque objects by means of lieberkuhns, parabolic reflectors, &c., perhaps 2 inches would be better. Naturally, with a given back focus, the larger the diameter the larger will be the angle of light that is parallelized, but unless the whole of the parallelized beam is utilized there will be a corresponding loss. Taking all things into consideration I think a 2-in. will probably be the most useful size. As to focus, or rather working distance, with one of my metal chimneys having a 3 × 1 slip I find that 1 in. will be sufficient.

Allowance will have to be made for the horns of the meniscus as well as for the brass mount. I have therefore made

$$P = 1 \cdot 6''.$$

Fig. 33 shows the proper mode of mounting a condenser.

Fig. 33.

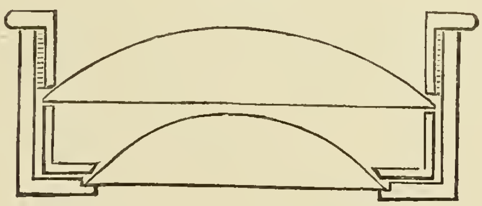


Fig. 34 is a drawing of a doublet of plate glass, $\mu = 1 \cdot 516$; 2 in. clear aperture; angle 70°; working distance 1·0″.

First lens, a meniscus, diameter 1·7″.

$$r = + \cdot 964''.$$
$$s = + 1\cdot 375''.$$

Second lens, double convex crossed, diameter 2·1″.

$$r' = + 1\cdot 816''$$
$$s' = - 12\cdot 07''.$$

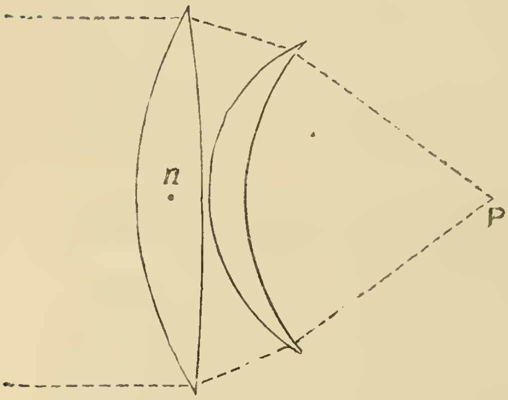
Distance between the lenses ·05″.

$$P = 1\cdot 6'' \qquad P' = 2\cdot 425''. \qquad nP' = 2\cdot 725''.$$

Spherical aberration $\delta f = - \cdot 335''$.

$$\delta F = - \cdot 168''. \qquad f = nP + \delta f = 3\cdot 06''.$$

Fig. 34.



P′

Fig. 35.

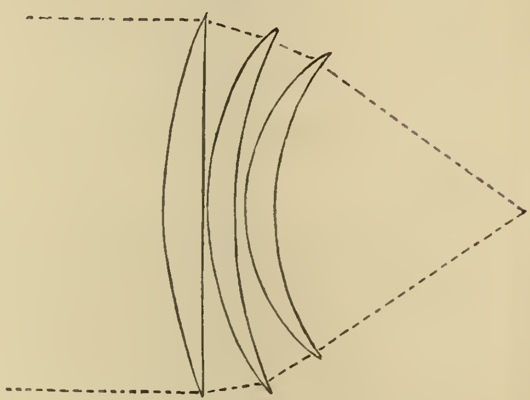


Fig. 35 is a drawing of a triple of flint $\mu = 1\cdot 62$; 2 in. of clear aperture; angle 70°. The first lens is a meniscus, diameter, 1·65″.

$$r = + \cdot 958''$$
$$s = + 1\cdot 35''.$$

The second lens is a meniscus, diameter 2·0″.

$$r' = + 1\cdot 67''$$
$$s' = + 2\cdot 55''.$$

The third lens is a plano-convex, diameter 2·1″.

$$r'' = + 2\cdot 914''.$$

Distance between the lenses ·05″.

$$P = 1\cdot 55''. \qquad P' = 2\cdot 51''. \qquad Q = 2\cdot 7''. \qquad Q' = 4\cdot 37''.$$
$$nQ' = 4\cdot 53''. \qquad \delta f = - \cdot 17''. \qquad \delta F = - \cdot 0226''.$$
$$f = nQ' + \delta f = 4\cdot 7''.$$

A still better doublet than that in fig. 34 could be made by combining with the plate glass meniscus there shown a plano-convex of flint, $\mu = 1\cdot 62$; diameter 2·1″.

$$r' = + 1\cdot 83''.$$
$$nP' = 2\cdot 675''. \qquad \delta f = - \cdot 272''.$$
$$\delta F = - \cdot 132''. \qquad f = 2\cdot 95''.$$

The spherical aberration of this form is therefore ·109″ greater than that of the flint triple, and ·036″ less than that of the plate glass double.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

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

a. Embryology.†

Theory of the Structure of the Placenta.‡—Mr. C. S. Minot's theory may be shortly summarized thus:—He looks upon the placenta as an organ of the chorion; primitively the chorion had its own circulation and formed the discoidal placenta by developing villi which grew down into the degenerating uterine mucosa; by the degeneration of the maternal tissues the maternal blood is brought closer to the villi, and the degeneration may go so far that all the tissue of the uterus between the villi disappears. A layer of the mucosa is preserved between the ends of the villi and the muscular layer of the uterus to form the so-called decidua; the placenta receives its fœtal blood by the means of large vessels running in the mesoderm of the allantois. From this discoidal chorionic placenta the zonary placenta of Carnivora, the diffuse placenta of the lower Primates, and the metadiscoidal placenta of Man have been evolved.

A second type of placenta, perhaps evolved from the first, is found in Ungulates, and is characterized by a vascular allantoic vesicle uniting with a now vascular chorion to form the fœtal placenta, and by the absence of degeneration in the maternal tissue. This is the allantoic placenta.

First Stages of Placental Union in Man.§—Prof. E. Selenka brings forward evidence against the general opinion that the ovum during the

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

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

‡ Anat. Anzeig., vi. (1891) pp. 125–30.

§ Biol. Centralbl., x. (1891) pp. 737–44.

first three or four weeks of its development lies free within its capsule. On the contrary, in the first week of development it is firmly and permanently united to the uterus, for the villi of the chorion grow into the openings of the uterine glands. Selenka bases this conclusion confidently on the results of his investigation of early stages both in apes and in man. Moreover, he urges the following considerations:—(1) If the ovum lie free for weeks, its encapsuling by the decidua is unintelligible, for this surely results from the stimulus of contact between ovum and uterus; (2) if the ovum does not unite very early with the uterine epithelium, the latter should be demonstrable on the internal surface of the capsule cavity, but it is not; (3) the supposition of a double-layered chorion ectoderm is unsupported by any analogy; (4) except on Selenka's conclusion, the early nutrition of the ovum is unintelligible.

Development of Apes.*—Prof. E. Selenka has a preliminary notice of the results of his studies on the development of Apes. The most primitive type is to be sought for in those Apes in which the germinal vesicle is not surrounded by a decidua reflexa; there are here two placentæ, one on the dorsal surface of the fœtus and the other on the ventral surface of the germinal vesicle. From this type two others have arisen independently; in both the decidua reflexa forms a capsule round the germinal vesicle. If the reflexa contains both blood-vessels and uterine glands two discoid placentæ are formed, but if these are wanting the second placenta remains quite rudimentary.

The most primitive form, or placenta bidiscoidalis typica, is found in all Catarrhine Monkeys of the Old World, but not in Man or the higher Apes. The placenta bidiscoidalis circumvallata, which has, as yet, been seen only in *Hylobates* (the Gibbon), differs only from the typical in that the ventral uterine placenta does not arise from the ventral, but rather from the dorsal wall of the uterus. The placenta monodiscoidalis or discoidalis, which is found in the other Anthropoid Apes and in Man, must be regarded as homologous with the dorso-placenta of other Apes.

Great as the differences in the placentation of the three types appears to be, those of the other embryonic membranes and of the fœtuses themselves are very slight. The rudiment of the placenta, for example, is always the same. A slight sketch is given of the developmental history of the Catarrhine Monkey *Semnopithecus maurus*. The general lesson is that, in Apes and Men some embryonic organs are developed earlier, and others later than in other Mammals. The precocious structures are the numerous chorionic villi, the cœlomic sacs, and the stalk of the allantois. Those that are later are the yolk-sac, whose vascular plexus is not developed for some time, and which must be regarded as a vestigial organ; the allantoic cavity is long in appearing.

The characteristic points are the loose tissue of the somatopleure which lines the chorion, the persistent stalk of the amnion, the outgrowth of the amnion and its fusion with the chorion, the vestigial nature of the yolk-sac, the formation of two opposed placentæ, one of which may remain rudimentary, and the attachment of the non-placental part of the embryonic sac to the surrounding uterine wall.

* SB. K. Preuss. Akad. Wiss., 1890, pp. 1257–62.

Development of the Germinal Layers in Sorex.*—Prof. A. A. W. Hubrecht, in the second of his studies in mammalian embryology, describes the formation of the germinal layers in the shrew, and discusses the general problems connected with the subject.

The earliest stage of which sections were made exhibits a distinct zona pellucida, internally clothed by a layer of flattened cells—the trophoblast, while at one spot there is an agglomeration of 50–60 larger cells—the material for the embryonic epiblast and for the hypoblast. The segmentation cavity beneath the polar thickening is distinct, though not yet very spacious; after the development of the cœnogenetic hypoblast, it becomes the cavity of the yolk-sac. At this stage the embryos were still free in the uterus.

The blastocyst widens, its cells are stretched, and the zona becomes thinner. In the last phases of the didermic stage, just before the appearance of a mesoblast and a gastrula ridge or primitive streak, the zona reaches its limit of tenuity. After that it disappears and the trophoblast is attached to the uterine tissue. From the embryonic knob hypoblast cells originate, which gradually form a continuous layer within the trophoblast. It seems likely that the trophoblast extends as a thin layer above the embryonic knob. After the migration of hypoblast cells from the embryonic knob, the patch of epiblast which remains may be termed the embryonic shield.

The hypoblast forms a complete and closed sac, clothing the entire inner surface of the trophoblast. Just below the anterior end of the embryonic shield the hypoblast undergoes an important modification, forming a patch in which a differentiation occurs, which ultimately leads to the formation of the notochord and the lateral mesoblast plates. As part of this patch will develope into the anterior portion of the notochord, it is called the protochordal plate. It is remarkable that this should precede the first hints of a gastrula ridge.

Towards the origin and further development of the middle layer in *Sorex vulgaris* three distinct sources contribute. These are:—(1) The protochordal plate; (2) the gastrula-ridge and its median prolongation forwards—the protochordal wedge which advances between the epiblast and the hypoblast; (3) an annular zone of hypoblast situated just outside the limits of the embryonic shield, and thus inclosing—but at the outset independent of—the protochordal plate. But soon the mesoblast becomes a confluent layer, and grows by the division of its own cells.

In his theoretical considerations on the gastrulation of the Mammalia, Prof. Hubrecht emphasizes the principle of precocious segregation as applied to part of the hypoblast. A didermic stage of the blastocyst is inaugurated before the actual process of gastrulation has set in. But another portion of the hypoblast arises in more palingenetic fashion, namely, in the gastrula ridge. An explanation is given of the manner in which the union of the palingenetic and cœnogenetic hypoblast comes about.

In explanation of the persistence of the yolk-sac in Didelphia and Monodelphia, Prof. Hubrecht notes that, for a satisfactory working of the new nutritive arrangements of the embryo, "it is undoubtedly of the utmost importance that the surface of the area vasculosa should be

* Quart. Journ. Micr. Sci., xxxi. (1890) pp. 499–562 (7 pls.).

stretched to its maximum extent, and at the same time should be elastic against pressure tending to throw it into folds." The change required would thus be the substitution of liquid contents instead of nutritive contents. With the absorption and retention of this liquid, under a certain pressure, the trophoblast is specially concerned. Moreover, the spacious blastocyst affords safe lodging for the developing head of the embryo. But the function of the trophoblast will be rendered more effectual if the hypoblast follows suit, and constitutes as soon as possible an inner lining to the trophoblast sac. By these and other considerations Prof. Hubrecht shows the necessity for the precocious segregation of part of the hypoblast in mammals.

Nomenclature of Chicken Embryos for Teaching Purposes.*—Prof. W. Baldwin Spencer suggests the use of fixed and simple designations to indicate the stages in chicken embryos, and he recommends the use of letters of the alphabet, such as was adopted by Prof. Balfour in his description of the early stages of Elasmobranch fishes. He defines the stages, and gives figures to explain and illustrate his meaning.

Development of Salamandra atra.†—Prof. R. Wiedersheim has examined a large number of females, and while for the most part confirming the observations of Schreibers, C. Th. Siebold, and Czermak, has found out more than one new fact of importance. In one case, instead of two embryos there were three; in another exceptional case there were four. Prof. Wiedersheim killed the animals in sublimate solution and cut out the gravid uteri. Yet, except in two cases perhaps abortive, the embryos remained alive, so securely closed is the distal end of the duct. The histology of the oviduct is described:—the numerous vessels between the serous and muscular layers, the plaited mucosa, the cilia all over the surface, the thousands of leucocytes in the intercellular spaces of the sub-mucosa and mucosa. In the uterus these spaces are occupied by crowds of red blood-corpuscles which burst the mucosa and are set free in the cavity in which the embryo lies. In this fluid, rich in oxygen and in nourishment, the embryo breathes and feeds. Its mode of respiration is no longer an enigma. As the material furnished by the undeveloped ova becomes exhausted there is a more abundant supply of blood, lymph, and epithelial débris from the wall of the uterus. After birth the mucosa is renewed, a process which recalls similar phenomena in mammals.

Disputed Points in Teleostean Embryology.‡—Mr. J. T. Cunningham draws attention to some of the firmly established facts, and distinguishes the sound from the unsound in recent descriptions and arguments. In many ova of Teleosteans there is no element in the egg-cell other than the pellucid yolk and the peripheral pellicle of protoplasm; in the gurnard and mackerel there is a somewhat large globule of oil; in others there are several free in the yolk or fixed in the cortical protoplasm. In all non-pelagic and in some pelagic ova the yolk is discontinuous, consisting of many yolk-spherules. Yolk-segments, intermediate between numerous yolk-spherules and the homogeneous yolk of

* Proc. Roy Soc. Victoria, 1890, pp. 23-6 (4 pls.).
† Arch. f. Mikr. Anat., xxxvi. (1890) pp. 469-82 (1 pl.).
‡ Ann. and Mag. Nat. Hist., vii. (1891) pp. 203-21.

a typical ovum, have, of course, nothing to do with segmentation. The development of the "vitelline membrane" has not been satisfactorily worked out. The segmentation-cavity of the segmented Teleostean ovum is homologous with that of other ova. Accepting the conclusions of Agassiz and Whitman in regard to the origin of the nucleated periblast, Mr. Cunningham adheres to his own observation that, as the nuclei from the marginal cells from the sixteen-cell stage onwards continually divide, cell-division also takes place in these cells, but at a slower rate than the nuclear division. In consequence of this, new cells are continually being separated from the ring of periblast at the same time that the nuclei in that ring continually become more numerous, and extend outwards and inwards from the marginal region of the blastoderm. The segmentation of cells from the Teleostean periblast to form hypoblastic and mesoblastic tissues corresponds perfectly with the subdivision of the yolk-cells in *Petromyzon* and Amphibians which gives rise to hypoblast and mesoblast in these forms. The real representative of the gastrula-cavity in Teleosteans is Kupffer's vesicle.

Later Larval Development of Amphioxus.*—Mr. A. Willey gives, at the commencement of his paper, a useful résumé of the entire development of *Amphioxus*.

I. The period of embryonic development comprises the first thirty-two hours. It commences with the segmentation of the ovum, and ends with the formation of the first gill-cleft.

(*a*) In the first eight hours, during which the embryo is confined within the vitelline membrane, the usual early differentiations are effected.

(*b*) After emerging from the membrane there is a successive formation of myocœlomic or archenteric pouches to the number of fourteen pairs. The myotomes which are added after this period never communicate with the intestine.

II. In the period of early larval development fresh gill-slits appear metamerically, slightly to the right side of the median line (subsequently passing well up to the right side) to the number of twelve to fifteen. Towards the close of this period the longitudinal metapleural folds appear, and the closure of the atrium commences behind by the fusion of the small subatrial ridges which are developed in the inner face of the metapleura.

III. The period of later larval development is that in which the second row of gill-slits is formed on the right side; the first or primary row crosses to the left side, the mouth assumes an anterior median and vertical position, the preoral cirri appear, and the endostyle is developed from its pre-existing rudiment.

IV. The adolescent period is marked by the attainment by the young *Amphioxus* of most of the essential features of adult structure; it now definitely ceases to lead a pelagic life and takes up its abode in the sand, where its further growth in size and maturity is accomplished.

The third period, or that now described, is divided into eight stages, in the consideration of which it is necessary to distinguish between what takes place on the right and what on the left side.

* Quart. Journ. Micr. Sci., xxxii. (1891) pp. 183–234 (3 pls.).

At first there are, on the right side, fourteen primary slits, none closing; above these are six secondary thickenings; the endostyle is in front of all the slits and the atrium is widely open anteriorly. On the left side there is a large lateral mouth, and one to two elements of the buccal skeleton. In the next three stages we find the fourteenth slit (on the right side) become closed, the thirteenth closing and the first very small; the secondary thickenings become slits, and some commence to form tongue-bars; the endostyle extends a short way backwards; and the atrium becomes closed. On the left side, we find the mouth bending round to the middle line, and the oral hood and the cirri beginning to make their appearance.

In the stage called the fifth there are twelve primary slits, just visible at the base of the pharynx, and the twelfth is closing; the first undergoes atrophy; there are eight secondary slits, the larger of which have complete tongue-bars; the endostyle extends further back. On the left side the primary bars have not yet quite appeared, while the upper and lower portions of the oral hood have joined. The club-shaped gland of the right side undergoes atrophy.

In the three succeeding stages the gill-slits tend more and more to arrange themselves in a bilaterally symmetrical manner, and there are at last eight on each side; the endostyle increases gradually in size.

The author gives a useful summary of the history of the individual structures, and then proceeds to certain general considerations. He thinks that the remarkable asymmetry of the larva may be ultimately traced to the adaptive forward extension of the notochord; the asymmetry is, then, a purely ontogenetic phenomenon, and is not an ancestral character. Reasons are given for regarding the club-shaped gland as a modified gill-slit of the right side, the corresponding slit of the left being represented by the first primary slit.

With regard to the endostyle, evidence is adduced to show that its position in the adult *Amphioxus* is secondary, and that, in its origin, it is perfectly homologous with the endostyle of Ascidians.

Some evidence is adduced in support of the startling assertion that the gill-slits or branchial stigmata of the Ascidians are not homologous with those of *Amphioxus* in origin, position, or relations. In the latter the slits are formed metamerically in the segmented region of the trunk; in the former they appear in front of the segmented region, and do not arise metamerically but irregularly. The common ancestor of the two groups cannot be properly imagined till we have further knowledge as to the significance of the primary pair of diverticula of the prechordal vesicle, and as to the function of the club-shaped gland. It is probable that gill-slits were present in the segmented region of the trunk and have been lost by existing Ascidians; if the evidence as to the club-shaped gland being a modified gill-slit is accepted, there must have been at least one pair of such glands.

Development of Muscular Fibres.*—M. L. Roule has studied, chiefly in *Porcellio*, the development of striated muscular fibres. Some of the elements of the mesoderm which are arranged in compact groups on

* Comptes Rendus, cxii. (1891) pp. 245–6.

the sides of the body of the embryo form the rudiments of the musculature of the body.

Each of these cells gives rise to a primitive fibre, by withdrawing its pseudopodial expansions, and growing by the addition of new protoplasmic material; this latter is not formed of granular plasm, like that already existing, but of contractile substance. This substance is at first deposited at the two extremities of the cell, then extends over the entire periphery, the deposit being always most abundant towards the ends; in this way the element grows along its longitudinal axis. The primitive granular protoplasm with the nucleus which it incloses thus becomes enveloped and set in the middle of a sheath of contractile substance. The differentiation into fibrils commences towards the centre and not the periphery of the cell; a transverse section taken at the level of the nucleus shows this nucleus in the very axis of the fibre, and from within outwards, the granular protoplasm, the deep contractile substance divided into fibrils, and the still homogeneous contractile peripheral substance.

This is different to what obtains in Vertebrates; the contractile substance in them appears first on one or both surfaces of the primitive element, and not at its two extremities; moreover, the primitive fibrils first appear towards the periphery of the cell, and not in its central region. The differences may be explained as due to the epithelial origin of the somatic muscular fibres of Vertebrates, and confirm, while they extend, the views of the brothers Hertwig as to the nature of the cœlom.

Both the epithelial as well as the mesenchymatous types of origin apply to smooth as much as to striated fibres; the smooth fibres of Nematodes, for example, are developed in the same way as the striated somatic fibres of Vertebrates, and the smooth muscles of Molluscs like the striated fibres of Arthropods. In both cases the nucleus is occasionally single, and this is frequently the case with smooth fibres, while it sometimes multiplies and converts the primitive element into a multinucleated primitive fibre.

Development of Sympathetic Nervous System in Mammals.*— Prof. A. M. Paterson has investigated the development of the main sympathetic system, chiefly in Rodents. The first event is the development of the main sympathetic cord. It is formed as a cellular rod or column, uniform in outline, and without ganglia or constrictions. It appears in and is derived from the mesoblastic tissue on either side of the embryonic aorta, and in front of the growing vertebral column. The cord appears after the formation of the roots and ganglia of the spinal nerves, and is at first entirely independent of them.

The connection with the spinal nerves is secondary; the inferior primary division of a (typical) spinal nerve divides, on reaching the junction of body-wall and splanchnopleure, into a somatic and a splanchnic branch. The latter gradually grows mesially and ventrally, and finally becomes connected with the sympathetic; some part of it does not join, but passes on into the splanchnic area. In the anterior part, however, of the thorax the whole of the splanchnic branch appears to be joined to the sympathetic cord.

* Phil. Trans., 181 B. (1891) pp. 159-86 (9 pls.).

The formation of the ganglia on the main cord of the sympathetic is a subsequent event, and is subordinate to the connection of the splanchnic branches of the spinal nerves with the cord. The causes leading to the formation of the ganglia are: mainly, the junction of the splanchnic branches, and the accession of a large number of nerve-branches at the point of entrance; the consequent persistence of the cells of the cord, which are joined by these nerves, as ganglion cells; and, to a less extent, the anatomical relations of the cord to the bony segments, &c., over which it passes; for these, in their growth, cause indentation of the cord at certain points.

Details are given as to the cephalic and caudal terminations and the peripheral branches.

From the morphological point of view, the most important of Prof. Patterson's conclusions are (1) that the sympathetic system is not a specialized portion of the central nervous system but has an independent origin, and is only secondarily connected with the cerebro-spinal system, and (2) that it is developed from the mesoblast.

It is very possible that under the term " sympathetic nervous system " there have been included two structures, entirely independent in nature, origin and function, one the sympathetic and the other the nervous system proper.

Degeneration of the Follicle in the Mammalian Ovary.*—Dr. T. Schottlaender finds that the degeneration of the follicle is an almost uniform process in the ovaries of the guinea-pig, rat, mouse, and dog. In primordial follicles, no more than a fatty degeneration of the epithelium was observed; but degeneration may befall all other follicles, especially those which are half ripe. The process usually begins with the destruction of the ovum; then the epithelium degenerates; before the latter disappears there is remarkable proliferation in the theca.

The zona of the ovum seems to become swollen and hyaline; the yolk undergoes fatty degeneration; the germinal vesicle is subjected to chromatolysis. Hints of irregular processes of nuclear division are observed, but Schottlaender saw only two figures which could be regarded as " directive." The granulosa cells migrate into the yolk, which degenerates completely and is absorbed. The epithelium degenerates in various ways:—the chromatin of its nuclei is destroyed and the cells become smaller and paler, or the cells undergo fatty degeneration without chromatolysis, or both processes are combined. Before ovum and epithelium are finally dissolved, the theca proliferates. A layer of connective tissue with blood-vessels and with fat sinks into the follicular space, but this layer varies considerably according to the age of the follicle and in different animals. What relation this connective-tissue body, which marks the disappearance of a follicle, may bear to the appearance of its successor, is still unknown.

β. Histology.

Attraction-Spheres and Central Bodies in Tissue and Migratory Cells.†—Prof. W. Flemming, referring to the few observations that have

* Arch. f. Mikr. Anat., xxxvii. (1891) pp. 192–238 (2 pls.).
† Anat. Anzeig., vi. (1891) pp. 78–81 (5 figs.).

been made in support of E. van Beneden's discovery of attraction-spheres and central bodies in cells, offers something to fill the lacuna. In the leucocytes of *Salamandra* he has found radiate spheres and central bodies when mitosis was not going on. And he has especially devoted himself to the study of very flat cells. As a result he has found the central bodies, not only in early stages, but in resting cells. In fixed cells they are small, but in leucocytes a good deal larger. If treated with safranin, gentian, and orange they are, in the former, only visible by their slight red coloration, and if the cells have been exposed too long to alcohol they cannot be seen at all. In leucocytes they are nearly always recognizable, on account of their size and rather high refractive power. The relation of the central bodies to the nucleus in fixed cells is generally this: they lie on a longitudinal side of the nucleus when this is of an elongated form, and when the nucleus is kidney-shaped they are found on the concave side; but these relations are not constant.

Although it is only rarely that these bodies are seen, Prof. Flemming believes that they may be always present. Their invisibility may be due to various causes. If they are not at the edge of the nucleus, but a little above or below its surface, they are hidden; the colour may be extracted from one and remain in another; the slightest darkening above or below them may cause them to be invisible; and, lastly, they may be too small in any given cell to be seen by means that have been used to observe them.

The author finds the central bodies much more often double than single, and he thinks that where only one is seen the other may be hidden. He offers these remarks as a contribution towards the confirmation of van Beneden's view that the spheres and central bodies are general and permanent organs of the cell.

Clasmatocytes.*—Prof. L. Ranvier gives to certain cells found in thin connective tissues of Vertebrata (epiploon of mammals, mesentery of Batrachia) the name of clasmatocytes (κλασμα, a fragment). They are demonstrated by stretching the membrane on a slide, and then pouring over it a few drops of one per cent. osmic acid. After two or three minutes it is washed with distilled water, and stained with a dilute solution of BBBBB methyl-violet, one part of the concentrated solution to ten parts of distilled water. After putting on a cover-glass the preparation is examined with medium powers, and the clasmatocytes are seen as branched or moniliform cells stained a red-violet. In their immediate neighbourhood, and especially about their prolongations, are to be seen accumulations of granules, a condition which the author supposes to be characteristic of these cells, and hence their name. Although these cells are derived originally from leucocytes they are quite immobile, and hence resemble extremely the macrophages of phagocytosis.

Transformation of Lymphatic Cells into Clasmatocytes.†—M. L. Ranvier has been able to watch in a glass the conversion of lymphatic cells into those modified migratory cells which he calls clasmatocytes.

* Comptes Rendus, cx. (1890) pp. 165–9.
† Op. c., cxii. (1891) pp. 688–90.

He placed in a glass cell a drop of peritoneal lymph of the frog, collected by means of a sterilized pipette. When the glass cover is added care must be taken to leave a little air round the lymph. If the examination be made at 15°, the amœboid lymphatic cells, which are among the cells present, will be found to exhibit very lively movements. Most sink to the bottom, where they attach themselves to the glass, extend themselves, and become so delicate that they will disappear from the observer unless closely followed. At this stage they are very active, and multiply pretty rapidly by direct division. If the temperature be raised for one hour to 25°, some of the lymphatic cells which have given off arborescent prolongations more or less long and complex will be found immobile. To observe the structure of these clasmatocytes, M. Ranvier has fixed the elements with osmic acid, and stained them with violet 5 B or hex-ethyl violet, or he has fixed them with picric acid and stained with hæmatoxylin, and then eosin. It is only in fixed preparations that the varied, complicated, and often sharp forms of the clasmatocytes can be properly appreciated.

Two Kinds of Chromatin.*—Prof. L. Auerbach finds that "chromatin" includes two kinds of substances, which stain in different ways and react differently to chemicals. The so-called "achromatin" consists for the most part of material belonging to one of the two chromatin substances. As one of these has a greater affinity for eosin, fuchsin, aurantia, carmine, and picrocarmine, while the other has a greater affinity for methyl-green, anilin-blue, and hæmatoxylin, Auerbach proposes to call them erythrophil and cyanophil respectively. In studying these two substances he has been confirmed in his conclusion that the presence of an intra-nuclear network is casual and of secondary importance, not a fundamental fact of structure. The network sometimes seen is due to a modification of the cyanophil, or less frequently of the erythrophil, or sometimes even of both, for a double network may occur. The erythrophil resembles the protoplasm of the cell-substance more than the cyanophil does. The latter has amœboid mobility; it forms the nuclear membrane when that is karyogenic or produced by the nucleus, and not cytogenic or produced by the cell-substance.

Red Blood-corpuscles of Amphibians.†—Prof. L. Auerbach gives a precise account of these cells so often observed. They have a distinct cell-membrane. The cell-substance is divided into a cortical layer and a medullary substance. In adults there are normally many nucleoli in the nucleus. An apparent homogeneity of the nucleus often results from the method of examination, while a reticulate structure may be produced in certain conditions by modifications of the nucleoli.

Nature and Varieties of Leucocytes.‡ — Dr. G. Lovell Gulland has prepared a critical and historical account of the varieties of leucocytes, which should be useful to those who are interested in the subject.

Evacuation of Cell-nuclei.§—Dr. R. Blanchard reports that he kept a specimen of *Proteus anguineus* with the object of studying its parasites.

* SB. K. Preuss. Akad. d. Wiss. (1890) pp. 735–49.
† Anat. Anzeig., v. (1890) pp. 570–8 (2 figs.).
‡ Rep. Lab. R. Coll. Physicians Edinb., iii. (1891) pp. 106–56 (1 pl.).
§ Bull. Soc. Zool. France, xvi. (1891) pp. 22–3.

As it was evacuating elliptical corpuscles he imagined that these were the eggs of a nematode, and that there was a nematode within. However, on dissection, not a parasite was found. Nor were the corpuscles coccidia. Maceration of the walls of the intestine showed that the bodies were the nuclei of mucus-producing cells; the cells become destroyed in consequence of their activity, and the nuclei escape in consequence of being protected by an envelope.

Structure of the Spinal Cord in Human Embryos.*—Prof. A. von Kölliker finds in the spinal cord of human embryos a corroboration of his conclusions in regard to that of other mammals. The fibres of the sensory roots divide as they enter the cord into an ascending and a descending branch; the longitudinal fibres of the strands in the cord give off collateral fibres which ramify in the grey matter and end in tufts; the anterior commissure is clearly seen in the neck and loin regions as a crossing of fibres, most of which arise from the axial processes of cells in all parts of the grey matter; these do not pass, as regards the commissure, into root-fibres, but into longitudinal elements of the anterior and antero-lateral strands. Sections prepared according to Golgi's method of staining, differentiate the elements as effectively as do those of Flechsig, and Weigert's method is also satisfactory.

Optical Characters of Medullated and Non-medullated Nerve-Fibres.†—Herr H. Ambronn demonstrated, in 1888, that the optical peculiarities of cork and some other vegetable tissues were due to crystalline particles of a wax-like substance. As medullated nerve-fibres differ optically from muscle, sinew, &c., as cork differs from most vegetable tissues, it seemed likely that the refraction peculiarities of medullated fibres were also due, as Klebs and Kühne suggested, to crystalline particles. By careful experiments, Ambronn convinced himself that the body to which the nerve owes its optical peculiarities is lecithin. This conclusion Gad and Heymans have corroborated in another way. According to Ambronn, the substance, both of medullated and non-medullated fibres (apart from Schwann's sheath), shows, in the absence of myelin or lecithin, the normal positive double refraction. If the lecithin be present in the form of very small crystals, with their optical axes radially and uniformly arranged, the positive double refraction of the matrix will be disguised; the opposite character will appear to a degree varying with the quantity of lecithin. But the use of ether will always bring out the positive character of the matrix-substance, and the optical change affords an index to the quantity of lecithin present.

Histology of Spermatozoa.‡—Mr. G. Dubern, working with a quarter and an eighth, and very intense sources of light, has discovered that the head of the human spermatozoon is composed of a number of closely set minute spheres, and that the tail is composed of thirty-five to forty small spheres, "very much like the beads of a single-row necklace." The wide generalizations that these and other observations have induced the author to formulate will be found in the author's paper.

* SB. Physik.-med. Gesell. Würzburg, 1890, pp. 126–7.
† Verh. K. Sächs. Gesell. Wiss., 1890, pp. 419–29.
‡ Indian Med. Rev., ii. (1891) pp. 30–6.

γ. General.

Plankton-Studies.*—Prof. E. Haeckel begins his account of plankton-studies with an historical sketch, in which the first date is 1845, when Johannes Müller began his memorable "pelagic fishing with a fine net." From him Haeckel and many others received their first impulse. After recording the various plankton studies conducted by himself and others, Haeckel draws a number of distinctions between Plankton and Benthos, Plankton and Nekton, Haliplankton and Limnoplankton, and so on. "Plankton" was originally defined by Hensen as including those animals which drift in the sea.

The plankton organisms are classified as follows:—

A. Protophytes: Chromaceæ, Calcocyteæ, Murracyteæ, Diatomeæ, Xanthelleæ, Dictyocheæ, Peridineæ.
B. Metaphytes: Halosphæreæ, Oscillatoriæ, Sargasseæ.
C. Protozoa: Infusoria, Foraminifera, Radiolaria.
D. Cœlenterata: Medusæ, Siphonophora, Ctenophora.
E. Helminths: Chætognatha.
F. Mollusca: Pteropoda, Heteropoda, Cephalopoda.
G. Echinodermata: larvæ.
H. Articulata: Annelids like *Tomopteris* and *Alciope*.
Crustaceans such as Copepods, Ostracods, Schizopods.
Insects, Halobatidæ.
J. Tunicata: Copelata, Lucidiæ, Thalidiæ.
K. Vertebrata: e.g. ova and larvæ of fishes.

Haeckel then discusses the sometimes homogeneous, but oftener heterogeneous character of the plankton; its annual, monthly, daily, and hourly variations; the difference in quality in different climatic zones, the influence of currents; the methods of study. Throughout there is vigorous criticism of Hensen's plankton studies.

Position of Nerve-Centres.†—M. A. Julien is of opinion that nerve-centres may be reduced to three types: the ventral (of Radiates), the dorso-ventral (of Annelids and Mollusca), and the dorsal (of Vertebrates). He formulates a general biological law in the following terms:—There is a constant relation between the position of the principal nerve-centres and that of the chief sensory and locomotor organs. Thus, in Asteroids, the locomotor system is formed by a circular canal which is placed around the mouth, and gives rise to five ventral canals; each of these canals carries tactile organs, and is often terminated by a visual organ. The circumanal canal is in relation with a nerve-ring, which gives rise to five ambulacral trunks. Illustrations are given explaining how this law may be applied to the other groups cited; a physiological explanation of the anatomical law is offered, and the corollary urged that the Vertebrate is not an Annelid on its back, or *vice versâ*.

Protoplasm and Life.‡—Under this title Mr. C. F. Cox has published a critical and historical essay on "protoplasm and the cell-doctrine,"

* Jenaische Zeitschr. Naturwiss., xxv. (1890) pp. 232–336.
† Comptes Rendus, cxii. (1891) pp. 741–3.
‡ New York, 1890, sm. 8vo, 67 pp.

and on the relation of the spontaneous generation theory to the general theory of evolution. We have not noted any new facts in it.

B. INVERTEBRATA.

Action of Nicotin on Invertebrates.*—Miss M. Greenwood has made a study of the effects of nicotin on certain Invertebrates. The toxic effect on any organism is mainly determined by the degree of development of the nervous system. For *Amœba* or *Actinosphærium* it cannot be regarded as paralysing; it is rather inimical to continued healthy life. The higher forms show that the nervous actions which imply co-ordination of impulse are the first to be stopped. In the Medusæ spontaneity, irradiation of impulse, and direct motor activity are affected successively. In still higher forms the paralysing action of nicotin is preceded by a phase of stimulation; this becomes marked in Ophiurids and Crinoids, and is very characteristic of the poisoning of *Palæmon* and *Sepiola.*

As this positively exciting action becomes noticeable, nicotin becomes more and more a medium in which life is impossible. For example, *Amœba* is not killed at once by a 1 per cent. solution of nicotin tartrate. *Hydra* dies rapidly in such concentration, but will live overnight in ·05 per cent.; such a solution kills *Lumbricus*, which tolerates ·01 per cent. for only a few hours. ·05 per cent. solution paralyses *Asterias* and *Antedon* in half an hour; ·005 per cent. in less than a minute so injures *Sepiola* that there is no subsequent recovery.

When very simple animals die under the action of nicotin death is often associated with injury of their substance so that it tends to disintegrate. The definite poisoning that occurs in higher types has sometimes, as one of its after-effects, a lingering trophic disturbance. An extreme case is presented by *Palæmon*, where there may be a progressive death of tissues from behind forwards.

Notwithstanding the general relation of the action of nicotin to the stage of development of the nervous system, there is an appreciable amount of difference in animals placed near one another in systematic classifications.

The Trochozoa.†—M. L. Roule proposes a new phylum of the Cœlomata to include some worms, the Mollusca, Bryozoa, and Brachiopoda. Its systematic position may be seen from the following table:—

Cœlomata	Vermes	Platyhelminthes
		Nemathelminthes
		Trochozoa
	Arthropoda	Arthropoda
	True Enterocœlia ..	Chætognatha
		Echinodermata
		Hemichordata
		Urochordata
		Vertebrata

The Trochozoa are characterized by the constant appearance (except in cases of abbreviated development) of a larva which belongs to the

* Journal of Physiology, xi. (1890) pp. 573–605.
† Ann. Sci. Nat., xi. (1891) pp. 121–78.

trochophore type; it is characterized by more or less numerous rings of cilia, one of which (the oral corona) is placed at the level of the mouth, and is remarkable by its persistence; by a mesoderm derived from a small number of initial cells (often two), and by a schizocœlic cœlom; the Brachiopoda alone form an exception to this rule; and by a pair of excretory organs or cephalic nephridia which appear very early in the course of development.

The first subdivision is that of the Polymeria; in them the mesodermal stripes early give rise to dissepiments which divide the cœlom into segments. The first series is that of the *P. intacta* or Annelids, among which we have the Archiannelids, achætous Euannelids, represented by the Hirudinea, and the Chætopodous Euannelids. The *P. distincta* or Pseudannelids are represented by the Sternaspidia and Gephyrea. The second subdvision is that of the Monomeria, in which there is a simple cœlom, or one divided into sinuses. Here we have the Rhyncota or unarmed Gephyrea, the Brachiata or tubicolous Gephyrea, of which *Phoronis* is a type, the Bryozoa, the Brachiopoda, the Velata—or our old friends the Rotifers, the Amphineura, and the Mollusca; of these last the Solenoconcha form the subtype of Premollusca, while Lamellibranchs, Gastropods, Pteropods, and Cephalopods unite to form the Eumollusca or true Mollusca. It is not for us to apologize for the numerous hybrid names proposed in this memoir.

Abnormalities in Crayfish and Earthworm.*—Dr. W. B. Benham reports an observation on a Crayfish in which, with normal ovary, there were two oviducts on either side, one of which opened on the 11th and the other on the 13th appendage; there were no indications of hermaphroditism. This, in conjunction with other facts, points to the possibility of a pore and a duct for each of the last three ambulatory appendages. It is possible that Arthropods had originally a pair of nephridia in each segment; in the Crustacea most of these are suppressed, but those of the second antennary segment and of the second maxillary remain, and with these three would help to fill up the series.

Of several thousands of common earthworms examined by Dr. Benham only one case of asymmetry has been observed. In this the genital orifices of the right side were on the 13th and 14th segments, instead of on the 14th and 15th as on the left side and in normal earthworms. On the right side there was only one spermatheca and two sperm-sacs, while the ovary was in segment xii. instead of xiii.; the calciferous gland was also absent from the right side of segment xii.

Mollusca.

Census of Scottish Land and Freshwater Mollusca.†—Mr. W. D. Roebuck summarizes the records of Land and Freshwater Mollusca which have so far been authenticated from Scotland; these records are comparatively small. In all 103 species are registered. This list should be very useful to Scottish naturalists.

* Ann. and Mag. Nat. Hist., vii. (1891) pp. 256–8 (1 pl.).
† Proc. Roy. Phys. Soc. Edinb., 1889–90 (1891) pp. 437–503.

γ. Gastropoda.

Anatomy of 'Hirondelle' Gastropods.*—M. E. L. Bouvier gives us the first of a series of studies on the Gastropoda collected during the voyage of the Prince of Monaco. He now deals with the relations of the arterial circulatory apparatus to the nervous system.

In the Prosobranchiata the aorta bifurcates almost immediately after leaving the ventricle; its posterior branch plunges into the viscera, while the anterior passes under the supra-intestinal branch of the visceral commissure; in the front part of the body it passes above the œsophagus, goes through the cerebro-pedal and pallio-pedal collars with it, and then divides into several branches unequal in importance.

In the Pulmonata—e. g. *Lymnæa stagnalis*—the visceral chain is elongated and its ganglia are well separated from one another; after reaching the anterior part of the body by passing above the œsophagus the anterior aorta passes below the visceral chain, then above the pedal commissure, and then divides almost as in the Prosobranchiata.

Very great differences are exhibited among the different representatives of the Opisthobranchiata. In *Bulla hydatis* the anterior aorta runs parallel to the right branch of the visceral commissure, and when it has reached the level of the pedal ganglion it gives off a cephalic artery, and then passes transversely in front of the great anterior pedal commissure. About the level of the middle of this commissure it gives off a labial and a buccal branch, and, then, on the left forms a cephalic and a recurrent pedal artery. *Scaphander lignarius* and *Philine aperta* show much the same relations. In *Aplysia* the anterior aorta passes under the right branch of the visceral commissure, above the "parapedal" and below the pedal and subcerebral commissures. Differences are again found in *Doris*, *Eolis*, and *Tritonia*.

Development of Paludina vivipara.†—Herr R. v. Erlanger finds that the mesoderm of *Paludina vivipara* begins to appear soon after the formation of the gastrula as a tubular outgrowth of the archenteron. This soon becomes constricted off from the gut, and takes on a semilunar form, in the cavity of which the gut lies. As the cœlomic sac gives rise to parietal and visceral lamellæ it surrounds the whole of the intestine. The mesoderm finally breaks up into the well-known spindle-shaped cells which traverse the cœlom in a very irregular fashion.

The pericardium is derived from the cœlom, and appears at first paired. Soon a small evagination of the wall is seen in the left portion, and a little later a somewhat larger one appears in the right. The latter forms the permanent kidney, while the former corresponds only to a rudimentary left kidney. The pallial cavity appears as a ventral ingrowth of the ectoderm just below the pericardium.

While these processes are going on all the organs found within the now formed shell undergo a change in position. Thus the pericardium, which was at first ventral and set perpendicularly to the long axis, passes altogether to the right half of the body. The heart is formed as an invagination of the hinder wall of the pericardium. This invagination forms an elongated groove, which soon becomes converted into a tube

* Bull. Soc. Zool. France, xvi. (1891) pp. 53–6.
† Zool. Anzeig., xiv. (1891) pp. 68–70.

which is connected anteriorly and posteriorly with the pericardiac wall, and remains open so as to allow of a communication between the lumen of the heart and the cœlom. The cardiac tube becomes very early constricted in its middle, the auricle appearing in the anterior and the ventricle in the posterior half. The blood-vessels are formed from lacunar spaces of the cœlom, which are inclosed by mesoderm cells. They soon become connected with the heart. All the ganglia are formed by delamination from the ectoderm, and arise independently of one another. The ventral ganglia appear in the velar area under the rudiments of the tentacles, and the buccal ganglia from the ectoderm of the œsophagus. The intestinal ganglia are formed on either side of the middle of the body, but are soon twisted, one above and the other below the intestine. The visceral ganglion is developed in the ectoderm of the pallial cavity.

The primitive kidney is formed on either side from a mass of mesoderm cells in which a cavity soon appears. The saccules grow out into a tube, one end of which reaches to the surface and breaks through the ectoderm. The opposite end becomes ciliated internally, but it is not certain that it has an internal orifice.

Anatomy of Corambe testudinaria.*—M. H. Fischer gives an account of the anatomy of this recently described species of Nudibranch. On account of the peculiarities which it presents, the author thinks it is more nearly allied to the Anthobranchiata than to the Polybranchiata; it has, however, some resemblances to the Phyllidiidæ.

The embryo, at the moment of extrusion, has the pigmented body which has been described in *Philine* as the anal eye.

Hepatic Epithelium of Testacella.†—M. J. Chatin has studied the minute anatomy of the so-called liver of *Testacella haliotidea.* He finds that the tubes of this organ are lined by large, depressed cells, intermediate in form between the cubical and the pavement cells. They vary in size, and have no proper membrane; a slight differentiation of the protoplasm can just be made out at their periphery. The protoplasm itself is reticulated and spongy, and between the bars there is a less refractive fluid substance in which there are granulations. Some of these last are brilliant and colourless, while others are yellowish or brownish.

Among these cells there are others which are smaller, have a large nucleus, and an almost homogeneous protoplasm; these appear to be young cells, ready to replace the older ones.

Intermediate stages can be made out between the flattened cells of the cæca, and the elongated cells of the canals of which the organ is composed; and this gland in *Testacella* may be cited as one which offers every intermediate stage between mosaic and palisade epithelium, which are usually regarded as profoundly different. The author concludes by insisting on the value of researches in Zoological Histology.

Heart of Dentalium.‡—Dr. L. Plate finds that Lacaze-Duthiers was in error in denying the existence of a heart in *Dentalium.* It is present,

* Comptes Rendus, cxii. (1891) pp. 504-7. † T. c., pp. 493-4.
‡ Zool. Anzeig., xiv. (1891) pp. 78-80.

though rudimentary, and is lodged in a special pericardium. It has the form of a rounded, thin-walled bag, and is not divided into two chambers. This simple structure, the complete absence of vessels with proper walls and of renopericardial orifices, are signs of degeneration. The heart is nothing more than a saccular invagination into the lumen of the pericardium of part of the dorsal pericardial wall. The blood-corpuscles enter the heart by narrow clefts, which lie between the stomach and the dorsal pericardial wall, and they leave it by similar spaces between the wall and the kidney. The minute structure of the wall of the heart is the same as that of the pericardium, and in both there are numerous muscular filaments set circularly and parallel to one another.

δ. Lamellibranchiata.

Blood of Lamellibranchs.*—Dr. H. Griesbach has investigated the blood of fifty-five bivalves with the following result. The red pigment of several (e. g. *Poromya granulata*, *Solen legumen*, *Tellina planata*, *Arca Noæ*, *Pectunculus glycimeris*) is hæmoglobin, or very nearly allied to it. The pigment is diffused in special disc-like or spherical cells which have a distinct membrane, a finely striated structure, a nucleus and nucleolus. The leucocytes are clear or granular, and consist of a spongy framework with more unstable material in the meshes. When alive they do not take up pigment injected into the blood, until they have lost their normal characteristics. In the intact cells there are no vacuoles. The unstable material forms long pseudopodia, which are insheathed for some distance by the firmer spongy substance. By these processes the leucocytes are never united to one another. The contractile substance is limited by a "plasma-membrane," which is readily affected by abnormal conditions. All the leucocytes have a distinct nucleus, which lies in a "free space," contains two chemically different substances, and has no definite reticulate structure, nor any nuclear membrane. No processes of division were observed. The blood of some Lamellibranchs contains crystals, which effervesce when an acid is added. The varied movements of the leucocytes as observed in artificial conditions are in great part the results of abnormal physical and chemical influences. When water enters the system the pigmented and unpigmented cells are abnormally affected—a fact which Griesbach uses as an argument against the supposition that water may enter the blood during normal life.

Lepton squamosum.†—The Rev. Dr. A. M. Norman has an interesting note on this Mollusc, which he shows to be a commensal. While digging at Salcombe he observed that wherever the long passages formed by *Gebia stellata* were still occupied by the living Crustacean, the *Lepton* was to be found near. The burrows of the *Gebia* are lined with an ochreous-coloured slimy deposit, upon which it is probable that *Lepton* feeds. The geographical range of the Crustacean and the Mollusc appears to be the same, and similar observations by Stimpson on the Floridan *Lepton loripes* confirm the view that we have here to do with a case of commensalism; as does also a specimen found at Puget Sound.‡

* Arch. f. Mikr. Anat., xxxvii. (1891) pp. 22–99 (2 pls.).
† Ann. and Mag. Nat. Hist., vii. (1891) pp. 276–8.
‡ T. c., p. 387.

The extraordinary compression of the shell of *L. squamosum* is now intelligible; it lies flat on the floor of the passage and is not injured or affected by the *Gebia* as it scuttles in and out.

Entovalva mirabilis.*—Under this name Dr. A. Voeltzkow describes a parasitic Lamellibranch found in the intestine of a *Synapta*. When removed from its host the creature moves about actively by means of its large foot, on which there is a small sucker; the shell is small, and the whole length is from two to three millimetres.

When the animal is extended, about one-third of the body is covered by the shell, and when it is irritated the whole of it cannot be drawn into this shell. The mantle incloses the shell-valves completely, is fused along the middle line in its lower part, and leaves only a small slit for the passage of the foot. At one end it is continued into a bell-shaped enlargement; this last has strong walls, is hollow interiorly and is only traversed by a few muscular fibres; like the foot, it is in constant movement. The author gives a few anatomical details as to various organs; the mollusc is hermaphrodite, and he has been able to observe some of the stages of development. No indications are given as to the systematic position of this endoparasite.

In a postscript there are a few notes on a Gastropod also found parasitic in the same species of *Synapta*; it would appear to be different from the parasitic species of *Entima* discovered by Semper.

Molluscoida.

α. Tunicata.

Blastogenesis of Astellium spongiforme.†—M. A. Pizon finds that the newly hatched larva possesses only two ascidiozooids, and not three as Giard described. The larva consists of the primitive oozoid with its sensory vesicle, a primary blastozooid, and a brown mass which Giard regarded as the intestine of a second blastozooid. But there is no trace of a second branchial sac; the brown mass diminishes and disappears within 24 hours after hatching; even after four days there are still only two ascidiozooids. This agrees with what Macdonald described in the closely related *Diplosoma Rayneri*, and with Lahille's description of *D. Koehleri*. The ectodermic tubes in the mantle of each ascidiozooid are not transformed into new individuals; the five or six blastozooids which Giard described on larvæ which had been fixed for seven or eight hours do not exist. A short diverticulum from the peribranchial membrane of the first blastozooid and a slight thickening of the peritoneal membrane were recognized as the two rudiments of the second blastozooid of the young colony.

Budding of Larva of Astellium spongiforme and Pœcilogony in Compound Ascidians.‡—M. A. Giard, referring to the work of M. Pizon on *A. spongiforme*, points out that he has failed to observe that in the Synascidiæ the development and number of blastozoites produced by one egg very often largely depends on etiological conditions. M. Giard has himself already insisted on this, and Lahille has given a striking

* Zool. Jahrb. (Abth. f. Systematik, &c.), v. (1891) pp. 619–28 (1 pl.).
† Comptes Rendus, cxii. (1891) pp. 166–8. ‡ T. c., pp. 301–4.

demonstration of it in *Leptoclinum Lacazii*, where ova of two kinds may be found in one colony.

The cases presented by Synascidians are not isolated in the Animal Kingdom; differences of development in *Aurelia aurita* have been observed by Haeckel and by Schneider; *Ophiothrix fragilis* may deposit eggs which give rise to perfect or imperfect plutei or even to embryos which cannot swim and which go through a direct development. Both the author and Dr. Boas have shown that the size and number of the eggs, and the rapidity of metamorphoses in *Palæmonetes varians* are not the same in northern salt as in southern fresh waters. And, finally, Portschinski has discovered that *Musca corvina* has completely different eggs and larvæ near St. Petersburg and in the south of Russia. These phenomena the author proposes to unite under the name of pœcilogony.

Development of Distaplia magnilarva.*—Dr. M. v. Davidoff now gives an account of the general developmental history of the germinal layers of this compound Ascidian. The various parts of his subject are dealt with in the following order:—I. Segmentation and Gastrulation: 1. The first three stages of segmentation; 2. Further segmentation-stages as far as the development of the Plakula-form; 3. Gastrulation and the formation of the fore-gut; 4. Comparative survey of the gastrulation of Ascidians—*a*. The relation of the gastrulation of *Distaplia* to that of other Ascidians; *b*. Remarks on the development of the bilateral plan of structure in Ascidians; *c*. On the relation of the axis of the gastrula to the body-axes in Ascidians; and *d*. Some remarks on Rabl's phylum of Vertebrates. II. Development of the mesoderm: 1. In *Distaplia*; 2. In *Clavillina Rissoana*; 3. In the simple Ascidians; 4. Comparative remarks on the origin of the mesoderm in Ascidians. III. On the formation of the gastric endoderm and of the chorda dorsalis: 1, 2, and 3 as in II. and 4. Comparative remarks. IV. On the development of the nervous system: 1. In Ascidians in general. 2. Comparative remarks on the nervous system of the Ascidians. V. On the separation of the tail-rudiment from the trunk.

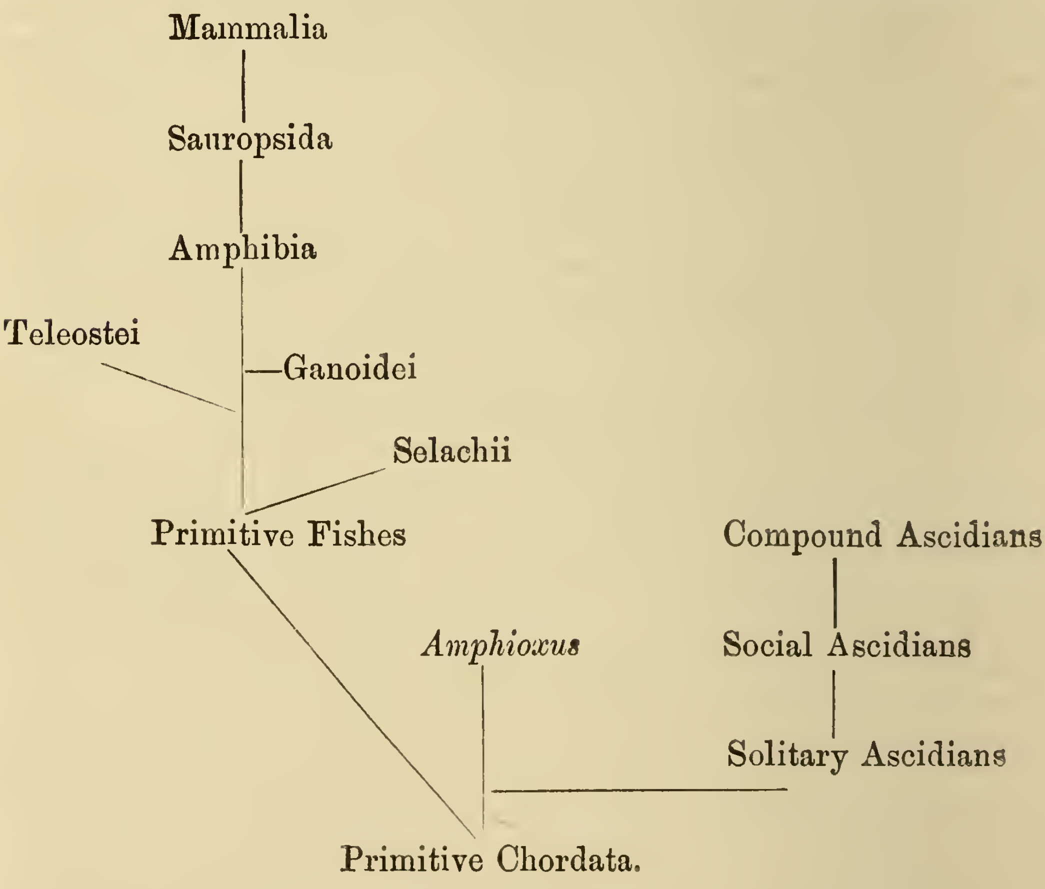
As far as the stage of four blastomeres segmentation in *Distaplia* is equal. The single asymmetrical phenomenon up till then observed is the excentric position of the cleavage-nucleus, which is retained unaltered in the nuclei of the first four cleavage-spheres. When the embryo becomes oval in form two endodermal cells remarkable for their small size may be seen at the hinder end; these are not only characteristic of the hinder end, but are the first rudiments of the nerve-ring.

After the completion of gastrulation the embryo remains for some time as a solid structure without any internal cavity. When a dorsal groove is formed its floor consists exclusively of endodermal cells. In simple Ascidians the early stages of development are of one type; cleavage is always equal and there is a more or less well-developed cleavage cavity which, sooner or later, becomes reduced to a cleft and, finally, completely disappears. The endoderm is formed by an invagination and leads to the formation of an archenteron, the primitively wide orifice of which (blastopore) narrows from before backwards in such a way that it disappears latest posteriorly. In social Ascidians there are

* Mittheil. Zool. Stat. Neapel, ix. (1891) pp. 533-651 (7 pls.).

conditions which approximate to the mode of development of compound forms (*Distaplia*); the cleavage cavity is greatly reduced, and may even be wanting; in consequence of this there is no true invagination, and emboly is converted into pseudemboly. The result of cleavage is a bilaminate plakula; the gastrula is formed by folding, the edges of the plakula rising up and growing towards one another; this pseudemboly is due to the unequal growth of the cells of the two germinal layers. In the development of compound Ascidians we go further, for the archenteric cavity is not formed either by emboly or pseudemboly but by delamination in the interior of the endodermal cell-complex. The overgrowth of the endoderm by the ectoderm in *Distaplia* is not effected in the same way along the whole length of the embryo; anteriorly it is purely epibolic, but posteriorly the dorsal endoderm-cells unite with the adjoining ectoderm-cells to grow round a space (pseudo-gastrula-pit) which is, later on, filled up by endodermal cells. This must be regarded as a rudimentary emboly which, notwithstanding its degeneration, typically repeats the conditions which obtain in social Ascidians. From this it is clear that the mode of development of Ascidians is parallel to the phylogenetic relations of their several orders.

Dr. v. Davidoff offers the following phylum of the Chordata:—



In the study of the development of the mesoderm the author finds it necessary to distinguish the mesoderm of the epibolic part of the embryo of *Distaplia* (pregastric mesoderm) from that of the pseudembolic portion (gastric mesoderm), The elements of the latter appear early, and are derived from ventral parts of endoderm-cells; they may be known as mother-cells or gonads of the gastric mesoderm. When pseudemboly is completed the mesoderm-gonads lie below the nerve-plate; posteriorly they take part in the formation of the chorda dorsalis. They give rise to mesodermal elements, but remain themselves true endodermal cells. The gastric mesoderm is developed bilaterally, and becomes divided into the somatic and caudal mesoderms. The latter persists as a solid rudiment and becomes converted into the muscular layer of the tail, while the former is gradually lost in the mesenchym.

The pregastric mesoderm arises much later from the cells of the pregastric endoderm that lie in front of the intestine; it becomes gradually converted into mesenchym-cells, which agree in all points with those of the gastric mesoderm. The somatic and pregastric mesoderm unite, finally, into a common tissue, the body-mesenchym. It is to be specially noted that no signs of segmentation are to be seen in the gastric mesoderm, and in the caudal there is no indication whatever of a cavity comparable to a myocœlom.

The history of development seems to show that neither *Amphioxus* nor the Ascidians are derived from ancestors which can be supposed to have been Enterocœlia.

The development of the medullary tube of *Distaplia* is not so simple as might have been supposed. Three parts have to be distinguished, two of which belong to the pseudembolic, and one to the epibolic region. Posteriorly, in the region of the future tail, elements of the nerve-plate enter into the formation of the medullary tube, but more anteriorly ectodermal cells form covering cells for the medullary tube, and only much later become differentiated into nerve-cells. From the epibolic portion of the embryo the medullary tube obtains an increase in material which forms the anterior wall of the future sensory vesicle, and is not developed in the ordinary way; the ectodermal cells multiply and give rise to a uni- or bilaminate rudiment, which is overgrown from the sides by ectodermal cells.

Amphioxus and the Ascidians are distinguished from Vertebrates by the fact that in the last the medullary plate closes from before backwards, and not in the opposite direction as in them. It is not yet quite clear which is the more primitive of these two modes of development.

β. Bryozoa.

British Species of Crisia.*—Mr. S. F. Harmer has come to the conclusion that the British fauna includes more species of the genus *Crisia* than are generally recognized; this result is based on a comparison of the ovicells, and especially of their apertures. He finds that the essential characters of the ovicells are extremely constant, in spite of the occurrence of variations of no inconsiderable magnitude in other parts of the colony.

The author thinks that it is necessary to pay careful attention both to the number of zoœcia in the individual internodes and to the character of the branching, and he has devised a method of graphic representation to show these points in each species.

C. denticulata Lamk., *C. eburnea* Linn., *C. aculeata* Hassall, *C. ramosa* sp. n. (from Plymouth) are diagnosed.

* Quart. Journ. Micr. Sci., xxxii. (1891) pp. 127-81 (1 pl.).

The author gives the results of his observations on the habit of the zoarium at different seasons, on regeneration, and on the mode of branching of the different species. At Plymouth the dominant species is *C. ramosa*, which is particularly fond of growing on stones. *C. eburnea*, which is also common at Plymouth, is always found on red seaweeds or on *Sertularia*.

Marine Polyzoa.*—The Rev. T. Hincks, in continuation of his contributions to a General History of Marine Polyzoa, describes some, chiefly South African, and with this concludes the first series of the "Contributions," so far as the descriptive portion is concerned. *Flustra nobilis* sp. n. is a handsome species, in which the zoœcia are of unusual size; when they are furnished with forked lateral spines their appearance is very picturesque. The genus *Adeonella* cannot be separated from *Adeona*. In *Mucronella aviculifera* sp. n. the avicularia are not only profusely present, but some are large and spatulate, while most are minute in size and mounted on the top of a calcareous column or erect spine-like process.

γ. Brachiopoda.

Development of Brachiopoda.†—Mr. C. E. Beecher points out that, so far as he has studied them, all Brachiopods have a common form of embryonic shell which may be termed the protegulum. It is semicircular or semi-elliptical in outline, and has no hinge area. The modifications exhibited appear to be due to accelerated growth, by which characters primarily neologic become so advanced in the development of the individual as to be finally impressed upon the embryonic shell. The structure of the protegulum has been described as corneous and imperforate. *Kutorgina* seems to preserve throughout its development the main features of the protegulum. The greatest departure from the normal is exhibited in the most variable and specialized valve, the pedicle valve.

Variation is also to be seen in the length and direction of the pedicle and in the position and structure of the pedicle opening. A long pedicle accompanies elongate shells with short hinges, while a short pedicle causes extended hinge-growth when the plane of the valves is ascending and vertical, but a discinoid form when the plane of the valves is horizontal.

The author proposes to divide the Brachiopoda into the Atremata, Neotremata, Protremata, and Telotremata.

Arthropoda.

Striated Muscles of Arthropoda.‡—Prof. O. Bütschli and Herr W. Schewiakoff have investigated afresh the minute structure of the transversely striated muscles of Arthropods. The objects of investigation was the thoracic muscles of *Scolopendra* sp. and *Lithobius forficatus*, the cephalothoracic and chelar muscles of *Astacus fluviatilis*, and the wing-muscles of *Lucanus cervus*, *Hydrophilus piceus*, and some other insects.

Every muscle-cell is found to consist of two different kinds of protoplasm—a contractile or fibrillar substance, which forms the contractile

* Ann. and Mag. Nat. Hist, vii. (1891) pp. 285–98 (2 pls.).
† Amer. Journ. Sci., xli. (1891) pp. 343–57 (1 pl.).
‡ Biol. Centralbl., xi. (1891) pp. 33–9.

elements, and of ordinary protoplasm in which these elements are imbedded, the so-called sarcoglia, sarcoplasm, and intermediate substance. The contractile elements are plasmatic columns or plates set in longitudinal rows in the muscle-cell; they are rounded or flattened in form. The sarcoplasm is plexiform, and generally irregularly so; it stains with difficulty. The nuclei imbedded in it vary in number, form, and size; they sometimes lie directly on the surface of the muscle-cell, and sometimes within it. The outermost layer of the sarcoplasmic network which forms the surface of the cell, exhibits a so-called alveolar layer; it is capable of being more deeply stained than the rest, and its higher refractive power gives rise to the so-called pellicula. This last may correspond to the sarcolemma of earlier authors.

The wing-muscles of all the Insects examined exhibit a still further complication. Spherical corpuscles are imbedded in the network; they vary greatly in form and size. In living muscle-cells they appear to be homogeneous, and are highly refractive; when fixed they have a fine plexiform structure, and stain almost as deeply as the muscle-nuclei. The finer structure of the contractile elements is also plexiform and complicated. The characteristic peculiarity of transversely striated muscle cells is the differentiation in a longitudinal direction of the framework of the contractile elements.

Comparing the results of the present writers with those of their predecessors it may be said that the "primary disc" corresponds to their two transverse rows of the anisotropic portion, while the two "isotropic discs" correspond to their two transverse rows of the isotropic portion; the "intermediate disc" is the boundary between two transverse rows of this portion, and the two "secondary discs" are the boundary-lines between every two opposed rows of anisotropic and isotropic parts. The transversely striated muscles of Vertebrates appear to have essentially the same structure as those of Crustacea.

α. Insecta.

Food of the Larvæ of Insects.*—Dr. D. Levi-Morenos has studied the contents of the intestinal canal of larvæ found in the marshes of the Piave, near Belluno. The larvæ belonged to the family of Culicidæ, to *Chironomus plumosus* or some allied species. The conclusion arrived at was that the food of these larvæ consisted almost entirely of diatoms belonging to the genera *Cymbella*, *Ceratoneis*, *Odontidium*, *Meridion*, *Navicula*, &c. This is contrary to the view of Lefevre, who describes the larva of this species as carnivorous. The author points out the importance of this question in relation to pisciculture.

Odoriferous Organs of Lepidoptera.†—Dr. E. Haase has studied the odoriferous organs in Indo-Australian Lepidoptera, and of his results F. Plateau gives a terse analysis. The odoriferous organs are either defensively repellent, as in some Danaids, or sexually attractive. In some Bombycidæ, as is well known, the females attract the males from long distances; in most cases the odour of the males is attractive to the females.

Some of the odoriferous scales occur on the wings. There they are

* Neptunia, i. (1891) pp. 7–11.
† Bull. Soc Entomol. Ital., xxii. (1891) pp. 138–43.

scattered in some diurnal Lepidoptera, but a localized arrangement is commoner. They lie on the upper surface of all the wings in *Heteronympha*. They often occur on the anterior wings only:—concealed by a costal fold in *Casyapa*, *Hecatesia*, *Aganais*, &c.; on the upper surface in *Ulysses*, *Peranthus*, *Argynnis*, &c.; on the under surface in *Bizone* and *Celerena*. Often they occur on the posterior wings only:—on the anterior margin in *Patula* and *Argiva;* on the upper surface in *Eronia*, *Ideopsis*, *Danais*, *Amathusia*, *Regadia*, &c.; on the abdominal or internal area, folded upwards in *Ornithopterus pompeus* and Papilionidæ, folded downwards in Morphidæ; on the lower surface in *Plecoptera*. Moreover in many Lepidoptera the parts of the wings which rub against each other in flight bear complex combinations of odoriferous scales and hairs.

But in *Chærocampa* the odoriferous organs are thoracic; in most Sphingidæ and Agaristidæ and in some Noctuidæ they are abdominal; in almost all Danaidæ and in many others they lie near the genital aperture. Finally, the organs may lie on the palps (in *Bertula*), or on the appendages, as in *Ismene*, *Caprila*, *Hyblæa*, and many others.

Development of Nervures of Wings of Butterflies.*—Dr. E. Haase has made an examination of the development of the neuration of *Papilio Machaon*. He finds that the so-called costa of the forewing is only a marginal thickening, but that all the other nervures are formed by tracheæ. The whole trunk of the latter becomes a concave or a branched convex nervure or some branches become convex and others concave nervures. The so-called convex folds in the middle cell of the wing are the remains of radial and median tracheal trunks, as van Bemmelen has already shown for the Nymphaliidæ. As in the Trichoptera three median trunks become convex nervures, but only the two most anterior cubital branches become convex nervures.

The nervures arise by the thickening of narrow membranous folds on each side of the wing over those tracheæ which become converted into nervures. The tracheæ themselves are single, but the cuticular structures which fuse into nervures are double. The closure of the primitively open wing-cells is effected by purely cuticular thickenings. The so-called costa of the hindwing is formed by the fusion of the subcostal with the first radial branch. The author is not inclined to accept the views of Adolph as to the morphology of the nervures of the wings of butterflies.

Effects of different Temperatures on Pupæ of Lepidoptera.†—Mr. F. Merrifield has been making experiments on the conspicuous effects on the markings and colourings of Lepidoptera caused by exposure of the pupæ to different temperature conditions. He finds that both the marking and the colouring of the perfect insect may be materially affected by the temperature to which the pupa is exposed. The markings are chiefly affected by long-continued exposure, probably previous to the time when the insect begins to go through the stages between the central inactive stage and emergence. Colouring is chiefly affected during the penultimate pupal stage, that is, before the colouring of the imago begins to show. A low temperature during this stage causes

* Zool. Anzeig., xiv. (1891) pp. 116-7.
† Trans. Entomol. Soc. Lond., 1891, pp. 155-68 (1 pl.)

darkness, while a high temperature has the opposite effect. In the species operated upon a difference between 80° and 57° is sufficient to produce the extreme variation in darkness caused by temperature. Dryness or moisture during the pupal period had little or no effect on the species used. If Prof. Weismann's theory that most existing Lepidoptera in Europe and North America have come to us from glacial times or climates is correct, icing the pupæ might assist us in tracing their evolution.

Larvæ of British Butterflies and Moths.*— Mr. H. T. Stainton has produced the fourth volume of the late Mr. William Buckler's account of the British Lepidoptera. In this volume part of the night-flying moths (Noctuæ) are described and figured in great wealth of detail.

Mistake of a Butterfly.†—Dr. R. Blanchard reports that one morning at 8·30 he saw a *Sphinx* fly into a deeply shaded room and examine the flowers on the carpet of the floor. Finding no success it tried those on the wall, and returned to the floor. The author was struck with the way in which the visitor avoided the representations of foliage, and he points out that this strange visit shows that the ordinary explanation that crepuscular plants are visited because of their odour is not completely satisfactory.

The Stinging Apparatus in Formica.‡—Dr. O. W. Beyer maintains that the stinging apparatus in *Formica* is a retrogressive modification of that possessed by *Apis*, *Vespa*, *Myrmica*, and other Hymenoptera. He bases his argument on a solid foundation, for he traces the development of the apparatus through eighteen stages in *Apis mellifica*, through fifteen in *Vespa vulgaris*, through eleven in *Myrmica lævinodis*, through eleven in *Formica rufa*. In all four, the essential parts of the apparatus, their arrangement and their relation to the surface of the body, and the succession of developmental stages are the same. From among the interesting facts which Dr. Beyer brings forward to show that the apparatus in question is retrogressive, not progressive, we may cite the correlation between the poison-gland and the sting. In *Apis* the sting is most complicated, the gland is simplest; in *Formica* the sting is reduced, the gland is very large; the other two genera, *Vespa* and *Myrmica*, are precisely intermediate. It seems most plausible that in the ancestors of *Formica* the sting ceased, for some unknown reason, to be very effective; there was the more need for abundant poison, and the gland grew; the muscles of the sting degenerated, those of the poison reservoir and the duct increased in strength.

Structure and Life-history of Encyrtus fuscicollis.§ — M. E. Bugnion describes this minute Chalcidian, which is parasitic within caterpillars, e. g. those of *Hyponomeuta cognatella.* In the abdominal cavity of the caterpillars he found a closed tube, inclosing the embryos and also the nutritive substance on which the larvæ feed. This tube seems to be formed by the ova themselves. The larva has an anus, though this is said to be absent in other entomophagous forms. When

* London, printed for the Ray Society, 8vo, 116 pp., pls. liv.–lxix.
† Bull. Soc. Zool. France, xvi. (1891) pp. 23–4.
‡ Jenaische Zeitschr. Naturwiss, xxv. (1890) pp. 26–112 (2 pls.).
§ Rec. Zool. Suisse, v. (1890) pp. 435–70 (2 pls.).

the store of nutriment is exhausted, the larvæ burst from the membranous tube into the perivisceral cavity of the caterpillar, where they feed on the lymph of their host. The essential organs are spared, and the caterpillar is apparently unaffected, until the parasites are about to undergo their metamorphosis. M. Bugnion begins to describe the anatomy of the larva, but his general results may be reserved until the publication of the complete memoir.

The Blood of Meloe and the Use of Cantharidine.*— M. L. Cuénot finds that the fluid which is exuded from the tibio-tarsal articulations of *Meloe proscarabeus* and similar insects is blood. It contains normal amœboid corpuscles, abundant fibrinogen which forms a clot, a pigment (uranidine) which is oxidized and precipitated when exposed to the air, a dissolved albuminoid (hæmoxanthine) which has a respiratory and nutritive significance, and finally, dissolved cantharidine. The blood is exuded when the insects are provoked or attacked, and is undoubtedly protective, for reptiles and carnivorous insects dislike it intensely. A mole-cricket on which some of the blood of *Meloe* was sprinkled was thereby saved for some days from the appetite of *Carabus*. The effectiveness of this defence compensates for the softness or incompleteness of the elytra in vesicating insects.

Moulting in Rhynchota.†—Dr. L. Dreyfus formerly shared the general opinion that the new bristles of moulting Rhynchota were made inside the old, and that the latter underwent a process of moulting. In his investigation of Phylloxerinæ he finds that the suctorial bristles are entirely thrown off in moulting, and that entirely new structures are drawn out of sacs which lie at the base of the old ones. In these sacs the new bristles are formed from the "retort-like organs."

Hemidiptera Hæckelii.‡ — Prof. N. Léon describes an interesting Ceylonese insect, which he at first mistook for a species of *Halobates*, but soon recognized as Dipterous. There are three simple eyes besides the compound pair; the wings are like those of Diptera; the mouth-parts resemble those of Hemiptera; but so many of the characters are neutral that Prof. Léon proposes to compound the names of the two orders in the generic title *Hemidiptera*, while the specific title records that of the discoverer. He describes the external features, and naturally wishes that he could do more.

Metamorphoses of Oxyethira.§ — Herr F. Klapálek describes the metamorphoses of *Oxyethira costalis* Curt. or *Lagenopsyche* Fr. Müller. The larva is Campodeiform, in form suggesting a queen-Termite. The head and thorax are relatively small; the abdomen is expanded. The mouth-parts and all the external features are described. The nymph is spindle-shaped, broadest about the first abdominal segment; the two sexes are approximately the same in size. Klapálek also describes the "house," how the larvæ close its openings and fasten it to the leaves of water-plants, how the nymphs rest within it, and so on, but the special

* Bull. Soc. Zool. France, xv. (1890) pp. 126–8.
† Zool. Anzeig., xiv. (1891) pp. 61–2.
‡ Jenaische Zeitschr. f. Naturwiss., xxv. (1890) pp. 13–15 (1 pl.).
§ SB. K. Böhm. Gesell. Wiss., ii. (1890) pp. 204–8 (1 pl.).

contribution which his paper makes is the detailed description of the larvæ and nymphs.

Development of Central Nervous System of Blatta germanica.*—Mr. N. Cholodkovsky has a preliminary notice of his observations on this subject. The nerve-groove is not continuous at first, but arises gradually by the union of separate small pits, which appear at the base of the developing extremities. It is continued forwards into two tentacular grooves. The supra-œsophageal ganglion arises from three pairs of rudiments, of which the first pair is pre-oral, the second lies on either side of the mouth, while the third is largely post-oral and forms the future optic lobes. The pre-oral and optic rudiments arise by delamination of the ectoderm, and are from the first covered by epithelium, while the adoral rudiments (which the author proposes to call the embryonic tentacular lobes) are for a long time naked. The ventral cords of the nervous system are also for a long time without any covering of epithelium.

After the dotted substance has become differentiated in the ganglionic rudiments the supra-œsophageal ganglion contains three pairs of aggregations of dotted substance corresponding to the three pairs of rudiments of which it is made up. It seems probable that the supra-œsophageal ganglion of all Insects is really made up of three ganglia, and thus, therefore, their head consists of at least six metameres.

Thysanura of Bohemia.†—Herr J. Uzel gives an account of these in a monograph which deals with seventy-six species, and describes twelve new species—two of *Smynthurus*, one of *Orchesella*, two of *Lepidocyrtus*, two of *Entomobrya*, two of *Isotoma*, and three of *Achorutes*.

γ. Prototracheata.

Peripatus Leuckarti.‡—In his additional notes on this interesting form, Mr. J. J. Fletcher calls attention to its existence in the midst of "the bleakness and winter snow of Mount Kosciusko," N.S.W. The prevalent colours of the species are indigo-blue and red, either of which may predominate; the former passes into black in some specimens, and the latter into orange or yellow. There is a median longitudinal dark linear stripe running down the back, in the middle of which is a fine microscopic, sometimes interrupted, line free from dark pigment. It seems no longer doubtful that constant specific characters are not derivable from the pattern and coloration of *P. Leuckarti*. The author adds some useful anatomical details.

δ. Arachnida.

Embryology and Phylogeny of Pycnogonids.§—Mr. T. H. Morgan has made a study of the embryology of *Tanystylum*, *Phoxichilidium*, and *Pallene empusa*. The differences exhibited by the last may be considered as being due to an abbreviation of what is seen in the second of these genera.

The author is of opinion that the Pycnogonids and Arachnids are

* Zool. Anzeig., xiv. (1891) pp. 115–6.
† SB. K. Böhm. Gesell. Wiss., ii. (1890) pp. 1–82 (2 pls.).
‡ Proc. Linn. Soc. N.S.W., v. (1890) pp. 469–86.
§ Studies from Biol. Lab. John Hopkins Univ., v. (1891) pp. 1–76 (8 pls.).

more closely allied than some later systematists have been inclined to allow. The mode of formation of the endoderm by a process of multipolar delamination is only seen in these two groups; the mode of origin of the stomodæum is the same in both, and the early formation of the body-cavity in the legs of Spiders has an exact parallel in *Pallene* and *Phoxichilidium.* In both groups, again, there are well-marked diverticula from the mid-gut into the legs, and in both the first pair of appendages is chelate.

There is a general resemblance between the Nauplius of the Crustacea and the larva of Pycnogonids, but the differences become greater and greater the more closely we examine the two forms; for example, none of the appendages of the Pantopod-larva are biramous, and the first pair is chelate. As to the affinities to the trochophore-larva, the author suggests that the Arachnids may have come from Annelid ancestors with many segments, and that the pantopod represents the most anterior segments of the adult Sea-Spiders, and, therefore, to some extent the anterior segments of Annelids or of the trochophore. But at no time in the ontogeny of the Pycnogonids have the trochophore and pantopod larvæ been transformed the one into the other, as Dohrn believes.

Mr. Morgan next gives a detailed account of the remarkable metamorphoses of *Tanystylum* which can hardly be made intelligible without figures.

In the third section of the paper the structure and development of the eyes of Pycnogonids are considered. All the evidence seems to show that the eye has developed by the turning in of two sides of a primitive optic vesicle, and that the simple eyes of Insects furnish all the intermediate stages, both in development and in adult structure, between a simple cup-like invagination and the three-layered condition of the Pycnogonid eye.

The development of this eye seems to have been abbreviated, and this shortening of the history complicates the matter; the presence of the eye in all the larval stages, in which it was presumably functional, must have changed to a very great extent the original process. Yet in all stages the three-layered condition of the eye may be recognized. The author thinks that in Pycnogonids the invagination (of the Arachnid type) has been retarded, so that, one end of the invagination having been formed, the inturned and inverted cells have functioned as larval eyes, and as the animal increased in size the invagination kept pace, adding more and more cells to the layers of the eye, so that all of the stages had presumably functional eyes, and at the same time the larva retained the original type of Arachnid invagination.

ε. Crustacea.

Bathynectes, a British Genus.*—Canon A. M. Norman reports that *Bathynectes*, a genus formed by Stimpson for certain Crabs nearly related to *Portunus*, is represented by two species in the British area; one, *B. superba*, has only been taken twice from 345 to 400 fathoms, but *B. longipes* appears to be much more common.

* Ann. and Mag. Nat. Hist., vii. (1891) pp. 274-6.

Embryology of Isopoda.*—Dr. J. Nusbaum gives a preliminary account of the results of his studies on the development of some marine Isopods taken at Concarneau.

Germinal Layers and Digestive Tract of Ligia oceanica.—In the earliest stage observed a layer of very finely granular protoplasm was seen at one pole of the egg; this occupied about a third of the periphery of the egg, and the whole of the rest was filled up with nutrient yolk. Only two oval, fine nuclei, which contained a number of chromatin granules, were observed in this protoplasmic layer; they may be regarded as the first products of the segmentation nucleus. In the next stage of development the layer extends itself more or less regularly over the whole periphery of the egg; the nuclei multiply and gradually extend through the layer. These blastoderm-nuclei elongate considerably before division; they appear to move about in amœboid fashion, as they are seen in sections to be provided with pseudopodia; these seem to be the objects which, in *Porcellio scaber*, Reinhard took for cells.

In the next stage of development a special layer of protoplasm becomes differentiated around each blastoderm-nucleus, and in this way a layer of blastoderm-cells is formed which becomes closely packed at that pole which corresponds to the future ventral surface and the hinder part of the embryo; this is the first sign of the germ-stripe. Somewhat later this spot becomes triangular in form and exhibits some signs of differentiation; the rest of the egg is formed of much-flattened cells, which are widely separated from one another; the blastodermal layer is several cells thick at various points, and some of the cells separate off and wander in the yolk.

The epithelium of the mid-gut and of the "hepatic" tubes is formed from two anterior aggregations of endodermal cells, just as in *Oniscus*. The salivary glands are evaginations of the stomodæum, and not of endodermal origin, as the author thought when describing *Oniscus*. It is important to note that the mesoderm arises from paired rudiments, as is the typical case in other Enterocœlia.

The Germ-stripe and the Extremities.—The author recognizes a stage corresponding to that of the Nauplius, and in the germ-stripes of this stage there are paired optic lobes and paired rudiments of the endoderm. The cells of that part of the germ-stripe that lies behind the third pair of extremities are regularly and segmentally arranged; at the hindermost, somewhat thickened and broader end there are some rows of closely packed and very regular larger cells, from which new segments are given off anteriorly. This segment-forming zone lies in front of what will be the anus; this last corresponds to the hinder part of the blastopore.

At a later stage there may be observed two optic lobes, two pairs of antennæ, a pair of mandibles, two pairs of maxillæ, and a pair of maxillipeds. The last and antepenultimate have two branches, while all the extremities of the mid- and hind-body are two-branched. In those of the mid-body the outer branch disappears later on. The cephalic nervous system is formed from two pairs of ectodermal thickenings which lie internally to the antennæ, while internally to all the other appendages are the rudiments of the ganglia of the ventral chain. Externally to all but the four foremost pairs of appendages there are

* Biol. Centralbl., xi. (1891) pp. 42-9.

paired thickenings of the ectoderm which occupy the same position as the stigmatic orifices in the germ-stripes of the Tracheata, and which are the rudiments of the lateral folds which serve to form the parts that correspond to the pleura.

Formation of Eggs in Testis of Gebia major.*—Dr. C. Ishikawa describes the hinder part of the testis of this Crustacean as having, to the naked eye, an undoubted resemblance to an ovary. In the anterior part or testis proper there extends, along its whole length, a germinal band in which young spermatic cells are to be found; the ripe spermatozoa are of nearly the same shape as those of *Gebia littoralis* described by Grobben.

In the hinder part of the organ there is still the germinal band, but its cells are differentiated into egg-cells of large size. At one point male and female cells lie among each other.

This condition of things obtained in all the twenty males examined; all the males are well characterized by secondary sexual characters, so that we have a new case of male animals producing in part the female elements. Here, as in the similar case of *Orchestia*, the eggs do not pass out of the generative organ; the author thinks that the eggs atrophy at certain seasons of the year.

Mediterranean and Atlantic Halocyprides.†—Prof. C. Claus gives an account of the genera and species of this group of Ostracoda, with notes on their organization. The chief anatomical characters of the family are the absence of the paired lateral and the trifid median eyes; the heart is short and saccular, with a hinder dorsal pair of clefts and an anterior arterial ostium, and lies above the stomach. At the commencement of the stomach there are two short, saccular, hepato-pancreatic tubes, which do not pass between the shell-fold. There is no anus, in consequence of the degeneration of the hind-gut. The paired gonads lie symmetrically and dorsally by the sides of the stomach. The male has a copulatory organ on the left side which is formed by the union of two metamorphosed appendages of that side. The copulatory orifice and the receptaculum seminis lie on the right side of the body of the female, and the egg-pouch on the left. The ova appear to be deposited separately.

The young, on emergence, appear to have their full complement of limbs, and only differ from sexually mature animals by the smaller size of the body and its extremities, and some unimportant points, such as the smaller number of furcal hooks; in some points the young male has the characters of the female.

The first subfamily is that of Conchœcinæ, in which are included *Conchœcia* Dana (*C. subarcuata*, *bispinosa*, *hyalophyllum*, *porrecta*, and *striata* spp. nn.); *Paraconchœcia* g. n. for *P. oblonga*, *spinifera*, *inermis*, and *gracilis* spp. nn.; *Conchœcetta* g. n. for *C. acuminata* sp. n.; *Conchœcilla* g. n. for *C. daphnoides* sp. n.; *Conchœcissa* for *C. armata* sp. n.; *Pseudoconchœcia* for *Conchœcia serrulata* Claus; *Mikroconchœcia* for *Halocypris Clausi* Sars. The second subfamily is that of the Halocyprinæ for *Halocypris* Dana (*H. pelagica* and *distincta* spp. nn.) and *Halocypria* Claus.

* Zool. Anzeig., xiv. (1891) pp. 70-2.
† Arbeit. Zool. Inst. Wien, ix. (1890) pp. 1-34.

Some notes are next given on the nervous system and sensory organs, the enteric canal and glands, the circulatory and respiratory organs, and those of reproduction.

The fact that the copulatory apparatus is formed from two rudimentary appendages of the left side shows that the Phyllopod-like stem-forms of the Ostracoda had a larger number of limbs, and that the number —seven—found in Ostracods is a reduction. It remains doubtful whether the same appendages have been retained in the various families.

Nervous System of Diaptomus.*—M. J. Richard has studied the nervous system of several species of this genus of Copepods, and finds them to agree in the characters now to be mentioned. The system is composed of a large supra-œsophageal ganglion united by two connectives with a subœsophageal ganglionic mass which is continuous with a ventral chain which is prolonged as far as the point of insertion of the fourth pair of limbs. The brain is an irregular mass formed of a central nucleus of dotted substance invested in a layer of cellular elements ; this layer varies in thickness at different points. A primary may be distinguished from a secondary brain ; the former consists largely of dotted substance, the latter is almost exclusively formed of nerve-cells. The nerves given off from the brain are those for the frontal organ, three for the eyes, two for the first pair of antennæ, and an azygos ventral branch which passes to the labrum.

The connectives of the œsophageal collar are very strong at their point of origin, and have nerve-cells scattered more or less over the whole of their outer side, but none on the inner : nerves are given off to the second pair of antennæ; a little lower a large nerve passes into the labrum; below, the two connectives are united by a transverse commissure.

The subœsophageal mass is formed of several ganglia and has the form of a band, wide anteriorly, which diminishes slightly in width at the level of the first maxillipede. There are three cellular swellings whence nerves are given off to the mandibles, maxillæ, and maxillipedes.

Between the first and second thoracic ganglia the ventral chain is reduced to a feeble cord, oval in section anteriorly and almost circular further back. These thoracic ganglia do not agree in the relations which they bear to the corresponding appendages. At the level of the fourth pair of limbs the ventral chain bifurcates at a ganglionic centre, whence nerve-trunks are prolonged into the abdomen, and which corresponds to a fifth ganglion. A rather large number of nerves is given off from the course of this ventral ganglionic chain.

Various parts of the nervous system exhibit regular lacunæ, which are continued through a long series of sections and are seen to form true canals which are, no doubt, destined to serve for the nutrition of the nerve-chain. The parts are enveloped in an extremely delicate neurilemma which is, at points, difficult to see. The author adds that he has never come across the "classical" nerve-cell with its abundant protoplasm ; all the cells were of the ordinary unipolar type.

A condition of things very similar to that of *Diaptomus* is to be found in *Heterocope saliens*.

* Bull. Soc. Zool. France, xv. (1891) pp. 212-8.

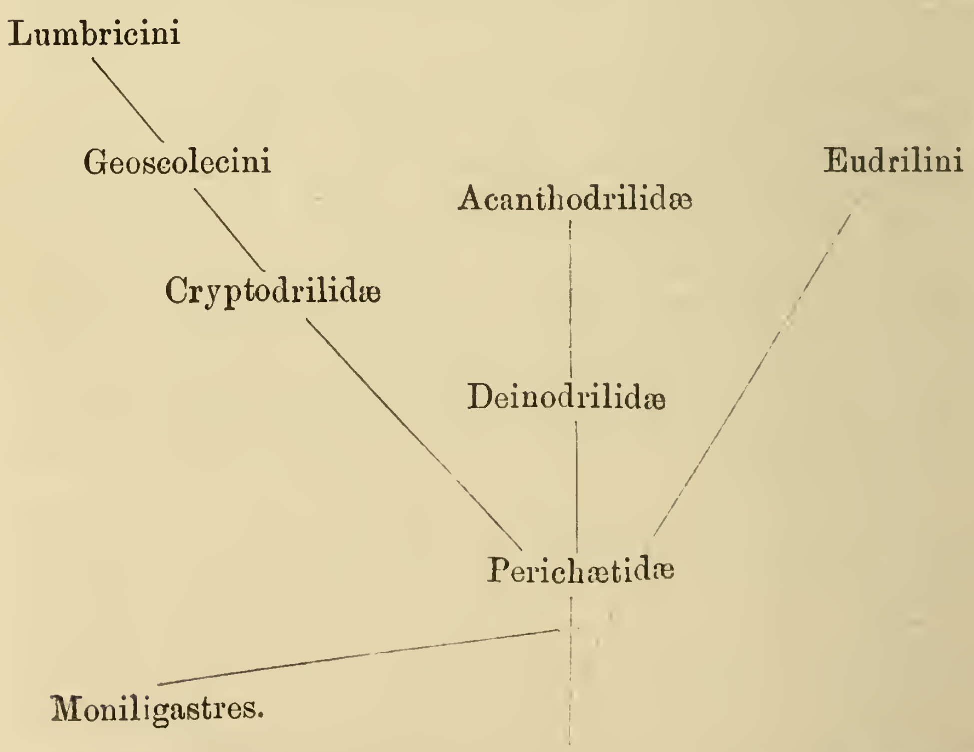
Males of Freshwater Ostracoda.*—M. R. Moniez states that, in collections brought from various parts of the world, he has not found the males of *Cypris* or of *Herpetocypris* to be rare as naturalists acquainted only with the European representatives of these genera would have supposed. He cannot find that the time of the year, climate, or salinity of the water are factors in producing males.

Vermes.

a. Annelida.

Classification and Distribution of Earthworms.†—Mr. F. E. Beddard commences his essay with a historical recapitulation of what has been done for the classification of earthworms by Perrier, Vejdovsky, Rosa, and others; the work of Rosa is critically considered, and the suggestion is made that the key to the classification of the group is to be found in the modifications of the excretory system. He associates those earthworms which have a nephridial system built upon the Platyhelminth type into one group, which is termed that of the Acanthodrilini, and which is divisible into the Perichætidæ, Cryptodrilidæ, Deinodrilidæ, and Acanthodrilidæ. The unique characters of the reproductive efferent apparatus requires the formation of a separate group for the Eudrilini. The family Lumbricidæ form the third group of Lumbricini. A combination of characters distinguishes the group Geoscolecini which contains the families Urochætidæ, Geoscolecidæ, and Rhinodrilidæ.

The relationships of the various divisions of earthworms may be indicated by the following table:—



The chief facts brought out by an examination of the distribution are, the author tells us—(1) The close resemblance between the Palæarctic

* Comptes Rendus, cxii. (1891) 669–72.

† Proc. Roy. Phys. Soc. Edinb., 1889–90 (1891) pp. 235–90 (2 maps).

and Nearctic regions, which necessitates their fusion into a Holarctic region; (2) the separation of Japan from the Palæarctic and its relegation to the Oriental region; (3) the great richness of South America and Australia in peculiar types; (4) the wide distribution of *Acanthodrilus* in the land masses of the southern hemisphere, which agree in the great abundance of species of this genus and comparative rarity of other forms; and (5) the marked difference between New Zealand and Australia.

Structure of New Earthworms.*—Mr. F. E. Beddard gives an account of the structure of two new genera of Earthworms belonging to the Eudrilidæ and coming from Lagos, West Africa. These new genera he calls *Heliodrilus* and *Hyperiodrilus*. As in other Eudrilidæ, and them only, the epidermis is furnished with peculiar organs which may be sensory; they have some resemblance to the Pacinian bodies of Vertebrates, and are scattered irregularly over the surface of all the segments except the first. There is only one pair of calciferous glands; in each of the tenth, eleventh, and twelfth segments there is a median diverticulum of the œsophagus; the epithelium of this is so folded as to present the appearance of a series of parallel tubes; the peripheral cells are excavated and form a ramifying system of ductules. There is no anterior gizzard, but there are six segmentally arranged gizzards at the junction of the œsophagus and intestine.

The supra-intestinal blood-vessel in the œsophageal region is inclosed in a special cœlomic compartment, which is almost filled by nucleated corpuscles. The male genital pore is single and median on segment xvii.; the "atria" are glandular and very long; there are no penial setæ, but in *Hyperiodrilus* there is a penis in the form of a hollow process of the body-wall. The ovaries are inclosed in special cœlomic sacs which communicate with the egg-sac, and are prolonged dorsally so as to entirely or partially inclose the single spermatheca which opens on the middle line. In *Hyperiodrilus* the perigonidial sacs form a ring round the œsophagus, and are connected with a dorsal unpaired sac.

Mr. Beddard has been able to examine some specimens of *Nemertodrilus* which may be referred to the Eudrilidæ for several reasons; the absence of certain characters ordinarily seen in Eudrilids is perhaps a sign of degeneration.

Structure of Deodrilus and Anal Nephridia in Acanthodrilus.†—Mr. F. E. Beddard describes an Oligochæte from Ceylon, which, on account of its intermediate characters, he calls *Deodrilus*; the species is *D. Jacksoni*. It is most closely allied to the Geoscolecidæ and Eudrilidæ as lately defined by Rosa. Like some of the former it has no prostomium; in the characters of its clitellum, &c., it is intermediate; the possession of ornamented setæ shows its affinity to *Rhinodrilus*; in the presence of a diffuse nephridial system it resembles certain genera of the Eudrilidæ. Concise definitions of the genus and species are given.

In a specimen of, apparently, *Acanthodrilus multiporus* tubes of precisely the structure of nephridia and communicating with the general system may be followed, through the lining epithelium of the

* Quart. Journ. Micr. Sci., xxxii. (1891) pp. 235-73 (5 pls.).
† Op. cit., xxxi. (1890) pp. 467-88 (2 pls.).

gut, into the lumen, into which they open. As there are anal nephridia in the Gephyrea and as many Arthropods are provided with gut-tubes—the Malpighian tubules—this discovery is of interest, and may prove to throw light on the origin of these last, which have, indeed, been already compared to nephridia.

Aquatic Earthworms.*—Mr. F. E. Beddard remarks that *Allurus tetraedrus* is not the only "earthworm" that has been found in water. Two freshwater species of *Acanthodrilus* have been found in the Falkland Islands.

Perichæta indica.†—Mr. R. Service has a note on the occurrence of this exotic species in hot-houses; he thinks an extensive search would show that it is of general distribution in British hot-houses kept at a high temperature.

Development of Vascular System in Annelids.‡—Dr. F. Vejdovsky discusses this subject with special reference to embryos of *Allolobophora fœtida*, *All. putra*, *All. trapezoides*, and *Rhynchelmis*, of which figures are given. The whole paper is, unfortunately, in Bohemian.

Phymosoma.§—Mr. A. E. Shipley, while describing a new species of *Phymosoma*, takes the opportunity of giving a synopsis of the genus and some account of its geographical distribution. *P. Weldoni* sp. n. is from Bimini Island, the Bahamas; the tentacles, of which there are from seventy to ninety, are distinguished from those of *P. varians* by the absence of the rows of skeletal cells which form so interesting a feature of the latter species. Their place is occupied by a well-developed fibrous connective tissue, which passes down into the base of the lophophore and is there continuous with the connective tissue which surrounds the œsophagus, and which serves as a point of attachment to the retractor muscles. The absence of hooks on the introvert is a marked feature of this new species. The blood-reservoir is much larger and the heart longer than in *P. varians*, and the latter organ becomes involved in the twisting of the alimentary canal, while its capacity is much increased by a number of small diverticula, which project as finger-like processes. The blood-corpuscles are either large clear cells with well-developed outlines, a well-stained nucleus and, apparently, no cell-contents, or smaller bodies with a protoplasmic body which stains well and a central nucleus.

The genus is divided into species that (I.) are without and (II.) have hooks; of the former four have four retractors and one (*P. Weldoni*) two; of the latter one has two, one three, and the rest (19) four retractors.

With regard to their geographical distribution, the existing body of evidence points to the Malay Archipelago as the head-quarters of the genus; with but few exceptions, it is only found in tropical seas, and the species have a preference for shallow waters. These latter facts may be explained by the fact that the animals only flourish in comparatively warm water. These conditions of temperature may be the

* Quart. Journ. Micr. Sci., xxxi. (1890) pp. 208-10. † T. c., pp. 390-8.
‡ SB. K. Böhm. Gesell. Wiss., ii. (1890) pp. 155-64 (1 pl.).
§ Quart. Journ. Micr. Sci., xxxii. (1891) pp. 111-26 (1 pl.).

cause of the association of specimens of *Phymosoma* with coral islands, but it is to be observed that several species make their homes in tubular holes burrowed in the soft coral rock.

β. Nemathelminthes.

Gordius tolosanus and Mermis.*—Dr. v. Linstow corroborates his discovery that the beetle *Pterostichus niger* is the host of the larval *Gordius tolosanus* Duj. As the pools in which the Nematodes are found dry up in summer, it seems that the beetles must repopulate them each spring. In the spring months the beetles fall into the pools and are drowned; from their bodies the nematodes pass into the water. Trout and some other fishes occasionally contain these parasites, which is readily explicable on the supposition that the fishes have devoured infected beetles. Meissner observed the larvæ of *Gordius tolosanus* boring into Ephemerid larvæ; it is perhaps in the Ephemerids that the parasites leave the pools and are eaten by beetles. The life of this nematode is annual. The sexual union, which Meissner observed, may take place in April; the females deposit the eggs in snow-white strings on the stems of water-plants; the development is completed in about four weeks. The structure of the larva is described, and von Linstow adds some details to his previous account of the adults. He also reports his discovery of the larvæ of *Mermis crassa* in the aquatic larvæ of *Chironomus plumosus*. In *Hyalina cellaria*, the larva of *Mermis Hyalinæ* was found, a fact of interest since only two other instances of Molluscs as hosts of *Mermis* are on record.

Arabian Nematodes.†—Mr. N. A. Cobb has collected more than two hundred marine Nematodes from the coast of Arabia, among which seven distinct species have been recognized; all may be referred to genera known to inhabit Atlantic waters. The author proposes a system of formulæ which reads thus for a species of *Oncholaimus*:—

$$\frac{1\cdot\quad 8{\cdot}2\cdot\quad 17{\cdot}2\cdot\quad 52\cdot\quad 93{\cdot}3}{\cdot 9\quad 1{\cdot}5\quad 1{\cdot}6\cdot\quad 1{\cdot}7\quad \cdot 8}\,1{\cdot}77 \qquad\qquad \frac{\cdot 8\quad 8\cdot\quad 16{\cdot}6\quad \mathrm{M}\quad 94{\cdot}1}{\cdot 8\quad 1{\cdot}3\quad 1{\cdot}4\quad 14\quad \cdot 8}\,1{\cdot}85$$

These numbers refer respectively to the pharynx, nerve-ring, base of neck, vulva, and anus; M stands for male; the numbers above the horizontal line relate to longitudinal and those below it to diametral measurements. Reading the formula from left to right reads off the dimensions of the animal from head to tail. The peculiarity of the formula is that the unit of measurement is not absolute but relative, being nothing else than the hundredth part of the length of the worm itself. The absolute length of the animal expressed in millimetres is put to the right. Mr. Cobb urges various recommendations for this formula, and expresses a belief that by averaging the specific we may get a generic formula. The seven new species found are fully described.

Echinorhynchus polymorphus and filicollis.‡—Prof. M. Braun gives reasons for thinking that *E. filicollis* Rud. is not, as is now generally

* Arch. f. Mikr. Anat., xxxvii. (1891) pp. 239–49 (1 pl.).
† Proc. Linn. Soc. N.S.W., v. (1890) pp. 449–68.
‡ Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 375–80.

supposed, a synonym of *E. polymorphus* Brems. Externally they may be distinguished by the smaller size of the latter, and its constant orange-red colour, while the female of *E. filicollis* is yellowish-white and the male whitish. There are also important internal differences.

γ. Platyhelminthes.

Connecting Canal between Oviduct and Intestine in Monogenetic Trematodes.*—Mr. S. Goto is able to confirm the statement of Ijima that a peculiar canal connects the oviduct with the intestine in some ectoparasitic Trematodes. The canal which Zeller calls Laurer's canal in *Diplozoon* is evidently this structure; the vas deferens of one individual of this twin-form distinctly opens into the yolk-duct of the other.

The Holostomidæ.†—Dr. G. Brandes gives a monographic account of this family of Trematodes, the known species of which are not very numerous. They are all characterized by the presence, below the ventral sucker, of a structure which divides the body into an anterior and a posterior region. The simplest form is that of a lamella; in some the anterior end becomes spoon-shaped, and this passes through various stages of complication to that of a cup. The anterior and posterior halves of the body are very rarely set in the same plane.

With regard to the food of these internal worms there is reason to suppose that they are not simply contented with what falls from the plate of their host, but that they are aggressively parasitic; they are not confined to the small intestine, but are also found in the rectum and bursa Fabricii, where the supply of food is not so abundant. The possession by them of holding organs supports this view. In, for example, *Hemistomum cordatum*, a parasite of the wild cat of Brazil, the ventral sucker is greatly reduced, but an attaching apparatus is enormously developed, and has connected with it a complex of glands. This attaching organ may be formed on one of two types, both of which are described in detail. The digestive organs are also described.

The male and female organs are united in the same individual, and the whole generative apparatus is characterized by the position of the efferent ducts at the hinder end of the body, while the uterus is only slightly coiled.

Less constant characters are the position of the ovary between the two testes, and the separate course of the duct of Laurer. The whole generative apparatus is always placed in the hinder part of the body. Here, again, full details are given. Some additions are made to our knowledge of the water-vascular system.

No previous author seems to have reported on the nervous system of these worms. In young stages of *Hemistomum* Dr. Brandes has, after treatment with osmic acid, seen the central mass of the nervous system lying on the lower part of the pharynx. Inferiorly two strong processes could be traced for some distance, while superiorly there branched off a pair of very short and delicate processes. In sections nervous elements have been observed in the parenchyma of the anterior end of the body.

* Zool. Anzeig., xiv. (1891) pp. 103–4.
† Zool. Jahrb. (Abth. f. Systematik &c.), v. (1890) pp. 549–604 (3 pls.).

Little is as yet known as to the details of the developmental history of these worms.

In the second or systematic portion of his work, the author, after some preliminary observations, defines the family Holostomidæ, which he divides into (1) the Diplostomeæ, with much flattened fore-bodies, and containing *Diplostomum* (with four new species) and *Polycotyle*; (2) the Hemistomeæ, in which the sides of the fore-body are curved round, and containing *Hemistomum* (with fourteen species, one of which is new); (3) the Holostomeæ, in which the fusion of the lateral edges of the flattened fore-body has led to the formation of a cup; in this are included the twenty-eight known species of the genus *Holostomum*, some of which are now for the first time described.

Anomaly of Genital Organs of Tænia saginata.*—Dr. R. Blanchard calls attention to a curious inversion of the genital organs of this Cestode. A segment about the 750th, situated between two normal joints which contained a large number of testicular vesicles but in which the uterus had already numerous lateral ramifications, was found to be larger than its neighbours; there was some trace of an aborted intercalated ring; on either side was a marginal pore. Of these, that on the right side was related to a complete hermaphrodite apparatus, which presented all the usual characters; the apparatus, however, which was connected with the left pore had a normal unpaired ovarian lobe, two feebly developed lateral lobes, and a normal body of Mehlis. With this latter was connected a vagina which was curved from behind forwards and was accompanied by an efferent canal of normal aspect.

δ. Incertæ Sedis.

Bohemian Rotifera.†—Herr F. Petr gives a list of Rotifera from Bohemian highlands. He enumerates eighty species including two new forms, *Floscularia diadema* and *Rattulus antilopæus*.

Galician Rotifers.‡—Dr. A. Wierzejski gives a list of fifty species of Rotifera found in Galicia. *Brachionus forficula* is a new species, and varieties of *Polyarthra platyptera*, *Schizocerca diversicornis*, and *Brachionus dorcas* are described.

Echinodermata.

Echinoderms of Ceylon.§—Prof. H. Ludwig reports on a small collection of Echinoderms from Ceylon, six of which are now recorded for the first time from the shores of that island. The most interesting of the observations are, however, on an already recorded species *Ophiomastix annulosa*. The dorsal knob-like spines were found to differ in minute structure from the ordinary arm-spines, for their epidermis was very much thicker and was very richly supplied with nerves. On this point Hamann has already made some observations and has suggested that some of the cells are sensory. Prof. Ludwig would rather regard these as supporters to the glandular cells, but it is obvious that the question is not one that can be settled on spirit specimens.

* Bull. Zool. Soc. France, xv. (1890) pp. 166–8.
† SB. K. Böhm. Gesell. Wiss., ii. (1890) pp. 215–25 (2 figs.).
‡ Bull. Soc. Zool. France, xvi. (1891) pp. 49–52 (4 figs.).
§ SB. Naturhist. Ver. Preuss. Rheinland, xlvii. (1890) pp. 98–105.

Perisomatic Plates of Crinoids.* — Messrs. C. Wachsmuth and F. Springer consider that the plates of a Crinoid fall naturally into two categories, the primary and secondary or supplementary plates. The primary form the fundamental part of a Crinoid, while the supplementary pieces serve to fill up spaces. The former may be separated into two classes: those developed on the right antimere, which, in one way or another, are related to the axial nerve-cords, and those developed on the left antimere and connected with the mouth or the annular vessel around it. To the first class they refer the stem-joints, basals, underbasals, radials, all brachials, whether fixed or free, and the plates of the pinnules; to the second the orals and all plates of the ambulacra to the end of the pinnules. The remaining plates are supplementary, and, in the opinion of the authors, neither strictly actinal nor abactinal.

Messrs. Wachsmuth and Springer would apply to all plates interradially disposed in the calyx the term interradials, and use interbrachials as a general term for all plates between the rays above the radials; the terms "interdistichals," "interpalme[a]rs," and "interambulacrals" explain themselves. They conclude with a criticism of some of the recent work of Mr. F. A. Bather.

Ovary of Ophiurids.†—Sig. A. Russo has studied the disruption and renewal of the ovarian parenchyma in *Ophiothrix fragilis*, *Ophioderma longicauda*, and *Ophiomixa pentagona*. The germinal vesicle and spot become hyaline or colloid, or, rarely, undergo fatty degeneration and chromatolysis. The vitellus and vitelline membrane also degenerate. Meanwhile, however, there is a process of regeneration, in which fresh elements are formed from follicular cells.

Revised List of British Echinoidea.‡—Mr. W. E. Hoyle has prepared a list of British Echinoids, giving some synonymy, brief definitions of genera and species, and the distribution in British seas and elsewhere. Twenty-nine species are recognized as British; Forbes, it will be remembered, enumerated only twelve. The general classification followed is that of Prof. Duncan.

Anatomy of Synaptidæ.§—Prof. H. Ludwig and Herr P. Bartels have investigated the anatomy of these Holothurians. They find that adult Synaptids have no radial water-canals. In all cases they found the radial nerve accompanied by an epineural space above, and below by a pseudhæmal space, but there were no signs of any water-vessel. As they are found in the young this reduction helps to support the view that the Synaptidæ cannot in any way be considered as primitive forms of the Holothurioidea. The semilunar valves of the tentacular canals were found, under similar conditions, in all the forms examined. Auditory vesicles were also always present; a pair is found on each radial nerve, at the point where the nerve emerges from the radial piece of the calcareous ring; they are either supplied by a short branch of the radial nerve, or they are placed directly on it. The so-called eyes of *Synapta vittata* are undoubtedly sensory organs; each pigment-spot has an en-

* Proc. Acad. Nat. Sci. Philadelphia, 1890, pp. 345–92 (2 pls.).
† Zool. Anzeig., xiv. (1891) pp. 50–9 (15 figs.).
‡ Proc. Roy. Phys. Soc. Edinb., 1889–90 (1891) pp. 398–436.
§ Zool. Anzeig., xiv. (1891) pp. 117–9.

largement of the tentacular nerve, which is distinguished by the presence of a large group of transparent sensory cells, surrounded by pigment; the whole group is invested by a pigmented layer. In *S. orsinii* each tentacular nerve gives off a short nerve-branch, the end of which enlarges into a spherical ganglionic structure. It may be supposed that the paired pigment-spots known to exist in *S. lappa* and *S. vivipara* are sensory organs. The fibrous bundles which are inserted into the inner side of the wheels of species of *Chiridota* arise from a mass of connective tissue common to the whole wheel-papilla, and consist of six fibres of equal thickness.

Fission of Cucumaria planci.*— Mr. H. C. Chadwick observed an adult *Cucumaria planci* become motionless and so remain for two days; it then became much attenuated in its middle, and the rupture which ensued and slowly elongated brought the intestine into view. The two ends snapped asunder, and the anterior slowly crawled onwards. The projecting intestine eventually decomposed. A fortnight afterwards the posterior half had a new mouth and a circlet of minute tentacles. In six weeks the author's three specimens were increased to seven, and a large number of ova had also been deposited.

Cœlenterata.

Organization and Development of Anthozoa.†—M. P. Cerfontaine has a preliminary notice of the results of his studies on various Anthozoa. He has studied the development of the twelve first septa in *Cereactis aurantiaca;* he finds that the laws of their appearance are identical with those recently formulated for *Manicina areolata* by Wilson. In young larvæ there is only one pair of septa, which divide the cavity into two unequal chambers; the second pair soon appears in the larger chamber, and the third in the smaller. The fourth, contrary to the statement of Lacaze-Duthiers, appear in the space bounded by the septa of the second formation, and not between the first and second septa.

The development of the sarcosepta of *Asteroides calycularis* has been investigated. After the first twelve sarcosepts have become united by their inner edge to the œsophagus, four new pairs, and then two others appear; they become of the same size as the first six pairs, and also become united with the œsophagus. Finally, twelve new pairs are developed between the first twelve, and bring the number of sarcosepts up to forty-eight; these last attain a full development, but do not unite with the œsophagus. The author was enabled to completely follow the course of development of the tentacles in *A. calycularis*, and he finds the order of the appearance as described by Lacaze-Duthiers for *Actinia mesembryanthemum.*

Cerianthus oligopodus is a new species from the Mediterranean, distinguished by the smaller number (19) of marginal tentacles from any one of the three species already recorded from that sea.

Alcyonacea of Bay of Naples.‡—Dr. G. v. Koch gives an account of the Alcyonacea of the Bay of Naples. He arranges them in three

* Trans. Liverpool Biol. Soc., v. (1891) pp. 81–2 (1 pl.).
† Bull. Acad. Roy. de Belgique, lxi. (1891) pp. 25–39 (2 pls.).
‡ Mittheil. Zool. Stat. Neapel, ix. (1891) pp. 652–76 (1 pl. and 28 figs.).

families: the Cornulari[i]dæ, in which the polyps are connected with one another by stolons or stolon-plates, and are all of much the same length when fully developed; in the other families—the Alcyoni[i]dæ and the Scleraxonidæ, the polyps are connected with one another by branched tubes, which rise to various heights, and have their walls fused into a common mass. The polyps may be very unequal in length. In the Alcyoniidæ the spicules are separated from one another, while in the Scleraxonidæ they are united into continuous skeletons, either by horny substance or by crystalline calcareous excretions.

Cornularia, *Clavularia*, and *Rhizomenia* are the recognized genera of the Cornulariidæ; *Alcyonium*, *Daniela*, *Cercopsis*, and *Paralcyonium*, of the Alcyoniidæ, and *Corallium* of the Scleraxonidæ.

Clavularia Marioni is a new species; *Daniela Koreni*, new genus and species, and *Cercopsis Studeri* is a new species.

Fissiparity in Alcyonaria.*—Prof. T. Studer calls attention to an Alcyonarian allied to *Gersemia*, and collected by the Prince of Monaco, which shows that fission does occasionally occur among the Alcyonaria. The specimen, unfortunately, is unique, and the author has had to content himself with a superficial examination.

Development of Arachnactis and Morphology of Cerianthidæ.†—Prof. E. van Beneden reminds us that Kowalevsky has shown that the endoderm of *Cerianthus* is formed by invagination, and that this Anthozoon passes through the gastrula-stage. The pharyngeal tube is formed by the pressing back of that part of the wall of the body which immediately surrounds the wall of the gastrula. This is effected in such a way that two endodermic cæca are formed, one on either side of the pharyngeal tube. This latter is flattened and has two surfaces and two edges; the former correspond to the cæca, while the edges are united to the wall of the body. Each cæcum soon divides, by the formation of a partition which unites the wall of the body to the lateral surface of the pharynx, into two chambers. At this time the first two pairs of tentacles have appeared, and they correspond to the first four mesenteric chambers. These results cannot be reconciled with those of Boveri, who makes no mention of Kowalevsky's results; in this Prof. van Beneden thinks he has erred, as his own studies of *Arachnactis* will show. The present observations made on *Arachnactis albida* demonstrate that, at the stage of development which is characterized by the presence of two pairs of tentacles, there are no signs of median chambers; the larvæ have, at the level of the pharynx, two cavities divided into four symmetrical mesenteric chambers. The appearance of these cavities is probably the consequence of the mode of formation of the pharynx and the primitive form of this organ. The pharynx forms a complete partition which separates the right from the left cavity. In the Hexactinaria and Hexacoralla it is different—in them the pharynx from the first occupies the axis of the ovoid larva; their pharynx does not divide the cœlenteric cavity into two lateral parts, and that cavity is undivided.

The first pair of mesenteric septa are transverse in *Arachnactis*, and to the mesenteric cavities there correspond the first two pairs of marginal

* Bull. Soc. Zool. France, xvi. (1891) pp. 28–30.
† Bull. Acad. Roy. de Belgique, lxi. (1891) pp. 179–214 (4 pls.).

tentacles. The antero-median and postero-median chambers become hollowed out in cellular buds which depend from the endoderm. The posterior chamber and the septa which bound it are only just anterior in development to the directive chamber and septa. The succeeding septa are formed in pairs and in the form of folds of the endoderm, in the postero-median chamber. These folds first arise on the neural surface. The two septa of a pair do not arise simultaneously, but successively, the left one being always in advance.

Each new pair of septa arises behind that just formed, with the exception of the directive septa which appear a short time after the septa of the second pair. No trace of longitudinal muscular fibres can be found in the directive or the other septa. On the other hand, a layer of ectodermal muscular fibrils appears early in the wall of the body. It follows from this account and the description of Kowalevsky, that the larvæ of Boveri are not the larvæ of a Cerianthid; the conclusions to which he has come as to the phylogeny of the group depend, therefore, upon an error of interpretation.

The development of Cerianthids differs *ab initio* from that of the Hexactinaria, though certain resemblances are to be seen between them; we cannot suppose that the Cerianthidæ, in the course of their development, pass through an *Edwardsia*-stage. *Edwardsia* has muscles in the septa which are wanting in *Arachnactis*.

Protozoa.

Notes on Ciliated Infusorians.*—M. Fabre-Domergue gives an account of *Lagynus lævis* Quenn. It is extremely flexible and contractile, bending before obstacles and contracting suddenly at the least cause for alarm. It varies extremely in form, and the colour varies with the degree of repletion or emptiness of the individual. It often feeds on prey of enormous size, which it swallows after dilating its buccal orifice to a considerable size. It multiplies abundantly by division in a cyst; this cyst is rounded and has a fine, structureless, and colourless envelope; the contents are granular and opaque in consequence of the presence in the endoplasm of a large number of refractive granules.

Frontonia marina sp. n. was found among putrefying Algæ at Concarneau. The trichocysts of living specimens appear like small, dark, highly refractive dots when seen from in front; from the side they look like rods slightly swollen in their middle, and set almost perpendicularly to the surface of the endoderm. When treated with ammonia, after fixation with osmic acid, they increase considerably in all directions, and lose their characteristic refrangibility. When protruded the trichocysts form long filaments like those of *Paramæcium aurelia*.

Fabrea salina.†—Under this name M. L. Henneguy describes a new Heterotrichous infusorian found at Croisic. It is from 0·45 mm. to 0·13 mm. long, with a pyriform body, the anterior end of which is deeply excavated and carries the peristome. It is violet or greenish black in colour. The peristome is elongated and directed from left to right. It is remarkable for a well-defined pigment-spot which is found

* Ann. de Microgr., iii. (1891) pp. 209–19 (1 pl.).
† Op. cit., 1890, pp. 118–35 (1 pl.).

in the region of the rostrum. The cilia are numerous and long in all parts of the body. There is a terminal anus, and no contractile vacuole. This new generic type has affinities with *Stentor*, *Bursaria*, and *Climacostomum*, and may be placed near this last among the Stentorinæ.

New Pelagic Zoothamnium.*—Dr. G. du Plessis calls attention to a pelagic species of *Zoothamnium*, fine colonies of which are to be found off Villefranche. They never become, even temporarily, fixed. Like other pelagic forms they are absolutely transparent, swim incessantly, and die rapidly in captivity. They are in the form of a star with from four to twelve rays; each ray is a miniature tree, and the branches of the second and third order carry elegant Vorticellids on very long stalks. Along the free edge there are immense cilia which are as long as the whole body. This peristome describes several spiral turns, and near the mouth there is a strong membranella.

A few forms are sessile; these are larger and their peristomial cilia are shorter than in the rest; these are the macrogametes which are characteristic of the genus *Zoothamnium*.

Contraction and extension are very sudden, and it is because of these movements that these transparent creatures are detected. They are best killed by a drop of glacial acetic acid, added at the moment of extension. They may be coloured by methyl-green and mounted in glycerin. In specimens so prepared the ribbon-shaped nucleus may be detected. Dr. du Plessis proposes to call this new species *Z. pelagicum*.

Estuarine Foraminifera of Port Adelaide River.†—Mr. W. Howchin reports the presence in this area of fifty-one species, belonging to fifteen genera. The fauna, as a whole, is characteristic of shallow water and a temperate climate. Two-thirds of the forms are living in British waters, while nearly all the rest are Australian or sub-tropical species. The most interesting are the nine arenaceous species. The rare *Trochammina inflata* occurs in considerable numbers high up the stream; the still rarer *Haplophragmium cassis*, previously known only from a few points on the borders of the Arctic circle, is not uncommon in some portions of the river. *Rheophax nodulosa* is also a characteristic cold water species, living at abyssal depths, where the temperature is low, and reaching its greatest development in size in Arctic and Antarctic waters. *R. findens* is a very rare species, hitherto known from two localities only, one of which is the Gulf of St. Lawrence.

New Sporozoa.‡—M. P. Thélohan describes two new sporozoa, from the muscles of *Cottus scorpio* and *Callionymus lyra*. They resemble the parasite which Gluge described in the skin of the stickleback, a form which M. Thélohan proposes to call *Glugea microspora* g. et sp. n., and also that which Henneguy found in *Gobius albus* and in *Palæmon rectirostris*.

Sarcosporidia.§—Sig. A. Garbini has found in the muscles of *Palæmonetes varians* a Sarcosporid closely resembling but not identical with the form which Henneguy discovered in *Palæmon rectirostris*. Instead of

* Zool. Anzeig., xiv. (1891) pp. 81–3.
† Trans. Roy. Soc. South Australia, xiii. (1890) pp. 161–9.
‡ Comptes Rendus, cxii. (1891) pp. 168–71.
§ Atti R. Accad. Lincei—Rend., vii. (1891) pp. 151–3 (1 fig.).

being confined to Mammals, Sarcosporidia are now known to occur in the lizard, tortoise, and frog, and in the two Crustaceans mentioned above.

Conjugation and Spore-forming in Gregarines.*—Herr M. Wolters has studied *Monocystis agilis* and *M. magna* of the earthworm, *Clepsidrina blattarum* of the cockroach, and *Klossia* of the snail. In *Monocystis*, conjugation of living forms was observed. Peculiar changes in the form of the nucleus and an increase in the number of nucleoli are regarded as preparatory steps. The characteristic granules do not contain fat or lime-salts, but seem to be amyloid reserve-products. A cellular mesh-work may be demonstrated by the use of reagents, but Wolters regards it as an artificial coagulation. The cyst of two conjugating individuals is sometimes surrounded by a membrane produced by the cells of the host. The nucleus of each unit forms a spindle; half is extruded as a "directive body"; a reconstruction takes place; a second sheath round the encysted pair becomes demonstrable; fusion takes place, both nuclear and cytoplasmic; the nuclei seem to separate again; then two spindles are seen in each half; then many spindles around the periphery. Each peripheral nucleus eventually becomes the centre of a sporogonium within which eight spores are formed around a residual core, the whole being surrounded by a sporocyst or pseudonavicella-sheath. The central body of the original cyst is gradually used up by the sporogonia. The development is the same in both species. Wolters describes some of the histological characters of *Clepsidrina*, especially in regard to the cuticle and its striæ. As in *Monocystis*, the nucleus changes its form and becomes stellate, while the chromatin elements also vary greatly at different stages. The conjugation and spore formation are briefly described, and the results corroborate those of Bütschli. The stellate stage of the nucleus in *Klossia* seems to be a preparation for division. Typical spindles like those of *Monocystis* were not demonstrable. Within the sporogonium there are often six spores, lying around a sporophore which gradually diminishes. Conjugation does not occur.

Parasitic Protozoid Organism in Cancer.†—Dr. Nils Sjöbring observed in sections of mammary cancer numerous peculiar bodies which appeared to represent different stages of development of a micro-organism belonging to the group Sporozoa. This organism passes the earlier part of its development within the nucleus of the cancer cells, and the later period either within the cell protoplasm or as a free wandering body. In its adult condition it exercises a pernicious influence on the tissues in which it lives. When fully developed the organism forms spores to the number of 20 to 30. Round about its soft body, the plasmodium, a membrane appears and germs are soon visible in its interior. The spores are surrounded by a common membrane. The germs are supposed to escape from their capsule by rupture of the investing membrane.

The author found this organism in six cases of carcinoma of the mamma, in one of the liver and of the prostate. Cultivations of the microbe failed.

* Arch. f. Mikr. Anat., xxxvii. (1891) pp. 99–138 (4 pls.).

† Fortschr. d. Medicin, 1890, No. 14. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) p. 731.

Protozoon- and Coccidium-like Micro-organisms in Cancer-cells.*— Dr. Schütz considers that the amœboid forms, observed by van Henkelom and Sjöbring in cancer-cells, which were supposed by those observers to be the cause of the epithelioid proliferation of the carcinoma tissue, are probably red blood-corpuscles, since they react in a similar manner to Flemming's staining method. Besides this, both Klebs and the author have noticed migrations of corpuscles from vessels into these cells, after which they undergo various changes of form.

The appearances described as sporocysts, the author thinks, are leucocytes which have undergone some peculiar change, and he holds that his opinion is confirmed by the absence of any observation of these appearances in fresh preparations of cancer tissue.

Myoparasites of Amphibia and Reptilia.†—From a further examination of his specimens with improved lenses, Prof. B. Danilewski now states that the myoparasites of Amphibia and Reptilia are Microsporidia; the muscle-fibres are distended with extremely small spores, which are extremely like Cornalia corpuscles, or Pébrine spores. The best examples of this disease are seen in the muscles of the posterior extremities of the frog, where they are commonly visible as whitish spindle-shaped streaks about 1–1·5 mm. long.

The parasitic bodies lie within the sarcolemma and consist of small (0·003–0·004 mm.) oval or ovate spores which consist of a sheath and protoplasmic contents. In the riper spores the central portion is more transparent than in the young, the sheath of which does not present a double contour.

The author proceeds to speculate whether there be any connection between Myosporidia and Hæmatozoa sporozoica.

* Münch. Med. Wochenschr., 1890, No. 35. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 285–6.

† Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 9–10.

BOTANY.

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

α. Anatomy.

(1) Cell-structure and Protoplasm.

Protoplasmic Connection between adjacent Cells.* — Herr F. Kienitz-Gerloff enumerates a very large number of instances in which he has detected protoplasmic connection between adjacent cells:—Among Musci, all the cells of the stem of *Thuidium delicatulum;* among Filices, all the parenchymatous cells of the rhizome, the sieve-region of the vascular bundles, and the endoderm of *Polypodium vulgare;* among Coniferæ the bud-scales and cortex of *Abies pectinata*, the bud-scales of *Pinus excelsa*, the bud-scales and sieve-tubes of *Pinus sylvestris;* among Angiosperms, the cortical cells of the rhizome, the embryo- and endosperm-cells, the young leaves, the central vascular bundle of the root, the fundamental tissue of the stem, collenchyme, epiderm, pith, cambium, mesophyll of the leaf, sclerenchyme, hairs, and other organs and tissues of plants belonging to a great number of natural orders of both Monocotyledons and Dicotyledons.

These protoplasmic connections are not merely between cells belonging to the same tissue; they are even more common between adjacent cells belonging to entirely different tissues, as between epidermal cells and those of the cortex or collenchyme, and between the endoderm-cells and those of the primary parenchyme and of the vascular bundle in *Polypodium vulgare.* The author believes, in fact, that, in the higher plants, all the living portions of the entire plant are connected by threads of protoplasm. The perforation of sieve-tubes is simply an instance of this general law where the threads are of unusual thickness. In Phanerogams the thickness of these threads varies between 0·05 and 1·0 μ, while in *Thuidium delicatulum* they were measured as thick as 3 μ. The thicker threads are usually solitary; where they are thinner it is more common for a number to be collected together into a fusiform mass. In the opinion of the author no perforation of the cell-wall ever takes place; but, at the spot where the threads pass through, no cellulose is formed at the time of cell-division. The connecting threads appear to be the remains of the spindle-fibres formed in the process of division of the nucleus.

With respect to the physiological value of this protoplasmic connection, the author takes the view of those who regard the threads as the conducting path through which the protoplasm passes out of the vessels and sclerenchymatous fibres into the adjacent cells.

A very complete bibliography of the subject is appended.

Formation of Vacuoles.†—Dr. G. Klebs contests the soundness of de Vries' and Went's conclusion that vacuoles are in all cases formed by the division of others already in existence, a conclusion which has, he thinks, been in many cases arrived at by neglecting the evidence

* Bot. Ztg., xlix. (1891) pp. 1–10, 17–26, 33–46, 49–60, 65–74 (2 pls.).
† Op. cit., xlviii. (1890) pp. 549–59. Cf. this Journal, *ante*, p. 58.

of facts opposed to it. He finds that in *Hydrodictyon utriculatum* there is no simultaneous division of the protoplasts into zoospores, but that the first process is a peculiar breaking-up of the parietal layer of protoplasm into ribbon-shaped pieces, from the division of which the zoospores are formed. In this alga, as in *Botrydium granulatum*, the original vacuole of the mother-cell remains until the zoospores are mature, and there is no evidence of its breaking up into from 7000 to 20,000 small vacuoles, corresponding to the number of the zoospores. Klebs further points out that Went fails to indicate any method by which pathological can be distinguished from normal vacuoles.

Formation of Cell-wall in Protoplasts not containing a Nucleus.*—Herr E. Palla has made further observations which confirm his previous statement that it is possible for a cell-wall to be formed round protoplasm destitute of a nucleus. One series of experiments was made on pollen-grains—*Leucojum vernum*, *Galanthus nivalis*, *Scilla bifolia*, *Hyacinthus orientalis*, and others—causing them to germinate in a solution of sugar and gelatin, by which the extremity of the pollen-tube was ruptured, and both nuclei expelled. Although the part below usually perished, yet in many cases a fresh cap of cellulose was formed on the apical side. Similar results were obtained, by the process of plasmolysis with a 10 per cent. solution of sugar, with leaves of *Elodea canadensis*, root-hairs of *Sinapis alba*, rhizoids of *Marchantia polymorpha*, and filaments of *Œdogonium*. The author does not reject the hypothesis that the formation of cellulose in such cases may be a secondary result of the activity of the nucleus which was once present.

Antagonistic Molecular Forces in the Cell-nucleus.†—M. C. Degagny discusses the question whether the facts already described in the division of the cell-nucleus in *Spirogyra* prove the existence of an antagonism between the different chromatic portions of the nucleus. The first indication of the rupture of the equilibrium which reigns in the interior of the nucleus is its increase in volume; the nucleole then no longer occupies its central position, but becomes placed sometimes on one side, sometimes on the other, of the nucleus; this may be due to the entrance into it of the red granulations; for, before their appearance, it had remained in equilibrium. The separation of the nucleolar particles usually takes place slowly, but at other times the nucleole breaks up suddenly, and the red particles are projected, not in all directions, but all on the same side, and the nucleole itself is then driven in a direction opposite to that of the granulations, and a visible antagonism is thus manifested between the different portions of the chromatic substance of the nucleus. Evidence of a similar nature is presented in the formation of the nuclear membrane.

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

Structure and Formation of Chromatophores.‡—Herr H. Bredow has investigated this subject, chiefly in connection with the development and germination of seeds. His observations agree with those of Tschirch,

* Flora, lxxiii. (1890) pp. 314–31 (1 pl.). Cf. this Journal, 1890, p. 475.
† Comptes Rendus, cxi. (1890) pp. 761–3. Cf. this Journal, *ante*, p. 58.
‡ Jahrb. f. Wiss. Bot. (Pringsheim), xxii. (1890) pp. 349–414.

as also in the main with those of Pringsheim, Meyer, Schimper, Schmitz, and F. Schwarz.

When the seeds are ripe the chlorophyll-grains do not become absorbed in the protoplasm, but only shrivel and dry up, and are then so concealed by the reserve-substances that they are difficult to detect. On germination the chlorophyll-grains again swell up, and multiply by a usually irregular division into four, so that the cells are filled with small particles which were formerly considered as microsomes of the protoplasm. In etiolated cotyledons the chromatophores develope in the same way as in green ones, but are somewhat smaller. Those cotyledons which are above the surface of the soil are not only receptacles for reserve-substances, but also organs for assimilation, since their chlorophyll-grains form starch. But they do not develope in the dark or in diffused daylight, but only in direct sunlight.

Experiments with Schwarz's reagents show that the stroma of the chlorophyll-grains does not consist of fibrillæ composed of granules and a matrix in which they are imbedded, but of a framework of bands, which holds the pigment in its meshes; these bands are in communication one with another. In by far the greater number of cases no protoplasmic membrane could be detected surrounding the chlorophyll-grains. In different plants, and even in the same species, the resistant power of the chromatophores varies greatly; some are completely destroyed even by water, while others resist much more powerful reagents.

Origin and Development of Starch-grains.*—Herr O. Eberdt criticizes the conclusions arrived at by previous observers on this subject, and especially those of Schimper.† His observations were made on the epiderm of the stem and leaf-stalk of *Philodendron grandifolium*, rhizome and tubers of *Canna*, *Stanhopea*, *Epipactis palustris*, *Convallaria majalis*, *Phajus grandifolius*, and the potato, and on the starch-grains in the laticiferous tubes of the Euphorbiaceæ.

The author agrees with Schimper in tracing the origin of the starch-grains in parts of plants which do not assimilate to proteinaceous bodies, which Schimper terms starch-generators, but which Eberdt prefers to call the ground-substance of starch. He dissents, however, from Schimper's view that these bodies play an active part in the formation of starch; and he regards them as purely passive bodies, while the active substance is the protoplasm solely. Again, while Schimper asserts that these plastids (leucoplastids, chloroplastids, or chromoplastids) are present in the cell from the first, Eberdt maintains that they are formed out of the protoplasm by differentiation.

These bodies have a tendency to move towards the cell-nucleus, and then either collect into groups or are scattered around it. In either case they are inclosed in a pellicle of protoplasm, which is connected by threads with the parietal protoplasm of the cell. When collected into groups, each one of these bodies becomes gradually transformed into starch from within outwards, and the protoplasm-pellicle then becomes detached, and finally incloses each separate group, or it is ruptured and the groups fall apart. In the former case the groups remain permanently

* Jahrb. f. Wiss. Bot. (Pringsheim), xxii. (1890) pp. 293–348 (2 pls.).
† Cf. this Journal, 1888, p. 71.

inclosed in protoplasm until the starch-grains are fully formed, and the separate grains then show no lamination; or they escape from it at an earlier period, and then become differentiated into concentric layers. In the latter case differentiation also takes place into either concentric or excentric layers; and these grains can no longer increase in size after they lie free in the cell-cavity.

When the proteinaceous bodies lie separately around the nucleus the protoplasm-pellicle also becomes detached, and a portion of it completely incloses each separate body. It is this protoplasm which brings about the transformation of the body into starch. When the newly-formed starch-grain has broken through the pellicle, the protoplasmic portion of the latter still remains attached in the form of a cap. Starch-grains which have been formed in this way always exhibit excentric lamination after they have broken through the pellicle. They can no longer increase in size after the loss of the cap.

It is therefore only to this pellicle or cap of protoplasm that the name starch-generator can properly be applied. Under the influence of light the portion of protoplasm which remains attached to the starch-grain, but not the ground-substance of the starch, may, in certain cases, become green.

M. E. Belzung * criticizes these remarks, pointing out that Eberdt does not agree with Schimper's view that the starch-grains found in the centre of the chlorophyll-corpuscles have a concentric structure, while those near the surface are excentric, and there is a decided divergence of views as to the function of the leucites. According to Schimper they are, briefly, the generators of starch, while Eberdt considers that there are two stages in the development of the starch-grain,—first, the transformation of the leucite into starch, and then the growth of the nucleus thus formed, and the differentiation of the concentric layers.

M. Belzung points out that the authors in question have conducted their researches on plants where there is a certain amount of complexity, owing to the presence of crystalloids, and that the true origin of starch ought to be sought for in the very young embryo.

Protein-crystalloids in the Cell-Nucleus of Flowering Plants.†—Herr A. Zimmermann finds protein-crystalloids to be much more common in the nucleus of the cells of flowering plants than has hitherto been supposed. They occur in plants belonging to many different natural orders, though in other nearly related species he was unable to detect them. They are not confined to any particular organs or tissue-systems; they were found most frequently in the tissue of the leaf and in the pericarp. The method employed for detecting the crystalloids was a double-staining of microtome-sections by hæmatoxylin and acid-fuchsin, by which the crystalloids were stained an intense red, the nucleole and framework of the nucleus blue-violet.

Localization of the Active Principles of the Cruciferæ.‡—M. L. Guignard finds that the composition of the various active principles of

* Journ. de Bot. (Morot), v. (1891) pp. 5–13. Cf. this Journal, 1888, p. 70.

† Ber. Deutsch. Bot. Gesell., viii. (1890) Gen.-Versamml. Heft, pp. 47–8.

‡ Journ. de Bot. (Morot), iv. (1890) pp. 385–94, 412–30, 435–55 (20 figs.); and Comptes Rendus, cxi. (1890) pp. 920–3.

the Cruciferæ varies from species to species. Black mustard contains sinigrin besides the ferment myrosin, as also does the horse-radish; while white mustard contains sinalbin in place of sinigrin. The active principle of *Cochlearia officinalis* is isosulphocyanate of secondary butyric alcohol; while the root, the stem, and the seed of *Sisymbrium Alliaria* and *Thlaspi arvense* contain a mixture of sulphur and sulphocyanate of allyl. The following are the author's conclusions on his researches:—(1) Nearly all the Cruciferæ are provided with special cells which contain a particular ferment, myrosin. It is in the seed that these cells occur most abundantly. (2) When these cells are found in the root it is in either the cortical parenchyme or the parenchyme of the liber; in the stem it is generally in the pericycle; in the leaf in the pericycle of the foliar bundles; in the cotyledons the localization is the same as in the leaf. (3) These special cells can be immediately distinguished by the nature of their contents. Pure hydrochloric acid, under the influence of heat, gives them a violet coloration. (4) In the embryo these specialized cells are differentiated some time before the maturity of the seed. (5) Sometimes in certain seeds (*Lunaria*, &c.) the embryo is rich in the glucoside, while the ferment is contained almost exclusively in the integument. (6) The ferment appears to be identical in all members of the family. (7) The presence or absence of the specialized ferment-cells can be made use of for purposes of classification.

(3) Structure of Tissues.

Vascular System of Floral Organs.*—Rev. G. Henslow describes and figures the course of the vascular cords in the various parts of the flower in 34 different natural orders. No appreciable differences are to be detected between the cords or traces of a sepal, a petal, a stamen, or a carpel. They all consist of the same two elements—spiral vessels or tracheæ representing xylem, and sieve-tubes or soft bast constituting the phloem. The predominating arrangement in all the floral structures is for the spiral vessels to be either placed accurately in the centre of a cylinder of phloem or to be scattered irregularly through it. In the pedicel the arrangement of the cords characteristic respectively of the stem of Exogens and Endogens is frequently reversed. The system of cords formed in the wall of the ovary of the poppy, alternating with the placentas, originates quite freely from meristematic tissue imbedded in the parenchyme, and has no connection with any cords arising from the axis.

Pericycle and Peridesm.†—In astelic stems (i. e. without any central vascular cylinder) M. P. Van Tieghem proposes to designate the layer of cells or the tissue which, beneath the special endoderm, surrounds the phloem and xylem of each vascular bundle, the *peridesm*, instead of, as hitherto, the special pericycle. Where the astelic stem is also "dialydesmic," as in the Nymphæaceæ, some species of *Ranunculus*, *Ophioglossum*, and some species of *Equisetum*, the peridesms are independent, as are the vascular bundles; but when the stem is "gamodesmic,"

* Journ. Linn. Soc. (Bot.), xxviii. (1890) pp. 151–97 (10 pls.).
† Journ. de Bot. (Morot), iv. (1890) pp. 433–5.

as in *Botrychium*, *Helminthostachys*, and many species of *Equisetum*, the peridesms also coalesce; and when the fusion of the vascular bundles is complete, as in the two former genera, the general external peridesm simulates a pericycle, and gives the appearance of a monostelic stem. In *Marsilea*, many ferns, and some species of *Auricula*, we have a gamo-polystelic structure in which the pericycles are united into a general external and a general internal pericycle; a structure very liable to be confounded with the general external and general internal peridesm in the gamo-astelic structure.

Abnormal Formation of Secondary Tissues.*—Herr H. de Vries describes the mode of formation of secondary tissues in the following abnormal cases, viz.:—a flower-stalk three years old of *Pelargonium zonale;* formation of wood in potatoes; in turnips two years old; abnormal formation of wood under the influence of galls; excrescences in leaves. As a general rule, conducting organs like flower-stems and leaf-stalks only last so long as the organ which they have to bear; when, from any exceptional cause, the life of the latter is prolonged beyond its normal limits, then the formation of secondary tissue is incited in the part that bears it.

Sieve-septum of Vessels.†—Herr O. Rodham describes the occurrence of peculiar vessels in *Tecoma* which are traversed transversely by a septum perforated in a sieve-like manner. They are found both in the outer normal woody structure and in the inner wood formed out of the secondary meristem in the pith, several being sometimes seen in the same transverse section.

Order of Appearance of the Vessels in the Flowers of Tragopogon and Scorzonera.‡—M. A. Trécul states that if one follows the order of appearance of the vessels in the interior of the bracts of the involucre of *Tragopogon pratensis*, *porrifolius*, &c., one finds that the first vessel of the median vein commences free at the two ends in the middle region of the bract, or sometimes even higher. In the flower itself the vessels of the stigmatic branches are formed after those of the corolla, but before those of the style. It is only after the appearance of vessels in the parts of the flower already mentioned, that the parietal vessels of the inferior ovary are formed. These usually result from the basal prolongation of five bundles or original substaminal groups.

Independence of Fibro-vascular bundles in the appendicular organs.§—M. D. Clos applies the term *exoneurosis* to the separation of the veins in the appendicular organs of plants, and their emergence in the form of teeth, spines, or bristles. A good illustration of exoneurosis is furnished by the transformation of leaves into spines in the barberry, and various other examples are described, especially in the case of stipules. In addition to stipules, this phenomenon is most frequently displayed in submerged organs, in the organs in the immediate vicinity of the flower or of the inflorescence, and in the parts of the flower itself, especially in the sepals.

* Jahrb. f. Wiss. Bot. (Pringsheim), xxii. (1890) pp. 35–72 (2 pls.).
† Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 188–90 (2 figs.).
‡ Comptes Rendus, cxi. (1890) pp. 327–33.
§ Mém. Acad. Sci. Toulouse, ii. (1890) pp. 248–67 (1 pl.).

Cortical Bundles in Genista.*—M. W. Russell states that in certain plants the foliar bundles, instead of passing directly from the central cylinder of the stem to the leaves, pass along in the cortex for several internodes. The author shows this to be the case in several species of the genus *Genista.*

Elliptically wound Tracheids.†—Mr. P. H. Dudley describes structures to which he gives this designation, and which he finds in trees growing in dense forests, where, for want of light, the lower branches die, are attacked by fungi, break off, and the scar is overgrown; the main purpose served is protection from the further attacks of fungi.

Anatomy of Saxifragaceæ.‡—M. M. Thouvenin has made an exhaustive examination of the comparative anatomy of the Saxifragaceæ, which he divides into ten tribes, viz.:—Saxifragaceæ, Francoeæ, Cunonieæ, Hydrangeæ, Brexieæ, Escallonieæ, Ribesieæ, Hamamelideæ, Brunieæ, and Cephaloteæ. Each of these ten tribes is treated separately, but their distinguishing anatomical characters are few, and subject to many exceptions. The only anatomical character which is common to the whole order is a negative one, the absence of an internal phloem. As a general rule, but subject to exceptions, the stomates are surrounded by irregularly arranged cells; the mechanical (i.e. the non-glandular) hairs are unicellular, there is no differentiated secreting system, and the deposits of calcium oxalate are in the form of rhomboidal prisms rather than of raphides. The affinities of the Saxifragaceæ with other orders are discussed, especially with the Crassulaceæ, Caprifoliaceæ, Rhamnaceæ, and Rosaceæ.

(4) Structure of Organs.

Morphology and Phylogeny of Gymnosperms.§—From an examination of a number of species belonging to different families, Dr. L. Celakovsky concludes that the female flowers of the Gymnosperms are always borne in the axils of scales (Deckblätter), and are arranged in spikes, the number in a spike varying greatly; only in *Gingko* are there also subtending leaves and bracts (Niederblätter). Only in the Taxeæ does the flowering shoot possess two or three pairs of scale-like bracts (Vorblätter). The flowering shoot is limited, and has no growing point or growing cone; what has hitherto been taken for this is a sterile carpid. The number of carpids in a flower varies between one and nine, three being the most common number, of which the central one is sterile and abortive; in the Podocarpeæ and Dammareæ there is usually only one. The ovule has either a double integument, or a single one the whole of which is homologous to the double one; and such ovules are therefore not strictly monochlamydeous. The carpid developes into a single ovule by reduction from cycad-like polymerous carpids.

Structure of the Rhizophoreæ.‖—Herr G. Karsten describes the structure of the mangrove-vegetation of the Dutch East Indies, consisting

* Bull. Soc. Bot. France, xxxvii. (1890) pp. 133–5.
† Journ. New York Micr. Soc., vi. (1890) pp. 110–4 (4 figs.).
‡ Ann. Sci. Nat. (Bot.), xii. (1890) pp. 1–174 (22 pls.).
§ Abh. Böhm. Gesell. Wiss., viii., 148 pp. See Oesterr. Bot. Zeitschr., xli. (1891) p. 14.
‖ Ber. Deutsch. Bot. Gesell., viii. (1890) Gen.-Versamml. Heft, pp. 49–56 (1 pl.).

of the genera *Rhizophora*, *Bruguiera*, *Ceriops*, and *Kandelia* belonging to the Rhizophoreæ, as well as others belonging to the Myrsinaceæ, Verbenaceæ, Myrtaceæ, Combretaceæ, Rubiaceæ, Meliaceæ, and Palmæ.

The ovules of all Rhizophoreæ possess, in their early stages, two integuments; but the inner integument frequently becomes more or less completely absorbed, and in *Bruguiera* the embryo-sac forces its way through it, and spreads itself out between the two layers. Of the 4-6 ovules in each flower all but one always abort. The embryo has two growing points, one of which penetrates the endosperm and bears 2-4 cotyledons, which soon fill up the entire cavity of the outer integument and act as absorbing organs, while the radicular growing point, which is directed towards the micropyle, breaks finally through it and developes into the hypocotyl. All the nutrient substances of the mother-plant are applied to the nutrition of this hypocotyl, which may attain a length of 1 metre.

The fruit (or seed) of all mangrove-plants floats on the water. The roots, which strike into soil saturated with water, are adapted for the interchange of gases, and serve, therefore, as organs of respiration. They are abundantly provided with lenticels, and are negatively geotropic.

Order of Succession of the Parts of the Flower.*—A series of observations on this subject by Herr K. Schumann leads him to the conclusion that the prevalent theory that the parts of the flower are formed in spiral succession is not tenable in the greater number of cases. In the Lobeliaceæ all the sepals always originate simultaneously, and the same is the case in many Campanulaceæ, Rubiaceæ, and Caprifoliaceæ, and in some species of *Acer* and *Abutilon*. The "superposition" of whorls is a distinguishing character of floral, as contrasted with vegetative, shoots, and is always the result of contact, and of adaptation to the space at command. Where an outer whorl appears later than an inner whorl, as in the Primulaceæ and Plumbagineæ, it is always the result of intercalation. There may be extra-axillary flowers, corresponding to extra-axillary leaf-buds. The author adopts Schwendener's view that purely mechanical influences outweigh all others in determining the early development of plant-members, whether axial, foliar, or floral.

Septal Glands of Kniphofia.†—Miss E. R. Saunders describes the nectar-glands on the septa of the ovary of several species of *Kniphofia* (Liliaceæ). Their minute structure is detailed, and their development traced from the earliest stage. The saccharine fluid which they exude in large quantities when mature appears to be formed out of the starch contained in them at earlier stages. This change is doubtless effected by the protoplasm, and is presumably due to some ferment action.

Development of Fleshy Pericarps.‡—M. A. G. Garcin has examined in detail the structure and development of the fleshy pericarp in a large number of berries and drupes. In the ripe berry the mesocarp may consist of one, two, three, or four layers, and there may or may not be a

* Neue Unters. üb. d. Blüten-anschluss (10 pls.), Leipzig, 1890. See Bot. Centralbl., xlv. (1891) p. 220.
† Ann. of Bot., v. (1890) pp. 11–25 (1 pl.).
‡ Ann. Sci. Nat. (Bot.), xii. (1890) pp. 175–401 (4 pls.).

distinct hypoderm. In drupes the flesh is rarely homogeneous; when heterogeneous, it may be formed of one, two, or three layers. The stone is composed, independently of the fibrovascular bundles, of five distinct elements, viz. sclerotic cells properly so-called, sclerotic fibres, sclerotic tabular cells, sclerotic tubular cells, and parenchyme. The development of these various elements is traced; and a large number of examples are then described in detail, as regards both the ovary and the mature fruit.

Integument of the Seed of Cyclospermæ.*—M. L. Meunier has made an exhaustive examination of the structure and development of the integument of the seed of the Cyclospermæ (Chenopodiaceæ, Phytolaccaceæ, Aizoaceæ, Illecebreæ, Portulacaceæ, and Caryophylleæ), characterized by having a curved embryo buried in a copious endosperm. He distinguishes two types, viz.:—(1) The *chenopodic* type (Chenopodieæ, Baselleæ, Amarantheæ, Gomphreneæ, and Celosieæ). The membrane of the cells, which are in general prismatic, takes, exclusively of its external surface, a thickening which is often considerable, and is composed of a number of bars, usually parallel, having their base in the external cuticle, and descending more or less deeply into the secondary membrane. The same type occurs with modifications also in the Aizoaceæ, Illecebraceæ, Phytolaccaceæ, and Portulacaceæ. (2) The *caryophyllic* type (Caryophylleæ). The epidermal cells have a wavy and not a polygonal outline, and the cuticle is often remarkably sculptured. The outer membrane has not the stalactite structure of the Chenopodieæ, but is remarkably thick, and is furnished with singular prolongations of cellulose which descend into the cell-cavity. The variations of these two types are described in detail in all the genera included in the group.

Stomates.†—Prof. A. Weiss gives details of the distribution, form, and measurements of the stomates in several hundred species belonging to a great number of different families.

Rudimentary Stomates in Aquatic Plants.‡—M. C. Sauvageau describes structures which occur frequently in the leaves of aquatic plants, both freshwater and marine, similar to those already known in the case of *Callitriche*. They consist of a depression on the upper side of the leaf near the apex of the mid-vein, which places the inner conducting system in connection with the external air, and which may be regarded therefore as aquiferous stomates. They are formed by the separation of epidermal cells, and occur in all species of *Potamogeton* examined, in *Zostera*, *Halodule*, and *Phyllospadix*, but not in other marine genera.

Metamorphosis of Vegetative Shoots in the Mistletoe.§—Herr E. Loew describes two abnormal metamorphoses of vegetative shoots into flowers in the mistletoe. In the first the three-flowered axillary shoot was suppressed, and in its place the foliage-leaves and bracts had become transformed into perianth-leaves. In the second instance the two lateral

* La Cellule, vi. (1890) pp. 299–392 (7 pls.).
† SB. K. Akad. Wiss. Wien, xcix. (1890) pp. 307–82 (2 pls.).
‡ Comptes Rendus, cxi. (1890) pp. 313–5.
§ Bot. Ztg., xlviii. (1890) pp. 566–73 (2 figs.).

flowers of the inflorescence were suppressed, but the lateral buds were each transformed into a flower. Both the examples were male plants.

Leaves of Lotus.*—M. P. Vuillemin states that the assimilating tissue of the lamina of leaves is usually bifacial with long palisade-cells on the upper, and spongy tissue on the under side; *Lotus corniculatus* is a good example of this. It is necessary, however, to contrast with this *L. villosus*, *L. pusillus*, &c., where the green parenchyme is uniformly spongy, and *L. arenarius* and *L. sessilifolius*, where there are short palisade-cells on both surfaces. The epidermal cells of the lamina are flat or spherical, and polygonal or sinuous in contour. Except in *L. glaberrimus* and *Delestrei*, the leaves of the species of *Lotus* are provided with hairs composed of three cells.

Production of Bulbils in Lilium auratum.†—M. P. Duchartre states that the production of bulbils has already been described in *Lilium Thomsonianum.* In *L. auratum* it was noticed that when the bulb was taken from the soil the scales were becoming proliferous. The external face of these scales was not in any way peculiar, but the internal face gave rise to numerous bulbils; these were spread over the surface in two different ways. Two of the most developed bulbils were generally to be found at the base of the scale, while the others occupied a higher position and were attached on the median line.

Nodosities on the Roots of Leguminosæ.‡—From a series of experiments in inoculating plants of *Pisum sativum* from infected specimens of various other Leguminosæ, M. E. Laurent arrives at the conclusion that the nodules are caused by the attacks of a microbe (not necessarily a bacterium), and that there is not a special microbe for each species, since infection can take place from one species of Leguminosæ to another. He further confirms the statement of earlier writers that the tendency towards the production of tubercles on the roots is in inverse proportion to the amount of nitrogen contained in the nutrient fluid.

Filaments in the Root-tubercles of Leguminosæ.§—Herr A. Koch has determined that the filiform bodies which infest the root-tubercles of various Leguminosæ possess a true cellulose-membrane, though the reaction with chlor-zinc-iodide can only be made out with certainty, after removing their contents, by laying thin sections for some hours in eau-de-Javelle. He does not consider that this necessarily negatives the hypothesis of their bacterioid nature, since several true bacteria possess a cellulose-membrane, notably *Sarcina ventriculi*, and the vinegar-bacteria. The observations were made on the following species of Leguminosæ:—*Vicia Faba*, *V. narbonensis*, *Robinia Pseud-acacia*, *Trifolium pratense*, *Medicago lupulina*, *Pisum sativum*, *Lens esculenta*, and *Onobrychis sativa.*

* Bull. Soc. Bot. France, xxxvii. (1890) pp. 206–13. † T. c., pp. 234–6.
‡ Bull. Acad. R. Sci. Belgique, xix. (1890) pp. 764–71 (1 pl.). Cf. this Journal, 1890, p. 372.
§ Bot. Ztg., xlviii. (1890) pp. 607–15.

β. Physiology.

(1) Reproduction and Germination.

Sexual Forms of Catasetum.*—Mr. R. A. Rolfe points out that Darwin was in error in describing a hermaphrodite as well as a male and female form of *Catasetum tridentatum*, the so-called hermaphrodite form being really male. Lindley's genus *Myanthus* must be sunk in *Catasetum*, while the same author's *Monachanthus viridis* represents the female form of three distinct species, viz. *Catasetum barbatum*, *cernuum*, and *macrocarpum*. In this genus, while the male forms of some species differ widely, the female forms are remarkably alike. The author finally enumerates the species of *Catasetum* of which both sexes are known, sixteen in all, and subdivides the genus into four sections, of which three are diœcious and one hermaphrodite.

Germination within the Pericarp in Cactaceæ.†—M. D. Clos describes the seeds of a species of *Pereskia* (Cactaceæ) from Martinique, which germinate normally within the pericarp; for which purpose the hypocotyl is provided at its base with a small cone, which fixes itself to the wall of the pericarp by a network of white filaments formed of narrow hyaline cells. By this means nutriment is obtained for the germinating seed from the decaying pericarp.

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

Increase in thickness of the Coniferæ.‡—Herr K. Mischke has investigated the mode of increase in diameter of the stem, especially in *Pinus sylvestris*. The initial cambium-cell divides, and gives off cells in the direction of the xylem and of the phloem, which again divide once or twice according to the vigour of the growth; where the growth is very sluggish, the cells which spring immediately from these initial cells are differentiated into elements of the xylem and of the phloem. Those which are given off towards the xylem develope into tracheids. The cambium forms a cylindrical layer, bounded on the inside by a xylem-, on the outside by a phloem-cylinder. A remarkable irregularity was observed in the growth of a specimen of *Picea excelsa*. Commencing in the middle of April, it attained one maximum of intensity about the beginning of June, from which it rapidly sank to zero at the commencement of July; from the middle of July it again rapidly rose, and reached a second maximum, still higher than the first, about the middle of August, falling again to zero by the end of that month.

Parasitism of Euphrasia.§—Pursuing his investigation of the life-history of the Rhinanthaceæ, Herr L. Koch finds *Euphrasia officinalis* to be a true and not merely a facultative parasite, and the phenomena to correspond in general terms with those of *Rhinanthus minor*. It is parasitic on the roots (but not on the rhizome) of grasses, and chiefly on the very finest roots, in which the vascular bundle has not become

* Journ. Linn. Soc. (Bot.), xxvii. (1890) pp. 206–25 (1 pl.).
† Comptes Rendus, cxi. (1890) pp. 954–6.
‡ Bot. Centralbl., xciv. (1890) pp. 39–45, 65–71, 97–102, 137–42, 169–75 (8 figs.).
§ Jahrb. f. Wiss. Bot. (Pringsheim), xxii. (1890) pp. 1–34 (1 pl.). Cf. this Journal, 1889, p. 665.

differentiated beyond the condition of a procambial string, differing in this respect from *Rhinanthus major.* When the seeds germinate without access to the host-plant immediately after germination, they never attain any considerable size or vigour. The haustoria of *Euphrasia* are exceedingly minute, and are best detected by the method of paraffin imbedding recommended by the author.* The initial-cells of the parasite which attack the host-plant commonly penetrate between the cells of the epiderm; the resulting tissue advancing towards and into the vascular bundle of the root. The result of the attack of the parasite is distinctly injurious to the host-plant; and, during the latter portion of its existence, the mode of life of *Euphrasia* is to a large extent saprophytic on the products of the decay of the tissue of the host-plant caused by its attacks. *Euphrasia officinalis* is very seldom parasitic on any plant not belonging to the Gramineæ.

Formation and Transport of Carbohydrates.†—Herr W. Saposchnikoff has studied these phenomena, especially in the cases of *Helianthus annuus* and *Cucurbita Pepo.* He finds the decrease of their amount when leaves are deprived of light to be only one-fifth in cut leaves compared to what it is in leaves still attached to the plant. The energy of this process shows a daily periodicity which reaches its maximum between 7.30 and 9.30 p.m., and its minimum between 12 and 5.30 p.m.; the maximum being at an earlier period of the day than the maximum of growth. The presence of glucose in the cells hinders the action of the ferment in the further conversion of sugar into glucose. The author found the energy of the formation of carbohydrates in the leaves to be greatly influenced by the weather, being very much greater with a clear sky and a large amount of light. With the increase of the amount of carbohydrates in the leaves, the energy of assimilation proportionately decreases. It is obvious, from quantitative experiments, that the whole of the carbon of the decomposed carbon dioxide is not used up in the formation of carbohydrates; there must be a second primary or secondary product of assimilation, which is probably an albuminoid.

Assimilation of Nitrogen by Plants.‡—From experiments, chiefly on leguminous plants, Herren B. Frank and R. Otto have determined that green leaves contain more nitrogen in the evening than the following morning, and this appears to depend on the quantity of asparagin being larger. Asparagin and sugar are the best nutrients for the symbiosis-fungus (*Rhizobium*) of the Leguminosæ. The larger proportion of nitrogen present in the evening was most striking in *Trifolium pratense*, *Medicago sativa*, and *Lathyrus sylvestris*, but was observable also, though to a smaller degree, in plants belonging to other natural orders.

Effect of Transpiration on Etiolated Plants.§—Prof. W. Palladin explains the effect of light in retarding the growth of plants (i. e. in shortening the internodes) by the fact that it greatly increases transpiration. From observations made on the dried weight, as compared with the fresh weight, of the leaves of various plants, he concludes that etiolated leaves may be divided into two groups,—when sessile they

* Cf. this Journal, 1890, p. 674.

† Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 233–42.

‡ T. c., pp. 331–42.

§ T. c., pp. 364–71.

contain more, when stalked they contain considerably less water than green leaves of the same species.

In another communication * on the same subject, Prof. Palladin states that etiolated leaves (of wheat) which have grown to an abnormal length contain more water than those that are green; while the reverse is the case with small leaves. The large young leaves near the apex of the stem, under the influence of light and transpiration, abstract water from the stem, which therefore grows slowly. In the dark, on the other hand, transpiration being arrested, the leaves do not grow so fast, while the stem grows faster.

Ascending and descending Current in Plants.†—Herr J. Boehm adduces confirmation of his previous views on this subject from experiments on a sunflower cut down at the second internode. The capillary interstices of the soil and of the plant form a continuous system through which the water is conveyed to the transpiring leaves. When the soil is comparatively dry, and the sap-conducting vessels remain permanently filled with water, there must be a current of water descending from these into the soil.

Internal Atmosphere of Tubers and Tuberous Roots. ‡ — M. H. Devaux states that the exchanges of gases in tubers and tuberous roots are produced in three different ways, which ordinarily coexist: — (1) There is transmission by diffusion of free gases through the pores of the periderm-envelope, (2) Transmission by diffusion through the membrane, the gas being dissolved; (3) Transmission by a strong gaseous current through the pores of the envelope.

M. Devaux § further describes an apparatus which illustrates the gaseous changes that take place in a tuber. Briefly, it consists of a bell, the orifice of which is covered with a piece of vegetable parchment, and thus represents fairly well a tuber reduced to its external pellicle. It is then subjected to analogous conditions to those of the internal mass of the tuber, with the following results :— (1) When the membrane is dry, (*a*) the carbon dioxide increases in the internal atmosphere, (*b*) the oxygen penetrates by diffusion, (*c*) the nitrogen is in smaller proportion than in the external air, (*d*) the pressure of the internal gas is greater than that of the air. (2) When the membrane is wet, (*a*) the carbon dioxide diminishes rapidly, (*b*) the oxygen diminishes, (*c*) the nitrogen increases rapidly.

(3) Irritability.

Sensitive Stamens and Stigmas.‖ —Prof. A. Hansgirg classifies the numerous examples of irritability in the stamens and stigmas which subserves the process of pollination, under the following five types, viz. :— (1) *Cactaceæ*-type: the numerous filaments are nearly equally sensitive on all sides, and curve centripetally, bringing the anthers towards the stigma; the contractile parenchymatous tissue is well developed only in

* Arb. Naturf.-Ver. Charkow, xxv. (1890) 5 pp. (Russian). See Bot. Centralbl., xlv. (1891) p. 279.

† Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 311–4, and SB. K. K. Zool.-Bot. Gesell. Wien, xl. (1890) pp. 55–6. Cf. this Journal, 1890, p. 632.

‡ Bull. Soc. Bot. France, xxxvii. (1890) pp. 272-9.

§ T. c., pp. 257-64.

‖ Bot. Centralbl., xliii. (1890) pp. 409–16.

the lower and most sensitive part of the filament (*Opuntia*); (2) *Cynaraceæ*-type: the five syngenesious stamens are epipetalous, the filaments are sensitive on all sides and for their whole length; when at rest they are curved outwards; when irritated they contract and become nearly straight; the contractile tissue penetrates the whole of the filament (many Compositæ); (3) *Cistineæ* and *Mesembryanthemaceæ*-type: the numerous free filaments are sensitive on all sides, but most so on the outer side; when irritated they bend centrifugally towards the corolla (*Helianthemum, Cistus, Mesembryanthemum*); (4) *Tiliaceæ* and *Portulacaceæ*-type: the numerous filaments are sensitive on all sides, but chiefly on the outer side, and become concave on the irritated side (*Sparmannia, Portulaca*); (5) *Berberideæ*-type: the six free filaments are sensitive only on the inner side, and only immediately above their insertion and immediately beneath the anthers; the curvature is centripetal and brings the anther into contact with the stigma (*Berberis, Mahonia*).

There is, on the other hand, no such difference in the structure or in the seat of the sensitiveness in irritable stigmas; they are found in the orders Scrophulariaceæ, Pedalineæ, Acanthaceæ, Bignoniaceæ, and Capparideæ.

A list is appended of those species in which the flower opens only once and then closes, and of those in which it opens and closes more than once.

In a subsequent communication * Dr. Hansgirg adds considerably to the list, and enumerates other examples of types (1)-(4). To type (4) belong several species of *Abutilon*, but sensitive stamens or stigmas were not observed in any other plants belonging to the Malvaceæ.

The author adds further remarks on the flowers which he terms "pseudo-cleistogamic," i. e. those which resemble the ordinary flowers in every respect except that they do not open, and are self-fertilized; presenting thus an intermediate condition between ordinary and truly cleistogamic flowers. A list is appended.

Nyctitropic Movements of Leaves.†—Prof. A. Hansgirg enumerates a large number of species of flowering plants which display nyctitropic movements of the leaves or leaflets, in which the phenomenon had not previously been recorded. As in the case of carpotropic, so with nyctitropic movements, it is not uncommon for nearly allied species to differ from one another in their presence or absence. The author arranges the genera in which the leaves display conspicuous nyctitropic, frequently accompanied by sensitive, movements, under a number of types, the primary distinction depending on the presence or absence of motile cushions at the base of the leaf or leaflet.

Carpotropic Curvatures of Nutation.‡—By this term Prof. A. Hansgirg designates those movements of the fruit-stalk, or of the sepals or bracts, which are designed for the protection of the ripe fruit, or to promote the dissemination of the mature seeds. They are not so dependent on the daily alternations of temperature as are the gamotropic

* Op. cit., xlv. (1891) pp. 70-5.
† Ber. Deutsch Bot. Gesell., viii. (1890) pp. 355-64. Cf. this Journal, 1890, p. 484.
‡ Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 345-55.

and nyctitropic movements of the floral organs. As regards the foliar organs of the flower, they can, of course, occur only where these persist till the ripening of the fruit, and do not always even in these cases. A very large number of instances are adduced by the author. It is not uncommon to find, in the same genus, some species the calyx of which displays carpotropic movements, and others nearly allied, where it is wanting, as in the genera *Rubus*, *Rosa*, and *Potentilla*. In some cases these carpotropic movements are simply passive, while in others they depend on growth, and are the result of epinasty and hyponasty. The burying of some fruits in the soil while they are ripening is the result of carpotropic movements of the fruit-stalk.

Influence of Gravitation on the Sleep-movements of Leaves.*— Herr A. Koch finds, in the trifoliolate leaves of *Phaseolus vulgaris*, a nyctitropic elevation of the leaf-stalk amounting to about 15°, and depression of the lamina to the extent of from 70° to 120°. By experimenting with the clinostat, he found that rotation round a horizontal axis entirely prevented this nyctitropic movement, or at least reduced it to a minimum. The same was the case also with *Phaseolus multiflorus*, *P. tumidus*, *Lupinus albus*, and *Gossypium arboreum*. With other plants, on the other hand, which exhibit nyctitropic movements—e. g. *Trifolium pratense*, *Portulaca sativa*, *Cassia marylandica*, *Goodia obtusifolia*, *Oxalis lasiandra*, and *Acacia lophantha*, the removal of the action of gravitation by horizontal rotation produced no change in these movements. We have therefore two classes of nyctitropic plants; for the first the author proposes the term *geo-nyctitropic*, for the second and more numerous class, *auto-nyctitropic*.

Heliotropism and Geotropism in Mosses.† — M. E. Bastit shows, from the result of experiments on *Polytrichum juniperinum*, that the phenomena of heliotropism and geotropism manifest themselves in Mosses in the same way as in the higher plants. When grown either in air or in water, the heliotropic influence on the growth of the stem of Mosses exceeds that of geotropism; the stem always directs its growth towards the light, whatever may be the position of the source of illumination.

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

Influence of Anæsthetics on Assimilation and Transpiration.‡—In confirmation of his previous views with regard to the relationship between assimilation and transpiration, M. H. Jumelle finds that anæsthetics increase transpiration in plants exposed to light, when the dose is sufficient to suspend respiration. This increase is due to the action of the ether on the chlorophyll-bodies. When, by any means, assimilation is arrested without suppressing the absorption of the rays of heat by the chlorophyll, all the energy of these rays is transferred to transpiration, and accelerates it.

* Bot. Ztg., xlviii. (1890) pp. 673-83, 689-701, 705-18.
† Comptes Rendus, cxi. (1890) pp. 841-3.
‡ Rev. Gén. de Bot. (Bonnier), ii. (1890) pp. 417-32 (1 pl.); and Comptes Rendus, cxi. (1890) pp. 461-3. Cf. this Journal, 1889, p. 669.

Respiration of Plants.*—Herr W. Detmer finds, in the case of wheat, that the optimum temperature for respiration is between 35° and 40° C., the minimum being below zero. Respiration ceases with death, any production of carbon dioxide after this being due to the presence of bacteria. When oxygen is excluded, an active decomposition of the albuminoids takes place, the resulting products being amides and amido-acids.

Respiration and Fermentation of Yeast.†—MM. Gréhant and Quinquad find, from a long series of experiments, that notable quantities of gas are included in yeast, especially carbon dioxide and nitrogen. When yeast respires at a temperature between 8° and 15° C., the quantity of carbon dioxide produced is less than the quantity of oxygen absorbed, or the proportion $\frac{CO_2}{O}$ is less than unity. Respiration does not cease even at zero, and the proportion becomes then nearly unity. At a temperature between 15° and 18°, the value of $\frac{CO_2}{O}$ is unity or higher; at 40°–50° it reaches two or more; one of the effects of a high temperature is to increase the production of CO_2. The respiration of yeast decreases in intensity when the temperature of the atmosphere is above 50°, and the proportion $\frac{CO_2}{O}$ falls again below unity. In the entire absence of oxygen, yeast can produce large quantities of carbon dioxide, borrowing the elements from its own tissue. Yeast absorbs the same quantity of oxygen when it produces fermentation as when it respires under simple conditions without fermentation. Fermentation can proceed rapidly in a vacuum with a temperature of 40°.

Lactase, a new Enzyme.‡—According to Herr M. W. Beyerinck, there are two ferments which ferment sugar of milk, *Bacillus caucasicus*, which exists in Kefyr, and a *Saccharomyces*, which he names *S. tyrocola*, which is found in Edam cheese, and which has been erroneously identified with *S. cerevisiæ* and with *S. Kefyr;* it differs from the latter in its form, being more nearly allied to *S. lactis*. He states that the fermentation is effected by a diastase distinct from invertin, which he calls *lactase*. It has no effect on the luminosity of *Photobacterium phosphorescens*, while glucose and galactose increase its luminous property. The invertin of *S. ellipsoideus* has no effect on sugar of milk, while *S. Kefyr* and *S. tyrocola* produce a diastase which inverts that sugar.

Nitrifying Process and its Specific Ferment.§—Prof. P. F. and Mrs. G. C. Frankland have made an investigation into the process of nitrification, the principal results of which are these:—They have succeeded, by the method of fractional dilution, in isolating a micro-organism present in ammoniacal solutions which were undergoing a nitrification which was originally induced by a minute quantity of garden soil. This organism is a very short bacillus, about 8 μ long, hardly longer

* Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 226-30.
† Ann. Sci. Nat. (Zool.), x. (1890) pp. 269–328.
‡ Centralbl. f. Bakteriol. u. Parasitenk., vi. (1890) p. 44.
§ Phil. Trans., 181 B. (1891) pp. 107–28.

than broad, and exhibits only vibratory motion; it can be cultivated in suitable ammoniacal solutions to which no organic matter whatsoever has been added. In these solutions the growth of the micro-organism is accompanied by the gradual transformation of the ammoniacal into nitrous nitrogen; in solutions inoculated with the pure growth no formation of any nitric nitrogen has yet been observed. Solutions thus nitrified remain perfectly transparent and pellucid. Though pure nitrifying solutions have as yet yielded no growth in gelatin-peptone, the authors have not abandoned the hope of cultivating the nitrifying organism on this and possibly other solid media.

γ. General.

Digestive Properties of Nepenthes.*—M. R. Dubois has come to the conclusion, from an examination of the fluid contained in the pitchers of a large number of species of *Nepenthes*, that the carnivorous habits ascribed to the plant are the result of erroneous observation; that the liquid contains no digestive substance analogous to pepsin; and that the phenomena of digestion attributed to it are due to the presence of microbes, and not to any secretion of the plant.

Absorption of Rain by Plants.†—Pursuing his investigations on the adaptations of plants to rain and dew, Herr A. N. Lundström replies to the objections to his views brought forward by Kny and Wille,‡ and describes further observations on *Stellaria media* and on several species of *Tradescantia*, in which the internodes are furnished with lines of hairs which serve to convey the moisture of the air either to aërial or to underground roots, the former being often very difficult to detect. Although the quantity of water thus absorbed by the aerial parts is very inconsiderable compared to that taken up by the roots, it may be of considerable importance to the life of the plant.

When water falls on a leaf it may be seen to pass along the course of the veins, leaving the rest of the surface comparatively dry.

Kirchner's Diseases and Injuries of Plants.§—Herr O. Kirchner deals in his excellent manual with the diseases and injuries of plants cultivated by farmers, market gardeners, &c. To them, therefore, this work chiefly appeals, although the botanist and zoologist may be indebted to it. The work is divided into two sections; the first of these deals with the various plants met with in North and Mid-Europe and the diseases to which they are liable, and the diagnosis, treatment, and prevention of these maladies. The second portion of the work describes the various animal and vegetable organisms alluded to in the first part as causing or being connected with the various diseases.

* Comptes Rendus, cxi. (1890) pp. 315–7.

† Bot. Sekt. Naturw. Studentsällsk. Upsala, Dec. 11, 1888. See Bot. Centralbl., xliv. (1890) pp. 391 and 424; xlv. (1891) pp. 7, 41, and 76. Cf. this Journal, 1887, p. 119.

‡ Cf. this Journal, 1887, p. 995.

§ Stuttgart, 1890, 637 pp. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 22–3.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Structure of Isoetes.*—Mr. J. B. Farmer has subjected both the sporophyte and the oophyte of *Isoetes lacustris* to a careful examination. He shows that the statement of Hofmeister and others that the apices of the stem and root grow by means of apical cells, is founded on a misconception of the structure. Also that the existence of a ligule in both *Isoetes* and *Selaginella* must not be taken as indicating a close affinity between these two genera. The mature structure of the ligule is different in the two genera, and that of *Selaginella* arises from a multicellular protuberance, not from a single cell as in *Isoetes*.

As regards the structure of the oophyte, the author differs from Pfeffer's view, who regards the upper small-celled portion of the products of division of the megaspore, above the first diaphragm, as constituting by itself the prothallium, and compares the lower and looser mass of cells below the diaphragm to the endosperm of Angiosperms. Farmer maintains that they are both parts of the true prothallium, the former being the specially reproductive, the latter the specially nutritive portion of that structure. He then further traces the resemblance between the processes which take place within the megaspore of *Selaginella* and *Isoetes*, and those which occur in the embryo-sac of Angiosperms.

Stem of Equisetaceæ.†—M. P. Van Tieghem proposes a rearrangement of the species of *Equisetum* according to the characters derived by Pfitzer from the endoderm (Schutzscheide) under five types, viz.:—(1) Special endoderms in the rhizome and aerial stem (*E. limosum, litorale, giganteum, pyramidale, debile, Martii, xylochætum*); (2) Special endoderms in the rhizome, two general endoderms in the aerial stem (*E. hyemale, trachyodon, ramosissimum, myriochætum, robustum, lævigatum, Schaffneri;* (3) Two general endoderms in the rhizome and in the aerial stem (*E. variegatum*); (4) Two general endoderms in the rhizome, one general external endoderm in the aerial stem (*E. sylvaticum*); (5) One general external endoderm in the rhizome (*E. arvense, maximum, pratense, palustre, scirpoides, bogotense, diffusum*).

The pericycle, which is always present and always simple, follows step by step the endoderm in all its modifications; and there are therefore three general types of pericycle and endoderm, viz.—(1) Special pericycles and endoderms; (2) two general pericycles and endoderms; (3) one distinct general external pericycle and endoderm. It is only in the first of these three modes that the stem possesses its typical structure, identical with that met with in many Phanerogams. In the second mode the structure is still astelic (without central cylinder); but there is lateral fusion of the pericycles and endoderm, although not always of the vascular bundles; and this may be termed *gamodesmic* in contrast to the typical *dialydesmic* structure. In the third mode the structure is also astelic. The astelic stem is then a general characteristic of the Equisetaceæ, in contrast to the polystelic (gamostelic or dialystelic) stem of most Filices and Hydropterideæ.

* Ann. of Bot., v. (1890) pp. 37–62 (2 pls. and 1 fig.). Cf. this Journal, 1890, 636.

† Journ. de Bot. (Morot), iv. (1890) pp. 365–73.

This grouping of the species of *Equisetum* according to the structure of the stem in no way corresponds to that of Milde founded on the nature of the stomates.

Muscineæ.

Sporophyte of Splachnum.*—The late Mr. J. R. Vaizey describes the structure of the remarkable umbrella-shaped apophyse of *Splachnum luteum* and other species. The parenchymatous tissue of the apophyse contains large numbers of chlorophyll-bodies, and the author has no doubt that this organ performs the function of a leaf; large quantities of starch being formed in its cells, which subsequently disappears. Its upper surface has a number of stomates the structure of which resembles in several respects those of flowering plants rather than those of other mosses. The structure of the sporange is typical; but the radial walls of the cells of the peristome have remarkable horizontal thickenings, recalling the thickenings in the elaters and cells of the walls of the sporange of many Hepaticæ.

Rabenhorst's Cryptogamic Flora of Germany (Mosses).—The last three parts of this publication, by Herr K. G. Limpricht, treat of the following orders:—Orthotrichaceæ, including *Amphidium* (2 sp.), *Zygodon* (9 sp.), *Ulota* (11 sp.), and *Orthotrichum* (38 sp.); Encalyptaceæ, including *Encalypta* (12 sp.), and *Merceya* (1 sp.); Georgiaceæ, including *Georgia* (1 sp.) and *Tetrodontium* (1 sp.); Schistostegaceæ (1 sp.); Splachnaceæ, including *Dissodon* (3 sp.), *Tayloria* (5 sp.), *Tetraplodon* (4 sp.), and *Splachnum* (3 sp.); Disceliaceæ (1 sp.); and the commencement of Funariaceæ, including *Pyramidula* (1 sp.), *Physcomitrium* (4 sp.), and *Entosthodon* (4 sp.). The characters of the genera and of many of the species are illustrated by the usual beautiful woodcuts.

Algæ.

British Marine Algæ.†—MM. E. M. Holmes and E. A. L. Batters print a complete list of all the British species of marine algæ that have at present been identified. Their distribution is indicated by a record of their occurrence in the fourteen sections into which the British coasts are divided, viz. nine for Great Britain and five for Ireland.

Lemaneaceæ.‡—Herr F. Bornemann gives a monograph of this order of Algæ, and describes two new species, *Sacheria rubra* and *S. cæspitosa*. He regards the *Chantransia*-form as a thallus, and the *Lemanea*-form as the fructification. This has usually a lateral, rarely a terminal, position. The fructification may display either true or false branching. The author describes the procarp as four-celled, two or three of the inner carpogonous cells developing into longer or shorter usually branched filaments, from the apices of which the spores are abstricted.

* Ann. of Bot., v. (1890) pp. 1–10 (2 pls.). Cf. this Journal, 1888, p. 460.

† Ann. of Bot., v. (1890) pp. 63–107.

‡ 'Beitr. z. Kenntniss d. Lemaneaceen,' Berlin, 1887, 49 pp. and 3 pls. See Just's Bot. Jahresber., xvi. (1890) p. 161. Cf. this Journal, 1890, p. 641.

Tuomeya fluviatilis.*—Mr. W. A. Setchell describes the structure and development of *Tuomeya fluviatilis* Harv. (*Baileya americana* Ktz.) which, both in its vegetative organs and its mode of fertilization, forms a connecting link between *Lemanea* and *Batrachospermum*. Young plants put out filaments resembling the *Chantransia* form of *Batrachospermum*. The antherids are developed from the terminal cells of the antheridial branches, and each produces a single antherozoid, which moves about for a short time with an amœboid motion, but soon becomes spherical and motionless. The carpogonial branches become at length spiral, and the procarps are formed from their terminal cells. The contents of the antherozoids enter the trichogyne through an opening in its wall; and the trichophore then produces chains of carpospores resembling those of *Batrachospermum*.

Structure of Zonaria.†—Mr. H. M. Richards describes the structure and development of the thallus of *Zonaria variegata* from Bermuda. It grows by the division of a marginal row of brick-shaped cells, and consists, in its most fully developed parts, of from five to nine layers of large medullary and two layers of cortical cells. Each initial cell of the superficial layers is soon divided into a large number of small cells. The concentric lines which are so conspicuous on the thallus are caused by some of the cortical cells overlapping others towards the margin of the thallus, the overlapping portion having a length of several cells.

The author records an abnormal division of the contents of tetrasporanges of *Dictyota ciliata*, by which they break up into an indefinite number of parts.

Chlorophyll-bands in the Zygote of Spirogyra.‡—According to observations made by Herr V. Chmielevsky on several species of *Spirogyra* and *Rhynchonema*, no coalescence takes place in the zygote (zygosperm) between the chlorophyll-bands of the male and those of the female cell; those of the latter always exhibit a more regular spiral than those of the former. After coalescence has taken place the female band always retains its green colour, while the male band becomes yellow, and gradually breaks up and becomes disorganized, being finally absorbed into the protoplasm of the cell-sap. In lateral conjugation the male band which disappears always lies nearer to the conjugating canal. When the zygote germinates after its period of rest, it always contains only a single nucleus, the result of the coalescence of the nuclei of the male and female cells, and a varying number of chlorophyll-bands, but always the same number as those in the female cell before conjugation, which remain unchanged in the zygote.

Germination of Closterium and Cosmarium.§—Herr H. Klebahn describes the structure and mode of germination of the zygote in species belonging to these two genera of desmids.

In *Closterium* the four chromatophores resulting from the conjugation of the two gametes remain for a time distinct, subsequently uniting into

* Proc. Amer. Acad. Arts and Sci., xxv. (1890) pp. 53–68 (1 pl.). See Bot. Centralbl., xliv. (1890) p. 81.

† Proc. Amer. Acad. Arts and Sci., xxv. (1890) pp. 83–92 (1 pl.). See Bot. Centralbl., 1891, Beih. 1, p. 5.

‡ Bot. Ztg., xlviii. (1890) pp. 773–80 (1 pl.).

§ Jahrb. f. Wiss. Bot. (Pringsheim), xxii. (1890) pp. 415–43 (2 pls.).

two large ones, rich in starch. In the following spring the two nuclei unite, and the contents of the zygote escape from their membrane. Nuclear division then takes its ordinary course, and the zygote divides in two by a constriction in its middle, each half containing a nucleus. Each of these two nuclei again divides into two of unequal size, the larger, which has the character of a resting nucleus, with one or two nucleoles, becoming the nucleus of the new individual, the other, which has the character of a nucleole, disappearing. The germination of the spiny zygote of *Cosmarium* exhibits similar phenomena.

It occasionally happens that three of the four nuclei resulting from the division pass into one of the two new individuals which are the product of germination, the other individual, which contains only one of the smaller nuclei, still undergoing complete development. The author observed also the germination of parthenospores, precisely resembling the zygotes except in their smaller size, each giving birth, like the zygotes, to two new individuals. The chromatic elements of the nuclei of the desmids are not filiform, as in *Spirogyra*, but granular or of the form of short rods, as in *Ascaris*; and Herr Klebahn thinks it probable that in the complete process of impregnation, two fusions take place, one between the two nuclei of the conjugating cells, the other between the large and small nucleus of each cell.

In the germination of other Conjugatæ, species of *Zygnema* and *Spirogyra*, the unicellular product has only a single nucleus, which divides into two when the cell itself divides.

Rhizoclonium.*—Herr S. Stockmayer reduces all the numerous species of *Rhizoclonium* described by various authors to five principal species, *R. hieroglyphicum*, *fontanum*, *Hookeri*, *angulatum*, and *pachydermum*, with numerous sub-species. He classes this genus, *Chætomorpha*, and *Cladophora* together, as forming the family Cladophoraceæ, nearly allied to Ulotrichaceæ. *Rhizoclonium* is distinguished from *Cladophora* by the absence of true branching, from *Chætomorpha* by the presence of rhizoids, though these are wanting in some of the slenderer forms; but it is probable that some of the more slender species of *Chætomorpha* should rather be assigned to *Rhizoclonium*. From *Conferva* and *Microspora*, *Rhizoclonium* differs in its reticulate chromatophores and the plurality of nuclei.

M. F. Gay † regards the presence of rhizoids as the only character which can at present be used to distinguish *Rhizoclonium* from the allied genera *Conferva* and *Cladophora*. He finds the cells to contain one or two nuclei; the zoospores escape through a lateral pore as in *Cladophora*, not by a circumscissile fissure through the middle of the cell as in *Conferva* and *Microspora*.

Oogone and Oosphere of Vaucheria.‡—Herr J. Behrens gives a careful description of the mode of formation of the oogone and oosphere in *Vaucheria sessilis* and *geminata*, confirming, in a general way, the account given by Berthold. The early stage of the formation of the oosphere consists in the detachment of the larger part of the protoplasm

* Abhandl. K. K. Zool.-Bot. Gesell. Wien., xl. (1890) pp. 571–86 (27 figs.).
† Journ. de Bot. (Morot), v. (1891) pp. 53–8 (4 figs.).
‡ Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 314–8.

from the wall of the oogone by vacuolization of the parietal layers. The beak of the oogone becomes perforated by the absorption of the swollen portion of the membrane; and the periplasm then flows out through the opening as a drop of mucilage which may contain a nucleus. In the young oosperm the chlorophyll-bodies become transformed into brown bodies, the process being similar to that which takes place in the antherozoids of the Fucaceæ.

Development of Hydrodictyon.*—According to M. A. Artari, the chromatophore in the cells of *Hydrodictyon utriculatum* is not granular, but forms a perforated and deeply lobed parietal plate, which becomes eventually very thin and reticulate. The mature cell is multinucleated, and the "light patches" are the nuclei seen through the chromatophore. Each nucleus subsequently forms a part of a megazoospore, these being formed by the breaking up of the chromatophore, and finally acquiring their vibratile cilia; each megaspore at this time contains a pyrenoid. The microzoospores (gametes) are formed in the same way as the megazoospores, the only difference being in their relative size and number.

Fungi.

Histology of Fungi.†—M. P. A. Dangeard has investigated the minute structure of Fungi belonging to the following families, especially with regard to the occurrence and number of nuclei:—Synchytriaceæ, Olpidiaceæ, Chytridineæ, Ancylisteæ, Saprolegniaceæ, and Peronosporaceæ; also *Spumaria* among Myxomycetes. A new genus *Resticularia* is described, belonging to the Ancylisteæ, nearly allied to *Lagenidium* and *Myzocytium; R. nodosa* is endophytic in *Lyngbya æstuarii.* The following are some of the more important conclusions arrived at.

The nuclei are most often limited by a double achromatic membrane; in the centre is a spherical nucleole which stains strongly with hæmatoxylin, being composed almost entirely of chromatin. Between the membrane and the nucleole is a more or less dense hyaloplasm, inclosing granulations, some at least of which consist of chromatin. The size of the nucleus varies greatly, the most frequent being between 1 and 5 μ; in *Synchytrium* it is much larger. In the young sporanges, cysts, spores, and zoospores, each cell contains a single nucleus; at a later period, especially in the vegetative cells, the number is often very large. The structure of the nucleus is subject to certain variations. The nucleole may be very minute or altogether wanting, when the nucleus is reduced to a simple vesicle with aqueous contents; the hyaloplasm may be destitute of granulations.

The mature sporanges and conids contain a definite number of nuclei, the number of zoospores being the same as that of nuclei, while each spore may contain several nuclei. The cysts are uninucleated.

The nucleation of the oosphere varies greatly in the different families. In *Ancylistes Closterii* the oosphere has, at all its stages, several nuclei, and the antherid is also plurinucleated. In *Saprolegnia Thuretii* the oogone includes a large number of nuclei; but those become

* Bull. Soc. Imp. Nat. Moscou, 1890, pp. 269–87 (1 pl.).
† Le Botaniste (Dangeard), ii. (1890) pp. 63–149 (2 pls.).

subsequently indistinct, and the young oospheres contain scarcely a trace of nucleus. In *S. monoica* the antherids possess several nuclei. In *Aphanomyces*, the number of nuclei in the oogone is about fifteen, in the antherids from three to six. In *Pythium*, the number in the oogone is from five to fifteen, according to the species, and it is possible to follow them out until the formation of the oospheres. In *Cystopus* the oogone has a large number of small nuclei; in *Plasmopora densa* both oogones and antherids are plurinucleated. As a general rule it may be said that both oogones and antherids contain several nuclei; those of the oogone may be divided into two groups; some of them are located in the periplasm, and are utilized in the formation of the spore-membranes; others remain in the oosphere; at the moment of fecundation they become indistinct, or only two of them are visible towards the centre; subsequently a large number are formed, which furnish, by division, the nuclei of the zoospores and of the vegetative filaments. A similar process appears to take place in the antherids.

Action of Fungi on copper and bronze.*—M. R. Dubois finds that concentrated solutions of cupric sulphate, neutralized by ammonia, as employed for the immersion of gelatinized plates used in photogravure, frequently contain whitish flocks of a septated fungus-mycele closely resembling that of *Penicillium* or *Aspergillus*. If a solution of cupric sulphate containing this mycele is placed on a carefully washed bronze coin, it will, when the liquid is completely evaporated, be covered by green spots resulting from the power of the fungus-mycele to convert the cupric sulphate into carbonate.

Effect of corrosive sublimate on Fungi.†—According to Mr. H. W. Russell glycerin containing 1 part in 10,000 of mercuric chloride does not interfere with the growth of *Penicillium glaucum*, while a proportion of 1 part in 6000 or 1 in 4500 entirely stops it. This fungus appears to be somewhat less resistant to the poison than some other forms.

Structure of the Peronosporeæ.‡—M. L. Mangin contests the view that the substance known as fungin or metacellulose exists as a distinct ingredient in the cell-wall of Fungi. The structure of the cell-wall in Fungi is complex, and varies greatly in the different families. In the Peronosporeæ, it consists, in the mycele and oosperms, of two substances, cellulose and callose, which can be separated by the method previously described by the author.§ The callose may occur in the form of spherical masses, or of rings on the inner side of the tube, sometimes almost completely closing its cavity. The mycele of the Peronosporeæ is readily distinguished from that of other families of parasitic Fungi by the presence of these thickenings of callose; the appearance resembles that sometimes presented by pollen-tubes. The mycele of these fungi also puts out small haustoria, of variable form, which furnish excellent characters for distinguishing the species; these also consist partly of callose, which is sometimes present in very large quantities. The constant presence of callose in the mycele of the Peronosporeæ serves as a test for the least trace of these parasites in the plants which they infest.

* Comptes Rendus, cxi. (1890) pp. 655-7.
† Bot. Gazette, xv. (1890) pp. 211-2.
‡ Comptes Rendus, cxi. (1890) pp. 923-6. § Cf. this Journal, 1890, p. 735.

Development of the Sporanges in the Saprolegniaceæ.*—Herr W. Rothert now publishes in German his paper on this subject previously printed in Polish, with an addition relating specially to the more recent papers of Berthold † and Hartog.‡

With regard to the observations of the latter, he points out that the species described by him as *Achlya polyandra* must be a different, hitherto undescribed species, since it has vibratile cilia, while *A. polyandra* is destitute of them. The two different structures of spore occur in the same genus. He also adduces reasons for dissenting from Hartog's view that the escape of the zoospores is due to the chemical stimulus of the oxygen in the medium acting on the motile zoospores.

Thamnidium mucoroides.§ — Herr H. Zukal describes this new species grown on alligator's excrement, which forms an interesting connecting link between *Thamnidium* and *Mucor*. It not unfrequently happens that the contents of the two conjugating cells fail to unite owing to the dividing wall not becoming absorbed. In that case two azygospores are formed.

Bargellinia, a new Genus of Ascomycetes.‖—Prof. A. Borzì describes, under this name, a fungus found in an excoriation of the human ear. Its mycele consists of exceedingly delicate branched and septated hyphæ, some of the branches of which swell at the apex into club-shaped asci, each containing usually a single ascospore, less often two. The author places *Bargellinia* among the Exoascaceæ, in the neighbourhood of *Endomyces*, *Eremascus*, and *Eremothecium*, but most nearly allied to *Oleina* and *Podocapsa*.

Semi-lichens.¶—Under the name "Halbflechten," Herr H. Zukal describes a number of organisms coming under one or the other of the following denominations:—Forms ordinarily occurring as lichens with their proper algæ, but in which the alga is sometimes wanting, and which therefore carry on a saprophytic existence; fungi which as a rule exist as saprophytes or parasites, but occasionally combine with an alga into a lichen-thallus; forms which generally occur united to particular algæ, but in their general behaviour resemble a parasite rather than a lichen-forming fungus. The following examples are given:—

Paruphädria Heimerlii g. et sp. n., on the stem and leaves of *Jungermannia quinquedentata*. The following is the diagnosis of the new genus:—Fructification blackish or dark brown, horny when dry, when moist cartilaginous and mucilaginous, inclosed when young by a flat cover perforated in the middle, which afterwards assumes the form of a ring or collar.

Glœopeziza Rehmii g. et sp. n., epiphytic on *Jungermannia trichophylla*. The genus is characterized by an almost microscopic fertile disc, bounded on the side by an envelope composed of modified para-

* Beitr. z. Biol. d. Pflanzen (Cohn), v. (1890) pp. 291–349. Cf. this Journal, 1888, p. 271.

† Cf. this Journal, 1887, p. 420.

‡ Cf. this Journal, 1890, p. 807.

§ Abhandl. K. K. Zool.-Bot. Gesell. Wien, xl. (1890) pp. 587–90 (1 pl.).

‖ Malpighia, ii. 1888 (1890) pp. 469–76.

¶ Flora, lxxiv. (1891) pp. 92–107 (1 pl.); and SB. K. K. Zool.-Bot. Gesell. Wien, xl. (1890) p. 53.

physes, above by a dome-shaped gelatinous mass. There is no pseudoparenchymatous cortex. Otherwise it resembles *Ascophanus*.

Nectria phycophila sp. n. (*Hypheothrix Zenkeri* Ktz.); *Endomyces Scytonematum* sp. n. (*Ephebella Hegetschweileri* Ktz.).

There is in fact no sharp demarcation between ordinary fungi and those which form lichens.

Calcareous Lichens.*—From an examination of exceedingly thin sections of *Verrucaria calciseda*, Herr E. Bachmann has satisfied himself that, contrary to the view of Zukal, the lime is not a product of excretion of the hyphæ of the lichen; but that both the hyphæ and the gonids are imbedded in hollows in the calcareous crystals, the principal part of the thallus penetrating the calcareous substratum to a depth of several millimetres. Similar results were obtained with other calcareous lichens.

Reserve-Receptacles in Lichens.†—Herr J. M. Hulth describes several examples of the occurrence of the reserve-receptacles in calcareous lichens, termed by Zukal "spheroid-cells." They contain a fatty oil; and that this is used up in the further development of the lichen is shown by the fact that the cells in question are frequently found empty.

Myriangium.‡—Dr. A. Minks has investigated the structure of this genus, which was erected by Nylander into an independent family of Lichens of primary importance, but has generally been placed under the Collemacei. Dr. Minks regards it as coming under his class of Pseudo-Ascomycetes. The ascus closely resembles that of *Arthonia*.

Pathogenic Species of Taphrina.§—Herr R. Sadebeck enumerates thirty-five species of *Taphrina*, five of them new, which cause injury to the plants on which they grow, these being almost invariably woody plants. Under the genus *Taphrina* (the older *Exoascus*), Sadebeck includes all those parasitic Ascomycetes in which the asci are not united into a fructification, but are distinct, often in great numbers, densely covering the leaves or flowers, and originating from a mycele which penetrates between the cells or beneath the cuticle of the tissue of the part attacked, but never piercing the cells themselves.

Distribution of Saccharomyces apiculatus.‖—From a fresh series of experiments, the details of which are given in full, Herr E. C. Hansen confirms his previous conclusions that this well-defined form of *Saccharomyces* propagates itself chiefly on ripe and succulent fruits, and not in the nectaries of flowers nor in the excrements of animals. The cells can retain their vitality in the soil for a period of at least three years.

The author expresses the opinion that the cycle of *S. apiculatus* may be taken as typical for most of the *Saccharomyces*. Pasteur, however,

* Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 141–4 (1 pl.).

† Naturv. Studentsällsk. Upsala, March 7, 1889. See Bot. Centralbl., xlv. (1891) pp. 209 and 269.

‡ Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 243–50.

§ Arbeit. Bot. Mus. Hamburg, 1890, 37 pp. and 5 pls. See Bot. Centralbl., 1891, Beih. 1, p. 75. Cf. this Journal, 1889, p. 680.

‖ Ann. Sci. Nat. (Bot.), xi. (1890) pp. 185–92. Cf. this Journal, 1882, p. 234.

considers that wine-yeasts pursue a different course, on the assumption that these cells are unable to retain their vitality in the earth from season to season.

Life-history of Puccinia Geranii sylvatici.*—Dr. A. Barclay has followed out the life-history of the Himalayan variety of this fungus, parasitic on *Geranium Nepalense*. Its cycle of development is complete without the formation of any other kind of spore than the teleutospores, of which it produces two distinct crops in the spring and summer. It is further interesting in partaking of the characters both of a *Leptopuccinia* and of a *Micropuccinia*, and thus breaking down the distinction between these two divisions of the genus.

Frankia subtilis.†—Herr H. Moeller supports Brunchorst's view that the swellings on the roots of the alder and of the Elæagnaceæ are true galls, and that they are produced not by a *Plasmodiophora*, but by a true fungus, *Frankia subtilis*. This has now been determined by Moeller to be a unicellular or pluricellular fungus belonging to the Hyphomycetes, producing a mycele of which each branch ends in a sporange; the protoplasm of this sporange divides into a large number of spores, each of which puts out a germinating filament, which gives birth to a new mycele. The galls are induced by the parasitism of this fungus.

Podaxon.‡—M. N. Patouillard gives a monograph of the eleven species of this exotic genus of Fungi, two of them new. They resemble the stalked *Lycoperdons*, and are composed of a tissue consisting of slender septated hyphæ, variously branched and anastomosing, and containing lacunæ. The basids are usually collected into large tufts on the trama, and the spores are, in most of the species, sessile.

Spores on the Surface of the Pileus of Polyporeæ.§—M. N. Patouillard records the occurrence of this phenomenon in *Polyporus fulvus* and *nigricans*. The spores are borne at the extremity of basids, which differ only in their position from those of the tubes. He regards the upper surface of the pileus as altogether homologous with the inner surface of the tubes, and as being equally entitled to the designation of hymenium.

Mycetozoa.

Orcadella, a new Genus of Myxomycetes.‖—Under the name *Orcadella operculata*, Mr. H. Wingate describes a new species and genus of Myxomycetes, found on living stems of *Quercus rubra* in the United States. He founds on it a new family of ORCADELLACEÆ, characterized by having sporanges without columel or capitulum, the upper part of the thick septum of the sporange being replaced by a delicate membrane with finely marked margin.

* Ann. of Bot., v. (1890) pp. 27–36 (1 pl.).

† Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 215–24 (1 fig.). Cf. this Journal, 1887, p. 611.

‡ Bull. Soc. Mycol. France, vi. (1890) pp. 159–67 (1 pl.). See Morot's Journ. de Bot., v. (1891) Bull. Bibl., p. xviii.

§ Soc. Mycol. de France, v. (1889). See Bot. Centralbl., xliv. (1890) p. 250.

‖ Rev. Mycol., xii. (1890) pp. 74–5.

Protophyta.

α. Schizophyceæ.

Symbiosis of Algæ and Animals.*—Prof. A. Famintzin describes the symbiosis of *Tintinnus inquilinus* with a diatom belonging to the genus *Chætoceras*, previously erroneously described as an *Ectocarpus*. The structures described as "yellow cells" he divides into two classes, one formed by *Zooxanthella extracapsularis*, the other by *Z. intracapsularis*. He has studied the vegetable parasite on species of the genera *Collozoum* and *Sphærozoum*.

Aquatic Vegetation in the Dark.†—Herr H. de Vries has investigated the fauna and flora of the dark places in the water supply system of Rotterdam. He finds the latter to consist almost entirely of enormous brown masses of *Crenothrix Künthiana*, together with a few desmids and diatoms. These were accompanied by large quantities of fresh-water sponges, and of *Dreyssena polymorpha* and *Cordylophora lacustris*.

Dicranochæte.‡—Dr. G. Hieronymus describes in further detail this genus of Protococcaceæ, distinguished by each cell putting out one, or less often, from two to four hyaline bristles, from 80 to 160 μ in length, composed of gelatin. The bristles pierce the gelatinous envelope of the cell, which is often conspicuously striated in a radial direction when stained, and are usually branched. The contents of each cell divide ultimately into from eight to twenty-four zoospores, which escape by the lifting up of a portion of the cell-membrane as a kind of lid which is furnished with spiny protuberances. The chlorophore contains one or more pyrenoids, as well as starch-grains. Each zoospore contains a nucleus.

Coscinodisceæ.§—With the view of checking the undue multiplication of the genera and species of diatoms, Dr. J. D. Cox has studied the various forms of Coscinodisceæ, and proposes the following seven types, round which several hundred alleged species range themselves, viz.:—*Actinocyclus Ehrenbergii*, *Coscinodiscus subtilis*, *C. radiolatus*, *C. lineatus*, *C. radiatus*, *C. centralis*, and *C. marginatus*. The characters of these seven types are given, and the following observations added:—(1) The so-called pseudo-nodule of *Actinocyclus* is less important as a generic mark than the other characteristics which are identical with the fasciculate *Coscinodisci*. (2) Colour is an untrustworthy mark of species. (3) The number of fascicles is no mark of species. (4) The so-called subulate spaces in *Actinocyclus* are not marks of distinction of species. (5) Considerable changes of form may occur without becoming the ground of new species. (6) Sparseness of alveoli is often misleading as to pattern of marking, and is not reliable as a specific distinction. (7) A striated margin is often apparently present or absent, as more or less of the bevelled marginal zone of the fasciculate forms is shown. (8) New species have often been based upon different valves of the

* Mém. Acad. Sci. St. Pétersbourg, 1890. See Neptunia, i. (1891) p. 33.

† 'Die Pflanzen u. Thiere in d. dünklen Räumen d. Rotterdamer Wasserleitung,' Jena, 1890, 8vo, 73 pp. and 1 pl.. See Bot. Centralbl., xlv. (1891) p. 46.

‡ Beitr. z. Biol. d. Pflanzen (Cohn), v. (1890) pp. 351–72 (2 pls.). Cf. this Journal, 1889, p. 101.

§ Proc. Amer. Soc. Micr., 1890, pp. 184–204 (2 pls.).

same frustule. (9) Marginal or intra-marginal circlets of spines are a very variable character. (10) The rosette in the centre of *C. radiatus*, &c., is not a mark of species. (11) *Craspedodiscus* is not generically or specifically distinct from *Coscinodiscus*. (12) The occurrence of two thin places in the rim of *Coscinodiscus* is not a mark of species. (13) Confluence of alveoli into larger ones is not a mark of generic difference. Much further knowledge is required of the life-history of diatoms before we can lay down final laws as to the limitation of genera and species.

New Genera of Diatoms.—M. P. T. Cleve* describes a new genus of Diatomaceæ, *Dictyoneis*, including several new species, and others previously included under *Navicula*, *Pseudodiploneis*, and *Mastogloia*, in which the outer layer of the valve is composed of large areolations, having the form of vesicles, and giving to this layer a reticulated appearance. It is exclusively marine, and from the warmer parts of the globe; fossil forms are also known.

Brunia is a new fossil genus from Japan, described by M. M. J. Tempère,† in which the valve has the form of a round plate, the hollow of which is moderately deep, and has its walls at right angles to the bottom; the edge is beautifully sculptured.

Diatoms from Java.‡—Among a collection of freshwater diatoms from Java, Herr O. Müller describes one in both the fresh and fossil condition, which must have persisted unchanged since the Middle Tertiaries, *Melosira undulata*. It is remarkable from the fact that many individuals have more than one stalk; and apparently any spot in the cell-wall can give rise to a stalk which connects itself with any spot in a neighbouring cell. The stalk appears to be a product of transformation of the outermost layer of the cell-wall. The author also had under his observation a fragment of a fossil auxospore, and was able to determine that the mode of formation of auxospores was the same in those remote times as to-day.

Pearls of Pleurosigma angulatum.§—Regarding the controversy whether the so-called "pearls" of this diatom are round or hexagonal, M. L. Duchesne states that it is shown by photomicrometrical observation that their apparent form is simply a question of focusing. If the objective is focused exactly to the summits of the pearls, they appear round, if to their base or lower, a hexagonal image is obtained. The author's own observations lead him to the conclusion that their true shape is round.

Commenting on this paper, Dr. J. Pelletan || maintains, contrary to the view of Van Heurck, that the "pearls" are not hexagonal and hollow, but are really, as their name implies, hemispherical projecting grains, which may possibly become hexagonal at their base owing to reciprocal pressure. When the focal plane was tangent to the pearls, each pearl was represented by a black spot (the top which was in focus) surrounded by a white circle (the rest of the pearl which was not in focus). As the focal plane was lowered, each pearl gave a larger and

* Le Diatomiste, i. (1890) pp. 14–7. † T. c., pp. 21–2 (1 pl.).
‡ Ber. Deutsch. Bot. Gesell., viii. (1890) pp. 318–31 (1 pl.).
§ Le Diatomiste, i. (1890) pp. 27–30 (2 pls.).
|| Journ. de Micrographie, v. (1891) p. 356.

larger black circular image, surrounded by a smaller and smaller white circle, until at length an image was obtained in the thickness of the valve where the pearls take their origin. The image was then hexagonal.

Deformed Diatoms.*—Dr. J. D. Cox describes a number of specimens of diatoms which are deformed in the following ways, viz.:—(1) indented or deformed outlines; (2) double or multiple centre in the scheme of marking; (3) marking unsymmetrically varied. He thinks that a further study of this subject may have the effect of reducing the enormous catalogue of species of diatoms.

β. Schizomycetes.

Bacteria and Disease.†—In a lecture on the connection between bacteria and the poisons of disease, Prof. Brieger, after alluding to the early historical aspects of the subject, takes as his keynote the aphorism invented by Mitscherlich, that Life is but Putrefaction. He then passes on to consider the alkaloidal bases met with in the human body. The aromatic series, such as indol, skatol, carbolic acid, kresol, are passed over rapidly, as being of little import. He then divides the products of bacterial metabolism into toxines and ptomaines, according as they are poisonous or non-poisonous. He then proceeds to show how closely connected these bodies are with the presence of bacteria and the process of digestion; for example, when fibrin is digested with pepsin, a poison, peptotoxin, is produced which kills the lower animals with palsy of the posterior extremities. So too from decomposing flesh can be isolated neuridin, cadaverin, putrescin, and certain toxines, as neurin, methylguanidin, mydatoxin, and a fourth isomerous with typhotoxin. Another toxine, alluded to at some length on account of its fatality and special character, is mytilotoxin, a poison found in mussels.

The author next proceeds to notice these ptomaines and toxines which are the direct derivatives of pathogenic bacteria. The first alluded to are *Staphylococcus pyogenes aureus* and *Streptococcus pyogenes*. These micro-organisms, which are intimately connected with pyæmia and septicæmia, show, however, important chemical differences; for the former when cultivated in meat broth throws off ammonia, and the latter trimethylamin.

The bacillus of typhoid is responsible for typhotoxin, and the cholera bacillus for several, such as penta- and tetramethylendiamin, methylguanidin, and certain specific toxines. Passing over the toxines of tetanus and anthrax, we may notice that four authors are quoted who have found that that curious disease cystinuria is due to an intestinal mycosis, and must therefore be placed among infectious diseases.

The specific action of the various toxines is regarded as a conclusive proof of the constancy of the species of bacteria.

Infection of Vicia Faba by Bacillus radicicola.‡—By an apparatus contrived for the purpose, Herr M. W. Beyerinck has been able to infect plants of *Vicia Faba* by *Bacillus radicicola*, and thus to induce the formation of the well-known tubercles on the root. He finds these bacilli to

* Proc. Amer. Soc. Micr., 1890, pp. 178–83 (1 pl.).
† Biol. Centralbl., x. (1890) pp. 364–73.
‡ Bot. Ztg., xlviii. (1890) pp. 837–43 (1 fig.).

be an extraordinarily delicate reagent for nitrogenous compounds, forming albuminoids out of them. The author regards *Bacillus Ornithopi*, which produces tubercles in the roots of *Ornithopus sativus* and *perpusillus*, as a different species from *B. radicicola*, the latter not causing the production of tubercles in species of *Ornithopus;* while the latter is without effect on *Vicia Faba*.

Micro-organisms of Influenza.*—Herr Bein examined twenty cases of influenza for the purpose of ascertaining if the disease were causally connected with one or various micro-organisms. In the sputum, in pleural exudation, in the lungs, and in the dead body, diplococci, streptococci, and staphylococci were invariably present, and the conclusion arrived at is that the lung mischief in influenza is due to the co-operation of several kinds of micro-organisms, no specific microbe being detected. The author regards the diplococci alluded to as being closely allied to, but not identical with, Fraenkel's diplococcus. Micro-organisms were never found in the blood of patients while alive.

Sig. S. Sirena † found in the sputum of influenza Fraenkel's diplococcus, together with numerous other micro-organisms. In a case of hæmorrhagic pneumonia this microbe was present in the sputum as an almost pure cultivation. Moreover, gelatin-plate cultivations of the nasal secretion failed to demonstrate any other micro-organism. Special attention was paid to the examination of the blood. In the fresh condition both stained and unstained preparations failed to show micro-organisms or other abnormal constituents, so too cultivations on various media remained without exception sterile. The author concludes, therefore, that the presence of certain microbes in the sputum and other secretions in cases of influenza is connected with the simultaneous or consecutive complications of this disease, and that its specific contagium is at present unknown.

Influence of Ozone on the Growth of Bacteria.‡—From an examination of the influence of ozone on the growth of bacteria, Herr Wyssokowicz finds that the bacteria examined by him (anthrax, typhoid, pneumonia, mouse-septicæmia) have their growth decidedly interfered with by ozone. With chromogenic bacteria the pigment development was either nil, much diminished, or tardy; a condition which apparently depends directly on the action of the ozone on the pigment. Spore-formation also was tardy and scanty. The action of ozone is the result of a diminution of the nutrient value of the medium, owing to the oxidation of the bases in the medium. The influence of oxygen depends not only on the formation of acids, but also on other changes, which have previously occurred in the nutrient medium.

Action of Pyoctanin on Bacteria.§ — The experiments of Herr Jaenicke, with *Pyoctanium cæruleum*, *P. aureum*, and methyl-violet 6 B,

* Zeitschr. f. Klin. Medicin, xvii. (1890) No. 6. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 171–2.

† La Riforma Med., vi. (1890) p. 680. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 174–5.

‡ Mittheil. Wiss. Brehmer's Heilanstalt, 1890. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) p. 662.

§ Fortschr. d. Med., viii. (1890) No. 12. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 598–9.

are practically a repetition of those previously made by Stilling, who found that certain anilin pigments possessed an inhibitory (and even disinfecting) action on the growth and development of bacteria. The author used as media meat-extract-peptone-grape-sugar-bouillon, and blood-serum; these were mixed with definite quantities of the pigments, inoculated with certain micro-organisms, and incubated for ten days at 36° C.

In the result it was found that the methyl-violet was more efficacious than the auramin, and might be used for practical purposes as a 1 per thousand solution. In the face of its toxic action and the by no means inconsiderable local irritation, the advantages are doubtful, although of course the observations are not without value.

Action of Artificial Gastric Juice on Pathogenic Micro-organisms.* —Herr G. Kabrhel, in examining the action of artificial gastric juice on typhoid bacillus, cholera bacillus, *Bacillus neapolitanus*, *B. diphtheriæ* Emmerich, *Staphylococcus pyogenes aureus*, and *Streptococcus articulorum*, adopted three modifications by combining an aqueous solution of pepsin plus hydrochloric acid, an aqueous solution of the acid alone, and an aqueous solution of pepsin to which hydrochloric acid and albumen were added.

It was found that the acid without or with pepsin had a powerful antibacterial action, especially on typhoid and cholera bacilli, to which micro-organisms special attention was devoted.

The question next arose as to the effect on micro-organisms which the gastric juice, or say the acid only, would have under approximately normal conditions; for in the stomach the acid compounds of albumen are formed, and this is hardly the same thing. And in fact the author's experiments showed that in the presence of albuminous bodies the hydrochloric acid lost its antiseptic action, at least to a considerable extent, for the cholera bacillus was the only microbe experimented on under the conditions alluded to, that is with hydrochloric acid and albumen, which did not survive.

Ripening of Cheese.†—Herr L. Adametz ascertained, by bacteriological examination of two kinds of cheese (Emmenthaler and Hauskäse), that these reeked with micro-organisms, Emmenthaler containing 850,000, and Hauskäse 5½ millions per gram.

That the presence of bacteria in cheese was certain follows from the fact that disinfectants stop the ripening process, as also does sulphuric acid vapour when new cheese is kept in it.

Nineteen species of bacteria were isolated from cheese. Of these, seventeen were new species, five belonging to the genus *Micrococcus*, four to the genus *Sarcina*, and eight to the genus *Bacillus*. From their physiological properties these bacteria are divisible into three groups:—(1) Those which being able to dissolve the paracasein or to convert it into a softened condition, give rise to a greater or less quantity of albuminoids or peptone, frequently accompanied by traces of disagreeable (butyric

* Archiv f. Hygiene, x. (1890) No. 3. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 282–3.

† Landwirthsch. Jahrb., 1889, pp. 227–69 (2 pls.). See Bot. Centralbl., xliii. (1890) p. 26.

acid) and agreeable (extractive matter) compounds. (2) Those which develope with difficulty in sterilized milk, and for which unaltered paracasein is a favourable nutrient medium. (3) Those which have no special effect on the nutrient material, and the presence or absence of which has, in contradistinction to classes 1 and 2, no bearing on the ripening process.

Pseudo-tuberculosis of Rodents.*—Herr Pfeiffer proceeded to examine this question by inoculating two guinea-pigs with pieces from the lungs and lymphatic glands of a horse affected with glanders. In about eight days the animals died, and on examination their various organs were found to be infiltrated with nodules (pseudo-tubercles). From the spleen and liver cultivations were made, and in 18 to 20 hours colonies of plump bacilli developed. These, although in certain respects resembling the bacilli of glanders, were not identical with them. From scores of infection experiments the author found that this bacillus was only inoculable on rodents. The cultivated bacillus did not stain with Gram's method and Bismarck-brown, only imperfectly with methyl or gentian-violet, somewhat better with fuchsin, but best of all with Loeffler's methylen-blue solution. With the exception of potato, the bacillus grew on all the usual cultivation media, and at high and low temperatures.

Spore-formation was not observed. The virulence of the organism was not affected by exposing it for hours to subnormal temperatures ($-16°$ C.), but $+60°$ C. destroyed it in one hour.

Present Position of the Theory of Immunity.†—In discussing the various views on immunity, Herr Ribbert divides them into two categories according as they deal with absolute or relative immunity. Absolute immunity embraces all the theories which do not require any active exertion or co-operation on the part of the immune body. To this class belong the hypotheses which assert that the bacteria die from want of nutrition or from some germicidal property of the blood-plasma, a property which is effective from its alkalinity, the presence of CO_2, or to coin a suitable word, its albuminism. According to this view immunity does not depend on a struggle; but relative immunity, which forms the second category, is the result of a contest between the bacteria and the body-elements. This practically amounts to Metschnikoff's theory of phagocytes. The author expresses his views somewhat as follows. Absolute immunity depends on the inability of bacteria to decompose the albuminoid products of the body in order to apply them for their own nutrition. This may be acquired by the body as the result of a single infection, by supposing that the cells thereby become habitualized to the bacteria, and transmit their acquired resistance to succeeding cell generations and the circulating albumen. Relative immunity depends on the imperfect or insufficient supply of nutrition to the bacteria in consequence of the greater or less resistance of the tissues and juices of the body. The vegetation of the micro-organisms causes an increased development of heat, and an augmented accumula-

* Leipzig, 1889, 6 microphotographs. See Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 379–80.

† Deutsch. Med. Wochenschr., 1890, No. 31. See Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 734–6.

tion of the germicidal products of tissue change. The increased metabolism is the result of heightened activity of the cells in the protoplasm of which the bacteria are most easily destroyed. In local diseases the leucocytes co-operate in the destruction of the bacteria by surrounding them, and thus preventing their entrance into the lymph-streams.

Antiseptic Action of the Fluoride of Methylen on the Pyogenic Bacteria of Urine.*—M. O. Chabrié made the following experiments to ascertain if the gas discovered by him, fluoride of methylen, possessed an inhibitive action on the development of the pyogenic bacteria found in the urine. Two test-tubes containing urine infected with pyogenic bacteria were inverted under mercury; one of the tubes contained equal volumes of air and the fluoride of methylen, the other air alone. After having been kept for 24 hours at a temperature of 35°, a drop was taken from each specimen and inoculated in sterilized bouillon. The two bouillon flasks were then incubated for 24 and 48 hours respectively. At the end of that time it was found that there was no development in the flask infected from the urine treated with the antiseptic gas, but in the other a copious development.

A similar experiment was carried out, but this time the mercury was omitted; the same result was obtained. Hence the author concluded that this gas might be used for treating certain cases of inflammation of the bladder, provided that its action were not too irritating. To ascertain this, a mesentery and the web of a frog's foot were exposed to the action of the vapour. No irritating effect was observed other than that produced by the mere passage of air.

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HURD, E. P.—**Diseases whose causal Microbes are known.**
Med. Age, 1891, No. 1, pp. 1-7.

* Comptes Rendus, cxi. (1890) pp. 748-50.

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Torino (Rosenberg e Sellier), 1890, 8vo, 121 pp.

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Brit. Med. Journ., 1891, No. 1570, pp. 213–7.

NETCHAEFF, P.—**Phagocyten in Beziehung zu infecktiosen pathogenen Mikroorganismen.** (Phagocytes in relation to Infectious Pathogenic Micro-organisms.)
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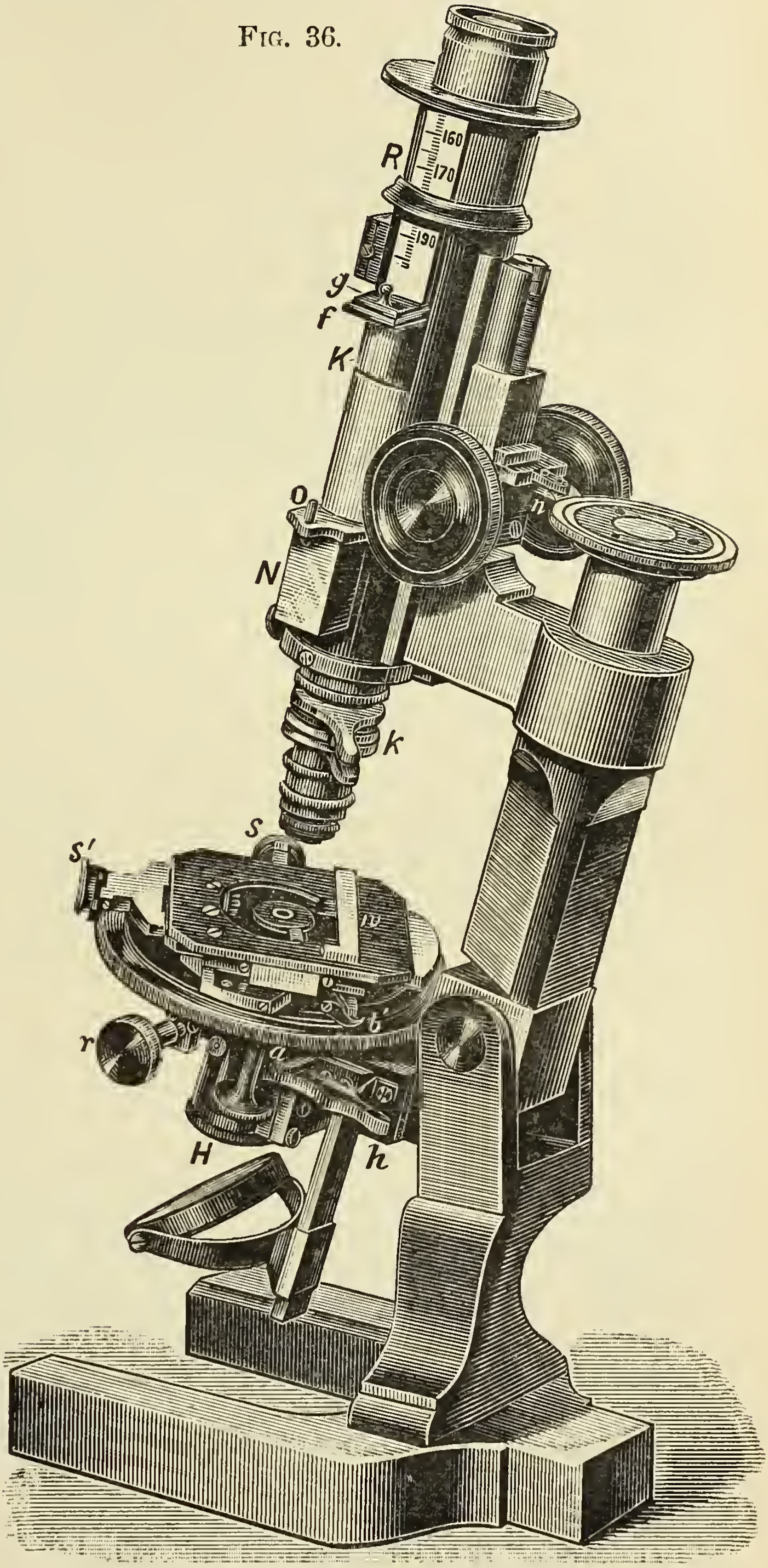
MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Fuess's Petrological and Crystallographic Microscopes.† — Herr R. Fuess has introduced several improvements into his Petrological Microscope, which now has the form given in fig. 36.

Fig. 36.



The object-stage is fitted for fine measurements. The scale is graduated in half degrees and two verniers read to minutes. The stage-plate has a toothed edge and is rotated by means of a pinion *a*, which can be thrown out of gear by the lever *h*. A mechanical stage is applied on the rotating stage-plate. By one of the rectangular movements effected by the screw S an interval of 0·01 mm. can be indicated. The other screw S′ has a more rapid thread to enable the preparation to be quickly passed across the field of view. The mirror slides vertically on an arm which can be rotated to one side. The polarizer has a rack-and-pinion movement. A conical stop fitting into corresponding slots in the socket determines the position of the nicol for 0°, 45°, and 90°. An iris-diaphragm can be inserted beneath the nicol. A condensing lens of great focal length atttached to the polarizer serves for 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.

† Zeitschr. f. Wiss. Mikr., vii. (1890) pp. 177–87.

illumination of the preparation when the lower objectives are used. This lens forms the lower member of the condensing system, which consists of three lenses, the other two being connected together but detached from the polarizer. The common socket of the two upper lenses is supported in a ring which forms the end of the arm *b* of a rotating plate fitted in the object-stage. By means of a weak spiral spring in the ring-holder, the socket follows the movement of the polarizer, so that the whole condensing system can be adjusted by the pinion which effects the movement of the polarizer. By a second arm *b′* from the rotating plate of the lens-holder, the upper pair of lenses can be moved to one side beneath the mechanical stage, so that the change from convergent to parallel light and *vice versâ* can be rapidly effected without moving the preparation.

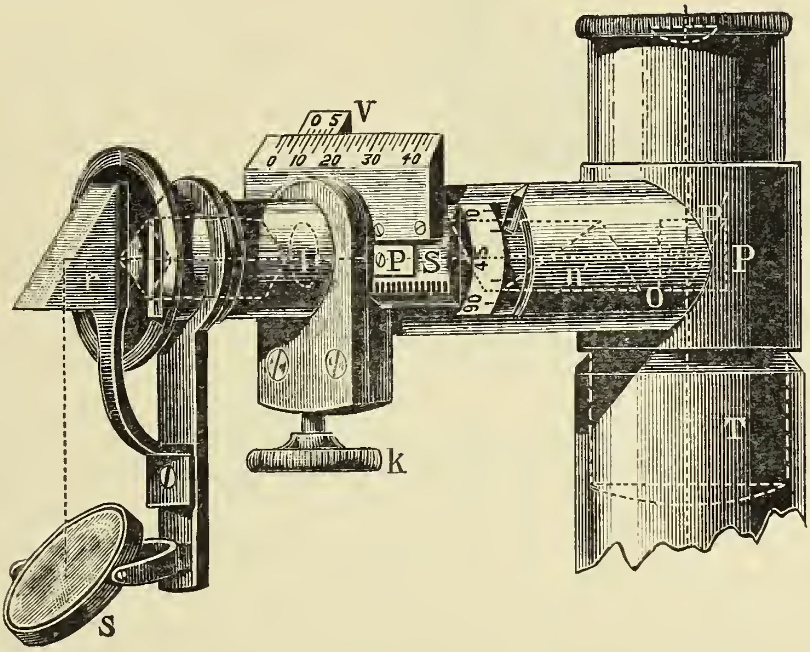
The coarse-adjustment of the Microscope is by rack and pinion. The fine-adjustment screw has a pitch of 0·5 mm. The head is divided into 100 parts, and a vernier reads to a fifth of a division, i. e. to 0·001 mm. The end of the body-tube carrying the objective is movable by two fine screws for centering. To facilitate the change of objectives, the latter are not screwed on, but held by the clamp *k*. Immediately above the clamp is a slit for the introduction of a Klein's plate, quarter-wave plate, &c. The analysing nicol N is inserted in a wider opening at the lower end of the body-tube. Another opening K serves for the introduction of the auxiliary objective into the draw-tube R. The lens is fastened in the slide *f*, and forms with the Ramsden eye-piece a complete Microscope, with a magnification of about five times. This constant magnification is advantageous for measuring the apparent optic axial angle. The draw-tube carries a millimetre scale which gives the distance of the eye-piece from the objective. Among the accessories of the Microscope are the illuminating apparatus and spectropolarizer of Abbe, the twin-nicol for stauroscopic measurements, and the illuminating arrangement of Sorby which serves for the observation of the internal and external conical refraction.

Of the special eye-pieces, the goniometer eye-piece consists of a Ramsden eye-piece which is directed upon cross wires centered by four adjusting screws exactly in the axis of a divided circle.

The quartz-wedge comparator shown in fig. 37 is a modified form of that of Michel Levy. It slides in the tube T of the Microscope, and in this part consists of an ordinary weak eye-piece, in which, in the place of the usual diaphragm, is a double prism of glass P P′, with the hypothenuse faces cemented together. The hypothenuse P′ is silvered with the exception of a small circle in the centre, through which the polarization tint of the preparation is seen. The main part of the comparator is contained in the side tube. Rays from the mirror *s* are diverted at right angles by the prism *r* into the polarizer *n*, the rotation of which can be measured on a divided circle. The lens *l* concentrates the light upon the quartz wedge *q*, behind which is a diaphragm with a very small aperture. The quartz wedge is fastened in the slide S′, which is moved by rack and pinion, and its position is given by the vernier V. The light passes through the analyser *n′* to the lens *o*, and is reflected from the hypothenuse of the prism P′ in the direction of the axis of the eye-piece. The polarization tint of the preparation is thus seen surrounded by that of the quartz wedge, and a ready comparison can be made.

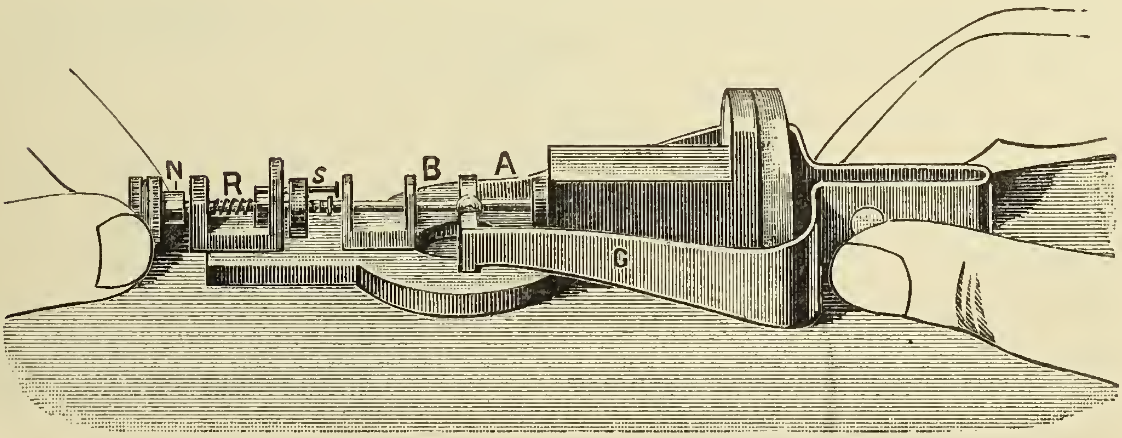
The axial angle apparatus for very small plates, shown in fig. 38, is similar to the Schneider-Adams apparatus, in which two small hemispherical lenses inclosing the plate can be rotated between condenser and

FIG. 37.



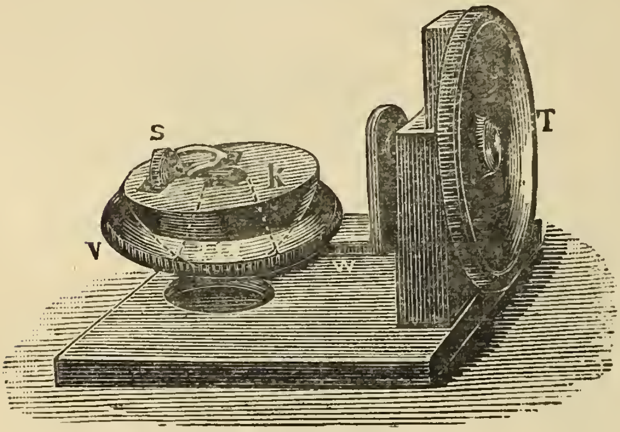
objective. The base-plate is held on the stage by spring clips. Above this plate is the horizontal axis, carrying at its outer end a divided circle, with vernier reading to five minutes. The spindle at the other end of the axis A reaches nearly to the middle of the apparatus, and

FIG. 38.



is funnel-shaped at its end. The cylindrical bolt B, also funnel-shaped at the end, is movable by the screw R in the direction of the axis. By left-turning of the mother screw N, a spiral spring drives forward the screw shaft, whose end has a funnel-shaped depression in which the end of the bolt fits. By right-turning of the screw the shaft is drawn back and with it the bolt, by the pin *s* coming in contact with the small projecting plate on the bolt. The two hemispherical lenses are held between the funnel-shaped depressions of bolt and axis. By pressure of the spiral spring the bolt is kept centered with respect to the axis, while it can move freely at both ends so that it rotates with the axis when the latter is turned.

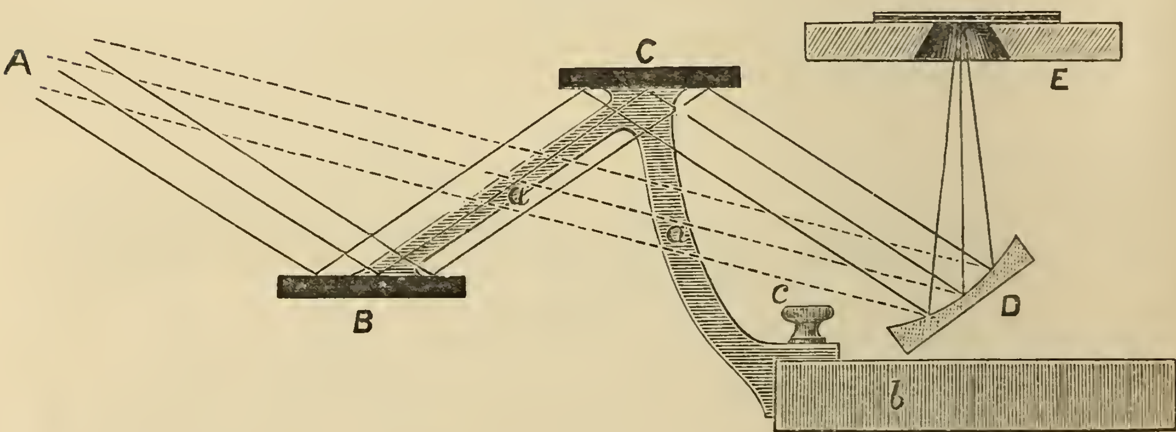
Fig. 39.



The goniometer for microscopic crystals (fig. 39) consists of a base-plate, on which is an upright carrying the divided circle T movable about a horizontal axis. The angle arm *w* ends in a ring which is parallel to the axis of the divided circle, and supports a second ring *v* movable in it. The hemisphere *k*, movable with friction in the ring *v*, has a conical opening bored through it, with the narrow central aperture in the flat surface. Along a radial groove runs the needle, at the point of which the crystal to be measured is fixed. It is kept in position by a spring, and is rotated by the milled head S.

Some Improvements in the Crystallization Microscope.*—Prof. O. Lehmann remarks that the old form of crystallization Microscope, described in Zeitschr. f. Instrumentenk., 1886, p. 325, suffers from the disadvantage that it is impossible to observe the preparation between crossed nicols during the heating. The method which first suggests

Fig. 40.



itself for obviating this difficulty, that of placing the polarizing nicol before the mirror, is unsatisfactory, owing to the large size of the nicol required.

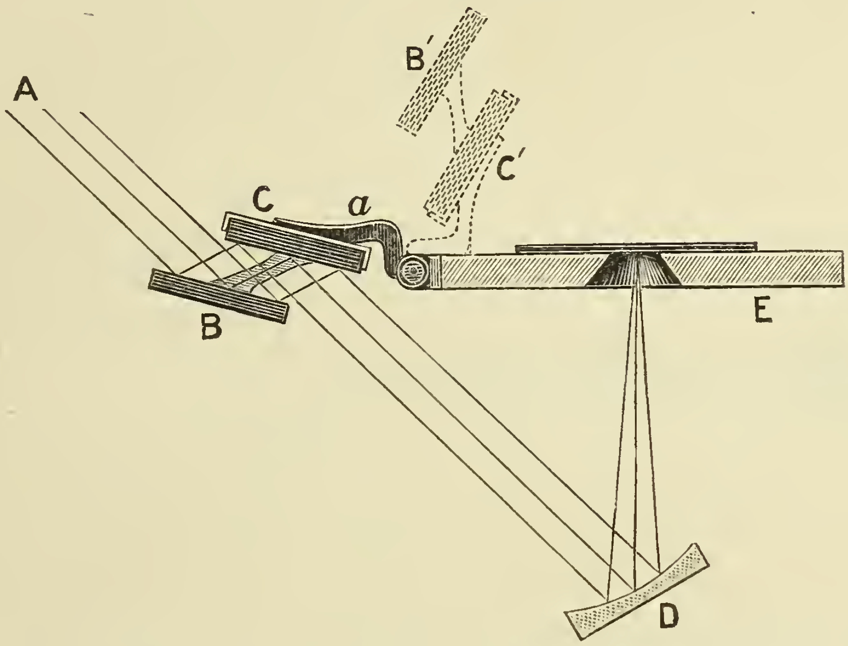
Fig. 40 represents the arrangement proposed by the firm of Zeiss, in which the polarizing nicol is replaced by two piles of glass plates.

* Zeitschr. f. Instrumentenk., x. (1890) pp. 202–7.

Light from the source A, incident at the polarizing angle on the first pile of plates B, is reflected to the second pile C, and thence to the mirror D. The two reflectors are fastened to the frame *a a*, which is firmly fixed to the foot *b* of the instrument by the binding screw *c*. A very slight turn of the mirror is sufficient to direct the unpolarized rays, represented by the punctuated lines in the figure, upon the object, so that the change from ordinary to polarized light and *vice versâ* is very easily effected.

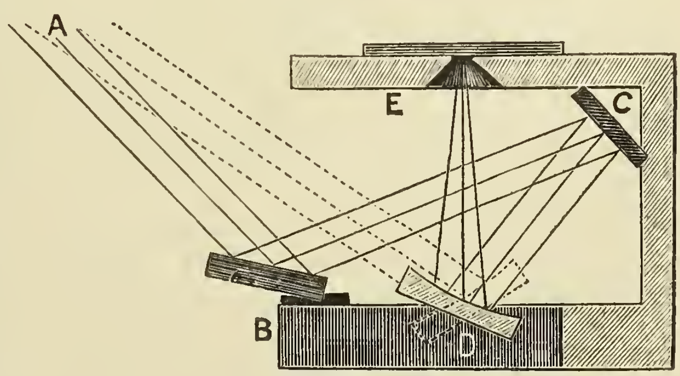
Fig. 41 shows a similar arrangement made at the author's suggestion, by O. Behm, of Karlsruhe. The frame carrying the two reflectors B and

FIG. 41.



C (each consisting of five large cover-glasses) is hinged to the edge of the object-stage E, so that for observation in ordinary light it may be swung back into the position B′ C′.

FIG. 42.



The arrangement shown in fig. 42, due to Voigt and Hochgesang, of Göttingen, is considered by the author as the most efficient. Rays from the source A fall upon the polarizing reflector B, and thence almost perpendicularly on an ordinary mirror C, from which they are reflected to the concave mirror D. Observation in ordinary light is effected by turning the latter into the position punctuated in the figure.

The heating apparatus of the Microscope has been simplified. For ordinary requirements a burner with small non-luminous flame is used to replace the inconvenient blow-pipe arrangement of the old instrument.

Fig. 43 represents the burner used when only slight changes ot temperature are needed. It gives a very small blue flame, and is itself so small as only slightly to interfere with the brightness of the field of view. In the other form of burner (fig. 44), used for higher temperatures, the gas issues from a ring-shaped slit. It is closed beneath by a thin plate of glass or mica, so that the flame is driven towards the centre by the draught thus produced. The brightness of the field of view is not sensibly affected by the passage of the rays through this transparent plate and the thin layer of burning gas within the ring.

Fig. 43.

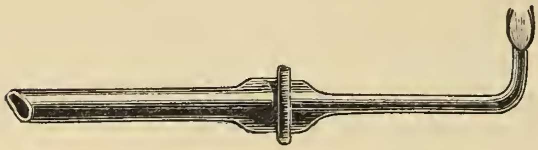
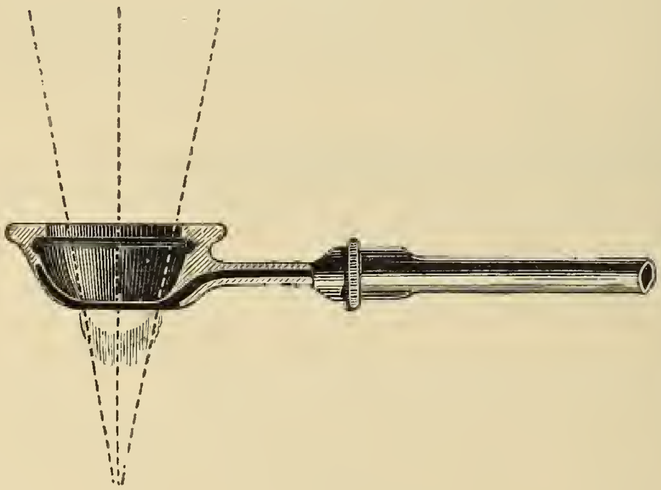


Fig. 44.



As a further improvement of the Microscope, the divided circle is enclosed in the object-stage, so that it is protected from dirt and injury from acid vapours, &c. The scale is read directly from above by means of a window in the upper side of the stage.

For experiments at very high temperatures, the larger instrument described in the Zeitschr. f. Instrumentenk., 1884, p. 369, is necessary. Into this several improvements have been introduced. In order to effect a greater concentration of heat upon the object, and to diminish the heating of the metal parts of the Microscope, the blow-pipe flame is directed through a chimney of asbestos, bound with brass, which can be fitted into the opening of the stage. A new form is given to the water screen protecting the objective. It consists of a socket 2 cm. long, with double walls and strong copper base, which fits tightly over the objective, and expands at its upper edge into a disc of about 5 cm. diameter. To prevent the condensation of water upon the objective, an arrangement is added by which a stream of air is directed upon it.

Improvements have also been made in the Projection Microscope described in this Journal, 1887, p. 291. The indiarubber tubes of the old instrument are replaced by metal ones. For cooling the alum solution, a spiral tube conveying a stream of cold water is used instead of the water screen. The mirror is not rigidly fixed as before, but can be turned about a hinge and fixed by a binding screw several degrees from its normal position of 45°. By this means a uniform brightness can be maintained when, by changes in the electric arc, the illumination of the field of view has slightly shifted. For cooling the preparation there are three small tubes in the stage, by which a stream of air can be directed upon its under side. Instead of the black cover of the old instrument, two screens are found to be sufficient to prevent the dispersion of the light. One of these is hinged to the holder of the totally reflecting prism, while the other is fixed horizontally above it. The prism is made of a specially strongly refractive glass of the firm of Zeiss, since by the use of ordinary glass a part of the field of view is cut off by total reflection.

Remarking on this paper,* Herr R. Fuess takes exception to the remark, that the old form of instrument, whose construction was undertaken by the firm of Fuess, has the great drawback that it is not possible to observe the preparation between crossed nicols during the heating. To prevent misunderstanding he states that he did actually at one time undertake the construction of the Microscope described in Zeitschr. f. Instrumentenk., 1886, p. 325, but that pressure of business prevented him from attempting any technical improvements in the instrument, and at length compelled him to relinquish the undertaking altogether. He wishes it, therefore, to be clearly understood that no Lehmann Microscope of the form described has been made by him. He adds, that some years ago he constructed a heating apparatus for his crystallographic Microscopes, by which the preparation could be heated to a clear red glow during observation between crossed nicols.

Van Heurck's Microscope for Photography and High-power Work.—The following description of this instrument (fig. 45) is translated, with modifications, from the fourth edition of Dr. Henri Van Heurck's work on 'The Microscope,' which is now in the press:—

"In the Microscope which W. Watson and Sons have made to our specification we have attempted to combine convenience for ordinary work with the utmost possible precision, and at the same time to keep the price comparatively low.

Messrs. Watson have admirably carried out all the plans we submitted to them, and the instrument they have produced may be justly considered as realizing in various ways a degree of perfection which has never hitherto been reached.

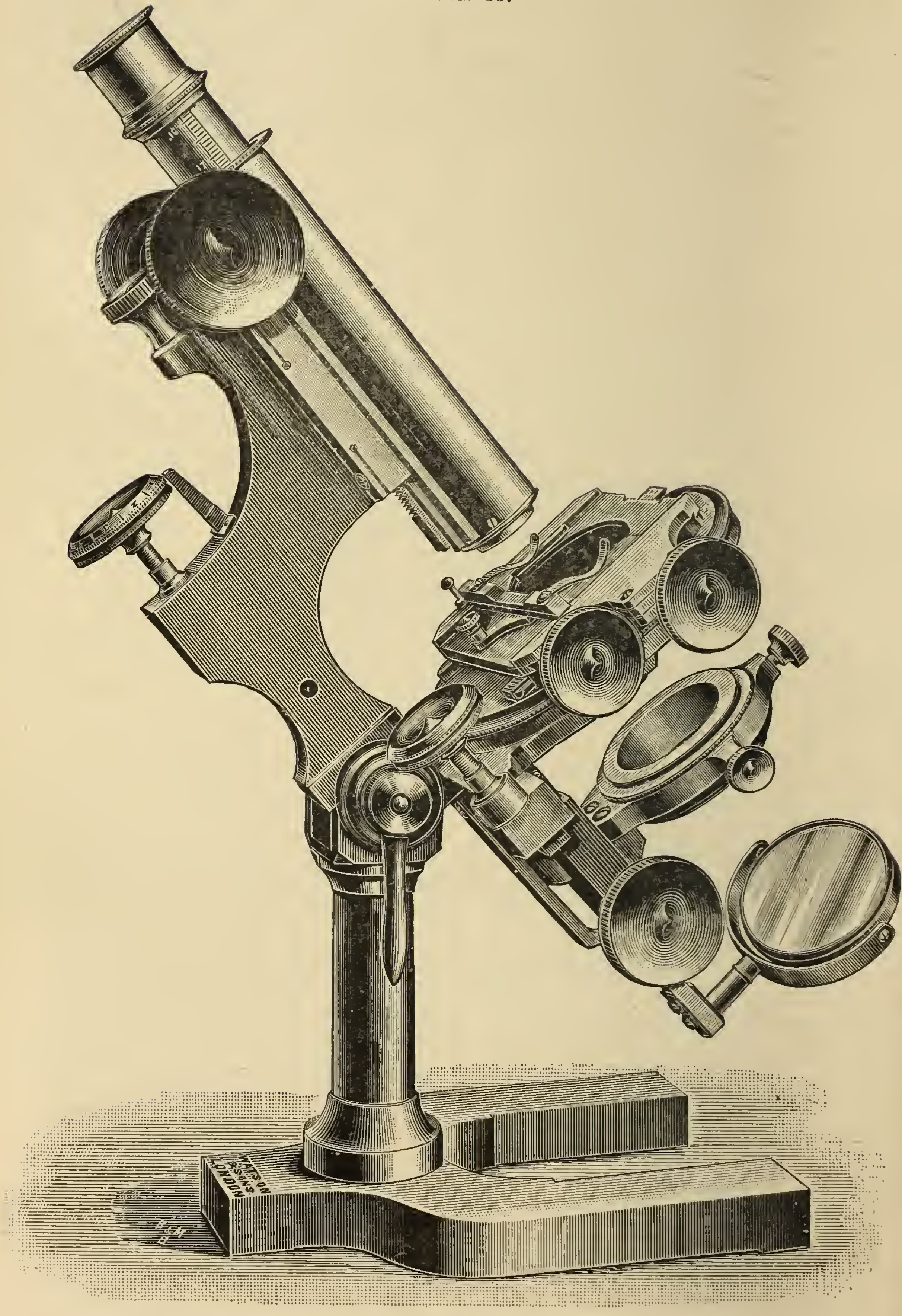
The base of the instrument is of the horseshoe form, bronzed; at the three points on which it stands slightly projecting pieces of cork are inserted, which reduce the tremor, prevent the instrument from slipping, and the table from being scratched.

A substantial brass pillar, jointed in its upper part to allow the inclination of the instrument, supports the Microscope, which can be fixed at any angle by means of a clamping screw, although the instrument is so well balanced as to render this screw almost superfluous.

To increase the general stability, all the parts of the instrument have been made as if they were cast in one piece. The stage-support is made of a single piece, and is prolonged into the articulation of the top of the pillar; the limb fits into the stage-support and is fixed by six screws, so that the whole has the same rigidity as if it formed a single

* Zeitschr. f. Instrumentenk., x. (1890) p. 261.

Fig. 45.



Van Heurck's Microscope for Photography and High-power Work.

piece. Finally, the two pieces fitted together are traversed by the clamping-screw for the inclination.

The stage rotates, and special means are provided to give a very smooth movement, and at the same time to secure perfect firmness in every position without the necessity for any toothed gearing, which seldom works smoothly for any lengthened period. The mechanical movements are effected by two superposed plates, as in the old Ross stands, actuated by lateral screws. The object rests upon a sliding bar provided with a stop-pin and clamping-screw. For ordinary work the sliding bar can be replaced by a fixed plate provided with two ledges. The horizontal and vertical movements have a range of 25 mm., and the divided scales (finders) allow a reading of the movements to 1/10 mm. by means of verniers.

The limb incloses the fine-adjustment and carries the tube in front; both the coarse- and fine-adjustments move in bearings which can be regulated as required. A screw attachment at the upper part of the limb fixes the instrument firmly in the horizontal position when it is required to photograph in that position, though we infinitely prefer photographing with the Microscope in the vertical position.

The fine-adjustment is of exquisite delicacy and of greater precision than that of any other Microscope in our collection. Each turn of the screw of the fine-adjustment corresponds to 1/13 of a millimetre. So perfect is the adjustment, that it is possible in certain cases to estimate to a hundredth of a turn, i. e. to 1/1300 of a millimetre. The mechanism of the fine-adjustment acts in an opposite direction to that of Continental Microscopes, we have therefore marked on the milled head the letters M (*monter*) and D (*descendre*), to indicate the direction in which it is necessary to turn to make the body-tube move up or down.

The body has a draw-tube; when closed up it has a length of 160 mm., which is necessary for the employment of Continental objectives; when drawn out it has a length of 260 mm. and can then be used for the apochromatics for the English tube. The draw-tube is arranged so that it can be blackened internally over part of the space covered by the eye-piece; thus all internal reflection, which is the cause of so much trouble in photomicrography, is absolutely prevented. It might be preferable to line this tube with black velvet. The lower end of the draw-tube is provided with the Society screw for use with the Abbe apertometer.

The mirror is carried by a rod having lateral movement; it can also be slid up or down within a moderate range.

Regarding the substage, which we have designedly reserved to the last, we have to point out some improvements which have not been introduced in any other Microscope. Needless to say, the condenser can be centered, and it can be raised and lowered by rack and pinion; but a fine-adjustment of great delicacy is also applied. In the few Microscopes to which a fine-adjustment of the condenser has hitherto been applied (an adjustment so necessary in certain cases and not yet sufficiently appreciated) this focusing has been simply effected by a screw which does not produce a very slow movement, and there has always been loss of time in the changes of direction. Here, however, the fine-adjustment is actuated by a lever as in the fine-adjustment of the body-tube, *and* *the milled head which actuates the movement is placed above the stage* close to the fine-adjustment screw of the body-tube. By this means it is possible to obtain very great precision and to adjust the two movements simultaneously with one hand.

The arrangement of the condenser as planned by us (and employed for several months with all our Microscopes) is, we believe, an important improvement. It consists of an iris-diaphragm surmounted by the lens-holder; between these two pieces slides a plate, removable at will, provided with a central rotating ring which serves for the reception of the diaphragms. The lens-holder is adapted to receive the different Abbe condensers, the Zeiss achromatic condenser, and also adapter plates allowing the use of all the excellent condensers of Powell and Lealand, and may hence be considered of universal application.

To sum up, we have in this instrument combined all the conditions of perfection which long experience in microscopical work has taught us, and Messrs. Watson have realized all our desiderata with a care and precision which we scarcely dared hope for. If we add that this apparatus, so perfect, costs only 400 francs (16*l.*), and consequently less than the large Continental models, it will readily be admitted, we believe, that the makers have rendered a real service to serious workers by its construction."

The Graphological Microscope.* — Mr. C. M. Vorce writes:— "Among the most important of the applications of the Microscope to what are called 'business uses' is the examination of writings, books, &c. The use of the Microscope for such purposes has rapidly increased in the last ten or fifteen years, until now scarcely a case of importance whose turning-point rests on the authenticity of written or printed matter, is tried without the papers or books in question being submitted to Microscopical examination at the hands of experts, real or supposed. Among the points to which such examinations are applied may be mentioned the detection of forgery, alteration, erasure, interpolation, &c., the detection of the authorship of simulated or anonymous writing, the determination of relative age of different writings, identity or difference in inks, pencil marks, paper, &c.; detection of erased writings, the character of stains, marks, mutilations on paper and elsewhere.

Many of the questions involved require very delicate and prolonged examination for their determination, and sometimes the use of high powers, but by far the greater number of questions involve the use of but low or medium powers, and usually the examination of considerable surfaces. Probably every Microscopist who has had occasion to examine writings to any extent has felt the inconvenience of the best modern Microscopes for that purpose, owing to their limited stage room and short rack. In very many cases the examination required involves the comparison of a considerable number of papers, and often of the entire surface of a good sized sheet of paper. The examination of books, such as hotel registers, Bibles, account books, &c., is almost impossible of satisfactory accomplishment with ordinary Microscopes, the only way to proceed being usually to place the instrument on the book and focus through the stage-well. The 'Tank Microscope' of some English

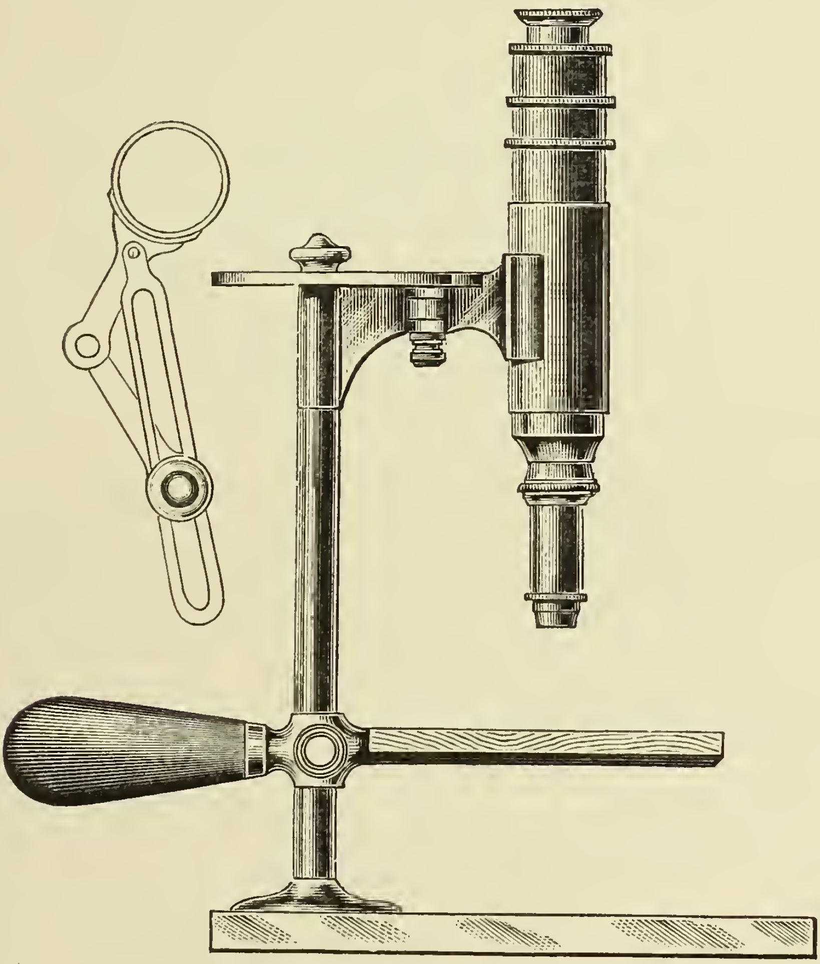
* Microscope, xi. (1891) pp. 47–50.

makers is better for this use than any other present form, but like the others, is objectionable on account of having to be moved about over the book or paper under examination. The danger of marring or obliterating some portions of the writing to be examined often prohibits the placing of the Microscope upon the writing or moving it about, and renders a satisfactory examination quite impossible.

Another serious objection to present forms of Microscope for the uses of the graphologist is the inability to use them as a class Microscope to be passed from hand to hand, with the objects to be viewed securely clamped in position and in focus.

To obviate the defects found in the present Microscopes for such uses and to produce a form adapted to the special needs of the grapho-

Fig. 46.



logist, as made apparent to me by some twenty years of my own experience in that line, and my observation of the work of others, I have devised the Microscope-stand which I have designated The Graphological Microscope, a cut of which is here given, and which is briefly described as follows:—

The pillar is a straight brass rod 5/8 in. in diameter, threaded with a long screw into a plate flush with the surface of the wooden base. The stage is of wood or hard rubber, 5×8 in., and rests on a forked brass plate projecting from a stout collar which slides on the pillar, and is clamped in place by a strong thumb-screw with milled head. From the back of the collar opposite the stage a strong screw projects, upon which a handle may be screwed when the instrument is to be passed about as a class Microscope.

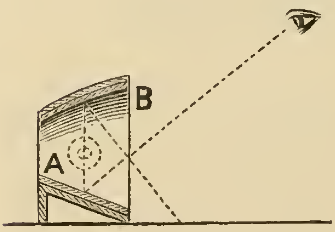
The arm is in two parts joined by a smoothly fitted joint with a nut on the pivot; the outer joint of the arm carries a slip-tube through which the body-tube is focused by sliding, and the inner joint of the arm is extended into a sleeve with a long conical bearing around the top of the pillar, insuring a smooth motion. A flat slotted plate is pivoted to the outer joint of the arm and rests on top of the sleeve of the inner joint, the top of the pillar passing through the slot, being threaded and pivoted with a strong thumb-nut to clamp the arm rigidly in place. By this construction the body-tube may be moved about over every part of a surface 6 in. square, and may be clamped in place over any part of that surface by means of the thumb-nut at the top of the pillar. The paper to be examined can be arranged on the large stage and secured in place by wire clips. In case it is desired to use the instrument as a class Microscope, the arm is clamped fast, the handle screwed on and the pillar unscrewed from the base-plate, when the instrument can be handed about as readily as a common stereoscope, and weighing but little more.

If provision is required for the use of transmitted light, which is but seldom needed, an opening in the stage is provided, and a mirror on the base like that of a dissecting Microscope. An arm for carrying a lamp may also be attached to the pillar by means of a clamping collar like that of the stage-arm, when the instrument is to be used as a class Microscope at night.

It has not been found requisite to provide for inclining the instrument in use, but if desired it can be readily accomplished by providing a slotted segment on the plate into which the pillar screws, hinging this plate to an under plate secured to the base-board, with a clamp screw to clamp the segment against a projection on the fixed plate.

The instrument, as made for me by the Bausch and Lomb Optical Company, has proved very satisfactory in use, and admirably serves the purposes for which it was designed, especially in its capability of being passed from hand to hand. An entirely unpremeditated advantage has also been discovered in the ease with which objects too bulky for examination on ordinary stands, such as large minerals, natural history specimens, &c., can be laid on the base-board (the stage being loosened and swung round out of the way), and examined with this Microscope over all their surface."

Fig. 47.



Magnifying Instrument.*—M. Th. Simon, of Paris, has devised an instrument to replace the ordinary magnifying glass. It possesses the advantage of affording a well-illuminated image. The magnification is obtained by means of a concave mirror B. This is set at such an angle to a second mirror A, that the magnified image is formed in a convenient position

* Zeitschr. f. Instrumentenk., x. (1890) p. 151.

for observation, and the illumination of the body is not interfered with by the instrument.

BERNARD, P.—Note sur un Microscope composé du 18me siècle. Lille, 1890, 8vo.

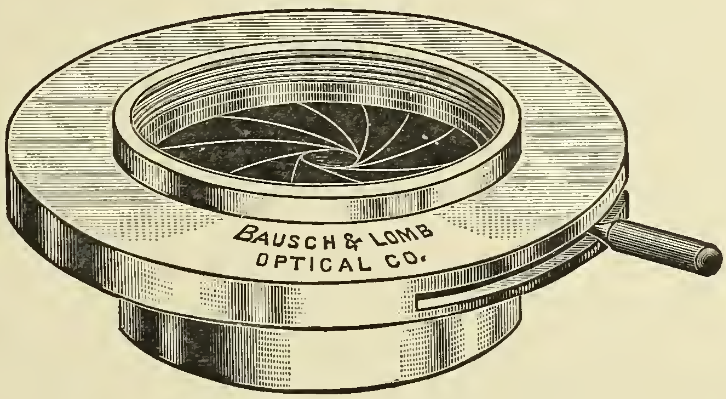
(2) Eye-pieces and Objectives.

JOHNSON, C.—The American Objective as compared with the German. *Maryland Med. Journ.*, XXI. (1889) p. 130.

(3) Illuminating and other Apparatus.

Bausch and Lomb's Condenser Mounting with Iris Diaphragm.—In addition to the form of this device which we figured in this Journal, 1890, p. 508, a simpler and less expensive form has been issued by the firm, as shown in fig. 48.

FIG. 48.



New Lens-holder with Stand.*—M. L. Malassez has constructed a new holder for use with his erecting objectives of long focus. Like the lens-holders in common use, this serves to support ordinary lenses, but will also hold a Microscope-tube provided with the new lenses. It consists of a triangular foot of cast iron and lead, very heavy, giving great stability with considerable space for manipulation. It is covered with india-rubber underneath, to avoid vibration being communicated to the arm of the lens-holder from the table. On this foot is the triangular standard with rack, on which the socket carrying the horizontal arm moves. This arm is not fixed to the socket itself, but to a ring which rotates on it. The result is that the arm can be turned round the standard, without the latter being displaced, so that when, during a dissection for example, it is necessary to dispense for a moment with lens or Microscope, there is no need to move the heavy base, but simply to turn the arm aside. Two fixed stops limit the extent of the rotation, and another stop provided with a spring enables the arm to be replaced in its original position. The friction surface of the ring of the socket is a truncated cone with the base below, an arrangement which prevents the oscillations which with another form of surface would be produced by the wear and tear of the pieces.

The arm of the lens-holder is long, so that, with the arrangement of

* Arch. de Méd. Expér., i. (1889) pp. 455-7 (1 fig.).

the foot above referred to, objects of large size can be examined. Its free extremity receives either a socket for holding the Microscope or pliers for holding the lenses. For this purpose, these pieces are provided with a pin, which fits into the hollow extremity of the arm, and can be fixed in any position required by means of a clamp-screw. By this arrangement the change of the pieces is rendered very easy, and the Microscope-tube can be placed vertically, obliquely, or horizontally. This last position is very useful when objects placed vertically, such as the side of an aquarium, are to be examined. Indices mark the vertical and horizontal positions, and also that at 45°.

The pliers for holding the lens are not, as in other forms of apparatus, in the exact axis of the arm, but at right angles to it. Owing to this arrangement, there is no risk of the nose of the observer coming in contact with the arm, and he is not obliged, in order to avoid this, to turn his head on one side. There are two pliers, the larger for ordinary lenses, the smaller for objectives. One is in front of the arm and the other behind, and they can be placed on either side by turning the pin fixed to the end of the arm.

The rotating ring of the arm has on the opposite side another arm, which is shorter and is terminated by a brass ball filled with lead. It serves to counterbalance the long arm and thus to maintain the stability of the apparatus.

Heating-Lamp with Electric Regulator for controlling the Gas-supply.*—In order to prevent the escape of gas after accidental extinction of the flame in a lamp intended for keeping up a constant temperature, Herren F. and M. Lautenschläger have patented one in which a valve is inserted in the supply pipe, and this valve is kept open by means of an electro-magnet as long as the lamp burns. If this be extinguished, the mercury in the contact thermometer falls until it sinks below a wire melted into the thermometer at a suitable place. As this wire forms part of the path of the electro-magnet, the current is thereby broken, the valve closes, and the gas supply is cut off.

Polarization without a Polarizer.—We cannot congratulate the author of the following note on the originality of the wonderful discovery he has made. Wheatstone and Brewster have unfortunately been before him. We cannot answer for American skies (which no doubt "whip creation" in polarizing as well as in other effects) but in this country at least we fancy that better results would be obtained, when no polarizing nicol was at hand, by the simple expedient of using for mirror a few glass slips inclined at the polarizing angle. Interference figures in crystal sections may often be seen with tolerable clearness when the polarization is produced by simple reflection from the work-table. Mr. H. M. Wilder says:†—"I have accidentally made a quite useful discovery, which I have not seen mentioned before. In order to *polarize*, we put a polarizer (Nicol) beneath the stage, and an analyser (Nicol) above the objective (either right next to it, at the end of the draw-tube, or above the eye-piece). The selenite comes on top of the polarizer. Now I found that the polarizer is not absolutely indis-

* Zeitschr. f. Instrumentenk., xi. (1891) pp. 73-4.
† Cf. Engl. Mech., liii. (1891) p. 113.

pensable. Given a certain polarizing condition of the sky (i.e. blue, with more or less watery vapour—as either before or after a rain, snow, or fog), you can polarize very nicely with the analyser alone, and, if you want display of colour, put the selenite on top of the slide, or anywhere convenient to you—so it comes beneath the analyser. The colours (and crosses) will, of course, be somewhat fainter than when you use the polarizer too. In order to get the best display, it will be necessary to rotate both analyser and selenite until in the proper relative positions; or, to speak more correctly, the relative position of the P.A. of the selenite to the beam of light from the mirror decides the more or less intense coloration. With any other sky, the polarization is not observed. This observation is useful in so far as to enable the possessors of Microscopes, without substage facilities, to polarize fairly well—under the circumstances—and the proper condition of the sky is often obtained in our latitude."

(4) Photomicrography.

Photomicrography.*—Mr. T. Comber writes:—"Photographing with the Microscope, or, as it is now the fashion to call it, "Photomicrography," has always had a great attraction to me. My first attempts at it were made so long ago as 1858, before the days of gelatino-bromide plates, and when the "wet-collodion" process was almost universal.

At that time one of the difficulties to be contended with was the want of coincidence of the actinic with the visual focus of the object-glass. Now most of our English makers can supply objectives specially corrected in this respect, so that when a visual image is focused on the ground glass, an image equally sharp in its actinic effects can be relied upon as thrown upon the sensitive plate. The apochromatics of Zeiss I have always found to be perfect in this respect. I should recommend any of you, who may be desirous of using your Microscope for photography, to be careful to obtain objectives corrected for the purpose; but in case you may be tempted to use an objective that is not so corrected, I may mention the method by which, in those early days, we managed to overcome the difficulty; the more so as the plan constitutes a good test to ascertain whether an objective said to be corrected for photography is in reality correctly corrected. Place a flat object on the stage, for choice a micrometer, and by putting a piece of card under one end of the slide, tilt it slightly up, so that the object no longer lies square to the axis of the Microscope, but is a little nearer on one side, a little further off on the other. Then focus carefully till the division of the micrometer scale lying in the centre of the field gives a sharp image on the ground glass, the other divisions will go gradually out of focus, those on one side being within, those on the other side beyond the focus. Next photograph the scale, and if any difference exists between the visual and actinic foci, it will be found that the centre division, which was sharp on the screen, is not sharp in the photograph, but that some other division more or less distant from the centre of the scale is. Replace the focusing screen and ascertain how much the fine-adjustment has to be moved to bring sharp on the screen the particular division that was

* Journ. Liverpool Micr. Soc., i. (1891) pp. 99–110.

sharp in the photograph. This will give the measure, for that objective, of the difference between the two foci, and whenever the same objective is used, you can always, by moving the fine-adjustment to that extent, but in the opposite direction, convert the visual into an actinic focus.

In 1859 I left England for India, and for nearly thirty years, having "other fish to fry," being, in fact, engaged in the "struggle for existence," I had no leisure for microscopical studies. On recently resuming, about two years ago, one of the first things I did was to read up what had in the meanwhile been done as regards photomicrography. What a change had taken place, whether regarded from the photographic or the microscopic point of view! I found that there were now available gelatino-bromide plates, infinitely more sensitive than the old collodion, and dry instead of wet, so that there need be no limit to the time of exposure. On the other hand, "immersion" objectives, followed by apochromatics, had greatly increased the delineating power of the Microscope. I promptly provided myself with a set of apochromatics, and proceeded to mount my old hobby, intending to apply it chiefly to the investigation of the minute structure of the diatom valve. I commenced with daylight (white cloud) illumination, which in the old days had been considered the best; next proceeded to artificial light (oxy-hydrogen); and finally adopted, for high magnifications, sunlight, with which Colonel Woodward had achieved his best results. My wish is to place before you to-night some of the results that I have so far obtained; to describe the apparatus I use in its present state of development, and explain, so far as I can without a "practical demonstration," the method of working with it.

A general idea of the apparatus you will gather from the woodcuts and description, which originally appeared in the Royal Microscopical Society's Journal, 1890, pp. 429–34.

[We omit the description and figures of the Microscope and heliostat as they were dealt with in the Journal, 1890.]

Turning now to the camera. This is fixed to a base-board, which pivots on a tripod, so that it can be slewed round out of the way when not in use. There is then room for the operator to sit at the Microscope, find and arrange his object, and adjust his illumination, also to effect the necessary corrections of the object-glass for variations in the thickness of the cover-glass, if an eye-piece is to be used; but if the photograph is to be taken without an eye-piece, this correction should be effected after the camera is attached, and when the image is on the ground glass. It is well for the table upon which the Microscope stands to be of such a height as to bring the tube of the instrument comfortably to the level of the observer's eye, and the height of the tripod must correspond, being such that the axis of the camera coincides with that of the Microscope. The light-tight connection of the camera to the Microscope can be effected in a variety of ways. The one I employ is a collar, covered with velvet, which fixes on to the upper end of the draw-tube of the Microscope, and has a deep groove, into which fits a wide brass tube attached to the camera front by a small conical bellows.

The image of the object may be projected on to the sensitive plate either (1) by means of the object-glass alone, or (2) by the use of what is termed a "projection" eye-piece. Much good work has been done by the former method, but not, so far as I can judge, the very best. I attribute this partly to the fact that in English objectives the spherical and/or chromatic aberration is often not entirely corrected, some being intentionally left for correction by a contrary error in the eye-piece; but chiefly to the object-glass being adjusted to project the image a fixed distance, which is generally 10 in., that being the usual length of the English Microscope-tube: but when the image is projected not to 10 in., but to a distance considerably exceeding this, say to a distance of 40 or 50 in., the corrections are altogether disturbed, and the delineation in consequence deteriorated. A main cause of the disturbance can be removed in object-glasses provided with a collar adjustment for cover-correction, by altering the relative distance of the different combinations of lenses in the object-glass; and I have had even a 1½ in. objective mounted so that the distances between the lenses could be changed; but other causes of disturbance are left, or even increased, by the change, and the image is never so clear as it is at the 10 in. A projection eye-piece, however, avoids this difficulty, for it takes up the image at the proper distance, and is furnished with means for adjusting its own action to whatever distance the sensitive plate may be placed. I have used Zeiss's, but I believe several English makers supply similar ones. You will see that there are two combinations of lenses, the distance between which can be regulated, and the adjustment thereby effected. It is correct when the edge of the field is sharp and clear.

The method of illumination may vary according to the work to be done. For moderate magnification, say up to about 300 diameters, I have found diffused daylight from cloud or blue sky to give good results. The same light, or a good lamp, can also be used for higher magnification, 500 or even 1000 diameters; but the light is then so feeble that focusing is difficult, and a very long exposure necessary. I show you one photograph of a Triceratium, × 1000, taken with diffused daylight, for which the exposure was 1 hour 40 minutes; and another of an Arachnodiscus, × 800, taken with a paraffin lamp, and an exposure of 1 hour 20 minutes. With such prolonged exposures the chances of vibration, or of changes of focus arising from the expansion or contraction of the instrument in consequence of variations of temperature, are greatly increased; so that the final result is seldom so clear and sharp as with a more intense illumination and shorter exposure. For high magnification, therefore, oxy-hydrogen light is usually employed; and better even than this I consider sunlight. It has, of course, some serious disadvantages. It cannot be obtained whenever you happen to require it by merely turning on a tap. You are dependent upon the clerk of the weather; and when you do get it, it is too apt to be intermittent. Many a time I had to wait patiently, waiting for a break in the clouds. But when you do get it, I think it is the *ne plus ultra*. When using it, exposures can be reckoned by seconds, and I have a negative of *Pleurosigma angulatum*, good so far as density is concerned, taken with an exposure of only one second to sunlight, on an ordinary Ilford plate. Whether the source of illumination be a lamp, or a lime cylinder, or the sun, care must be taken so to focus the sub-stage achromatic condenser, that an image of the source of illumination is thrown on the exact plane of the object. This is all-important.

I will now try to describe, with some minuteness, my course of procedure when taking a photograph by sunlight, premising that my objects are generally diatoms, and the magnification 1000 diameters. The Microscope is placed in its horizontal position, and the milled head of its fine-adjustment brought into gear with the focusing-rod by means of a piece of thin whipcord. The heliostat is placed in front, on a wooden stand, which carries also the fixed mirror and the alum-cell for absorbing heat-rays. Care has to be taken that the optical axis of the whole apparatus is directed due south, which is insured by the end of the board upon which it stands being cut at such an angle that when this end is placed against the plate glass of the window, all is in right direction.

The first operation is to accurately centre the achromatic condenser, using a two-thirds objective and regulating the diaphragm so that its opening may be a little smaller than the field; next, to centre the further diaphragm at the end of the brass plate; and afterwards, removing the movable mirror from the heliostat, to ascertain that the spindle appears precisely end on and in the centre of the field, which it should do if the heliostat has been properly placed. Exactness in this last adjustment is necessary, otherwise the beam of sunlight will not be motionless. The movable mirror is then replaced on the spindle, and set to reflect the image of the sun in the centre of the field. At this stage the eye must be protected by a dark-coloured glass being placed below the condenser. The object being placed on the stage, brought into the centre of the field and focused, the condenser has next to be focused to throw the sun's image exactly in the plane of the object. Sharpness of the ultimate image upon the ground glass cannot be secured without this.

Changing the objective to a one-sixth (4 mm.) I next measure the thickness of the cover-glass, or rather the distance between that plane of the object which it is desired to photograph and the upper surface of the cover-glass, by means of the fine-adjustment screw. The purpose of this is twofold. First, to facilitate cover-correction; secondly, to ascertain whether the 2 mm. object-glass, which is now put on, can get down to it, for its front lens is rather more than a hemisphere, and the mount in which it is set is so extremely thin that it has hardly any grip on the lens, and the slightest pressure suffices to displace it. My glass, with a distance of 0·18 mm. between the object-plane and the upper surface of the cover-glass, requires no correction. For a thinner cover—and the covers of English-mounted slides generally are thinner—correction is effected by lengthening the tube-length; for a thicker cover, by shortening it. Lastly, the illuminating cone thrown by the condenser has to be regulated. You are probably aware that there is great controversy as to what this should be in order to produce a "true" image. My experience is that the width of the cone should vary according to the nature of the object and the quality of the object-glass. Too narrow a cone produces diffraction fringes, that bane of photomicrography; too wide a cone, even, I think, with the best objectives hitherto made, produces haze. With thin "test objects" I find my own glass works best when about two-thirds of its back lens is filled with light; for thick objects, I get the best results with a somewhat narrower cone. Of one thing I am convinced, that to get true images, the cone, whether it be wide or narrow, must be absolutely axial. Even a very slight obliquity renders the images unreliable.

The ordinary eye-piece is now changed for a projection eye-piece, set to the distance at which the sensitive plate is to stand; the camera is attached, and the long focusing-rod coupled on. The image of the sun will be found in the centre of the ground glass. If it is not, the centering of the condenser must be wrong, and will require alteration. The sun's image should be sharp at the edge, unless the sky is hazy. Any light fleecy clouds near the sun will be visible on the screen, almost as if an ordinary landscape lens were being used, and the effect when they drift across the sun's disc is very curious. The image of the object, as seen against that of the sun, will be somewhat out of focus, but a slight turn of the focusing-rod brings it right.

With sunlight I find it unnecessary to use anything for focusing except the ground glass. The image is so bright that the details can be sufficiently seen. With other less brilliant sources of illumination it is necessary to use other means; and that which I have found most convenient is a Microscope eye-piece. The ground glass is removed, and replaced by a wooden slide, in the centre of which is a hole fitting the eye-piece. It should be so set that the diaphragm of the eye-piece is in register with the sensitive plate. Even a very faint image, when viewed through this eye-piece, is sufficiently visible to admit of focusing.

The next step is exposure. I wish I could give you some rule by which to regulate exposure, but I find it altogether impossible to do so. Its wide range has already been indicated. From one second with bright sun, to an hour and forty minutes with diffuse daylight, is a "far cry." Exposure depends not only on the source of light, but on variations of that source. A winter sun, shining through an east wind haze, is very different from a midday sun in summer, when the sky is clear. Exposure varies, too, with the degree of magnification. A magnification of 1000 diameters requires 100 times the time that one of 100 diameters requires. It varies with the width of the illuminating cone. It varies with the opacity or transparency of the object. It varies with the colour of the medium in which the object is mounted. A diatom mounted in Prof. van Heurck's high refractive medium, which is of a deep yellow colour, requires at least six times the exposure that would be proper if it were mounted in balsam, all other conditions remaining equal. All I can tell you, therefore, is that a little experience, and a few dozen spoiled plates, of which notes have been kept, will enable you to judge, almost instinctively, what exposure is required. I always make two exposures on each object, one longer than the other, and thus have a double chance.

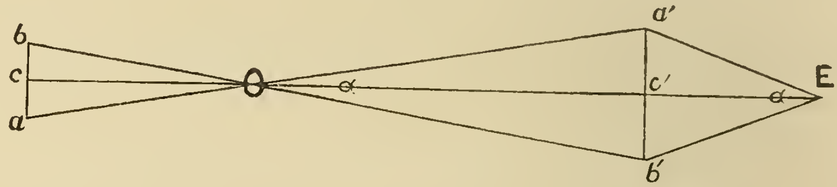
As regards plates, I recommend you to use slow ones, and to develope with hydroquinone. The usual difficulty, with most microscopical objects, is to obtain sufficient contrast, and this is most readily obtained on slow plates."

FRAZER—**On Photography as an aid in Anatomical, Histological, and Embryological Work.**
Report 59th Meet. Brit. Assoc. for the Advancement of Science, 1890, p. 639.
PRINGLE, A.—**Practical Photomicrography by the latest methods.**
New York, 1890, 8vo, 192 pp., 7 pls.

(5) Microscopical Optics and Manipulation.

Microscope Magnification.*—Mr. W. Le Conte Stevens, in spite of the distinction drawn by some authors between "magnification" and "amplification," † sees no good reason for discarding the usual acceptation of the term magnification, as denoting the ratio of the diameters of the retinal images produced with and without the magnifying instrument respectively. To obtain the magnification of a Microscope it is necessary to know the equivalent focal length of the eye-piece and objective, and also the tube-length. Unfortunately all of these data are seldom supplied by the makers. The equivalent focal length of the eye-piece is rarely given, and great diversity exists as to the points to be taken as the limits of tube-length. The tables of magnification given by certain firms are only applicable when "standard tube-length" is used, and such a standard exists only in name. Examination of such a table supplied by one maker showed that the magnification was calculated by dividing 100 by the product of the focal lengths of objective and eye-piece. This rough approximation is deduced as follows:—

Fig. 49.



Let $a'b'$ (fig. 49) denote the image of the object $a\,b$ given by the objective O. O c is taken as the focal length of the objective, and O c' as the tube-length, 10 in. The magnification of the objective m is then given by

$$m = \frac{a'\,b'}{a\,b} = \frac{10}{f}.$$

The eye-piece increases the visual angle from α to α' producing a virtual image assumed to be 10 in. away. For the magnification m' of the eye-piece whose focal length is F we have

$$m' = \frac{\tan \frac{1}{2}\,\alpha'}{\tan \frac{1}{2}\,\alpha} = \frac{10}{F}.$$

The total magnification M is then

$$M = m\,m' = \frac{100}{f\,F}.$$

A more exact formula is obtained as follows:—For the objective we have

$$m = \frac{a'\,b'}{a\,b} = \frac{T}{O\,c},$$

where T is the tube-length defined as the distance from the focal plane to the point which behaves as an optical centre.

* Amer. Journ. Sci., xl. (1890) pp. 50–62. † See this Journal, 1889, p. 818.

But

$$\frac{1}{Oc} + \frac{1}{T} = \frac{1}{f},$$

$$\therefore \quad m = \frac{T}{f} - 1.$$

For the eye-piece

$$m' = \frac{D}{F} + 1,$$

where D is the distance of distinct vision

$$\therefore \quad M = m\,m' = \frac{(D + F)(T - f)}{F f}.$$

The equivalent focal length of the eye-piece can be easily calculated, if the focal length of the eye-lens is known. Thus by the formula for the combination of two lenses

$$\frac{1}{F} = \frac{1}{f'} + \frac{1}{f''} - \frac{d}{f'f''},$$

where f' f'' are the focal length of eye-lens and field-lens respectively, and d is the distance between them.

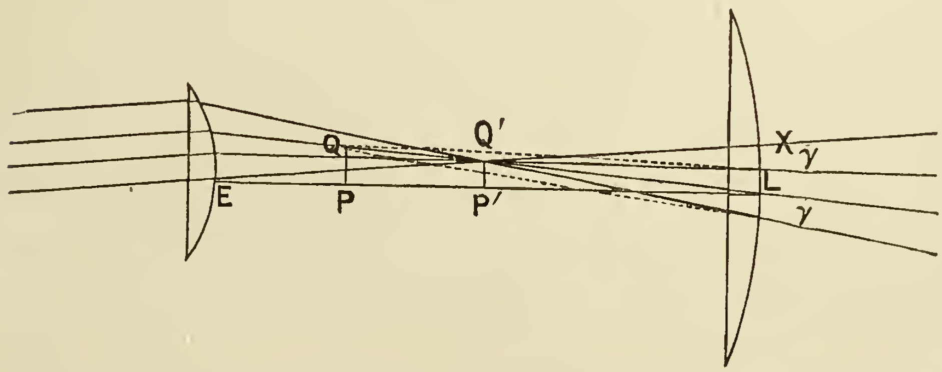
But in the case of a properly constructed negative eye-piece $f'' = 3f'$ and $d = 2f'$, so that $f' = \frac{2}{3}F$.

To determine f' the magnification of the eye-lens can be measured by the use of the camera lucida. A micrometer is placed at the diaphragm of the eye-piece, and the Microscope is inclined until the optical centre of the eye-lens is 250 mm. (distance of distinct vision) above the paper, on which the camera lucida projects the figures of the micrometer. The magnification m' is thus directly determined and f' given by the formula

$$m' = \frac{D}{f} + 1.$$

Fig. 50 explains the theory of the negative eye-piece, and shows how

Fig. 50.



the effect of the field-lens is to diminish the magnification by two-thirds. The rays $r\,r$ converging from the objective to the point Q, are made more convergent by the field-lens L, so as to cross at Q′ in the principal focal plane of the eye-lens E.

We then have

$$\frac{1}{LP'} - \frac{1}{LP} = \frac{1}{f''},$$

$$\text{i. e.} \quad \frac{1}{f'} - \frac{1}{LP} = \frac{1}{3f'},$$

since in a negative eye-piece $EL = 2f'$ and $f'' = 3f'$.

$$\therefore \quad LP = \frac{3}{2}f' \quad \text{and} \quad PQ = \frac{3}{2}P'Q'.$$

The focal length of the objective is best determined by the formula of Prof. C. R. Cross.* A micrometer scale divided into tenths of a millimetre is placed on the stage, and a second, divided into millimetres, at the diaphragm in the focal plane of the eye-lens, the field-lens being removed. The magnification m of the objective is then given by focusing the image of the stage micrometer upon the eye-piece micrometer.

If p, p' denote the distances of the two micrometers from the point which behaves as optical centre of the objective, we have

$$m = \frac{p'}{p}.$$

And if l is the distance between the micrometers

$$l = p + p'$$

$$\therefore \quad p' = \frac{m\,l}{m+1}.$$

Then from the formula

$$\frac{1}{p} + \frac{1}{p'} = \frac{1}{f}$$

we have

$$f = \frac{m\,l}{(m+1)^2}.$$

Determinations, made by use of the above formulæ, of the focal lengths and magnifications of the eye-pieces and objectives of various makers showed how generally erroneous was the labelling. In the case of five eye-pieces of one of the best known of American makers, the percentage of error in the value of F varied from 2·7 to 7·4, and in no case was $f'' = 3f'$ or $d = 2f'$. In ten out of eleven objectives examined, the percentage of error was greater than 4, and for two of them it reached as high as 41 and 50. Application of the formula $M = \frac{100}{Ff}$ for various combinations was shown to give very inaccurate results as compared with determinations of the magnification made by the camera lucida.

For the application of the more exact formula $M = \frac{(D+F)(T-f)}{Ff}$

* Journ. Franklin Institute, lix. p. 401.

which gives perfectly reliable results, it is necessary that makers should have accurate values of the equivalent focal length of eye-piece and objective stamped on their mountings, and also the tube-length stamped on the body-tube.

A standard tube-length should be agreed upon. The author considers that of 180 mm. of Continental makers more convenient than the 10 in. generally adopted in England and America. The upper limit of the tube-length should be the focal plane in which an image would be formed by the objective if there were no field-lens. In a negative eye-piece this plane is midway between the diaphragm and the optical centre of the eye-lens. Eye-pieces should therefore be so constructed that when slipped into position this plane should be exactly at the top of the body-tube. Such par-focal eye-pieces have been made for several years past by the firm of Zeiss. The lower limit of the tube-length should be the point within the objective which behaves as an optical centre. The distance from the top of the body-tube to the extremity where the objective is screwed on is taken a little shorter than the desired tube-length, say 160 mm. instead of 180 mm. Then in the formula $\frac{1}{p} + \frac{1}{p'} = \frac{1}{f}$, $p' = 180$ and p can be calculated, since f is known. Subtracting then from p the working distance between slide and the exposed lens, we have the distance within the objective of the point which acts as an optical centre. Allowance can then be made in the mounting of the objective to make this point just 20 mm. from the extremity of the body-tube where the objective is screwed on.

β. Technique.*

ARLOING, S.—**Cours élémentaire d'anatomie générale et notions de technique histologique.** (Elementary Course of General Anatomy and Histological Technique.) Paris, 1890, 8vo, 388 figs.

BEHRENS, W.—**Leitfaden der botanischen Mikroskopie.** (Outlines of Botanical Microscopy.) Braunschweig (Bruhn) 1890, large 8vo, 288 pp., 150 figs.

BONNET, R.—**Kurzgefasste Anleitung zur mikroskopischen Untersuchung thierischer Gewebe.** (Concise Introduction to the Microscopic Examination of Animal Tissues.) München (Rieger) 1890, 2 figs.

PAUL, F. T.—**On the relative Permanency of Microscopical Influence of the different Staining and Mounting Agents.** *Liverpool Med.-Chirurg. Journ.*, X. (1890) p. 65.

(1) Collecting Objects, including Culture Processes.

Method for making Permanent Cultivations.†—Herr W. Prausnitz preserves roll and puncture cultivations (and even liquid ones provided the liquefaction is not too general) by filling the tubes with a gelatin solution to which a disinfectant has been added. The tubes are placed in ice water, the cotton wool plugs removed, and the fluid and antiseptic gelatin solution is then slowly poured in through a pipette. The tube is then plugged with a cork cut off flush with the top, and finally

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

† Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 131–2.

sealed over in order to prevent the gelatin from drying. The disinfectants recommended are 5 per cent. acetic acid, or 1 per cent. carbolic acid. The gelatin solution is of course a simple one, and without any additions; it is clarified by means of egg albumen, and the acid added after filtration.

By this method the author preserved cultivations for two years, but he admits that sometimes, for reasons inexplicable, the gelatin liquefies.

Simplified Method for preparing Meat-Pepton-Agar.* — Mr. N. Tischutkin prepares and filters meat-pepton-agar in the short time of 2–2½ hours. The requisite quantity of agar is placed for 15 minutes in a dilute solution of acetic acid (5 ccm. acid. acet. glacial. in 100 ccm.). The swollen agar is then carefully washed free from acid and then mixed with bouillon. Boiling for 3–5 minutes suffices to make a perfect solution of the agar in bouillon. After neutralizing and cooling down the whites of two eggs are added, and the mixture placed for half to three-quarters of an hour in a Koch's steamer. It is next filtered through Schulze's paper.

Preparing Nutrient Agar.†—Prof. van Overbeek de Meyer prepares nutrient agar in a very satisfactory manner by the aid of his disinfection oven, which insures a constant temperature of 100° to 101°. The agar is cut up into very small pieces and in the proportion of 1½ to 2 per cent. is poured into 0·5 litre of Loeffler's bouillon. To this is added 1 per cent. pepton, and 0·5 per cent. common salt.

After the lapse of about an hour, the mixture is placed in the disinfection oven, and there steamed for three-quarters of an hour at 100°. This dissolves the agar and separates out the coagulable albuminoids.

The next step is to neutralize or impart any suitable reaction to the solution, after which it is filtered through blotting-paper into flasks. The funnel is covered over with a glass, and the funnel, flask, and cover are again placed for three-quarters to one hour in the disinfection oven. In the end about 0·25 litre of perfect bouillon-agar are thus obtained. If requisite any additional substances, such as grape-sugar, glycerin, &c., may be added, after which the mass is sterilized for half an hour, and the process repeated on the two following days.

Cultivating Actinomyces.‡—Herren N. Protopopoff and H. Hammer cultivated Actinomyces on glycerin agar bouillon, potato gelatin, and in milk and eggs. The cultivations were derived from a pure cultivation prepared by Prof. Afanassiew from the pus of a person affected with actinomycosis.

By rubbing granules of the agar cultivation together with sterilized bouillon and inoculating with this emulsion, a much more rapid development was obtained than by direct transference of the granules. On glycerin agar the cultivation presented a mass of miliary granules, about the size of hemp-seeds, of a yellowish-white colour, and firmly

* Wratsch, 1890, No. 8. See Centralbl. f. Bacteriol. u. Parasitenk., ix. (1891) p. 208.
† Centralbl. f. Bakteriol. u. Parasitenk, ix. (1891) pp. 163–5.
‡ Zeitschr. f. Heilk., xi. (1890). See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 63–4.

fixed to the medium. On potato the growth was particularly luxuriant and quite typical, the cultivation having a characteristically dry appearance. In bouillon the miliary nodules soon appeared, and grew up into masses the size of a hazel-nut, the bouillon remaining clear. In milk, the ray fungus throve well, the albuminoids of the milk being apparently directly peptonized without previous coagulation.

The authors found that the growth of the fungus was completely stopped at a temperature of 52° C. and that even 40° C. exerted an inhibitive action.

The authors further observed that the fungus presented in their cultivation a cyclical polymorphism, that is, the Actinomyces filaments, at first distinguished by their dichotomous ramifications, eventually assumed, by continual subdividing transversely and longitudinally, the appearance of rodlets and cocci, from which again developed the long branched filaments.

This variety of polymorphism was specially observable in potato cultivations, while in old cultivations real retrograde metamorphoses, e. g. club-shaped or spirilla forms, mucous degeneration, &c., were remarked.

The authors regard the rosette form found in men and beasts as the expression of a parasitic adaptation to the animal body.

Further experiments showed that in old cultivations the further development of the cultivation was inhibited in consequence of the accumulation of metabolic products.

The results of the experiments on animals are reserved for a further communication.

Apparatus for facilitating Inoculation from Koch's Plates.*— Herr W. Prausnitz has devised an apparatus for facilitating the inoculation of particular colonies from Koch's plates.

It consists of a metal ring which is screwed on to the Microscope-tube. From one side projects a metal piece, in which is left a linear fissure for the insertion of a platinum plate. From the lower end of the plate is excised a triangular piece. The inoculating needle is made to rest in the angle of the platinum plate, its point being about 2 mm. from the colony. The apparatus is merely intended as a device for keeping the needle steady, so that the special micro-organisms only are removed, and uncontaminated either by the medium or by adjacent colonies.

Picric and Chromic Acid for the rapid Preparation of Tissues for Classes in Histology.†—Mr. S. H. Gage remarks:—" The standard methods of hardening tissues and preparing them for sectioning require so great an expenditure of time that it is practically impossible for students in college and carrying on other university work to perform all the processes and to make any satisfactory progress in the limited time devoted to histology. Believing firmly that unless a student learns to take every individual step himself in histology, as in all other branches of sound learning, the great object is unattained, I have been experimenting for the

* Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 128–9 (1 fig.).
† Proc. Amer. Soc. Micr., 1890, pp. 120–2.

last few years in the laboratory, hoping to so shorten and modify existing methods that every step may be taken by the student himself without too great an expenditure of time. The following are the results, and they are given, not because they are the best possible methods that might be used if unlimited time were at the disposal of the student, but as methods that give excellent results in a very short time.

Picric Alcoholic Method.—The hardening and fixing solution consists of 95 per cent. ethyl alcohol, 250 ccm.; water, 250 ccm.; picric acid crystals, 1 gram.

The tissue is cut into pieces of moderate size and placed in a preserving jar containing about 25 to 50 times as much of the preservative as there is tissue. It is well also to suspend the tissue or support it on absorbent cotton, or to stir the tissue around occasionally. The tissue should be left in the picric alcohol about 24 hours. If the piece is small, 12 hours will do, and an immersion of 2 to 3 days seems to do no harm. After one day the tissue is placed for 24 hours in 67 to 70 per cent. alcohol, and then for one day or longer in alcohol of from 75 to 82 per cent. It may be left indefinitely in this. Finally, just before imbedding, the tissue is dehydrated one day only in 95 per cent. or stronger alcohol. It may then be infiltrated with paraffin or collodion in the usual manner, the whole time required being 7 days, at the longest, to harden, infiltrate, and imbed a tissue ready for sectioning.

The picric-alcohol method has given excellent results for all tissues except peripheral nerves. It is especially to be recommended for organs or parts possessing ciliated epithelium.

The double stain of hæmatoxylin and picric acid gives very sharply defined appearances, the hæmatoxylin staining the nucleus and the picric acid the cell-body and also the ground-substance somewhat.

If ammonia-carmine is used as a stain, more sharply differentiated appearances are obtained by dehydrating with the following:—95 per cent. alcohol, 100 ccm.; glacial acetic acid, 1 ccm.; picric acid crystals, 1/10 gram.

Nothing has been found more satisfactory for a clearing medium than:—Carbolic acid crystals (melted), 40 ccm.; turpentine (oleum terebinthinæ), 60 ccm.

And for a mounting medium, Canada balsam, dissolved to the consistency of thick syrup in xylol or cedar-wood oil, has given excellent results.

Flemming's Chrom-Acetic Acid Method.—This has proved satisfactory for the rapid fixing of peripheral nerves and for stratified epithelia. For the stomach and intestines it has not proved so satisfactory as the picric alcohol. Chromic acid crystals, 6 grams.; glacial acetic acid, 2·4 ccm.; water, 2400 ccm.

The tissue is cut into pieces of moderate size and placed in 50 to 75 times its volume of the fixing agent for 12 to 24 hours. It is then washed two hours or more in water and left about 12 hours in 50 per cent. alcohol, then placed indefinitely in 75 to 82 per cent. alcohol. It may be dehydrated, infiltrated, and imbedded as described for the picric-alcohol method.

Hæmatoxylin is, on the whole, the most satisfactory stain, but the staining is not so satisfactory as after the use of picric alcohol. The staining may be hastened in this case, as in all others where it is desirable, by heating the staining agent.*

Apparatus for making Esmarch's Rolls.†—The apparatus devised by Herr N. Prausnitz for preparing Esmarch's rolls consists of a tin box 10 cm. high, 23 cm. broad, and 19 cm. deep. In the middle of the short sides two grooves are cut out for the insertion of a spindle worked by a handle. On the spindle and at a distance of 14 cm. from one another are two circular tin plates, in the periphery of which ten round holes are cut out. When required for use, the box is filled with water heated to 10°–12°, and in the holes are placed test-tubes, filled with liquid gelatin. The handle is then turned until the gelatin is set.

The best results are obtained when the tubes are one-fourth full of gelatin.

New Cultivation Vessel.‡—Dr. L. Kamen gives an account of how he devised a cultivation vessel suitable for the examination of water, &c., and how in its main features it resembles closely that invented by Petruschky.§ The main differences seem to be, from the illustrations given, that the author's vessel is 4 cm. longer and 1 cm. broader, and that the neck is indented at one side only.

A comparison of the two sets of drawings will be quite sufficient for easily understanding the trivial differences between the two forms.

Dixon, S. G.—**An Apparatus for the Collection of Dust and Fungi for microscopical and biological tests.** *Therapeut. Gaz.*, 1890, p. 308.

(2) Preparing Objects.

Demonstrating the Membrane of the Red Corpuscle of Batrachia.‖—Dr. L. Auerbach, after submitting the red corpuscles of Batrachia to a renewed investigation, comes to the conclusion that they are invested with a colourless membrane. This is demonstrable if a drop of blood, carefully protected from loss of fluid, be left alone for some hours. By this time the contents of the corpuscle have receded from the membrane, usually being massed at the poles. On the addition of physiological salt solution, the membrane swells up like a bladder. This may be still better observed after hardening in saturated picric acid solution, subsequently washed out with water. Such a preparation, stained with eosin and anilin-blue, shows the membrane blue and the adjacent layer red. Certain reagents cause the corpuscle to swell up to a thin-walled bladder which bursts, allowing the contents to escape, and leaving an empty sac behind; such are sublimate in 0·1 to 0·25 per cent. solution, 1 per cent. boracic acid, chloride of sodium, and chromate of ammonia in 2 to 10 per cent. solution. In the corpuscle can be distinguished a cortical and medullary substance, the latter inclosing the nucleus. This is well

* If the picric alcohol solution, as given above, is diluted with an equal volume of water, it makes a most excellent dissociating medium for almost all the tissues. It is especially good for epithelia and for smooth and striated muscle. The striation in the striated muscle is exceedingly clear and the longitudinal fibrillation of the smooth muscle is easy to demonstrate.

† Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 129–30 (1 fig.).

‡ T. c., pp. 165–7 (2 figs.). § See this Journal, 1891, p. 131.

‖ Anat. Anz., v. (1890) pp. 570–8 (2 figs.). See Zeitschr. f. Wiss. Mikr., vii. (1891) pp. 511–2.

seen after the action of a 1 per cent. aqueous sublimate solution and in picric acid preparations.

After hardening in picric acid, subsequently washed out, the cortical layer may be seen as a very fine network, an unnatural condition, the result of the formation of vacuoles. In sublimate preparations the medullary substance is bestudded with dark granules, while in picric acid preparations it is quite clear, and has the appearance of a hollow space. The nucleoli in the cells of adult animals usually stain blue (cyanophilous), while in the larval condition a few are to be found which stain red (erythrophilous). In the early days of larval life there is a single large nucleolus composed of both substances.

New Characteristics of Nerve-cells.*—Sig. G. Magini, who states that the absence of chromatin in the nucleus is a special characteristic of nerve-cells, as compared with neuroglia-cells, advises for the study of this distinguishing feature methylen-blue, and also, but less effectively, vesuvin and Ehrlich's hæmatoxylin. Carmine staining is quite useless for the purpose. The objects must be hardened in Kleinenberg's fluid, or in absolute alcohol, or in sublimate. Müller's fluid is not at all suitable.

Impregnation of the Central Nervous System with Mercurial Salts.†—Mr. W. H. Cox finds that a uniform impregnation of the central nervous system is obtained when the hardening and impregnating fluids are allowed to act together for two or three months. The reaction of the hardening fluid should be as slightly acid as possible. The fluid which Mr. Cox used consisted of 20 parts of 5 per cent. bichromate of potash, 20 parts of 5 per cent. sublimate, 16 parts of 5 per cent. chromate of potash, 30–40 parts of distilled water. The preparations cannot be preserved under a cover-glass in Canada balsam or dammar, for the acidity of the medium and some other unknown cause spoil them. A freezing microtome must be used, for the alcohol involved in the paraffin or celloidin methods endangers the impregnation. The sections are placed for an hour or two in 5 per cent. solution of sodium carbonate, are washed in water, placed for a short time in absolute alcohol, then in some oil, and finally covered with some rapidly drying resin. If they must be covered with a glass, the resinous layer should be allowed to dry, and then covered with castor-oil. Then the cover-glass is put on and pressed down so as to squeeze out the superfluous oil, or by using styrax, or a mixture of gum-arabic and water, &c., the preparations may be kept intact under a cover-glass.

Preparing Nervous Tissue of Amphibia.‡—Mr. A. Smirnow adopted the methylen-blue injection method for demonstrating nerve-cells of Amphibia. 1/4 to 4 per cent. methylen-blue solutions in 1/2 per cent. salt solution were employed. In from half to three hours after injection the tissues were removed from the animal, and the stain fixed with iodopotassic iodide or picrocarmine or picrate of ammonia. The prepa-

* Atti R. Accad. Lincei Roma—Rendiconti, vi. (1890) pp. 19–23. See Zeitschr. f. Wiss. Mikr., vii. (1891) p. 519.

† Arch. f. Mikr. Anat., xxxvii. (1891) pp. 16–21 (1 pl.).

‡ Op. cit., xxxv. (1890) pp. 407–24 (2 pls.). See Zeitschr. f. Wiss. Mikr., vii. (1891) p. 511.

rations were mounted in pure glycerin, in acidulated glycerin, or in glycerin to which 1 per cent. of picrate of ammonia solution had been added.

Examining Spermatozoa of Insecta.*—Herr E. Ballowitz used male beetles, the vas deferens of which was quite full of spermatozoa. The living spermatozoa were fixed with osmic acid vapour, and usually stained with gentian-violet.

Maceration specimens showing a fibrillation of the flagellum were obtained by removing the wings and upper abdominal wall and then immersing in very dilute sodium chloride solution for some days. A piece of vas deferens was then cut out, carefully washed, and then teased out on a slide in 0·8 per cent. salt solution. A drop of this fluid was covered over with a cover-glass, and after the lapse of one to three days stained with some anilin dye. Movements of the spermatozoa were shown on Schulze's hot stage, the optimum temperature being from 30° to 35° C.

Demonstrating Structure and Termination of Muscular Nerves in Œdipoda fasciata.†—Sig. V. Mazzoni employs the following modification of the gold chloride method for staining nerve-endings. Pieces of muscle, 1 to 2 mm. in size, are placed for half an hour in a watery solution of 1/3 formic acid. When quite transparent they are transferred to gold chloride solution (1:100), wherein they remain for 7 or 8 minutes. After this they are left in the dark for 12 hours in the formic acid solution, and then mounted in glycerin.

Mounting Acarina.‡—M. E. L. Trouessart finds that dried material containing mites makes better preparations than can be obtained from fresh specimens. The material is placed in a large drop of glycerin on a slide, but is not covered. The preparation is then carefully and slowly warmed over a spirit-lamp. By this the animals are cleared up and freed from air-bubbles and any adherent impurities. For imbedding, glycerin-gelatin is recommended, but if it is desired to keep the animals this may be done in alcohol or Hantsch's fluid.

Preparing Eggs of Pycnogonids.§—Mr. T. H. Morgan found the best way of hardening the eggs of Pycnogonids was to put them into alcoholic picro-sulphuric acid for several hours, and then to gradually carry them through different grades of alcohol of increasing strength. After an hour in absolute alcohol, two to four hours in turpentine, one hour of soft and one to two hours of hard paraffin, the eggs were cut in paraffin, and fixed to the slide with albumen fixative. Again, they were passed through turpentine, absolute alcohol, 95, 80, 70 per cent. alcohols to Kleinenberg's hæmatoxylin, where they remained for from twelve to forty-eight hours. They were then washed in acid alcohol for fifteen minutes, and passed through the alcohols and turpentine into balsam. Very excellent results were obtained.

* Zeitschr. f. Wiss. Zool., l. (1890) pp. 317–407 (4 pls.). See Zeitschr. f. Wiss. Mikr., vii. (1891) pp. 503–4.

† Memorie R. Accad. Scienze Bologna, ix. (1889) pp. 547–50 (1 pl.). See Zeitschr. f. Wiss. Mikr., vii. (1891) pp. 504–5.

‡ CR. Séances Congrès Internat. Zoologie Paris 1889, pp. 164–75. See Zeitschr. f. Wiss. Mikr., vii. (1891) p. 502.

§ Studies Biol. Lab. John Hopkins Univ., v. (1891) p. 3.

Preserving Caprellidæ.*—P. Mayer finds that these animals may be preserved without shrivelling by placing them in a mixture of glycerin 1 part and 50 per cent. spirit 2 parts after they are taken from the alcohol in which they have been kept. The alcohol is then slowly evaporated with moderate heat. The author considers that balsam is contra-indicated since on account of its strong refraction the finer skeletal details are imperfectly seen.

Mode of studying free Nematodes.†—Mr. N. A. Cobb collects from sand by applying his knowledge of the fact that, in standing water, sand sinks at once, while small organisms sink rather slowly. "Put half a pint of sand with a pint of water into a dish of the form and size of an ordinary one quart fruit-tin. Having a second beaker or fruit-tin at hand empty, pour the water and sand rapidly back and forth until the water is well roiled, then suddenly stop; the sand at once sinks to the bottom of the dish, but the organisms remain for a few seconds partially suspended. The instant the sand reaches the bottom of the dish, pour the supernatant fluid containing the organisms into a third dish and there let it stand until clear, when the sediment of organisms may be obtained in a very satisfactory state by decanting the clear water." In collecting from mud the process must be reversed.

If the animals are to be studied in the living state they may be rendered motionless by adding a little chloral hydrate to the water. If glycerin preparations are to be made, kill with 1/100 to 1/10 osmic acid and allow the worms to remain in it till they become a trifle coloured. It is best to use warm weak osmic acid.

For the very finest histological as well as coarser anatomical work Mr. Cobb has devised a method which gives far better results than any other with which he is acquainted.

Mode of examining Calcareous Bodies of Alcyonacea.‡—Dr. G. v. Koch says that the easiest way of examining these bodies is to cut a polyp through longitudinally with the scissors, to spread out in glycerin, cover with cover-glass, and observe with crossed nicols. The spicules will appear white on a dark ground and are generally very distinct. The same method may be employed with particles of cœnosarc.

Demonstrating Structure of Siliceous Sponges.§—Herr F. C. Noll succeeded, by treating with nitrate of silver, in showing that the spicules of *Desmacidon Bosei* were covered with an organic layer, the exact origin of which would appear to be uncertain. The same reagent was used with advantage in examining *Spongilla*. Small pieces of sponge were suspended on the slide in the aquarium, and when they had properly spread themselves out, were treated for about twenty minutes with 0·25 per cent. silver nitrate, and afterwards stained with picrocarmine. The flat epithelium was by this means well preserved. For imbedding,

* Fauna u. Flora d. Golfes v. Neapel, Monogr. xvii. (1890) pp. 157 (7 pls.). See Zeitschr. f. Wiss. Mikr., vii. (1891) p. 501.

† Proc. Linn. Soc. N.S.W., v. (1890) pp. 450–2.

‡ Mittheil. Zool. Stat. Neapel, ix. (1891) p. 655.

§ Abhandl. d. Senkenbergischen Naturf. Gesellsch., xv. (1888) pp. 1–58 (3 pls.). See Zeitschr. f. Wiss. Mikr., vii. (1891) pp. 497–8.

Canada balsam was found unsuitable, but good results were obtained with the following medium. Glycerin-gelatin is mixed with equal volumes of acetic acid and glycerin and warmed up until all the constituents have become thoroughly mixed. At a temperature of 12° R. the mass is fluid but below this it is necessary to warm it before using it. If the mass under the cover-glass be not quite firm it is advisable to ring the preparation round with some cement.

Demonstrating the Structure of Rotten-stone.*—Herr F. Dreyer adopted the usual procedure for examining the structure of rotten-stone and the distribution of the Radiolaria, viz. grinding down to one flat surface, then fixing this with balsam to a slide and then grinding down the other side, followed by balsam and cover-glass.

Isolation of the skeletons of the organisms was effected by the following ingenious device. A saturated solution of Glauber's salts was heated in a test-tube and pieces of rotten-stone, dried in the air, dropped therein. By this means they were thoroughly saturated and as they cooled down the process of crystallization effectually pulverized them. If the siliceous skeletons only be desired the following procedure is more simple. Small pieces of rotten-stone are boiled for a short time in hydrochloric acid, the carbonate of lime is dissolved and the thus separated skeletons fall to the bottom as a fine meal. The material should be washed with water in a large glass vessel, stirred up and allowed to stand for one or two hours. The supernatant fluid is pipetted off and the washing repeated several times. Finally, the material is dried in the air. By tapping the watch-glass containing some of the material, the finer may be separated from the coarser particles; some of the former can be mounted in balsam.

Collodion-method in Botany.†—Mr. M. B. Thomas advocates the use of collodion rather than of paraffin for infiltrating plant-tissues. The tissue to be treated is first dehydrated and hardened in alcohol. It is then placed in a 2 per cent. solution of collodion made by dissolving 2 grm. of gun-cotton in 100 ccm. of equal parts of sulphuric ether and 95 per cent. alcohol. In this solution it remains from 12–24 hours, and is then transferred to a 5 per cent. solution, where it again remains 12 hours. It is then laid on cork and covered, by means of a camel's hair brush, with successive layers of collodion, until it is quite inclosed in the mass, allowing each coat to dry slightly before applying the next. After a few hours the collodion will be firm enough to section.

(3) Cutting, including Imbedding and Microtomes.

Imbedding and Sectioning Mature Seeds.‡—Mr. W. W. Rowler gives some useful hints as to the best method of imbedding mature seeds in paraffin and preparing them for the microtome. The method described is that in use in the botanical laboratory of the Cornell University.

* Jenaische Zeitschr. f. Naturwiss., xxiv. (1890) pp. 471–548 (6 pls.). See Zeitschr. f. Wiss. Mikr., vii. (1891) pp. 498–99.

† Proc. Amer. Soc. Micr., 1890, pp. 123–7 (3 figs.).

‡ T. c., pp. 113–5.

A Method of Imbedding Delicate Objects in Celloidin.*—Mr. Frank S. Aby writes:—The object, properly fixed and hardened, is placed for twenty-four hours in a mixture of equal parts of alcohol and ether. It is transferred to a thin syrupy solution of celloidin, made by dissolving celloidin in a mixture of equal parts of alcohol and ether. After remaining in this solution for about twenty-four hours, the object is covered with a thicker solution of celloidin and is allowed to remain in the same for about twenty-four hours, when it is ready to imbed on cork.

When ready to imbed the object, a small quantity of the celloidin solution is spread on clean glass (a slide will answer the purpose), and allowed to dry. Then another coat is applied and allowed to dry. This affords a firm celloidin bed upon which the object is placed and arranged, care being taken to place it in the desired position as quickly as possible, before the celloidin begins to harden. The whole is now covered with successive layers of the celloidin solution, until a firm support is built up for the object. When sufficiently dry, the celloidin is removed from the glass by means of a sharp knife, and if necessary, a pair of scissors is used to trim the bed to the proper size and form. It is now ready to imbed on cork.

The top of a cork is coated with celloidin solution and allowed to dry. This is done to prevent air from rising from the cork and forming bubbles in the celloidin. The object, in its matrix of hardened celloidin, is placed in the desired position on the cork, and fastened to it with celloidin. After drying in the air until a layer is formed on the outer surface firm enough to retain the shape, the cork is dropped into 50 per cent. alcohol. Usually the object is ready to cut after remaining in the alcohol one hour.

This method of preparing a bed of celloidin has been employed with very satisfactory results in obtaining sections of embryo chicks. Blastoderms of the earlier periods of incubation have been successfully sectioned. By arranging the embryo on the bed of hardened celloidin, it has been possible to get large symmetrical sections of the blastoderm. Celloidin contracts during the drying process, but by exercise of due care in arranging the blastoderm, distortion may be avoided.

This method of imbedding has given good results in studying *Hydra*, and the preparation of the celloidin bed may be resorted to in almost every case where delicate objects are to be sectioned.

(4) Staining and Injecting.

Vasale's Modification of Weigert's Method.†—Sig. G. Vasale says that Weigert's method for staining central nervous tissue may be rendered less cumbrous by the following procedure, for which three solutions are necessary. (1) Hæmatoxylin 1 grm. dissolved in 100 grm. water by aid of heat. (2) Neutral acetate of copper, saturated filtered solution. (3) Borax 2 grm., ferridcyanide of potash 2·5 grm., dissolved in 300 grm. water.

The sections taken from spirit are placed in solution 1 for three to five minutes, then for same length of time in solution 2, whereon they

* Microscope, xi. (1891) pp. 58–9.

† Rivista Speriment. Freniatria e Med. Legale, xv. (1889) pp. 102–5. See Zeitschr. f. Wiss. Mikr., vii. (1891) pp. 517–9.

become black. They are then washed quickly in water and transferred to solution 3, whereby the ganglion-cells, the neuroglia, and degenerated parts are quickly decolorized, the medullated fibres remaining stained dark violet. Finally, the sections are well washed in water, then dehydrated in absolute alcohol followed by carbol-xylol (3 parts xylol to 1 carbolic acid) and balsam. If a contrast stain be desired, alum-carmine or picrocarmine or Pal's method are recommended.

Upson's Gold-staining Method for Axis-cylinders and Nerve-cells.* —Dr. A. Mercier describes two new methods, the invention of Dr. Upson, of Ohio, for staining axis-cylinders and cells of central nervous system, the results of which are stated to be wonderful. The pieces are hardened in the dark for four to six months in potassium bichromate, beginning at 1 per cent., afterwards increased up to 2½ per cent. The hardened pieces are then washed in water, and after-hardened in spirit, beginning for the first two or three days with 50 per cent. alcohol, and ending with 95 per cent. spirit, until the pieces are of a greenish colour. The sections may be made either with or without imbedding; in any case the sections are to be thoroughly dehydrated before either method is applied.

Method 1. The section is placed for one to two hours in 1 per cent. gold chloride solution to which 2 per cent. hydrochloric acid has been added. Wash in distilled water. Transfer on platinum or paper lifter to following solution for half a minute:—Potash, 10 per cent. solution, 5 ccm.; ferricyanide of potash, a trace. Wash for half a minute in 10 per cent. potash solution. Wash well in distilled water, and transfer to following solution:—Acid. sulfurosum, 5 ccm.; tinct. iodi, 3 per cent., 10–15 drops. Mix, and add liq. ferri chlorid., 1 drop. In this fluid the section is allowed to remain until it assumes a rose colour; it is then thoroughly washed in distilled water, dehydrated in absolute alcohol, oil of cloves, and balsam.

Method 2. The section is immersed for two hours in the following solution:—Gold chloride, 1 per cent., 5 ccm.; saturated solution of ammonium vanadicum, 10 drops; acid. hydrochlor., 3 drops. Having been washed in distilled water, it is immersed for thirty to sixty seconds in the following mixture:—Caustic potash, 10 per cent., 5 ccm.; ammonium vanadicum, a trace; permanganate of potash, 10 per cent., 10 drops. It is again washed in distilled water, and thereupon placed in the following fluid:—Tin solution, 15 drops; aq. dest., 3 ccm.; iron solution, 3–5 drops; acid. sulfurosum, 3 ccm.

The tin solution is made by adding so much chloride of tin to 3 per cent. tincture of iodine until the colour is white or yellowish. The iron solution is a saturated solution of ferrum phosphoricum in aq. dest.

When the section has become red it is then treated as in method 1.

The author states that although this method may appear somewhat complicated, in reality it is not more cumbersome than most other procedures, and that the results are splendid.

Three new Methods for Staining Medullary Sheath and Axis-cylinder of Nerves with Hæmatoxylin.†—Dr. M. Wolters describes the following method for staining the medullary sheath. The nerve-fibres

* Zeitschr. f. Wiss. Mikr., vii. (1891) pp. 474–9. † T. c., pp. 416–73.

appear of a blue-black colour, while the cells are yellow or yellowish brown. The specimens hardened in Müller's fluid and afterwards in alcohol were imbedded in celloidin. The sections were then placed for twenty-four hours in a paraffin stove at a temperature of 45° in Kultschitzky's hæmatoxylin solution (hæmatox. 2 g., alcohol abs. q. s. ad solut., acetic acid, 2 per cent., 100 ccm.).

After this the sections were immersed in Müller's fluid, and then treated with 1/4 per cent. permanganate of potash, after which they were decolorized in acidum oxalicum 1·0, kalium sulfurosum 1·0, aq. dest. 200·0. Then, having been washed in water, they were dehydrated, cleared up, and mounted.

The second method stained beautifully the protoplasmic process of Purkinje's corpuscles in the cerebellum. In this the procedure consisted in hardening and sectioning as before, and then using the following mordant:—Vanadium chloratum, 10 per cent., 2 parts; aluminium aceticum liquidum, 8 parts. Herein the sections remained for twenty-four hours, they were then washed for 5–10 minutes in water, and then having been stained with hæmatoxylin as in the first method, were decolorized with Weigert's fluid.

In the third method the pieces were hardened by Kultschitzky's method,* and after-hardened in 96 per cent. spirit. The section mass was imbedded in either celloidin or paraffin. The sections were then immersed for twenty-four hours in the following mordant:—Vanadium chloratum, 10 per cent., 2 parts; aluminum aceticum liq., 8 per cent., 8 parts. After having been washed for ten minutes in water the sections were placed in the hæmatoxylin for twenty-four hours. The staining was then differentiated with 80 per cent. alcohol to every 200 parts of which 1 part HCl was added.

When they assumed a bluish-red hue the acid was removed in weak spirit, after which the sections were dehydrated in absolute alcohol, cleared up in origanum oil, and mounted in balsam.

By this method the large cells of cerebrum and cerebellum, their protoplasmic processes, axis-cylinders, and the glia-cells were well stained.

Staining Osseous Tissue by Golgi's Method.†—Sig. V. Tirelli found that Golgi's method was suitable for studying osseous tissue, and very advantageous for flat bones; for example, the skull bones of an almost mature rabbit embryo. Against a yellow background the bone-corpuscles stand out stained more or less dark-brown, the staining in the centre of the elements being less pronounced than at the periphery or in the processes.

The reaction does not affect every individual element, but occurs usually in groups of five to thirty; and this is an advantage rather than not, since it allows the recognition of delicate details of structure.

Impregnating Brain of Amphibia by Golgi's Method.‡—Herr A. Oyarzun calls attention to the fact that in Ramón y Cajal's modification

* See this Journal, 1888, p. 510.

† Atti R. Accad. Lincei Roma—Rendiconti, vi. (1890) pp. 24–6.

‡ Arch. f. Mikr. Anat., xxxv. (1890) pp. 380–7 (2 pls.). See Zeitschr. f. Wiss Mikr., vii. (1891) p. 509.

of Golgi's silver method the observance of definite lengths of time for the different stages of the procedure is important. In frog's brain the best results were obtained by allowing the hardening and impregnating fluids to act for twenty-four hours. For the brain of the triton and salamander twenty-four hours were sufficient. If the fluids were allowed to act for thirty to forty hours, the results were very unsatisfactory.

Staining Medullary Sheath of Nerves of Spinal Cord and of Medulla.*—Dr. A. Mercier says the following simple procedures give satisfactory results for sections of spinal cord and medulla. The sections, according as they contain much or little of the chromic acid salt, are immersed in one of the two following solutions:—

Solution 1. Weak alcohol, 100; hæmatox., 2; aq. dest., 100; alum, 2; glycerin, 100.

Solution 2. Strong alcohol, 120; hæmatox., 2; aq. dest., 130; alum, 2; glycerin, 50. Dissolve the hæmatoxylin in spirit and the alum in the water, add to the latter the glycerin, and then mix with the hæmatoxylin in spirit.

Herein the section remains from twelve to twenty-four hours. It is then washed carefully in water, after which it is transferred to a modified Weigert's decolorizer:—Aq. dest., 200; ferricyanide of potash, 6; borax, 4. When sufficiently decolorized it is washed in distilled water, dehydrated, cleared up in oil of clove, and mounted in balsam.

It was found, however, that if the first decolorizing solution were followed by a second composed of potash, 10 per cent., 2 ccm.; aq. dest., 10 ccm.; æther sulphureus, 1 ccm., the differentiation was more satisfactory.

Demonstrating Nerve-end Plates in Tendons of Vertebrata.†—Sig. G. V. Ciaccio adopted the following method for demonstrating nerve-endings in tendons of Amphibia. The pieces were taken from a living animal, or from one just dead, and placed at once in 1/1000 hydrochloric acid, or better in 1/500 acetic acid until they were quite transparent.

They were then immersed for five minutes in a mixture of gold chloride and potassium chloride solutions (1/1000 each).

This imparts a pale yellow colour.

The pieces were next placed in a large quantity of 1/500 acetic acid and kept there in the dark for a whole day, and then exposed to the sun for two or three hours. When the tendon has assumed a pale violet hue, it is taken out and placed for a day in 1/1000 osmic acid solution and finally mounted in glycerin to which 0·5 per cent. of its bulk of acetic or formic acid has been added. The medullated fibres are stained dark violet, their extreme terminations being also violet, but passing into red or blue. The tendon itself is stained a pale yellow or light violet.

Preparing and Staining Testicle.‡—Sig. H. Brazzola in studying the testicle and the formation of spermatozoa, found that Podwyssozki's

* Zeitschr. f. Wiss. Mikr., vii. (1891) pp. 480–3.

† Memorie R. Accad. Sci. Bologna, x. (1890) pp. 301–424 (6 pls.). See Zeitschr. f. Wiss. Mikr., vii. (1891) pp. 507–8.

‡ Memorie R. Accad. Sci. Bologna, viii. (1888) pp. 681–94 (1 pl.); ix. (1888) pp. 79–85 (1 pl.). See Zeitschr. f. Wiss. Mikr., vii. (1891) pp. 516–7.

modification of Flemming's chrom-osmium-acetic acid was very suitable for the purpose. The objects were placed in 60 per cent. and absolute alcohol for 24 hours each, after which they were imbedded in celloidin. The sections were fixed to the slide with Mayer's albumen-glycerin. For staining purposes the Pfitzner-Flemming safranin, afterwards washed out with very dilute acid (0·1 to 0·25) gave the best results. A good double stain was effected with picric acid by Podwyssozki's procedure. Instead of the Pfitzner-Flemming safranin, a saturated aqueous solution of safranin or a 1 per cent. aqueous solution of gentian violet, or better still, one of these followed by the other may be used.

Gram's method followed by eosin made excellent preparations, and these were still better if the sections were further stained with safranin. The chromatin granules, like the mitoses, were stained red, the achromatic substances a pale blue.

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

Deterioration of Mayer's Albumen-Glycerin Fixative.*—Dr. J. Vosseler draws attention to the fact that Mayer's albumen-glycerin is extremely apt to lose its adhesive property after the lapse of a few months.

The loss of this essential property, its *raison d'être* in fact, is usually accompanied by a slight browning of the colour and a decrease of the viscidity, and the change is so gradual that it is easily overlooked. At first the author was inclined to lay the blame on the corks with which the bottles were stopped, or on the salicylate of soda added as antiseptic. Both these views turned out to be untenable. Little or no effect was observed from using different antiseptics, the least unsatisfactory being camphor. After noting that the peculiar decomposition was more liable to take place in summer than in winter, probably from being hastened by the increased light, air, and temperature, the author came to the conclusion that the glycerin was at the bottom of the mischief, and confirms his view by adducing the frequency with which preparations mounted in glycerin deteriorate.

Hints for fixing Series of Sections to the Slide.†—Dr. H. Suchannek has now altogether given up the use of mica plates, and employs glass slides or cover-glasses. These must be perfectly clean and free from grease. If greasy, spirit when run over a slide shows a tendency to form in balls and not to spread itself out in an even layer. The best adhesive is Mayer's albumen-glycerin, which is rubbed on the slide with the finger. The layer should be extremely thin and perfectly even. To this the sections will firmly adhere in about half an hour at a temperature of 40°.

If the sections be thin and betray any tendency to crumpling and will not lie quite flat, then Gaule's method is undoubtedly the best to pursue. This consists in fixing the sections with 50 per cent. neutral alcohol. The slides are then placed on top of an incubator with a sheet or two of blotting-paper interposed in order that the glass may not be heated above 40°. This causes the gradual and regular evaporation of

* Zeitschr. f. Wiss. Mikr., vii. (1891) pp. 457-9. † T. c., pp. 463-6.

the spirit and leaves the section smooth and adherent to its underlay. A higher temperature always fails to get rid of some little amount of moisture owing to the unequal rapidity of the evaporation; hence the author lays it down as an axiom that the lowest possible temperature is an indispensable condition for the production of a successful preparation. The rest of the procedure is that which is commonly adopted.

Preparation of Venetian Turpentine.*—Dr. H. Suchannek, while recording his estimation of the value of Venice turpentine for microscopical purposes,† advises that it be dissolved in neutral absolute alcohol. About equal volumes of these ingredients are mixed together in a tall glass vessel and placed in a porcelain tile oven. It is necessary to shake the mixture frequently. In from twelve to twenty-four hours the turpentine is dissolved and has deposited its impurities, and in from twelve to eighteen hours more it will have acquired the necessary consistence.

Vosseler's Cement and Wax Supports.‡—Dr. J. Vosseler recommends that paper or cardboard slips should be cemented on the slide by means of a cement made of commercial bleached shellac. Thoroughly broken up shellac is placed in a glass vessel, and alcohol of 90–96 per cent. poured over in quantity just sufficient to cover it. The vessel covered over is then placed on a paraffin stove. In a comparatively short time a clear brownish-looking mass of a syrupy consistence results. It is at once ready for use and, according to its inventor, is a very valuable cement.

The wax supports are made out of a mixture of Venetian turpentine and white wax. A quantity of wax is melted in a porcelain vessel, and thereto is added, stirring continually the while, from half to two-thirds its bulk of Venetian turpentine. Addition of turpentine softens, addition of wax hardens the mixture; the desired consistence is easily ascertained by letting fall a few drops on a glass plate or into water.

Although sufficiently plastic or impressionable it adheres very firmly to glass, hence the position of the supported cover-glass may be altered by slight pressure with a needle on one or all of the supports.

The medium may be used instead of the compressorium in the examination of fresh specimens of living Crustacea, the restless movements of which are easily restrained by fixing the cover-glass to the slide.

(6) Miscellaneous.

Use of Polarized Light in Observing Vegetable Tissues.§—M. Amann describes the results of a long series of observations made on the tissues of Mosses under polarized light, which have led to some curious results. The different cell-walls present, under these circumstances, very different appearances, depending largely on their degree of cuticularization; and it is possible in this way to define the characters of the cells belonging to the different organs in a moss, and even to a certain extent to distinguish between the characters presented by different families.

* Zeitschr. f. Wiss. Mikr., vii. (1891) p. 463. † See this Journal, 1890, p. 258.
‡ Zeitschr. f. Wiss. Mikr., vii. (1891) pp. 459–62.
§ Arch. Sci. Phys. et Nat. xxiv. (1890) pp. 502–8.

PROCEEDINGS OF THE SOCIETY.

Meeting of 15th April, 1891, at 20, Hanover Square, W., the President (Dr. R. Braithwaite, F.L.S.) in the Chair.

The Minutes of the meeting of 18th March last were read and confirmed, and were signed by the President.

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

	From
Cox, C. F., Protoplasm and Life. pp. 67. (8vo, New York, 1890)	*The Author.*
Slides (3) of sections of Teeth and Bone permeated with coloured collodion	*Mr. T. Charters White.*
Report and Proceedings, Ealing Microscopical Society	*The Ealing Microscopical Society.*

The President said it would no doubt be remembered that at the last meeting, Mr. T. Charters White exhibited some specimens of sections of teeth permeated with collodion. He had now presented three slides to the cabinet of the Society, which would be valuable as illustrations of the results obtained by the process which he described in his paper.

Prof. F. Jeffrey Bell, in reply to the President, said he had not yet read the book on 'Protoplasm and Life,' presented by Mr. C. F. Cox; but he had—as he often did—opened it at the end, where his eye fell upon the words, "Here I must leave the subject, lame and impotent though the conclusion may be." He would take it home, and see if he could not get something better out of it than that.

Mr. J. Mayall, junr., said there was also amongst the donations a copy of the Report and Proceedings of the Ealing Microscopical Society, which was worthy of notice, as it was not often that a society of so little pretension issued such an interesting abstract of its proceedings. Amongst other papers in the report there was one by Mr. Seebohm which had greatly interested him, and there were some others which he thought would also be found very well worth reading.

The President read a letter from Mr. J. Aitken, of Falkirk, dated from Mentone, on "A Spot Mirror Method of Illumination."

Mr. Mayall said the application of an opaque disc to block out more or less of the central portion of the mirror had long been known. In some of the Microscopes made in the last century by Dellebarre, the optician of Delft, Holland, there was a strip of brass 3 in. or 4 in. in length, with disc-like ends of different sizes, blackened or covered with cloth, made to slide under the stage in a spring-clip, and thus exclude the central light from the mirror, and give a more or less dark ground. Other methods had also been adopted by Dellebarre, one of which was to cement discs of black paper of different sizes on the under-faces of glass stage-plates. Central stops were very commonly applied to a disc of diaphragms rotating beneath the stage. The more modern arrangements of central stops to be used in conjunction with some form of condenser, or with a lieberkühn, were far preferable.

Prof. Bell read an abstract of a paper contributed by Surgeon V. Gunson Thorpe, R.N., on "Some New and Foreign Rotifera" found on the West Coast of Africa, and belonging to the genera *Trochosphæra*, *Floscularia*, and others. The paper had been submitted to their late President, Dr. Hudson, who regarded it as one of great interest, and strongly recommended the Society to print it *in extenso* with the figures.

Mr. E. M. Nelson referring to the subject of his paper read at the meeting of the Society in March last, exhibited two forms of bull's-eye condenser, one of which was made like Herschel's aplanatic, and the other was a new and simpler form than he had previously described, being made of two plano-convex lenses, the mounting of which was also peculiar, and what he considered to be the most useful method. This condenser seemed to answer its purpose admirably, the amount of spherical aberration being only about one-fifth of that which existed in the old form.

Mr. Nelson also read a paper entitled "Further Notes on Diatom Structures as Test Objects," which he illustrated by photographs.

The President said the photographs appeared beautifully clear, and would, he thought, be found of much interest as bearing upon the points to which Mr. Nelson had particularly drawn their attention.

Mr. C. Haughton Gill's paper "On the structure of certain Diatom valves as shown by sections of charged specimens" was read, the subject being illustrated by photomicrographs.

The President thought Mr. Gill's experiments were of great interest; but the subject was so new that discussion could hardly take place, especially in the absence of the author, which he regretted to learn was due to illness.

Mr. Mayall said the problem Mr. Gill had endeavoured to solve was as to the existence or not of cellular structure in diatoms extending through their substance, and this he sought to demonstrate by making chemical depositions of a more or less opaque character, which would probably fill up the cavities sufficiently to be plainly distinguished by the Microscope. He (Mr. Mayall) had some time ago translated a paper which appeared in the Proceedings of the Belgian Microscopical Society, on a process of preparing sections of diatoms by grinding portions of Cementstein from Jutland. The sections obtained in this way were imbedded in the material forming the matrix of the stone, and were filled up by the same material, showing to some extent the points which Mr. Gill had reached in another way. He thought that Mr. Gill's observations were of still greater interest because he had not merely taken a natural formation, but had deliberately experimented with the definite purpose of testing a special point, thus applying to Microscopy what Herschel would have termed an "experiment of inquiry"—a direct questioning of nature on a point that had hitherto been regarded as almost beyond the sphere of experiment. Dr. Flögel's sections of diatoms made with his unique microtome dealt with the same point by direct experiment, but unfortunately the production of such sections was attended by very great difficulties, and their preservation for inspection by other observers was apparently so uncertain as to be unreliable, judging from the specimens sent by Dr. Flögel to the Society. Mr. Mayall regretted that Mr. Gill's photographs of the specimens he described were so faint that it would be very difficult to utilize them for any photomechanical process of printing for the Journal.

Mr. Mayall said that in Part IV. Vol. I. of the Journal of the Liverpool Microscopical Society there was a paper by Mr. T. Comber, in which he dealt very practically with the processes of photomicrography with sunlight. He was, of course, sorry that this paper did not come directly to the Royal Microscopical Society; but considering the interest which attached to the subject, and the references made recently to Mr. Comber's work, the paper would probably be dealt with rather extensively in the next number of the Journal.

The President asked the Fellows present to bear in mind that the Conversazione was fixed for Thursday, the 30th of April, at which he hoped to see a good attendance, and that the next ordinary meeting would take place on the 20th of May.

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

Mr. C. H. Gill:—Six photographs of Diatom Structures in illustration of his paper.

Mr. E. M. Nelson:—Bull's-eye Condensers and Photographs of Diatoms in illustration of his papers.

Mr. C. F. Rousselet:—A slide of *Stephanoceros Eichornii*.

Mr. T. Charters White:—Three preparations permeated with coloured collodion.

New Fellow:—The following was elected an Ordinary Fellow:— Mr. Wilmot Tunstall.

MEETING OF 20TH MAY, 1891, AT 20, HANOVER SQUARE, W., THE PRESIDENT (DR. R. BRAITHWAITE, F.L.S.) IN THE CHAIR.

The Minutes of the meeting of 18th February last were read and confirmed, and were signed by the President.

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

	From
Kölliker, A., Handbuch der Gewebelehre des Menschen . . . Dritte Auflage. pp. xxiv. and 686, text illust. (8vo, Leipzig, 1859)	*Prof. F. Jeffrey Bell.*
Slides (3) of *Cysticercus*	*Mr. T. B. Rosseter.*

Prof. F. Jeffrey Bell mentioned that the book which he had presented was a copy of the third edition of Kölliker's well-known text-book, which he was surprised to find was not already in the Society's library. It would be of much interest also to them to possess copies of the other editions which had been published, and he ventured to throw out the hint that if any Fellows of the Society should be able to present these, they would be valuable as enabling them to trace the advances made in Animal Histology.

The President said he regretted to have to announce that since their last meeting they had lost several of their Fellows by death; amongst these was Mr. Joseph Beck, who was so well known throughout the microscopical world, and who for many years had been a Member of the Society's Council. They had also lost two of their Honorary Fellows, Dr. Carl Von Naegeli, of Munich, and Prof. Leidy, of Philadelphia, both of whom were elected in 1879.

The President notified that the Council had nominated as an Honorary Fellow of the Society, Prof. Thos. Henry Huxley, F.R.S.; and as an ex-officio Fellow, Prof. William Rutherford, F.R.S., President of the Scottish Microscopical Society, whose names were ordered to be suspended for election at the next meeting.

Mr. C. L. Curties exhibited a new form of Mayall's mechanical stage, recently manufactured by Zeiss, which gave upwards of an inch motion each way, and merely required to be clamped on the pillar of the Microscope when wanted for use. The Microscope on which its adaptation was shown was the same as that described by Mr. Nelson a short time ago, except that it was mounted on a horse-shoe foot, so as to give more working room below the stage as suggested by Mr. Mayall.

Mr. J. Mayall, jun., said that, in the study of bacteriology, it was often important to be able to move a preparation of larger size than usual upon the stage, and it was evidently with a view of meeting this requirement that, instead of the ordinary range of movement of about 5/8 in., this stage had been made so as to move nearly $1\frac{1}{4}$ in., which was effected by separating the rackwork vertical movement from the screw lateral movement, placing the latter in a box-fitting in front of the rackwork. He noticed, however, that whilst the vertical movement was rapid, the lateral motion was on the contrary, rather slow. He should have preferred the movements to act about equally. At the first glance, too, he had been somewhat puzzled by the latchet arrangement for clamping it to the Microscope; but its action was really very simple and efficient. A good point was in making the milled heads smaller than usual, and the milling broader, which would be found a matter of great convenience in use. Messrs. Zeiss had hit upon a novel way of accommodating slides of different sizes by applying a stepped base-piece, into the angles of which slides of three different sizes fitted, being held in position by a sliding spring-clip of very simple construction, and which was a novelty in that connection. The expense was necessarily somewhat greater than that of the simple forms made by Messrs. Swift and by Mr. Baker; but then a much greater range of movement was provided, with the additional conveniences of finders, and the facility of using large or small slides. This stage was well made, and was one of the best forms he had yet seen of that class. He thought, however, that it would be an advantage to have the rack-and-pinion work covered up, as far as possible, to exclude dust, &c., and to protect it from the hands.

Mr. Watson exhibited and described a Microscope which his firm had recently made specially to meet the wants of Dr. Henri Van Heurck, of Antwerp (see *ante*, p. 399).

Mr. Mayall said he did not propose to criticize the workmanship of the new Microscope, as he had not had an opportunity of examining the mechanism and of testing the movements. He understood, however, from the description already published, and from a description he had received, which was about to appear in a new edition of Dr. Van Heurck's work on the Microscope, that Dr. Van Heurck had supplied the specification of the design; his criticism would therefore be limited to the design for which Dr. Van Heurck was responsible. The Microscope was said to be intended specially for photomicrography and high-power work of the most delicate kind. With these aims in view, he must at once express his objection to the fine-adjustment, which was on what was generally known as the Zentmayer system, and which had long been condemned by those who had had special experience in testing fine-adjustments, such as were applied to Microscopes of the highest class. In the Zentmayer fine-adjustment, the bearings extend generally from end to end of the Jackson limb, and in order to secure a sensitive motion portions of the contact surfaces were removed to reduce the friction, and in all cases these bearings had to be left somewhat free, otherwise the motion would either be completely stopped or more or less irregular. Probably no one had made the mechanism more carefully than the late Joseph Zentmayer, in the large Microscope for which he was awarded a gold medal at the Philadelphia Exhibition, 1876, and a silver medal at the Paris Exhibition, 1878, which instrument he (Mr. Mayall) had had in use during several months. He could affirm that, in spite of Zentmayer's excellent workmanship, the fine-adjustment was unsatisfactory, and this he attributed to the fact that the system involved that the coarse-adjustment and body-tube were carried on the delicate bearings of the fine-adjustment, and the strain thus put upon these bearings soon introduced shakiness that was practically intolerable in high-power work. The apparent simplicity and consequent economy of the system had induced many opticians to adopt it, with more or less modification, both in England and in America; but, so far as he was aware, no permanent success had been attained—the radical defects of the system always cropped up sooner or later. He had witnessed a large number of experiments with the system conducted by Ross and Co., who acquired Zentmayer's patent rights in England, and who had spared no expense with a view to rendering it as perfect as possible, but the results were not satisfactory, and other systems had since been substituted by that firm. The adoption of the Zentmayer fine-adjustment by Dr. Van Heurck seemed to him a radical error in the specification, especially in an instrument intended for high-power work. It should be noted that other systems of fine-adjustment had been worked out, which were applicable to the Jackson model of Microscope, and which were known to be superior. He referred particularly to Swift's fine-adjustment as recently exhibited in the photomicrographic apparatus made for the Royal Veterinary College. In the original construction Messrs. Swift placed the coarse-adjustment in front of the fine-adjustment, so that the delicate bearings supported both; but upon his pointing out that the mistake would really be equivalent to that of Zentmayer, Messrs. Swift at once altered the arrangement, making the fine-adjustment act by itself, and independently of the coarse-adjustment, so that the bearings had no other strain to endure than that involved in the motion of the fine-adjustment. It was clearly Dr. Van Heurck's province to have known of this improvement in fine-adjustments already applied to the Jackson form of Microscope, and to have either adopted it or devised a new and better system.

With reference to the application of a lever fine-adjustment to the substage, having the actuating milled head above the level of the object-stage, by which Dr. Van Heurck claimed that both fine-adjustments could be used simultaneously with one hand, Mr. Mayall said he considered such an arrangement based on a total misapprehension of the essentials of practical microscopy. The position of the milled head was most inconvenient; the observer's fingers were liable to be caught by the stage mechanism; it impeded the freedom of manipulation on the stage, and it stopped the rotation of the stage; moreover, Dr. Van Heurck seemed to have overlooked the fact that the substage focusing motion was only brought into action in commencing an observation, and once being accurately adjusted was hardly touched again, unless for experimental purposes. The focal adjustment of the objective was a totally different factor, demanding incessant manipulation in many high-power investigations. He could not imagine what possible motive Dr. Van Heurck could have in view when he claimed as a point of utility the faculty of using both fine-adjustments simultaneously. Fine-adjustments had long been applied to the substage. Mr. Nelson had had one carried out by Messrs. Powell and Lealand, by means of a cone-pointed screw and stud mechanism. He had had this arrangement applied to his own Microscope, and he regretted to have to confess his disappointment with it, for it had introduced a new element of unsteadiness that was far more difficult to cope with than the former difficulty of focusing the condenser with the ordinary rack-and-pinion, which the fine-adjustment was intended to correct. A differential-screw mechanism had been applied by Mr. C. L. Curties, at the suggestion (he believed) of Mr. W. Lombardi, and this was embodied in Baker's recently-made photomicrographic apparatus, which was exhibited at the Society's Conversazione in November last. Various forms of direct-action screw arrangements had been applied for the same purpose on the Continent. Hence, it could not properly be said that Dr. Van Heurck had discovered an important point hitherto neglected, and forthwith devised special and novel mechanism by which an essential improvement was effected in the Microscope as an instrument of research.

The general design of the instrument seemed to have been copied from Bulloch's Histological Microscope, and he was surprised that the single pillar support should have commended itself to any one in these critical days. The milled heads of the mechanical stage seemed inconveniently large, especially when compared with those of Zeiss's stage that was shown that evening. The centering motions of the substage seemed to be of an ordinary cheap type, that could hardly be compared with the best right-angled motions known. The stud at the back of the Jackson limb for fixing the Microscope on a support when used for photography was evidently suggested by Swift's Microscope, to which reference had been made.

Mr. Mayall concluded by expressing his regret that Dr. Van Heurck's specification should have resulted in the production of the Microscope exhibited. In view of the enormous number of Microscopes that had been figured and described in the various text-books, and in the Journal of the Society, it appeared to him that Dr. Van Heurck had made a most inferior selection of points for his specification, resulting in an instrument the design of which he (Mr. Mayall) regarded as much below the standard claimed for it by Dr. Van Heurck.

Mr. E. M. Nelson said that as regarded the method of working the fine-adjustment of the substage, he agreed with Mr. Mayall that the position of this head was inconvenient, and it might also easily interfere with the rotation of the stage; indeed, he hardly knew why it was wanted at all, because when once the substage was focused it was done with and remained the same through the rest of the operations, whereas the other adjustments were being worked almost continually. He thought, therefore, that it would be an improvement if it was put on the other side of the Microscope, and on the under side, so as not to impede the rotation of the main stage.

Mr. Watson said he had heard the criticisms which had been made, but would take one exception to them all—namely, that no one could properly judge of any Microscope unless he had tried it; and because it happened that Mr. Mayall once had a Zentmayer Microscope and it went wrong, he was not prepared to admit that therefore no others would keep right, knowing, as he did, how many of similar construction he had made and sold without even one ever being returned as faulty. As to the No. 1 Zentmayer model, he could quite understand how it was possible for that to work loose and become useless; but as regarded such as were made in the same way as the one before the meeting, he had demonstrated to his own satisfaction that it was quite possible to make a Microscope in which the adjustments were perfectly firm, and would remain so with any amount of ordinary usage. Dr. Van Heurck in ordering this form did not do so without experience, but gave as his reason that the Microscope with which he was supplied by their firm, and in which the principal points were the same, had been in use for three or four years, and was now as good as ever. In his letter to them he said that he had Microscopes in his possession by all the best English and Continental makers; but the one he had from them had proved to be so satisfactory that it was preferred for use to any other. He thought that in matters of this kind an ounce of practice was worth any amount of theory, and for his part he did not see why, if an Englishman brought out a Microscope, because some one in another country made something like it which was bad, therefore, the English article was to be condemned. As to the substage adjustment, that had also been considered, and found to be very much more convenient where it was than if put under the stage, and it did not stop the rotation of the stage for any practical purpose, it being impossible to give the stage a complete rotation. Putting it round on the other side would certainly be no improvement, and he appealed to practical men as to how they would like to have to turn round to the other side of the instrument to get at it. On the points raised he would therefore say that his judges should be the people who used that form, and not those who merely theorized about it.

The President suggested that Mr. Mayall had not spoken of the instrument which Mr. Watson exhibited, but merely as to the principles of the construction.

Mr. Watson said that was just his point, and he maintained that it was quite possible to make a Microscope on those principles which should stand the test of practical use.

Dr. Dallinger said it appeared to him that when an instrument of that or any kind was brought before them, and their opinion was invited, remarks made could not be called criticism if they were not to speak honestly of what they felt to be its merits or demerits, as the case might be. Mr. Mayall, their Secretary, had, on his part, a very extensive knowledge of the Microscopes which had been produced by the makers of the world. Mr. Nelson also, on his part, had a practical acquaintance both with the construction and the working of the instrument such as few other persons had the opportunity of possessing. He might also add that his own laboratory contained instruments by every maker of any reputation here or elsewhere, and he felt bound to say that this form of fine-adjustment was not satisfactory; indeed, for use with the highest powers it was most unsatisfactory. When they had a thread so fine as the 1/100 in., and placed upon it the whole weight of the body, the ultimate result could hardly be otherwise than as he had found it. When, as a defence, it was said that an arrangement which they had before them "did not interfere with rotation of the stage," it seemed as if it was time to inquire what was meant by rotation. Those who were engaged in special investigations knew quite well what they wanted, and the microscopist so employsd knew that he wanted to completely rotate, if need arose, the stage of the instrument he was using. His own feeling was that, when a Microscope of that kind was brought before them, there were only two courses open to them—either absolute silence, or absolute honesty, in the matter of criticism.

Mr. Grenfell exhibited a photograph, taken by Mr. Nelson, of a small organism found a short time ago, the nature of which he had been as yet unable to determine, some of the best zoologists and botanists to whom he had shown it being unable to say whether it was vegetable or animal in its nature. The whole of the details were brought out in such a way as to afford a striking instance of the value of photography for such purposes. He also wished to mention that at the present time in the Botanical Gardens (and, he also believed, in the boating-pond, Regent's Park) there were considerable numbers of a free-swimming infusorian known as *Tintinnus*, formerly described by Claparède. It was remarkable for its chitinous lorica, a specimen of which he had brought for exhibition, the creature itself not being easy to exhibit, in consequence of its rapid movements. Claparède mentioned its having been found at Berlin; but hitherto it had only seemed to be found in sea-water.

Prof. Bell said they had received another communication from Mr. T. B. Rosseter, who had for some time been interesting himself in endeavouring to trace out the life-history of certain tape-worms. It would be remembered that some months ago he had sent a paper on the subject, but it was then shown that his observation had been anticipated. He had now sent a paper describing the development of *Tænia lanceolata* from the duck, the cysticercoid form of which had not been previously known. He appeared to have fed the ducks with some of the *Cypris* known to be infested with the parasite, and after some weeks opened the ducks and found the tape-worms mentioned. It was, of course, interesting to get the life-history of another tape-worm worked out.

Mr. T. B. Rosseter has prepared the following abstract:—He reports the discovery of a new *Cysticercus* which makes *Cypris cinerea* its intermediate host. The peculiarity of this *Cysticercus* consists in the fact that when evaginated from the cyst by the action of reagents the four suckers on the scolex are seen to be armed with from 180 to 200 very minute hooks; their measurement, individually, is 1/5000 in. from base of anterior root to tip of claw. These hooks are arranged around the periphery of the suckers and again longitudinally from the polar axis to the base of sucker in rows of three hooks in each row, and their position on the sucker is in reverse order to the hooks on the rostellum. The rostrum, which is invaginated in the cysticercus stage, bears ten hooks, each one measuring 1/600 in. Ducks when fed with this *Cysticercus* produce a tape-worm similar in every respect to the embryonic scolex in the cyst, even the minute hooks on the suckers existing in this stage of the life-history of the creature. This armature of the suckers is unique in the history of cysticercoids and Cestoida. The hooks on the rostellum, the rostrum itself, the elongated proboscis, scolex, and generative organs all correspond to the *Tænia lanceolata* of Goeze, Rudolphi, and Dujardin. No mention is made by any of these investigators of the existence of hooks on the suckers of this tape-worm. Such being the case, *Cysticercus* with ten hooks and armed suckers (Rosseter) equals *Tænia lanceolata* (Goeze, Rudolphi, Dujardin).

Mr. E. M. Nelson read a note on the subject of "Lateral Development in Photography," advanced by Mr. Pringle in his note printed in the Journal of the Society for April last, pp. 263–4. He had tried many experiments, leading to the conclusion that Mr. Pringle was wholly mistaken in supposing that the width of a flagellum is increased to an extent at least 50 per cent. by lateral development. If lateral development of this kind occurred, it would eat into the image of the flagellum on the negative, and so make it thinner than the image on the screen; but when the negative was printed this lateral development would act in the opposite direction, and if the actions were equal in extent the size of the flagellum would be restored to the original size of the image on the screen. In no case could the action of the lateral development on the negative and on the print be cumulative. Mr. Nelson considered it highly important to dispose of the lateral development theory, for if such an error were allowed currency without challenge, it would very soon be said that a photomicrograph, on account of this lateral development, had no scientific value.

Mr. Nelson also read a short paper "On the Use of Monochromatic Light in Microscopy," and exhibited and described the model of a new and simple apparatus for obtaining the same by means of a glass prism.

Mr. Mayall said he recollected the original apparatus designed by the late M. Prazmowski at the time he was in partnership with Hartnack; it was troublesome to manage, so that not very much was done with it. That made by Zeiss, later on, was practically the same thing. He thought, however, that the apparatus before them was very likely to do good work, and the facility with which the prism could be turned, and the illumination varied from one end to the other of the spectrum, at once commended it to notice. He understood Mr. Nelson to say that by changing the monochromatic light from yellow to blue, the resolving power of the objective could be plainly seen to be augmented by an amount equivalent to ·1 N.A., and that in many cases an ordinary achromatic objective produced images as perfect as those given by apochromatic objectives. These were points of special scientific interest. He should not be satisfied, however, until Mr. Comber had seen it and put it through its paces, using sunlight, because now they were not content with mere performance with the Microscope, but they must have good photographic results as well. Of course, to be of permanent value, the apparatus must not be made of wood, as in the model. There would be no difficulty in adapting an inexpensive form of spectroscope for the purpose.

Mr. Nelson also described a new Projection Microscope fitted with a special condenser made of three flint lenses so as to embrace the whole cone of 82°. The only novelty about it was the system of collecting the light, by which a beam of 4¼ in. was brought down to one of 1¼ in., and by passing through the two lenses placed in a water-trough, a beam of parallel rays of great intensity was obtained for use in projecting the image upon the screen. It was necessary to have a different condenser for each objective, as the one must be perfectly adapted for use with the other. He had at present only two, one being for use with Zeiss's A A, equal to about an ordinary 1 in., and the other being a lower power. A number of slides were exhibited upon the screen.

The President said he had been very much struck with the beauty of the views which had been shown, and thought that it would be a great acquisition to any one who wanted to give exhibitions of microscopical objects. Very few schools should be unprovided with such an apparatus. He was sure those present felt greatly obliged to Mr. Nelson for what he had shown them.

Mr. Mayall said that some seven or eight years ago, when Dr. Hugo Schröder first came to England, he gave a description of a Microscope for projection purposes which he had devised, examples of which were in use in Germany and in the United States. Figures of this instrument had been given in the Journal of the Society, and Mr. Crisp had been so much struck with the importance of having such an instrument for use at the Society's meetings, that it was decided to order one, and if it proved successful the Society would have been strongly advised to acquire one. Unfortunately, however, from various causes, the order had never been executed. The intention in Dr. Schröder's apparatus was much the same as that of Mr. Nelson, though the plan of the latter was much less ambitious and much less expensive. He thought Mr. Nelson was rendering valuable services to microscopy in working out these improved forms of condensers for projection apparatus. The images he had shown upon the screen were very clear, sharp, and luminous, comparing most favourably with the exhibition made some time ago at the Society by Mr. Lewis Wright. He might also say that Mr. Nelson's projection images were far superior to anything shown at the Crystal Palace and elsewhere, with Microscopes said to magnify 50,000 diameters. It was interesting to note the extent of sharp field given by objectives of different construction; the projection images enabled the observer to select different qualities of objectives with great facility. He hoped the Society's funds would soon enable them to acquire such an instrument for practical demonstrations in illustration of papers at the meetings—a point which Mr. Crisp and he had long regarded as worthy of the Society's most careful consideration. The possession of a projection lantern for exhibiting photographs, &c., on the screen was, of course, involved in the equipment required by the Society; but the projection Microscope itself, with which Microscope objectives could be employed effectively, was the essential thing required.

The President announced that the next meeting would take place on Wednesday, 17th June.

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

Mr. C. L. Curties:—Baker's Improved Student's Microscope, and Zeiss's Mechanical Stage (Mayall's form).

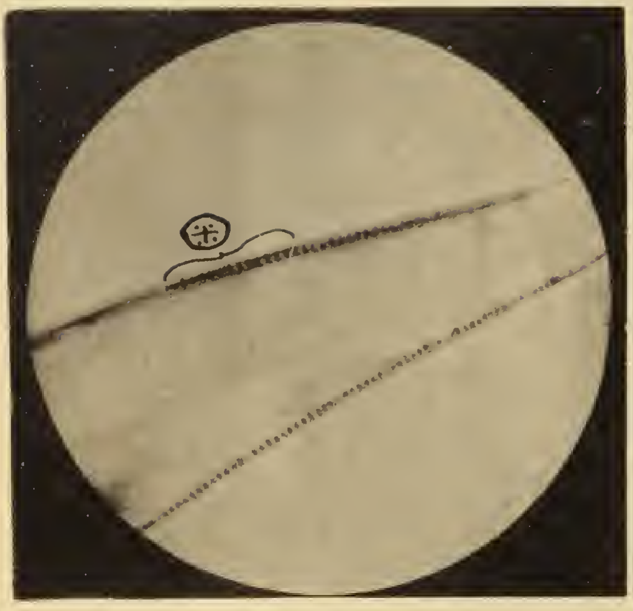
Mr. E. M. Nelson:—(1) Projection Microscope. (2) New Apparatus for producing Monochromatic Illumination for the Microscope.

Mr. T. B. Rosseter:—Slides (3) of *Cysticercus* in illustration of his note.

Messrs. W. Watson & Sons:—Dr. Van Heurck's Microscope for Photomicrography and high-power work.

New Fellows:—The following were elected *Ordinary* Fellows:—Mr. Samuel Hartshorne Ridge, B.A., F.R.G.S., and Sir Walter Joseph Sendall, K.C.M.G., Governor of Barbados.

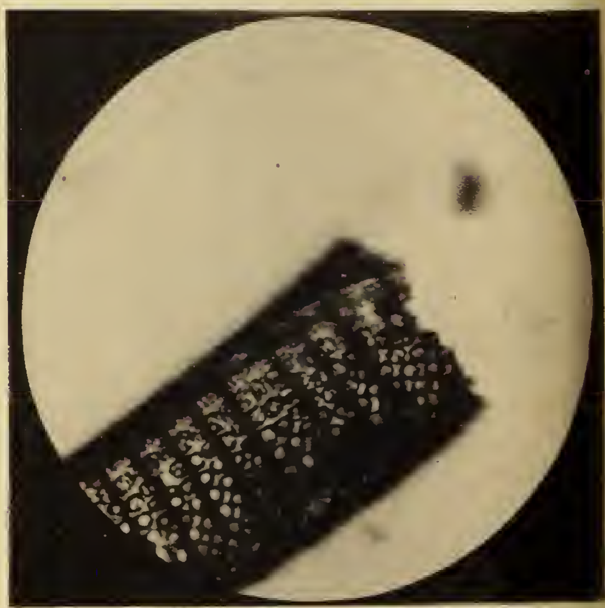
No. 1.



No. 2.

No. 3.

No. 4.



C. H. GILL Photo. J. MAES Phototyp.

Broken Edges of charged Diatoms, showing pores extending from face to face of shell.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

AUGUST 1891.

TRANSACTIONS OF THE SOCIETY.

VII.—*On the Structure of certain Diatom-valves as shown by sections of charged specimens.*

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

(*Read* 15*th April*, 1891.)

Plate VIII.

In a paper which I had the honour to read before this Society on the 19th of March, 1890, it was demonstrated that the "striæ, dots," &c., of very various forms of diatoms were cavities of some kind, inasmuch as they could be filled with opaque foreign matter, e. g. platinum or the sulphides of mercury or silver. I added, " Whether these lacunæ are complete perforations through the silicious test or mere pits or depressions on the inner or outer surface of the valve, or more or less flask-formed cavities communicating by one or more canals with the inner or outer surface, or with both, cannot at present be resolved with any degree of certainty in the case of those diatoms which have the finer markings."

Since writing the above I have found among my slides a few fragments of charged diatoms so tilted as to give a clear edge view of the fractured shell. Some of these I have photographed, and they seem to me to show clearly that the lacunæ in these cases at any rate extend from face to face and are not mere surface depressions.

Photograph No. 1, taken from a specimen of *Cocconema lanceolatum*, gives, at the points inclosed by the bracket, a picture of a broken edge which is not quite straight, and therefore not in sharp focus everywhere at once. It shows the mercurous sulphide filling the pores or lacunæ and extending, apparently, from face to face of the shell. The same thing is seen in optical section only and confused by interference lines in the other margin of the valve as photographed.

When examining the original slide (and others which I have not photographed) by help of a good 3 mm. apochromatic objective N.A. 1·4, and careful adjustment of the light, I think that I can detect the presence of a limiting film of silica, on the outer face at least, corresponding to the cell-cappings of the coscinodiscs.

Photo No. 2 shows the same things in the case of the more finely dotted *Stauroneis phœnicenteron*.

Photo No. 3 is taken from a valve of *Pleurosigma Balticum.* In this case, as the structure is so very minute, and as I have not been able to find even a second specimen presenting the same aspect to view, I bring forward an isolated example for what it is worth. As however the picture it gives is entirely in accordance with what we should expect to see, judging from analogy with the coarser forms cited and illustrated above, and about which no doubt can exist, I consider it is a substantially true representation, and that in this *Pleurosigma* at any rate the dots represent cavities which extend from face to face of the shell.

The question as to whether these pores are absolutely complete perforations through and through the walls of the valve or have any sort of operculum or capping on either or on both faces, as is the case with the large discoid diatoms, is one which can hardly be decided by optical means. But the way in which various precipitates are retained in the pores in resistance to violent agitation with water, leads me to incline strongly to the opinion that such "cappings" exist. Moreover, in the case of one large and coarsely marked form of *Epithemia* the "secondary markings," i. e. the perforations of the cappings, are plainly visible in an imperfectly charged specimen of which I now exhibit a photograph (No. 4).

I must apologize for again trespassing on your attention with such a threadbare subject as diatom markings, but plead that it is done in the hope of finally laying to rest a subject of controversy which has engaged a most disproportionate amount of attention.

There is indeed still one aspect in which the subject may even yet be regarded as of serious interest. So long as the structure of these much studied organisms remains in doubt, so long must a great feeling of uncertainty prevail as to the value to be attached to the interpretation of appearances presented by other minute structures under the Microscope.

Now, if by any means we attain to a feeling of comparative certainty as to the truthfulness of the visual impressions received from the Microscope in any one case of minute structure, we *pro tanto* increase our confidence in the reality of the things pictured to us in those cases where none but purely optical means are available in making out the subject under examination. This method of filling the pores of diatoms has rendered it certain that the conclusion previously arrived at by observers like Messrs. Flögel, Weiss, Van Heurck, H. L. Smith, Cox, Nelson, Morland, and others, viz. that the dots, &c., on diatoms were perforations or depressions, and not beads, was substantially correct, and that therefore the microscopic images on which they founded their opinions were at any rate approximately true images. Hence we derive the comforting assurance that we need not receive with utter distrust the conclusions arrived at by the study of microscopic images, even in those cases where the close approximation of minute structures must lead to the production of endless diffraction spectra.

VIII.—*A New Illuminating Apparatus.*

By E. M. Nelson, F.R.M.S.

(*Read* 20*th May*, 1891.)

In the direction of monochromatic light very little has been done. This may be attributed to the unsatisfactory results already obtained. Who, for instance, has seen a critical image with monochromatic light? Many have witnessed attempts, and some of us have ourselves tried experiments. There has been one universal verdict to all these efforts—viz. that of dismal failure. The experiments have taken two forms: first, that of obtaining monochromatic blue light by interposing absorption media, the other by prism dispersion.

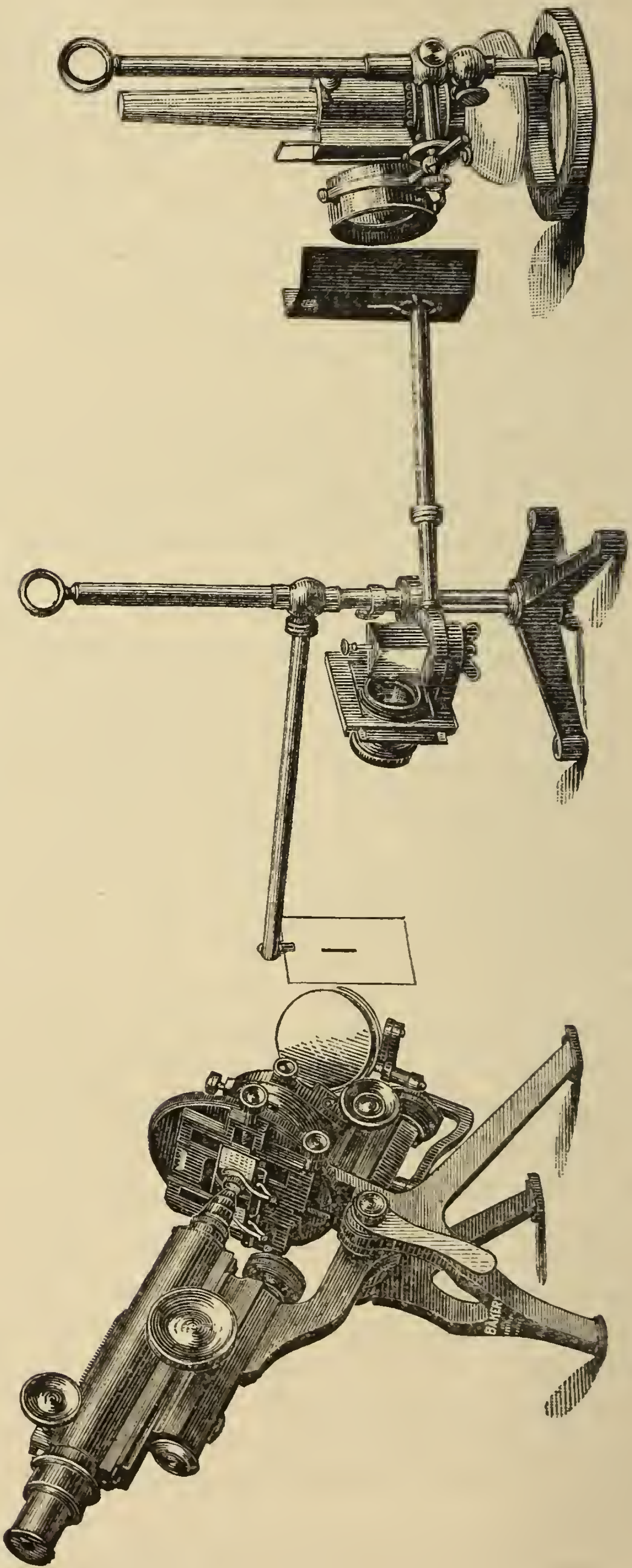
The first may be dismissed in a word: so far as is known there does not exist a medium that will only pass a blue ray. Ammonio-sulphate of copper passes any amount of red light, blue glass does the same. The examination with a spectroscope of the light which has passed through any of these absorbing media immediately dispels the idea that it is monochromatic. Before proceeding I may say that the best results in this direction were obtained by using two thicknesses of pot cobalt glass supplied by Messrs. Powell and Lealand. The spectrum through these curiously agrees with that through Rainey's light-modifier, which was composed of three different tints of glass; an account of which will be found in the Transactions.* For monochromatic light in the strict sense we are thrown back on prism dispersion. Instruments on this plan have been made, notably by Zeiss on a Hartnack model. The Zeiss monochromatic apparatus is probably very suitable for obtaining a spectrum, but in its design the requirements of the Microscope are absolutely ignored. It consists of a slit; a low-angled achromatic lens having the slit at its principal focus; two prisms; and another low-angled achromatic lens very similar to the first. The rays diverging from the slit are parallelized by the first lens, and after passing through the prisms are received by the second lens and by it brought to a focus. With this apparatus the use of a substage condenser is impossible because it yields convergent rays.

It must be borne in mind that none of Abbe's condensers will focus parallel rays; much less therefore will they focus convergent. If it is used, as intended, without any additional apparatus the cone from the low-angled condensing lens is too narrow to be of any service. As therefore this apparatus will work neither with nor without a condenser, it becomes mere lumber in the microscopist's cabinet. I never heard of one that had been used after its first trial. The apparatus I am exhibiting this evening is, as may be seen, only a makeshift; but I claim that it has for its end the requirements of the modern Microscope.

* Trans. Micr. Soc. London, N.S. ii. (1854) pp. 23-4.

It is composed of a base-board, on which slides a piece of wood holding an adjustable slit. Screw adjustment to the slit is quite unnecessary, as clear definition of the lines in a spectrum is not what

Fig. 51.

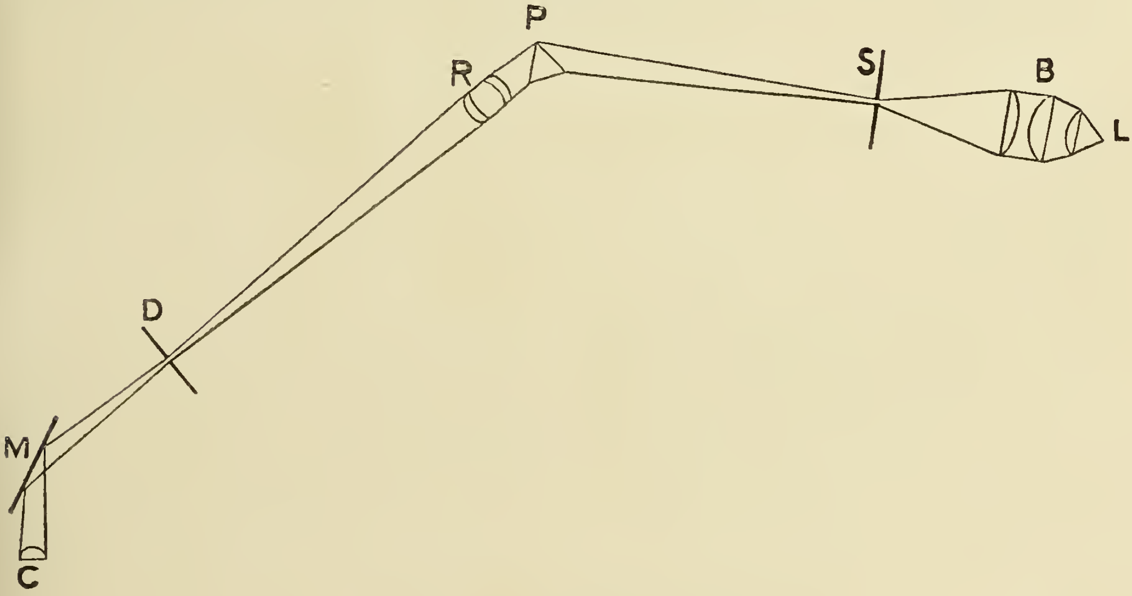


Nelson's Apparatus for obtaining Monochromatic Light.

we have in view. On the same piece of wood that carries the slit another piece of wood slides which carries the prism. This piece of wood rotates on its axis; connected to this is another piece of wood which rotates round the prism as a centre. This holds a photographic lens known as a Wray 5 × 4 R.R., working at $f/5 \cdot 6$. Lastly there is a card on a movable stand. The method of use is as follows. A strong beam of light is condensed on to the slit S, fig. 52, which is kept about 1/12 in. open, by means of one of my new bull's-eyes, B to which an additional lens has been added. From the slit the light passes to a dense flint prism P which by means of its rotating holder is set at minimum deviation.

The Wray photographic lens R, which is eminently suitable for this purpose, both on account of its being corrected for rays high up the spectrum and also on account of its large aperture, is rotated

Fig. 52.



round the prism until the refracted beam falls directly on it. The prism and this lens, which is attached to the same fitting, are now both moved to a distance from the slit equal to twice the focal length of the lens, the image of the slit, i. e. the spectrum, being focused on the card D, which is placed at a similar distance from the lens, and on the other side of it. The card is then moved so that the kind of light required may pass through an aperture in it to M the mirror of the Microscope. The apparatus has also been made in metal (see fig. 5), attached to a firm bull's-eye stand; another form is also made in wood, suitable for direct illumination without a mirror. The condensing system is not absolutely necessary; by placing the edge of the lamp-flame close to the slit a good light can be obtained, but the light is more intense when the condenser is used. We then proceed with the manipulation of the Microscope in the usual way, the slit in the card being treated exactly as if it were the lamp-flame. By a slight rotation of the Wray lens any colour of the spectrum is made to fall on the aperture in the card, and by this means the required colour for the illumination of the Microscope is obtained. For resolving purposes the blue-green will probably be found the most suitable.

The next question is—What do we gain by this apparatus? In the first place, with regard to resolving power with blue-green light, it practically adds ·1 to the N.A. of the objective: thus a D.D. of ·8 becomes a lens of ·9 N.A., and that too without incurring any increase of spherical aberration. Secondly, as there can be no secondary spectrum, an ordinary achromatic lens performs as well as an apochromatic. For photomicrographic work it will be useful in taking the place of the coloured screens which are so necessary when isochromatic plates are used. For purposes of resolution, however, I do not think that it will prove of any assistance to photomicrography, Mr. Comber having pointed out that the plate itself is a monochromatic light-selecter.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

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

α. Embryology.†

Fecundation.‡—M. H. Fol gives an account of his observations on the egg of the sea-urchin. The spermatozoon, five minutes after fecundation, is still conical; a small corpuscle, the spermocentre, is detached from its tip. The spermatic pronucleus then swells and approaches the ovarian pronucleus, its spermocentre being always in front. The ovarian pronucleus has an ovocentre which is placed on the side opposite to that which gives rise to the polar globules. The spermocentre becomes placed on the polar side of the ovarian pronucleus, and is afterwards applied to its lateral surface. There are now two prolonged phases, the "solar," and the "aureolar"; at the end of the first of these the spermocentre and ovocentre are divided in the form of halteres, which are not placed in the same plane. These halteres become set parallel to one another, and are situated in a plane which will be that of the aureole. In the next phase the spermocentre and ovocentre become divided and the halves, passing in opposite directions along a fourth of the circumference of the combined nucleus, arrive at a point which is at right angles to their first position. This M. Fol calls the "marche du quadrille."

At the moment when the demi-spermocentres are on the point of touching the demi-ovocentres, the aureole rapidly disappears and true asters become apparent; these are composed of perfectly distinct fibrils, which can be isolated and are different from the simple protoplasmic radiations visible till then. The demi-centres unite and fuse to form the first astrocentres.

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

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

‡ Comptes Rendus, cxii. (1891) pp. 877–9 (10 figs.).

The author concludes that fecundation consists not only in the addition of two demi-centres arising from individuals of different sexes, but in the union of two demi-spermocentres with two halves of ovocentres to form the two first astrocentres. All the succeeding astrocentres are derived in equal parts from the mother and the father.

Comparative Anatomy of Placenta.*—Prof. E. Klebs has endeavoured to throw light on some unsolved problems by a study of the placenta in the white rat. From the distribution and appearance of the arteries and veins seen on a cross section of the gravid uterus, he argues that in the vascular layer of the maternal placenta there must be a slow circulation at relatively high pressure. The blood-stream finds its main outflow in the so-called peri-placenta. As the result of abundant nutrition, the maternal epithelium, the connective matrix, and the endothelium of the widened vessels are all hypertrophied. In the layer of the "monster-cells," as Minot calls them, the endothelial proliferation closes the openings of the vessels, but this closing membrane is not impervious. It allows red blood-corpuscles to pass into the numerous clefts between the monster-cells, and these corpuscles are found in the space between maternal and fœtal epithelium, and also between the serous membrane and the extension of monster-cells on the lateral regions of the placenta. During life there must be some way of securing that the blood in the important inter-epithelial space flows off. Klebs believes that this is secured by the layer of smooth muscle-fibres covering the internal surface of the vascular part of the maternal placenta, and he ventures to speak of a "placental heart." He compares the placenta in the rat with that in the rabbit, and with that in man; all the three may be called vascular, for it is to elements of the vascular system that the chorionic villi become apposed; but the details of vascular arrangement are different. The placenta may be called *plexiformis* in the rabbit, *cavernosa* in man, *per appositionem* in the rat.

Placenta of the Cat.†—Prof. G. Henricius has corroborated by an investigation of the placenta of the cat some of the observations which he previously made in regard to that of the dog. Where the fœtal ectoderm or chorionic epithelium begins to come into connection with the uterine mucosa, the superficial epithelium of the latter has disappeared. At this early stage the glandular cells are already much modified; they give origin to material which passes through the superficial layer of connective tissue into the uterine cavity. Before or during the firmer fixing of the embryo there is a complete or almost complete closure of the uterine glands. The chorionic villi certainly do not penetrate at first into the glands, but enter the superficial connective tissue. As they penetrate deeper they are seen to be surrounded by a syncytium, a kind of decidua due to a modification of the connective tissue. Neither glandular epithelium nor fœtal epithelium takes part in forming the syncytium. Most of it subsequently disappears, probably absorbed by the fœtus. In the neighbourhood of the villi, the glandular cells undergo disruption, and perhaps help in the nutrition. Moreover, red blood-corpuscles seem to pass through the walls of the vessels, and

* Arch. f. Mikr. Anat., xxxvi. (1891) pp. 335–56 (1 pl.).
† Op. cit., xxxvii. (1891) pp. 357–74 (2 pls.).

through the glandular epithelium, to the chorionic epithelium close to which they accumulate. At a later stage, the tissue between the more numerous villi is much reduced; the villi are separated by thin strands each with a capillary close to which the chorionic epithelium lies. The villi eventually insinuate themselves into the glandular spaces, and their epithelial cells are modified for the absorption of the "uterine milk"—the secretion and débris of the glands. Outside the strict placenta, red blood-corpuscles have accumulated around the chorionic epithelium, by which they are absorbed and probably utilized.

Gastrulation in Lacerta agilis.*—Dr. K. F. Wenckebach finds that the bilaminate stage of the germinal disc of *Lacerta* is due to cleavage and not to invagination. Gastrulation is effected by the invagination of the upper layer; only a small part of the enteric wall is formed from the archenteron; the notochord is formed in its dorsal wall, and with this is developed the gastric mesoderm; the peristomial mesoderm is developed from the whole circumference of the blastopore. The formation of the notochord and gastric mesoderm is continued towards the cranium in the lower layer. The author points out the resemblance between the gastrulation of the Reptilian egg and that of the Mammalia. While the egg of *Amphioxus* may be called the primary holoblastic egg, that of Amphibians is secondary, and that of Mammals tertiary. The recent work of L. Will on the development of the Gecko would make it, if taken in combination with the author's observations on the Lizard, possible to derive the gastrula of Mammals from that of Amphibians even without the assistance given by *Ichthyophis* and *Echidna*.

Fœtal Membranes in Chelonia.†—Prof. K. Mitsukuri has published in detail and with illustrations an account of his studies on the fœtal membranes of Chelonia, the preliminary notice of which has already been reported.‡ It will be remembered that he called attention to the presence of a rudimentary placenta, and he now makes some suggestions as to the phylogeny of the fœtal membranes in Vertebrates. He strongly inclines to the view that the amnion was originally developed by mechanical causes; there are, in the Chelonia, two reasons why the headfold, when produced, should sink into the yolk below. The yolk is very large and liquid, so that a slight weight is sufficient to sink any structure into it, and there is no space for the headfold to grow in any other direction than downwards. It is the dorsal part of the proamnion that primarily consisted of epiblast only.

Primitive Segmentation of Vertebrate Brain.§—Mr. B. H. Waters has made a study of the brain of *Gadus morrhua*, from which he concludes that the neuromeres appear at a late period in the ontogeny and soon degenerate; this disproves the view that they are formed mechanically, and strengthens that of their phylogenetic importance. The olfactory pits develope early in connection with the first pair of nerves which arise from the fore-brain. This fore-brain contains three neuromeres; from the first the roots of the olfactory nerve arise; and at a point somewhat above the second the optic diverticula are formed. The

* Anat. Anzeig., vi. (1891) pp. 57–61, 72–7 (15 figs.).
† Journ. College of Science, Imp. Univ. Japan, iv. (1891) pp. 1–53 (10 pls.).
‡ See *ante*, p. 22.
§ Zool. Anzeig., xiv. (1891) pp. 141–4.

mid-brain is composed of two well-marked neuromeres. Evidence of the origin of the third and fourth nerves from the two neuromeres of the mid-brain is unsatisfactory.

β. Histology.

Structure of Amœboid Protoplasm.*—Prof. E. A. Schäfer has succeeded, by the instantaneous application of a jet of steam to the surface of the cover-glass, in immediately killing blood-cells. The most striking point is the contrast between the protoplasm of the body of the cell and that of the pseudopodia. For while the former exhibits, according to focus, either a finely punctated or a reticular aspect and stains decidedly with hæmatoxylin, the pseudopodia exhibit not a trace of structure, and remain almost entirely unstained. We may conclude, therefore, that protoplasm is composed of two parts, which are morphologically distinct; one exhibits a reticular arrangement and has an affinity for hæmatoxylin, while the other has no structural arrangement, and is chemically different. These bodies may be called spongioplasm and hyaloplasm ; the former is the firmer, though not, perhaps, actually solid, and is, in all probability, highly extensile and elastic; the latter flows, and it is by its movement that the movements of cells are produced, and it is the more active of the two. Hyaloplasm is probably the essential part of protoplasm, but we not yet know how its flowing is brought about.

If the structure of protoplasm be compared with that of striated muscle, there may be seen to be many points of coincidence. In the latter the substance of the sarcous element stains while the homogeneous substance of the clear intervals remains unstained. The changes which occur in contraction are so like those which occur in the protoplasm of an amœboid cell, that it is hardly possible to believe that the resemblance is merely accidental. It becomes clear, moreover, that neither the protrusion nor the withdrawal of pseudopodia are signs of a resting condition ; both are produced by a flowing of the hyaloplasm.

As to ciliary motion, Prof. Schäfer suggests that, if we suppose a cilium to be a hollow curved extension of a cell, occupied by hyaloplasm, and invested by a delicate elastic membrane, it follows that if there be a rhythmic flowing of hyaloplasm from the body of the cell into and out of the cilium, there must be an alternate flexion and extension of the process. If the membrane be thickened more on one side than another, or if the line of lessened extensibility passed in a corkscrew fashion, the spiral direction of certain cilia may be explained.

Morphology and Physiology of the Cell.†—Dr. A. B. Macallum offers some contributions to our knowledge of the cell. He commences with a discussion of the nature of structures observed within epithelial cells of the alimentary canal. He classifies them thus :—1, Parasites; 2, Remains of broken-down cells and nuclei swallowed by the healthy adjoining cells ; 3, Material swallowed by the epithelial cell from food passing over its free surface ; 4, Plasmosomata migrated or extruded from the nucleus (in the glandular cells of the pancreas only). He

* Proc. Roy. Soc. Lond., xlix. (1891) pp. 193–8.
† Trans. Canadian Inst., i. (1891) pp. 247–78 (2 pls.).

describes some intracellular parasites from the intestines of the spotted newt and the lake lizard (*Necturus*). Next are described some chromatophagous and other intracellular parasites in the intestine of *Necturus lateralis*. There is a critical study of observations on certain structures in the pancreatic cells of Amphibia, and certain more purely physiological deductions.

Indirect Fragmentation.*—Dr. E. Göppert finds in the lymphatic cortical sheath of the liver of *Salamandra* and *Triton* distinct evidence of nuclear division by a process of indirect fragmentation similar to that described by Arnold. At first the nucleus exhibits a distinct meshwork of chromatin; a perforation appears, around which the chromatin forms a ring; the ring becomes divided into two to eight fragments generally different from one another in form and size, but still disposed in a circle; during the whole process the nucleus remains surrounded by its membrane; no associated cell-division was observed.

History of Blood-corpuscles.†—Herr H. F. Müller has studied this both in cold-blooded and warm-blooded Vertebrates. He finds that the leucocytes and the erythrocytes originate from similar mother-cells. These mother-cells exhibit indirect division, and their daughter-cells undergo various modifications:—(1) Some become erythrocytes; (2) others are subject to further karyokinesis, but eventually form erythrocytes; (3) others form mononuclear resting leucocytes which grow into resting mother-cells ready to divide; (4) others seem to become the ordinary polymorphic leucocytes. Karyokinesis prevails in the formation of both erythrocytes and leucocytes, but the occurrence of other modes of division must be admitted.

Origin of the Fibrillæ in Connective Tissue.‡—Herr B. Lwoff has investigated the connective tissue in various parts of sheep embryos. He agrees with Schwann and Boll in concluding that from each cell a portion of the fibril-bundle is formed, and with Rollett in maintaining that the fibrils appear on the surface of the cells. But he has furthermore observed that the formative cells are disposed in long rows and are connected by their processes, and that the fibrils are formed superficially along these rows. The formation of the fibrils proceeds from the surface inwards; from each row of cells arises a fibril-bundle, in the middle of which are the remains of the formative cells. In origin these connective tissue fibrils are comparable to those of muscle and to those on the cortex of hairs and feathers.

γ. General.

Elementary Biology.§—Prof. T. Jeffery Parker, formerly one of the Associate Editors of this Journal, has published what is certainly a very readable and will probably be found a very useful introduction to the study of Biology. The author hopes that his work may also be useful "to that large class of workers whose services to English science often receive but scant recognition—I mean amateur microscopists."

* Arch. f. Mikr. Anat., xxxvii. (1891) pp. 375–91 (1 pl.).
† SB. K. Akad. Wiss. Wien, xcviii. (1889) pp. 219–94 (5 pls.).
‡ T. c., pp. 184–210 (2 pls.).
§ 'Lessons in Elementary Biology,' London, 1891, 8vo, 408 pp. and 89 figs.

Prof. Parker has kept before himself the wise principle that biology as a branch of a liberal education should familiarize the student not so much with the facts as with the ideas of science; this aspect of his subject he has treated in a way quite novel in a text-book, but in one which seems to be excellent.

Another characteristic of the book is the large space devoted to unicellular Animals and Plants, but the advantage of that need hardly be dilated on in a Microscopical Journal. Two lessons are devoted to *Polygordius*; the selection of this worm as a type of triploblastic organization is quite new, and events must show if it is as wise as we may hope it is. The distinctive characters of the higher forms of animal and vegetable life are dealt with much more summarily.

Classification of Animal Kingdom.*—Prof. W. Schimkewitsch has proposed some changes in the classification of the Animal Kingdom. His scheme is as follows:—

- I. Protozoa s. Monozoa.
- II. Metazoa s. Polyzoa.
  - 1. Radiata
    - A. Cœlenterata
      - Hydrozoa.
      - Scyphozoa.
      - Ctenophora.
      - Ctenophoroidea [i.e. Ctenoplanidæ and Cœloplanidæ].
    - B. Spongiaria.
  - 2. Bilateria.
    - A. Gastroneura.
      - α. Acœlomata
        - 1. Anæmaria s. Plathelminthes.
        - 2. Hæmataria s. Nemertini.
      - β. Pseudocœlomata
        - 1. Nemathelminthes (Kinorhyncha, Echinorhyncha, Nematodes, Nematomorpha).
        - 2. Trichhelminthes
          - Asegmentata (Rotatoria, Gastrotricha).
          - Segmentata (Dinophilidæ).
          - Parasita (Orthonectida and Dicyemida).
      - γ. Eucœlomata
        - 1. Helminthozoa s. Vermes
          - Inarticulata (Sipunculoidea, Phoronida, Bryozoa, Rhabdopleurida).
          - Triarticulata (Chætognatha, Brachiopoda).
          - Articulata (Chætopoda, Stelechopoda [including Myzostomida], Hirudinei, Echinoidea.)
        - 2. Prototracheata.
        - 3. Tracheata (including Arachnida).
        - 4. Branchiata s. Crustacea.
    - B. Tetraneura s. Malacozoa.
    - C. Cycloneura s. Echinozoa.
    - D. Notoneura
      - α. Achordata s. Enteropneusta.
      - β. Chordata
        - 1. Leptocardii.
        - 2. Tunicata.
        - 3. Vertebrata.

The objections to some of these names are sufficiently obvious.

* Biol. Centralbl., xi. (1891) pp. 291–5.

B. INVERTEBRATA.

Zoological Paradoxes.*—Under this heading Prof. A. Korotneff deals with some exceptional forms which "look like real nonsense, and can only as paradoxes excite the interest of naturalists."

The first with which he deals is *Gastrodes parasiticum*, already described as being found in the gelatinous investment of *Salpa fusiformis.* It is now seen to be an endoparasitic Actinian which has become simplified by its mode of life, and so modified as to seem much like a *Scyphosoma.* In its internal cavity there are single and double folds, the former consisting only of endoderm, the latter of endoderm and ectoderm. These two layers are, in the wall of the body, separated from one another by a pretty strong gelatinous layer. The endoderm forms six processes which are either true or false septa; the two true septa consist of ectoderm also.

The ectoderm of *Gastrodes* differs in structure with the age of the animal and the part of the body whence it is taken; thus it may consist, on the surface, of one or two layers, while at the floor of the mouth there are several layers; near this it may contain true glands. Eggs appear in the ectoderm of quite young forms; their number, as in all parasitic forms, is somewhat considerable; their presence in the outer ectodermic layer is probably caused by their parasitic habit. The author has been able to detect what appear to be spermatozoa.

The endoderm seems to have a very peculiar construction; it consists of small cylindrical cells found at various spots on the inner wall of the stomach; these cells form the base of the gastric lumen which seems to be very much reduced, as it is almost completely filled by various endodermal elements; the endoderm of the gastric tube spreads out into a layer which lines the inner side of the oral disc and serves as the seat of origin of the spermatozoa. These cylindrical cells pass into others which form the peculiar endodermal mass; this consists of large vesicular elements, rich in yolk. There are other cells which are still more remarkable; here and there, and ordinarily inclosed in the endodermal mass, there are aggregations of protoplasm of a finely granular substance. No cell-boundaries are to be detected here. This plasmodium perhaps serves to effect chemical changes in the food.

The nearest ally of *Gastrodes* would appear to be *Scyphosoma.*

The next form discussed is also one on which Prof. Korotneff has before written; it is the remarkable creature called by Metschnikoff *Cunoctantha parasitica.* A number of stages have now been observed, and it would seem that the ectoderm always consists of seven cells which exhibit absolutely no tendency to increase. In the endoderm it is otherwise. In *Cunoctantha* there appears to be a case of sporogony.

The author states he has but little to add to the careful descriptions already given by R. Hertwig and Fol of the structure of the rhizopodal *Sticholonche zanclea.* The pseudopodia resemble exactly the protoplasm of the Heliozoa, for an axial homogeneous portion and a finely granular protoplasmic investment are to be seen. The relation of the pseudopodia to the body-mass appears to be also the same as in the

* Zeitschr. f. Wiss. Zool., li. (1891) pp. 613–28 (3 pls.).

Heliozoa. The remarkable "corps en spiral" which Fol is inclined to regard as a spermatophore appears rather to be a parasitic intruder, and is probably a life-stage in the history of one of the Orthonectida.

Biological Results of Cruise of the 'Argo.'*—Prof. W. A. Herdman has a report on the biological results of the cruise of Mr. A. Holt's steam yacht 'Argo' round the west coast of Ireland; bad weather unfortunately prevented dredging in deep waters. *Molgula holtiana* and *Polycarpa argoensis* were two new Tunicates that were found during the expedition.

Mollusca.

β. Pteropoda.

Development of Clione limacina.†—Mr. N. Knipowitsch has a preliminary account of the development of this Pteropod, on which Fol has already made some observations. The formation of the gastrula commences with the division of one of four macromeres into two; henceforward these two blastomeres distinguish the hinder end of the egg and are placed quite symmetrically; the structure of their protoplasm, which is clearer, is not inconsiderably different from that of other macromeres. These cells are the mother-cells of the mesoderm. By the division and invagination of the three other macromeres a bilaterally symmetrical gastrula is developed. The blastopore is elongated and almost cleft-like; it becomes gradually narrowed by the small ectodermal cells at its margin.

After the formation of the gastrula the mesoblasts begin to develope and small mesoderm-cells with a coarsely granular protoplasm like that of the mesoblasts become formed. As the cells grow forward they arrange themselves in such a way as to form a splanchnic and a somatic layer. The cells of the endoderm pass directly into those of the mid-gut, and the only differentiation to be noted is that some of the cells remain rich in yolk while others are smaller and consist only of protoplasm. The former appear to become the hepatic cells. There seems to be no doubt that in those Pteropods where one macromere is smaller and poorer in nutrient yolk that cell gives rise to the mesoderm.

γ. Gastropoda.

Embryology of Crepidula and Urosalpinx.‡—Mr. E. G. Conkton has a preliminary note on the embryology of *Crepidula fornicata* and *Urosalpinx cinerea*. In the former the cleavage follows the type of *Fusus*, *Planorbis*, *Neritina*, and others, but there is not, normally, any trace of an invagination at the ectodermal pole, such as has been seen in *Neritina* and *Fulga*. The gastrula is formed by typical epibole. The mesoblastic bands are soon separated from the mesoblasts, but the latter continue to proliferate mesoderm. The velum first appears on the ventral side and primitively consists of a single row of cells; two large velar lobes become formed, one on each side. The velum does not become ciliated until quite late in development, though the embryo swims

* Trans. Liverpool Biol. Soc., v. (1891) pp. 181–212 (3 pls.).
† Biol. Centralbl., xi. (1891) pp. 300–3.
‡ John Hopkins Univ. Circ., x. (1891) pp. 89–90.

about in the pouch by means of the cilia of the large ciliated cells which form the head-vesicle.

The foot is single and median, and though it shows no trace of a double origin, it may be considered as having arisen on both sides of the blastopore. At the posterior end of the embryo three or four large ciliated anal cells appear, and just ventral to them the distal end of the intestine is pressed against the ectoderm. The walls of the intestine are formed by small cells free from yolk. The supra-œsophageal ganglia appear as proliferations of the ectoderm on each side of, and dorsal to the mouth, and in connection with them, the eyes are formed as involutions of ectoderm; the pedal ganglion is formed by delamination from the ectoderm at the sides of the foot.

The segmentation of *Urosalpinx* is almost identical with that of the Oyster; only the very earliest stages of this Mollusc were investigated owing to the great difficulty in cutting sections of the egg.

Eyes of Pulmonata Basommatophora.*—M. V. Willem points out that suitable sections show that the portion of the integument placed above the eye is almost entirely occupied by a vast lacuna. This is limited externally by a delicate wall formed of epidermis and of a layer of connective tissue in which there is neither pigment nor mucus-forming gland. The constant presence of blood-corpuscles and often of coagulated plasma in spaces which correspond to this cavity, shows that it is part of the general lacunar system of the body. Injections of the circulatory system of *Limnæa stagnalis* show that the pre-ocular sinus is the confluence of afferent and efferent canals distributed in part of the eye and especially in the tentacle. The author has observed the lacuna in the snail just mentioned, in *L. palustris*, *Planorbis corneus*, *Physa fontinalis*, and *Aplexa hypnorum*, and it is probably generally present in the Basommatophora. The morphology of this lacuna is easier to understand than its physiology.

δ. Lamellibranchiata.

Anodon and Unio.†—Mr. O. H. Latter has some notes on these animals. He first discusses the passage of the ova from the ovary to the external gill-plate, and thinks that this is effected by suction. With regard to the attachment of the *Glochidia* to the parent gill-plate it appears that the young attach themselves by their byssus, as the nutritive reserve in their neighbourhood becomes used up. It is very remarkable that the parent is able to draw back within the shell the long slimy masses of *Glochidia* even after they have been ejected a distance of two or three inches. It is not true, notwithstanding repeated statements to the contrary, that the young can swim; they can be put easily into a state of great excitement by the introduction of the tail of a recently killed stickleback into the watch-glass in which they are lying. The Glochidium-shell has nearly always an influence on the shell of the adult, causing an irregular notch in the otherwise symmetrical curve. Schierholz is correct in stating that it is impossible to distinguish the sexes by their shells. All the fish with which the

* Comptes Rendus, cxii. (1891) pp. 1378–80.
† Proc. Zool. Soc. Lond., 1891, pp. 52–9 (1 pl.).

author experimented have a strong dislike for *Glochidia* as an article of food. Both adult and young are able to resist a certain amount of freezing.

Molluscoida.

α. Tunicata.

Ecteinascidia and other Clavelinidæ.*—Prof. W. A. Herdman gives an account of the characters and relations of this group of Tunicata, and criticizes the work done since he established the genus in his 'Challenger' report. He describes two new species, *E. Thurstoni* from the Gulf of Manaar, and *E. Moorei* from Alexandria Harbour. A classification of the Clavelinidæ is proposed; this family is of great interest phylogenetically, because *Clavelina* comes nearer than any other known form to what we have good grounds for believing to be the common ancestors of all the simple or compound Ascidians (Proto-ascidiacea), and because this group occupies a central point between the simple and compound Ascidians; *Rhopalæa* links on in one direction to *Ciona* and the Ascidiidæ, while *Clavelina* and *Ecteinascidia* pass in the other direction into *Diazona*, *Chondrostachys*, and the Distomidæ.

Tunicata of Plymouth.†—Mr. W. Garstang publishes the first part of a report on the Tunicata of Plymouth, in which he deals with the Clavelinidæ, Perophoridæ, and Diazonidæ. Definitions of families, genera, and species are given, and there are copious synonymic lists. *Pycnoclavella* is a new genus for *P. aurilucens* sp. n., in which the zooids are small and delicate, clavate, and arise by slender stalks from a more or less thick basilar mass of test-substance.

β. Bryozoa.

Budding in Bryozoa.‡—Mr. C. B. Davenport has a preliminary notice of the results of his studies on budding in the Bryozoa. He makes some critical remarks on the recent work of Braem. It is stated that the polypides of the Bicellariidæ, Membraniporidæ, and Alcyonidiidæ arise like those of *Paludicella*; that is, from a mass of indifferent cells at the margin of the colony—a mass from which the body-wall is also derived. In all cases the polypide is formed by an invagination of the body-wall, which is two-layered at the margin of the colony.

In marine Gymnolæmata budding seems to obey certain laws, which may be deduced from the study of erect colonies like *Bugula*; these laws appear to be partly as follows:—The lateral buds are formed earlier than and do not extend so far distally as the terminal buds. When a terminal and a lateral bud attached to the same proximal individual are each immediately followed by two buds, the two laterals lie adjacent, and the two terminal buds outside. Lateral buds tend to arise at the same time on two branches which spring from a common individual, but this may be modified. The marginal branches are the shortest and the middle ones the longest. There is one proximal individual to each "fan"; this is followed by two and then by four;

* Trans. Liverpool Biol. Soc., v. (1891) pp. 144–63 (2 pls.).
† Journ. Mar. Biol. Assoc., ii. (1891) pp. 47–67 (1 pl.).
‡ Proc. Amer. Acad., 1891, pp. 278–82 (sep. copy).

each of the two outside individuals of these four bears more individuals than does each of the inner individuals. New individuals are constantly being formed at the periphery of the fan and at about the same time, but on some branches only one new bud arises, and on others two.

The normal architecture of the colony is obscured by inequalities of the surface on which it lies in the case of creeping forms like *Membranipora*, *Lepralia*, and *Escharella*.

Regeneration of Lost Parts in Bryozoa.*—Mr. S. F. Harmer has studied, especially in *Crisia*, the process of regeneration. It may take place in various ways; an old zoœcium may form a fresh aperture and again become tenanted by a polypide, or it may grow out into a rootlet or into a growing-point, which will, in course of time, give rise to a complex branch. If a rootlet is formed, it may become pretty long, and then either give rise to a fresh stem as a lateral branch, or it may, after a time, take on the characters of a growing-point, so that the new stem is the direct prolongation of what was at first an ordinary rootlet. The new branches formed from the stumps of old colonies are more commonly developed from the old joints; sometimes from the lateral joints, at the points where old branches have been thrown off; and sometimes from the axial joints, at the points where old axial internodes have been lost. The broken surface of an internode has the power of developing a fresh growing-point, which ultimately gives rise to a new branch.

In the lower parts of a colony of some species of *Crisia* the long tube that forms the ordinary aperture of the zoœcium is often lost, when the part left is protected from further injury by a calcareous diaphragm which prevents foreign bodies from falling into the cavity of the zoœcium. Such a zoœcium contains a brown body but no functional polypide. Sometimes a polypide-bud is developed below the diaphragm; as the bud developes the diaphragm becomes absorbed, and the mouth of the aperture again grows out into a long tube.

Origin of Embryos in Ovicells of Cyclostomatous Polyzoa.†—Mr. S. F. Harmer has investigated species of *Crisia*, in which the mature ovicells contain a large number of embryos. These are imbedded in the meshes of a nucleated protoplasmic reticulum, which also contains a mass of indifferent cells, produced into finger-shaped processes, the free ends of which are from time to time constricted off as embryos. These, after developing various organs, escape as free larvæ through the tubular aperture of the ovicell. The budding organ from which the embryos are formed makes its appearance at an early stage in the development of the ovicell. The supposed ovum is found in very young ovicells, imbedded in a compact follicle, and appears to give rise to the budding organ. The embryos are thus produced by the repeated fission of a primary embryo developed in the ordinary way from an egg.

Fresh-water Polyzoa.‡—Mr. A. Oka has studied *Pectinatella gelatinosa*, a new species found in a pond at Tokyo, with the object of throwing light on some obscure points in the structure and development

* Rep. Brit. Assoc., 1890 (1891) pp. 862–3.
† Proc. Camb. Philos. Soc., vii., pt. ii., 1 p. [separate copy].
‡ Journ. College of Science, Imp. Univ. Japan, iv. (1891) pp. 87–150 (4 pls.)

of the Phylactolæmata. The study was favoured by the transparency of the gelatinous ectocyst, the unique size of the polypide, and the promptness with which it is evaginated. The largest colony seen measured 7 cm. in diameter. The author proposes to apply the term polyzooid to every equal part of a colony which consists of a polypide and a portion of the cœnœcium, and to call "cystid" such portion of the cœnœcium.

In his detailed account of the organization of his new species the author does not confine himself to new facts. He confirms the statement of Verworn as to the presence of cilia at the end of the external wall of the stomach. He denies the existence of a circumœsophageal commissure; the ovary is a solid club-shaped outgrowth of the internal lining epithelium. He found muscular fibres in the funiculus, though their presence in *Cristatella* has been denied by Verworn. The statoblast and its development are described in considerable detail.

Arthropoda.

Extremities of Embryo of Arachnids and Insects.*—Dr. A. Jaworowski has been led to construct the following table:—

	Arachnida.		*Insecta.*	
Cephalothorax	1st appendage,	Antennæ in embryo only.	Antennæ also in post-embryonic stage.	Head
	2nd ,,	Mandibles.	Mandibles.	
	3rd ,,	Maxillæ i.	Maxillæ i.	
	4th ,,	Maxillæ ii, later 1st pair of legs.	Maxillæ ii., fused in embryo and forming labium.	
	5th ,,	Later 2nd pair of legs.	1st thoracic appendage.	Thorax
	6th ,,	Later 3rd pair of legs.	2nd ,, ,,	
	7th ,,	Later 4th pair of legs.	3rd ,, ,,	
Abdomen	12 (?) abdominal segments in *Trochosa singoriensis*.		11 embryonic abdominal segments.	Abdomen
	4–5 pair of abdominal appendages in general.		Abdominal appendages of varying number.	

α. Insecta.

Chemistry of Insect Colours.†—Mr. F. H. Perry Coste has investigated the behaviour of the colours of Lepidoptera when treated with various chemical reagents. He gums the wings on to watch-glasses and then submits them to the action of reagents for one hour.

After describing his *a priori* expectations, and pointing out that in nearly every instance he has succeeded in modifying the colours *retrogressively* only, and not *progressively*, he describes his method of working and the reagents used. After experimenting with about two dozen different reagents, he concluded to make use of hydrochloric, nitric, sulphuric, and acetic acids; of potassic, sodic, and ammonic hydrates. He finds no difference between the action of acids and of alkalies, except that some colours are affected more by the one, some by the other; but

* Zool. Anzeig., iv. (1891) pp. 164–9, 173–6

† Entomologist, April 1890–August 1891.

in no case are *different* coloric reactions produced by the two classes of reagent. He next gives a list of the species experimented upon, the results being chiefly in tabulated form; and then proceeds to discuss the significance of these results. He distinguishes between *pigmental* and *physical* colours, the latter of which he subdivides into interference colours, reflection colours (other than interference colours), and absorption colours. He then discusses the colours one by one.

Black he finds in every instance, almost without exception, is unaffected by his reagents; and after discussing the subject in detail, he concludes that black is merely a (physical) absorption colour, and not due to any pigment. He points out the surprising nature of this result, seeing that a black pigment exists so commonly in the animal kingdom; and also remarks that, as a consequence of this, his experiments fail to throw any light on the melanic varieties of Lepidoptera.

White also he finds to be no pigment colour, but simply a reflection effect. In one case, however (*Arga galathea*), he found the white wing changed to a deep yellow, which yellow finally dissolved, leaving the wing colourless; he explains this by supposing an unstable pigment-mother-substance to exist in this species; this mother-substance is decomposed by his reagents with the production of the yellow pigment, whose subsequent dissolution is comparable with the behaviour of various normally yellow species.

Before discussing the other colours in detail, the author justifies his assumption that the changes induced by his reagents are uniformly retrogressive; and then proceeds to distinguish (among pigmental colours) between the "reversion" and the "soluble" effects. Some colours are soluble, and then the wing is permanently discoloured; but in the case of red, the effect of acid is to change this instantly to yellow, which yellow may subsequently be restored to red, and the process repeated indefinitely: this is the "reversion" effect.

Yellow and *red* he finds to be very closely related. In nearly every species red or pink is changed to yellow; but the yellow thus produced cannot be further affected, except in the very interesting case of species of *Delias*, in which the yellow so formed subsequently dissolves, leaving a white wing. He distinguishes at least three stages of coloric evolution in yellow. In the first stage the yellow is completely soluble in his reagents, leaving a pure white wing; and these yellows are very often of a pale tint. In the second stage, the yellow is only somewhat affected; and in the third stage (which also includes all the metamorphosed reds) the yellow is absolutely indifferent to the reagents: these last yellows are very often of a deep tint. The author proposes to account for all these facts on the theory of the gradual evolution of a deep yellow and finally of a red, from the primitive pale yellow; but he specially insists that this yellow was not developed from any white pigment, although usually in a white wing; experiments tending to prove this contention are cited. The author reserves his opinion as to whether among the unaffected yellows there may not be one or two that are not pigmental but simply "physical" colours.

The "reversion" experiments on red are next described. The author finds that a red wing when yellowed by nitric acid is permanently yellow; but when yellowed by other acids, the yellow is permanent only so long as the wing remains acid; as soon as the acid is *entirely* removed, either by copious washing with water, or neutralization with ammonia, or by prolonged drying (exposure to the air for some weeks) the original red returns.

These phenomena are explained by assuming that the acids form probably *molecular* compounds with the red pigment molecule, thus producing yellow pigments; these molecular compounds being unstable are readily decomposed by excess of water, or by gradual oxidation (?) as in the air-drying experiments, leading to the restoration of the original red. In the case of nitric acid, it is clear that instead of the formation of such molecular compounds, a destructive action on the pigment molecule has taken place.

Chestnut or *brown* is very closely similar in character and behaviour to yellow; here too he distinguishes three stages of solubility, corresponding with those in yellow, and he also thinks it possible that some of the insoluble chestnuts also may be "physical" colours, and not pigmental at all. He finds further that a few reds (e. g. in *V. Atalanta*) have been evolved not from yellow, but from *chestnut:* these reds do *not* show the "reversion" effect.

Among the *greens* some are certainly physical; some are probably physical; and some are pigmental. The first class includes all the metallic greens; these may be either unaffected, or temporarily or permanently dulled or browned by the reagents; the alteration in such cases is to be attributed to injury of the molecular structure of the wing. The second class of greens are instantly changed to brown, or bronze-brown: these, too, are probably physical. The third class are dissolved, leaving a white wing: in some cases, however, a more or less yellowish white, and occasionally a deep yellow, are produced; it is therefore very probable that green also has been evolved from yellow.

Blue is an unsatisfactory colour from the author's point of view. In nearly every instance he finds it to be physical in nature; and the same general account may be given of these physical blues as of the physical greens. As to the blue of the Lycænidæ, however, the author reserves his opinion for the present, although strongly inclined to consider this also a "physical" blue.

An account of the reaction of very damp potassic cyanide on certain yellow species is also given. The author's attention was called to this matter by a reported experiment of Edwards concerning which he was formerly very sceptical. He now finds, however, that in many species of Rhopalocera (no such results have yet been obtained from yellow Heterocera) the yellow, under these conditions, is changed to a more or less brilliant red; this is extremely interesting as being an instance of progressive modification. The author thinks it probable that in such cases, combination takes place between the pigment molecule and the cyanide radicle: but he is still employed in investigating the subject.

In the last section of his paper, the author remarks on the general chemical effect of soil, food, and the like, on the colours of insects, and suggests an explanation of several varieties such as white specimens of *E. Janira*, *Lycæna phlœas*, *Colias helice*, &c., and finally points out, by quoting details, the interesting fact that in the course of his experiments he has succeeded in producing varieties* identical in appearance with those occasionally found in nature. He also criticizes Mr. Cockerell's theory that yellow is anterior to white in the course of evolution, and argues that the course of evolution has really been white, yellow, red.

Early Stages of Development in Eggs of Insects.† — Dr. H. Henking, in his second memoir, deals with spermatogenesis in *Pyrrhocoris apterus*, and its relation to egg-development. He finds that the primordial sperm-cells correspond to the primordial ova; both forms of cells contain the characteristic number of twenty-four chromosomes. The spermatocytes of the first order correspond to unripe ova; both increase considerably in size, and both develope a proportionately large vesicular nucleus, in which yolk-spherules are produced. The formation of the first polar globules corresponds to the first division of the spermatocytes. In both cases there is a "reduction-division," for twelve chromosomes are found in each new cell. The formation of the second polar globule corresponds to the second division of the spermatocytes. The twelve chromatic elements are directly halved by "equation-division."

The following points are noticeable in the spermatosome:—The secondary nucleus is formed from the peripheral connecting fibres and by division of the spindle-fibres; the central bundles of the former give rise to the mitosoma; the paired secondary nucleus attaches itself to the nucleus which will become the head of the spermatozoon. The portion of the mitosoma which becomes attached to the nucleus becomes chromatic and wanders to the anterior end of the spermatozoon. It is probable that small quantities of chromatin substance pass into the secondary nucleus and the mitosoma. There are two distinct kinds of normal spermatozoa. Some contain only eleven chromatic elements, while others have in addition a chromatic element which remains undivided and is probably to be regarded as a nucleolus.

Insects injurious to Forest and Shade Trees.‡—Prof. A. S. Packard publishes, in the reports of the United States Entomological Commission, a report on Insects injurious to Forest and Shade Trees; it is a subject to which, as yet, but little attention has been given. The materials are dealt with in twenty chapters, under the heads of various trees, such as oak, elm, hickory, and so on. There is a brief explanatory introduction.

Insect-larva eating Rust on Wheat and Flax. § — Messrs. N. A. Cobb and A. Sidney Olliff have observed orange-coloured larvæ (of a species of *Cecidomyia*) on many specimens of rusted wheat. Observation showed that the larvæ fed greedily on the rust. They suggest further study of the relations between insects and mites and fungi, and propose next season to continue their investigations. The larvæ are described.

Role of Nucleus in Formation of Muscular Reticulum in Larva of Phrygane.‖—M. E. Bataillon believes he has shown that the transverse

* In a note to the 'Entomologist,' March 1891, the author warned collectors against buying varieties, since such might now be easily manufactured by the methods described as having been employed in his experiments.

† Zeitschr. f. Wiss. Zool., li. (1891) pp. 685–736 (3 pls.).

‡ U.S. Department of Agriculture, Washington, 1890, vi. and 955 pp., 38 pls., and 306 woodcuts. § Ann. and Mag. Nat. Hist., vii. (1891) pp. 489–93 (3 figs.).

§ Comptes Rendus, cxii. (1891) pp. 1376–8.

striation of the muscles of the larvæ of Phryganids is developed in relation with the nuclei; it is from the nucleus that there grow out the striæ of the transverse plexuses, on which the refractive granules of the developed fibre represent the chromatic bodies of the formative period. The author has not been able to make out the origin of the longitudinal fibres or of the rods which appear in connection with the granules. The transverse plexuses appear first, before the muscle segments, and even before the longitudinal fibrils.

Absence of Wings in the Females of many Lepidoptera.*—Herr L. Knatz expresses surprise that biologists have not given more attention to the absence or the reduction of wings in many female Lepidoptera. There are many grades of this reduction, from the wingless female *Psyche* to forms like *Stilbia* and *Epimecia*, in which the wings of the females are but a little smaller than those of their mates. Herr Knatz classifies these grades of reduction, and compares them with cases of similar sexual dimorphism in Strepsiptera, Telephoridæ, and Mutilidæ. He notes that the distribution alone is enough to show that the ancestors of the wingless females must have had wings. This is obviously corroborated by the fact that the males are winged, and further proof of the reality of the reduction is furnished by the state of the rudiments in the pupal stages of the females. External conditions, deficient food, warmth, or moisture may injuriously affect the development of wings, or the reduction may be a constitutional variation. Females which cannot fly are in some ways at a disadvantage, they cannot soar away from their enemies nor attract their mates in flight; but there are obvious compensations,—the sedentary females are often hidden, the winged males become proportionately more active and eager in seeking their mates. Moreover, the reduction of wings is associated with a greater development of the abdomen, with an increase in the size of the ovaries, with greater fertility. It is therefore hardly surprising to find that the author is able to give no less than 183 instances of female Lepidoptera with reduced or absent wings. His paper is full of suggestiveness to evolutionists.

Natural History of Solitary Bees.†—Herr H. Friese records his observations on solitary Apidæ, describing the two genera of Archiapidæ, —*Prosopis* and *Sphecodes*, twenty genera of Podilegidæ which collect pollen on their hind legs, and seven genera of Gastrilegidæ which have either no collecting apparatus or simply a special arrangement of hairs on the abdomen of the females. Notice is taken of the variability of these bees, of their seasonal and sexual dimorphism, of their nests and stores, of their eggs and larvæ, of their modes of life and manner of death. Herr Friese also maps out the relationships of the solitary bees, basing his scheme mainly on the nature of the collecting apparatus, of the mouth-parts, and of the nests. But the importance of his contribution consists in the numerous observations which he has made on the natural history of the twenty-nine genera described.

* Arch. f. Naturgesch., lvii. (1891) pp. 49–74 (1 pl.).
† Zool. Jahrb., v. (1891) pp. 751–860 (1 pl.).

β. Myriopoda.

Anatomy of Scutigera.*—Herr C. Herbst finds that this Myriopod is provided with five sets of glands in the head, and describes their arrangement and minute anatomy; some of them probably act as spinning glands and others prepare food. It is suggested that they are the homologues of the coxal gland. A cardiac nerve, arising from the sympathetic probably, is described in connection with the circulatory apparatus.

δ. Arachnida.

Development of Araneina.†—Mr. Kamakichi Kishinouye has especially studied the development of the eggs of *Lycosa* and *Agelena*, but *Theridion*, *Epeira*, *Dolomedus*, and *Pholcus* were used for comparison. He agrees with Locy in thinking that the superficial polygonal areas on the egg are due to a pressure of the yolk columns on the periplasm; they are probably formed when the eggs pass through the oviduct. In the process of segmentation the yolk and the nucleus are divided at the same time; segmentation is syncytial. After segmentation all the nuclei are formed on the surface of the egg. The primary blastodermic thickening is regarded as a modified gastrula mouth, the formation of which was obstructed by the abundance of yolk. The brain and the ventral nerve-cords are formed as a continuous ectodermal thickening. All the appendages are post-oral in origin, but the first abdominal segment bears no appendages.

The large fat-cells, which are derived from the endoderm, form blood-corpuscles. The lung-book is formed by an invagination at the posterior base of the first abdominal appendage; a similar invagination at the base of the second gives rise to an abortive trachea. There is an unpaired cœlomic cavity which belongs to the anal lobe; this becomes converted into the so-called stercoral pocket, but it is excretory in function, and not part of the alimentary canal. The dorsal circulatory vessel is formed by the fusion of the mesoblastic somites at the dorsal median line. The so-called body-cavity of the adult is not a true cœlom, but a secondary cavity.

The posterior median eyes are developed in connection with the brain, and the mode of their origin is quite different from that of the other eyes; all, however, are dermal and not neural in origin. A pair of coxal glands opens at the base of the third appendage; its duct is an ectodermic invagination, and its glandular portion is cœlomic in origin. Pharynx, œsophagus, stomach, and anus are all derived from the ectoderm, but the Malpighian tubes are products of the mesoderm.

Mid-gut of Galeodidæ.‡—Mr. A. Bigula describes the anterior part of the mid-gut of the Galeodidæ as consising of three layers; the connective tissue, which is outermost, corresponds generally with that described by Frenzel in some Decapods. The tissue is spongy internally, while the outermost layer consists of cellulofibrous elements. With higher powers the tissue is seen to be made up of finely granular and rounded portions of protoplasm in which lie nuclei; they are separated by

* Jena, 1890. See Amer. Nat., xxv. (1891) pp. 280-1.
† Journ. College of Science, Imp. Univ. Japan, iv. (1891) pp. 55-88 (6 pls.).
‡ Biol. Centralbl, xi. (1891) pp. 295-300.

refractive, colourless, homogeneous bands; the nuclei are polyhedral, feebly staining bodies containing large, intensely coloured chromatin granules. The epithelium of the same region of the gut consists of high and very delicate cylindrical cells, which widen out somewhat at their free ends. The nuclei are large and of an elongated oval form.

Between the third pair of blind tubes and the enteric sacs the dorsal wall of the mid-gut forms a glandular area; the peculiarity of the epithelial cells is that the nuclei, lying in the centre of the cell, are surrounded by a clear area. Just before the mid-gut passes into the abdomen there is developed a so-called enteric sac; this is a gland made up of four parts, which may be regarded as simple, pouch-like evaginations of the wall of the mid-gut. In the hind-body the mid-gut gives rise to the so-called hepatic tubes; these are not, as in true Spiders, united into a compact mass, but form a system of dichotomously branching cylindrical tubes, not connected together with intermediate tissue; these tubes fill up all the interspaces between the different organs. Their investing tunica serosa does not form a complete layer, but rather a loose meshwork, which consists of groups of cells connected with one another in a plexiform manner. The epithelium consists throughout of similar, cylindrical, high cells, and there is no division into ferment- and liver-cells, as in true Spiders and Crustacea. The pigment-granules contained in them show, however, that they must be compared with the liver-cells of Spiders, Crustacea, and Molluscs.

American Spiders.*—The first volume of this valuable and interesting work presented evidences of original and persistent research not often equalled in the class of biological work it deals with, and revealed to a much larger area of readers than his previous academic memoirs could possibly have done, the great value, and frequent entire originality of Dr. McCook's researches. Beyond this, the book was so written and illustrated as to arrest many other readers than biologists studying and seeking the fullest knowledge of aranean life and habits.

The present volume surpasses its predecessor in many respects; it represents a very large amount of close personal observation, and that on just those points on which information is so desirable and needed. Dr. McCook throughout deals lightly with the anatomy and physiology of the group; although he shows perfect familiarity with the latest and best work done on these subjects, up to the time of going to press. But his observations throughout are on the habits and work of the spiders. The chapters in this volume on "The Courtship and Mating of Spiders" are certainly treated in a popular manner; but manifestly this is the character of the entire book; nevertheless, it nowhere obscures or even endangers accuracy, and in so complex and difficult a subject this is evidence of a high order of success.

The illustrations given are as life-like, as to the observer of spider life they are singularly happy and true; only the author's opportunities of observation have been of an unusually ample nature. His observations on these aranean lovers, the stages of their courtship, and the fierce and curious quarrels of the males for the possession of the females, are not

* McCook, H. C., D.D., 'American Spiders and their Spinning Work. A Natural History of the Orbweaving Spiders of the United States, with special regard to their Industry and Habits.' Vol. ii., 479 pp., 5 pls. Published by the author.

only of much interest, but of much value; for it will be remembered that Mr. Blackwall informed Charles Darwin that he had never observed and was not inclined to think a quarrel probable. The drawings from life, and the further descriptions given by this indefatigable student of the living spiders, are of the utmost practical value. The same may be said of "the love dances of Saltigrades," as displays to attract females, and many similar observations are not only valuable confirmations of the studies of others, but are indications to field naturalists of new and important directions for observation.

On maternal industry and instincts we have another group of chapters, full of evident work and suggestiveness. The weaving of the silken sac within which the eggs are deposited, and its subsequent disposal so as to secure the greatest protection for its vital contents from the exigencies of weather and the assaults of enemies, are presented with a detail and sympathetic insight, accompanied by beautiful graphic portrayal, which gives unique value to the work; and at the same time attention is called to the work of others, so that a practical account of our present knowledge on the subject is fully given.

On the early life and distribution of species, and on the "ballooning" habits of spiders, there are many things of much interest said, as there are on the senses of spiders and the relation which the senses bear to habit, dealing with the minute structure of their eyes, and discussing in detail specialities in work, such as cocooning and snare-building in the dark, and the general "night habits" of the Spider; the colour of eyes, the cases of atrophy in these, their sensitiveness to light and the limit of their vision when they are normal, and the condition of cave spiders, are all carefully considered and illustrated. So also are the sense of smell, of hearing, and the delicacy of touch; in like manner an account is given of the nature and purpose of stridulation in some spiders.

This careful study of the nature and habits of aranean life also involves a discussion of colour and the colour sense in spiders, which we are inclined to believe would have been more broad and deep had their manifest sexual influence been more readily admitted; but no student of spiders can study it without much profit. The influence of mimicry amongst spiders is carefully considered and illustrated in all its relations; the influence of the enemies of spiders on their habits, and the disguises of death feigned by them are presented and illustrated in a manner which, if this book were accessible to the multitude, would secure for it a larger number of readers than are now likely to peruse its pages.

The book has yet to be completed by a third volume. Certainly this second one, with its five beautiful chromolithographic plates, surpasses the promises of its author, and when the whole book is complete we can but hope that its popularity, combined with its accuracy and originality, may make a new edition possible, which will at once relieve the author of the cares and, we fear, uncompensated cost of the present mode of publishing.

External Characters of Mites *—Dr. L. Karpelles describes the bristles, the extremities of the appendages, and the jaws of some mites.

* Verh. K. K. Zool.-Bot. Gesell., xli. (1891) pp. 300–6 (6 pls.).

The bristles on the back of *Smaridia pileifera* n. sp. are club-shaped and hollow; it may be that they are simply protective, but there is reason to believe that from them a repulsive excretion may exude. In a species of *Tinoglischrus* from a bat, the strong appendages end in two chitinous claws between which is a cup viscid internally. Some other peculiarities of the appendages are noticed. Herr Karpelles also describes the remarkably strong and long jaws of *Sciphiodes maxillatus*, and gives other illustrations of remarkable modifications.

Embryology of Mites.*—Dr. E. Sicher describes some of the stages in the development of *Tyroglyphus longior*, *Pterodectes bilobatus*, *Freyana anatina*, *Histiostoma iulorum*. The first stages were not in any case satisfactorily observed, but the history of the appendages was followed. The most novel result of Dr. Sicher's researches is the demonstration of the presence of a fourth pair of limb-buds in the earliest stages of development. They represent the corresponding pair of appendages, and suggest the idea of a "proto-larva."

Brain of Limulus Polyphemus.†—Prof. A. S. Packard has continued his investigation of the brain of the King-Crab. Its most striking histological feature is the immense development and singular arrangement of the convoluted, ruffle-like masses which form the thick layer of "nucleogenous bodies," which form the cortex of the cerebral and other lobes, and which inclose masses of myeloid substance. They appear to be simply nuclei, but when they are scattered they are seen to be ganglion-cells. Another characteristic of the brain of *Limulus*, as compared with all other Arthropods, is the remarkably small number of the normal ganglion-cells. The striking differences between the brain of *Limulus* and that of Arachnids are pointed out; in the adult it is made up of three pairs of lobes, the first and uppermost of which are the lateral-eye lobes; below them are the median-eye lobes, and the third are the cerebral; these last are very irregular in outline and slender. On the whole, however, the brain of *Limulus* resembles that of Arachnids more than that of Crustacea; no "deutocerebrum" or "tritocerebrum" is to be found in it.

The cerebral differences in addition to the other points of distinction appear to the author to warrant the separation of the Podostomata (Merostomata and Trilobita) from the Arachnids, although their common origin is not to be denied.

δ. Crustacea.

Arterial System of Crustacea.‡—M. E. L. Bouvier gives an account of his investigations into the arterial system of Crustacea. The ophthalmic artery, before reaching the anterior edge of the stomach, gives off several branches not only in the Brachyura, but also in some of the Macrura; at this edge it forms a more or less marked dilatation which is probably homologous with that observed in Amphipoda and Schizopoda. The antennary arteries always supply the eyes as well as the ophthalmic arteries, and combine with them in the Brachyura to irrigate the rostrum. In those Macrura in which the rostrum is well developed

* Atti Soc. Ven.-Trent. Sci. Nat., xii. (1891) pp. 1–22 (3 pls.).
† Zool. Anzeig., xiv. (1891) pp. 129–33.
‡ Ann. Sci. Nat., xi. (1891) pp. 197–282 (4 pls.).

they anastomose frequently. The green gland is supplied by the antennaries and by the anterior branches of the maxillipedal artery. The liver is almost entirely nourished by the superior abdominal artery. There are two small valves at the orifices of all the arteries in the heart, but the arrangement of the arteries varies somewhat. All the Decapoda with the exception of *Pagurus* are provided with two abdominal arteries, an upper and a lower. Important communications put these two vessels into connection with one another; these take the form of vascular arches which are always more or less symmetrical, and always circum-intestinal. The existence of these anastomoses is due to the great flattening of the abdomen; the two vessels having to irrigate parts very close to one another, fuse almost at once. The lamellated form of the abdomen in the Brachyura destroys completely the symmetry of the two abdominal arteries. In the Macrura the upper abdominal artery is very much more developed than the lower, in correlation with the great development of the dorsal muscles. In the Brachyura the lower artery is not as feeble as might be expected.

All the facts lead us to conclude, with Claus, that the arterial system of Decapod Crustaceans is most like that of the Isopoda.

Renal Organs of Decapod Crustacea.*—Prof. W. F. R. Weldon describes the renal organs of certain Carididæ (*Pandalus*, *Virbius*, and *Crangon*) in which the structure of the green gland is modified in a very remarkable manner. The result of his observations is that these forms exhibit a series of modifications which result in the disappearance of the whole tubular portion of the green gland, and the hypertrophy and specialization of the end-sac. A comparison is made between the different parts of the excretory system in the various families of the Decapoda; the general result appears to be that the nephro-peritoneal sacs of this division should be regarded rather as enlarged portions of a tubular system, such as that found in *Mysis* and the Thalassinidæ, than as persistent remnants of a "cœlomic" body-cavity into which tubular nephridia open.

Female Reproductive Organs of Decapoda.†—Dr. G. Canu has studied the structure of the ovaries, oviducts, and cement-glands in Decapoda, and has also made observations on the modes of impregnation. Beginning with the external morphology of the reproductive organs, he notes that they are primitively double and bilaterally symmetrical, that in Penæidæ they are least differentiated and nearest the simple type exhibited by *Nebalia*, and that the presence of a vagina and a receptaculum seminis in the females is correlated with the presence of a penis in the males.

In *Dromia* the receptaculum is formed after copulation as a simple evagination of the vagina, which seems to show that the evolution of the receptaculum was subsequent to that of the penis. The ovary and oviduct are formed from an external stroma of connective tissue and an internal stratum of epithelium; the ovary differs from the oviduct in the nature of its epithelium and in the presence of an internal stroma arising from the supporting membrane; the ova are always formed on

* Quart. Journ. Micr. Sci., xxxii. (1891) pp. 279-91 (2 pls.).
† MT. Zool. Stat. Neapel, ix. (1891) pp. 503-32 (1 pl.).

the internal surface of the ovary, and, except in the Mysidæ, along its whole length; in Macrura and Paguridæ the vulva is the only ectodermic portion of the internal reproductive organs; in Dromiidæ and Brachyura the ectoderm is invaginated to form a vagina and a seminal reservoir; the receptaculum seminis is a diverticulum of the vagina; the aggregating material in the receptaculum resembles fluid chitin.

In Macrura, the cement-glands are situated just under the epidermis on the internal surface of the epimera and on the ventral surface of the lateral laminæ of the telson; the Thalassinidæ and *Stenopus* are exceptional in having the glands restricted to the pleopods; in Paguridæ the glands occur in 12–16 groups on the ventral and lateral surfaces of the pleon, near the pleopods and in the anterior labriform expansion; in *Homola* and in all Brachyura the receptaculum acts as a cement-gland.

In Brachyura and in Anomura the eggs are fixed to the hairs of the internal branch of the pleopods, in Palinuridæ and Astacidæ to the hairs on the stalk of this branch, in Caridæ to the hairs on the abdominal surface and on the basal joints of the first four pleopods, in *Lucifer* near the last pair of thoracic appendages. In Penæidæ the eggs are not fixed, perhaps because no incubatory chamber can be formed. It is likely that the cement-glands are modified glands of the appendages ("Beindrüsen"). The ova have at first a single membrane or chorion which becomes chitinous, but they subsequently acquire a second envelope formed from the cement-glands.

Copulation is always preceded by a moult, first of the male then of the female. When a receptaculum is developed, the ova are fertilized as they pass the opening of the seminal reservoir; when there is no receptaculum, they are fertilized as they are liberated. The cementing substance may serve as a medium through which the spermatozoa reach the ova, into which they pass in all likelihood through the pores of the chorion.

Compound Eye of Macrura.*—M. H. Vialanes is of opinion that Patten's views on the morphology and physiology of the eye have not the general character which he claims for them; each of the segments of the cone, far from being continuous with the rhabdoms, terminates in a filament which becomes attached to the basal membrane. In other words, the cone is to be regarded as merely an organ of refraction. The nerve-fibres do not terminate in the protoplasm of the retinal cells, but are directly connected with the rhabdoms. Each of the seven rhabdomeres is connected with a special nervous tube, and it is, therefore, very probable that each ommatidium may be the point of departure of at least seven distinct luminous sensations.

Development of American Lobster.†—Dr. F. H. Herrick gives a somewhat detailed account of the development of the American lobster. The animal appears to spawn at a definite period of the year, and copulation to precede oviposition by a considerable period.

There is great irregularity in the segmentation; the period of incubation is about three hundred days. Some remarkable variations

* Comptes Rendus, cxii. (1891) pp. 1017–9.
† Zool. Anzeig., xiv. (1891) pp. 133–7, 145–9.

and irregularities occur in the keel and egg-nauplius stages. Degenerating nuclei occur in the fully-formed egg-nauplius, and are most noticeable in the region of the stomodæum and optic discs. The author believes that the fragmentation and dissolution of cells is a common phenomenon among the Crustacea and other Arthropods.

Development of Daphnia from the Summer-egg.*—Mr. J. Lebedinsky has made a study of *Daphnia similis*, the summer-egg of which is quite spherical and 0·125 mm. in diameter; it is invested in a chorion and a vitelline membrane; the nutrient yolk is concentrically arranged, is green or blue in colour, and makes the egg quite opaque. In each egg there is always a large excentrically placed fat-sphere, around which smaller ones are grouped: the protoplasm is amœboid, has a lobate zone, and takes up the yolk.

Segmentation is superficial; the descendants of the amœboid cell multiply by division and creep from the centre to the periphery of the egg, only a few remaining in its interior; others give rise to plasmodia. In time a continuous blastodermal layer is formed, the cells of which are all of the same size and form. Some of the cells become high and cylindrical and form the elongated germ-stripe. The embryo is now bilaterally symmetrical, but has still a spherical form. The blastopore is a slight depression below which are a few amœboid cells which slowly sink into the yolk. These cells form the meso-endoderm which becomes differentiated into separate, independent layers. The endoderm forms a solid cord in which cavities appear later on. All the endodermal cells do not form part of the mid-gut, as some extend over the nutrient yolk, and form two large provisional liver-sacs.

The shell-gland is formed as a paired mass of mesodermal cells, which are clearly distinguished from their neighbours by their structure and size; the heart is at first an aggregate of mesodermal cells; later on the peripheral cells form a unilaminate pericardium. No special genital cells are present in the early stages of cleavage, and the rudiments of the gonads are not to be recognized in the nauplius stage.

Vermes.

α. Annelida.

Innervation of Proboscis of Glycera.†—M. E. Jourdan finds that in the muscular sheath of the proboscis of *Glycera* there are eighteen nerve-fibres; these end in a collar which is arranged around the opening of the proboscis, and which contains numerous nerve-cells; it may be called a proboscidial nerve-ring. The fibres penetrate into the epithelial layer, and are distributed in the very curious papillæ which are found on the surface of the organ. At the extremity of the proboscis the nerve-elements enter into relation with an epithelial pad, which is set like a crown behind the hooks. The papillæ of the proboscis are of two types; some are cylindroconical, and others are irregularly spherical and analogous to fungiform papillæ. The investing cuticle is very delicate and perforated at a point which corresponds to the tip of these organs. The body of each papilla is formed of a pigmented protoplasm;

* Zool. Anzeig., xiv. (1891) pp. 149–52.
† Comptes Rendus, cxii. (1891) pp. 882–3.

this generally contains one, but sometimes two spherical nuclei. Other cellular elements appear to have other functions than that of forming the papilla.

Staining shows that there are three or four nuclei in the centre of the papilla; these are ovoid in form, and belong to fusiform cells which are arranged in bundles and traverse the papilla longitudinally.

The annular pad represents a region in which the sensory elements of the papilla are grouped into a larger organ and one of different morphological appearance. It is entirely formed of sensory fusiform cells, intermixed with which are a few cylindrical elements, and it is situated in a zone where the epidermic cells are ciliated. We need not wonder at the delicate tactile powers of the proboscis of these worms.

Nephridium of Lumbricus and its Blood-supply.*—Dr. W. B. Benham finds that where Goehlich's recent statements as to the structure of the nephridium differ from those of Gegenbaur, the latter author is the more correct.

He describes in detail the structure of the various regions of the nephridial tube, and makes suggestions as to the functions of the parts. A comparison is then instituted with the same organ in other genera of earthworms; greatest variety in structure obtains in the funnel. It has long been known that the nephridium is provided with an elaborate blood-supply, but no drawings or detailed descriptions have as yet been given; this lacuna the author now supplies.

In conclusion, an account is given of the nephridium of *Arenicola*, which has an elaborate vascular network, and a wide intercellular lumen. A figure of the whole organ is given, which represents more clearly than the generally accurate figures of Cosmovici and of Cunningham the form and situations of the parts.

Regeneration of Tail in Lumbricus.†—Miss H. Randolph has been led to conclusions which differ materially from those at present accepted. She finds that the new ectoderm arises by the proliferation of the ectoderm around the line of fission. From the ectoderm the ventral nerve-chain and the lateral nerve-line are formed. Between these two are two other "foundations" on each side, which correspond in position to those subsequently occupied by the nephridia and the ventral setæ. The new endoderm is formed from the old; as the ectoderm grows faster than the endoderm the material necessary for the proctodæal invagination becomes formed. The new mesoderm is largely formed from specialized cells of the peritoneal epithelium of the ventral longitudinal muscles, on each side of the ventral cords; these cells, which it is proposed to call neoblasts, are distinguishable from the cells of the peritoneum by their great size and by the presence of a cell-body. They represent the "chorda-cells" described by Semper in the Naids and *Chætogaster*. In very early stages, as soon as the ectoderm and endoderm have extended themselves sufficiently to form a new cavity, small cells are seen dorsally, laterally, and ventrally; they seem to have no connection with the neoblasts and their products, but no positive account can be given of their origin. These smaller mesoderm cells give rise to all the circular

* Quart. Journ. Micr. Sci., xxxii. (1891) pp. 293–334 (3 pls.).
† Zool. Anzeig., xiv. (1891) pp. 154–6.

muscles, and apparently to the dorsal longitudinal muscles, and the wall of the dorsal blood-vessel.

The neoblasts are to be regarded as specialized embryonic cells set apart for the rapid formation of new mesodermic tissue immediately upon the fission of the worm. Their general interest consists in their bearing upon the subject of the germ-layers and of organic reproduction. Their presence seems to point to the independent existence of the mesoderm as a germ-layer. With regard to the latter subject, the presence of neoblasts in Naids and *Tubifex* appears to connect the processes of budding and of regeneration on definite structural grounds.

New Earthworm.*—Mr. F. E. Beddard gives an account of the structure of the earthworm, whose remarkable action on the soil of Lagos we have already noticed.† It belongs to the genus *Siphonogaster*, and it is proposed to call it *S. Millsoni*. It is at once distinguished from *S. ægyptiacus* by the smaller size of the remarkable appendages which seem to have the function of copulatory organs, and which are so rarely developed in terrestrial worms.

Libyodrilus.‡—Mr. F. E. Beddard also describes a new genus of earthworm from West Africa, likewise discovered by Mr. Millson. It is allied to *Hyperiodrilus*, but is unique among earthworms in that the oviducal pores are on segment XV. The author abstains for the present from offering any suggestions as to its particular affinities. It is called *L. violaceus*.

Embryology of Nephelis.§—Dr. O. Bürger finds that the cavitary system of *Nephelis* which ultimately incloses the ventral cord and the nephridial funnels is developed in the following manner. In each segment a pair of primitive segmental cavities is developed which fuse with one another in the middle of the germ-stripe and form a median cavity; this gives rise to a continuous tube which traverses the whole length of the germ-stripe, and connects the lateral cavities not only with one another, but those of one segment with those of another. The primitive segmental cavities arise separately from one another by the cleavage of the two inner cell-layers of the germ-stripe which forms a somatic and a splanchnic layer.

The author thinks that the lateral cavities—the direct descendants of the primitive segmental cavities—are the spaces which Prof. A. G. Bourne has described as only secondary, and as formed by the botryoidal tissue; that, in fact, they are true cœlom-spaces and homologous with the segmental portions of the cœlom of Annelids.

The two blood-vessels first appear, at a relatively late period, in the œsophageal region; they are either developed from the remains of the primitive cleavage-cavity, which, extending actively forwards and backwards, drive the tissues apart, or they arise for their whole length by cleavage which commences in the œsophageal region. Their development has nothing to do with the cœlom or its layers.

Not only do the facts of embryology and anatomy show that there is no communication between the blood-vessels and the cœlom, but this is

* Proc. Zool. Soc. Lond., 1891, pp. 48–52 (3 figs.). † See *ante*, p. 40.
‡ Proc. Zool. Soc. Lond., 1891, pp. 172–6.
§ Zool. Jahrb. (Abth. f. Anat.), iv. (1891) pp. 697–738 (3 pls.).

confirmed by the difference in colour between the blood of a quite young *Nephelis* and the blood which fills the cœlom, for one is red and the other yellow. Later on this difference in colour disappears.

After some notes on the development of the nephridia the author treats at greater length of that of the generative organs. He finds that the ovaries are developed on the peritoneum of sections of the cœlom which, later on, become constricted off from it and cease to communicate with it; they then form special ovarial cavities on either side of the ventral cavity. The testes commence as a ridge of cells derived from the fusion of rudiments which have appeared in each segment on the peritoneum. This ridge becomes constricted off for its whole length from the cœlom, is hollowed out and formed into a tube. This gives rise to the testicular sacs by developing numerous outgrowths which widen out more and more, but never lose their connection with the genital tube. The epithelium of the testicular sacs which is derived from that of the tube, and ultimately from the peritoneum, gives rise to the rudiments of the male generative cells. The genital tube persists and takes on the function of a vas deferens. The development of the organs of the male copulatory apparatus is very complicated, but is interesting, from the histogenetic point of view, in consequence of the various glandular cells and muscular layers which go to make it up. In the course of his investigation the author was much struck by the many points of resemblance between the developmental history of *Nephelis* and that of certain Annelids, so that he is brought to regard the Hirudinea as a special group of that division, standing nearest to the Oligochæta.

β. Nemathelminthes.

Nectonema agile.*—Dr. O. Bürger has made a study of this little-known worm, which, with some doubt, Prof. Verrill, its original describer, regarded as a Nematoid. The investigation shows that it is certainly a round worm, and it has some points of affinity to *Gordius*. It resembles it in the want of lateral areas, and the developed ventral ridge recalls the nervous system of *Gordius*; in its muscular and digestive apparatus it approaches rather *Trichocephalus*, but it is peculiar in having only a very small part of the enteric wall formed of four cells, and the rest consisting of two rows of cells only. In this latter point there is likeness to the *Rhabditis*-forms, but they have a pharynx which *Nectonema* has not. On the whole, the form seems to occupy a very isolated position.

Anticoma.†—Mr. N. A. Cobb has a monographic account of this genus of free-living Nematodes, in which he gives a detailed definition of the genus and of its four constituent species, one of which, *A. typica*, is new.

γ. Platyhelminthes.

Diplozoon nipponicum.‡—Mr. Seitaro Goti describes a new species of this remarkable Trematode which differs from *D. paradoxum* in the smallness of the posterior suckers, the greater length of the posterior

* Zool. Jahrb. (Abth. f. Anat.), iv. (1891) pp. 631–52 (1 pl.).
† Proc. Linn. Soc. N.S.W., v. (1891) pp. 765–74 (2 figs.).
‡ Journ. College of Science, Imp. Univ. Japan, iv. (1891) pp. 151–92 (3 pls.).

half of the body, the shortness of the "connecting canal" between the intestine and the oviduct, the presence of a pair of glands at the entrance to the mouth, and the absence of lateral branches from the posterior part of the intestine. The author gives a detailed account of the anatomy of his new species.

He confirms the view of Zeller that the union of the two individuals is a permanent copulation, but corrects him as to the mode, for he states that the vas deferens of one individual opens into the yolk-duct of the other, and not into Laurer's canal. It appears probable that in *Microcotyle* the spermatozoa are passed into a dorsal vagina which leads into a canal opening into the yolk-duct. If in *Microcotyle* there is also cross-copulation then the only extraordinary point about *Diplozoon* is that the mode of copulation regular in allied forms is there made permanent.

Structure of Phagocata gracilis.*—Mr. W. M. Woodworth devotes the first of his contributions to the morphology of the Turbellaria to the study of the remarkable Triclad, for which Dr. Leidy proposed the generic name. This worm differs from all known Triclads in possessing not only the ordinary pharynx, but many additional pharynges which are joined to the two lateral trunks of the intestine. Histologically they resemble the median pharynx, and differ from it only in size.

The rhabdites are developed in cells which lie in the subhypodermal mesenchyma, and these are connected with the hypodermis by fine tubular prolongations; they are ultimately discharged, and new rods are constantly being developed in new parent cells; these last are unicellular glands, and the rods are their condensed secretions.

The structureless basement membrane is a product of the hypodermis; the pigment is intercellular and occurs in the form of scattered granules. The pseudocœlar spaces of the mesenchyma are intercellular in origin, and sagittal muscles are directly continuous with processes of the mesenchyme cells. The superficial and deeper portions of the nervous system are indirectly connected by a marginal nerve, and the condition in *Phagocata* may be intermediate between that of *Gunda* and *Rhynchodesmus;* the brain has an anterior and a posterior commissure; the so-called "Substanzinseln" are regarded as intrusive connective tissue.

The vasa deferentia have terminal enlargements and function as vesiculæ seminales; the yolk-glands arise by cell proliferation from two cell-masses, the parovaria, which are in immediate contact with the ovaries. The intimate connection of the parovaria and ovaries indicates that the ovary and vitellarium were differentiated from a common gland. The so-called uterus is not merely a gland, but a place in which the sexual elements are brought together, and fertilization effected.

Rhynchodesmus terrestris.†—Mr. S. F. Harmer has been able to show that this Land Planarian is by no means uncommon in Cambridge. It is probable that this animal is much commoner than is usually

* Bull. Mus. Comp. Zool., xxi. (1891) pp. 1-42 (4 pls.).
† Proc. Camb. Philos. Soc., vii., pt. ii., 1 p. [separate copy].

supposed; it should be looked for on the damp lower surface of logs of wood which have been lying for some time on the ground.

Victorian Land Planarians.* — Mr. A. Dendy describes fifteen Victorian species of Land Planarians, eleven of which are new. All but one—*Rhynchodesmus Victoriæ*—belong to the genus *Geoplana*. These forms do not appear to have wide specific areas of distribution. Specific distinctions may be safely based on a combination of the following characters—colour and pattern, position of the external apertures, and general shape of the body.

If a living land Planarian is placed in loose dry earth it forms a cyst for itself by cementing together the particles of earth with its slimy secretion. Within this cyst the worm lies completely hidden, and the habit of forming the cyst may be a protection against desiccation, and account for the disappearance of these Planarians in the heat of summer. They are certainly carnivorous in habit. The mode of copulation and the formation of cocoons are described.

The brilliant coloration of these worms appears to be of a warning nature, for the application of the tongue to the slimy surface of the animal suffices to produce an exceedingly unpleasant sensation, something like that caused by putting a piece of velvet or a lump of alum into the mouth. A living specimen of *Geoplana Spenceri* was thrown to some hens who, not being native birds, would not recognize it; they speedily took it into their mouths, but quickly dropped the pieces.

Genital Organs of Tristomidæ.†—M. G. Saint-Remy has studied the generative apparatus of *Tristomum molæ*, *Phyllonella soleæ*, *Pseudocotyle squatinæ*, *Microbothrium apiculatum*, and *Udonella pollachii*. The male apparatus is formed on one and the same plan, but is simplest in the Udonellinæ, and most complicated in the Tristominæ. There are special glands which secrete a liquid destined to mix with the spermatozoa, and these "prostates" empty their products into a reservoir which communicates with the ejaculatory canal, and are under the influence of the muscles of ejaculation. In *Phyllonella* there are, in addition, special glandular cells which line a part of the seminal canal; these are analogous with those which have been observed by Linstow in *Epibdella*. The ejaculatory apparatus consists of an ejaculatory vesicle which is under the influence of more or less powerful muscles, and of a canal which is often situated in a penis, which, again, is lodged in a deep invagination of the wall of the body; in the Udonellinæ, however, there is no copulatory organ.

The female organs are similarly formed on a common type, and as in the male, the principal modifications are to be found in the copulatory apparatus. A seminal reservoir is always connected with the genital ducts; of these latter there is one or two, or none. In *Udonella* it is probable that self-fecundation is effected by the intermediation of the genital cloaca. *Tristomum* is the exception to the rule that the orifice of egress for the ova and that of the tegumentary invagination which incloses the penis are found in a common cloaca. There does not

* Trans. Roy. Soc. Victoria, 1890, pp. 65–80 (1 pl.).
† Comptes Rendus, cxii. (1891) pp. 1072–4.

appear to be in the Tristomidæ any duct analogous to the vitello-intestinal canal of many Polystomidæ.

Tristomum histiophori.*—Prof. F. Jeffrey Bell describes a new species of Trematode under the above name, and points out its differences from *T. coccineum*, to which it is closely allied, and which has been found on *Xiphias*, a close ally of *Histiophorus brevirostris*, the host of the new species.

Remarkable Flat-worm Parasitic in Golden Frog.†—Prof. W. A. Haswell describes a remarkable flat-worm, superficially like a *Ligula*, which he has found parasitic, chiefly in subdermal lymph-sinuses, in *Hyla aurea*. It has the form of a long and narrow, transversely ribbed white ribbon, and the largest was about two inches long and a tenth of an inch in breadth. The narrow segments of the body are very sharply defined in front; no opening could be found and no vestige of hooks or suckers. There is no alimentary canal and the worm is probably, therefore, a Cestode. Its situation and the absence of reproductive organs show it to be a scolex. Only three genera of Cestodes are known to have solid, elongated scoleces—viz. *Tetrarhynchus*, *Schistocephalus*, and *Ligula*, but that of the first is cylindrical in form, and is unsegmented.

An account is given of the appearances presented by sections of the worm; a nervous system can be detected, but it is very indistinct; the only internal organs that are well developed are the canals; a main trunk of considerable size runs along each side; numerous branches are given off, but not in any regular relation to the segments.

Symbiosis of Echinococcus and Coccidia.‡—Herr Lominsky found in the muscle of a ham a large number of nodules, roundish or oval in shape, and of a dirty grey or brownish colour. Most of the nodules were quite minute. The smallest consisted of a connective-tissue capsule with granular contents, in which the ovoid coccidia were very obvious. The larger ones contained as well as the coccidia an Echinococcus head with the characteristic hooklets.

The author supposes the coccidia to be *Coccidium oviforme*, and that these have found their way into the nodules through the blood-vessels in the capsule.

δ. Incertæ Sedis.

Anatomy and Transformation of Tornaria.§—Mr. T. H. Morgan comes to the conclusion that the larval *Tornaria* found on the coast of New England, and regarded by Agassiz as the young of *Balanoglossus Kowalevskii*, is not the young of that form. This explains the difficulty of Bateson who found direct or abbreviated development in that species.

The free-swimming *Tornaria* undergoes many changes both in size and structure during its pelagic life; the ciliated bands are not nearly so complicated in earlier as in later stages. As the larva increases in size, two posterior pairs of body-cavities appear, and a mass of cells is

* Ann. and Mag. Nat. Hist., vii. (1891) pp. 534–5.
† Proc. Linn. Soc. N.S.W., v. (1891) pp. 661–6 (1 pl.).
‡ Wratsch, 1890, No. 18. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 124–5.
§ John Hopkins Univ. Circ., x. (1891) pp. 94–6.

formed in the region of the opening of the water-tube. The first pair of paired body-cavities do not originate as folds from the gut, but a proliferation of cells forms a thickened mass at two opposite areas of the mid-gut. These cells afterwards arrange themselves round a central cavity, and the body-cavity arises by increase in number of these cells; the second pair of paired bodies arises from a solid fold at two opposite points of the posterior division of the mid-gut, which very early pinch off from the endoderm.

The two eyes are not simple pigment-spots, but well-defined structures; each is semicircular in shape, and each constituent cell ends towards the concave side in a sharp spine-like process.

As the larva alters in shape there is a decided decrease in size and the ectoderm becomes thickened over the whole embryo; the diminution in size is very similar to the process found in Echinoderms just before their metamorphosis. The most important change at this time is the development of the nervous system in the collar region; a plate of ectoderm sinks below the surface, and at the same time the collar rolls over the invaginating plate of ectoderm from the two sides. It is clear that in this region the nervous system originates in the same way as in *Amphioxus*, that is, the ectoderm from the two sides rolls over a median plate and fuses above it.

The walls of the heart are formed by the application of two vesicles—the mesenchymatous vesicle and the enterocœl—just as the other blood-vessels are formed by the contact of the body-cavities of the two sides.

It is obvious that the similarity of *Tornaria* to the larvæ of Echinoderms is very great, and the author cannot believe it to be superficial. If it be not, the antiquity of the larva must be very great.

Echinodermata.

Embryology of Asterias vulgaris.*—Mr. G. W. Field has commenced the study of the development of the common American starfish. The mother-cell gives rise to four spermatozoa. The formation of mesenchyme appears to precede and to be continued during the process of invagination; cells in the endodermic region of the blastula divide transversely, the part next to the segmentation cavity becomes amœboid, and wanders freely in the jelly-like substance, filling the segmentation cavity. Any endodermal cell may, with or without division, become a free, wandering, mesenchyme-cell. These observations seem to confirm the view of Metschnikoff and Korschelt as to the absence of the two primitive mesenchyme cells in Echinoderms.

The amœboid mesenchyme-cells form a supporting network between the external walls and the digestive tract; many apply themselves to the wall of the body and of the digestive tract; on the former they give rise to a discontinuous lining, and on the latter they form long, delicate, anastomosing processes, and give rise to muscles. The author's account of the distribution of cilia does not quite agree with that of Semon.

There is an ectodermal thickening at the apex of the pre-oral lobe, due to the more columnar character of the cells in this region; this thickening corresponds exactly in position with the apical plate of *Tornaria*.

* John Hopkins Univ. Circ., x. (1891) pp 101–3.

The pore-canal is formed from endodermal and ectodermal elements, and not as in *Antedon* (Bury), by the perforation of a single elongated cell. The stage with two bilaterally symmetrical pores does not appear to be pathological, but to be a definite stage in the ontogeny of *Asterias*, and to have a phylogenetic significance.

On the whole, this investigation tends to strengthen the view that the bilateral larval form of Echinoderms is ancestral and not secondarily acquired.

Early Stages of Echinoderms.*—Prof. W. K. Brooks found that normal, vigorous starfish larvæ have the water-system at first bilaterally symmetrical in every particular, though the right water-pore and pore-canal degenerate and disappear very early. Soon after the appearance of the ciliated bands there is, on each side of the stomach, an ingrowth of ectoderm, so that, later on, each enterocœl has a fully developed canal to the exterior, though the right one degenerates and disappears, while the left migrates towards the middle line of the body. The author thinks that this phenomenon furnishes a strong argument in favour of the view that the larva is ancestral, for a bilateral structure which loses its symmetry almost at the beginning of locomotor life cannot be an adaptation to locomotion.

The resemblance between the paired pore-canals of these larvæ and such structures as the spiracles of *Appendicularia* and other Tunicate larvæ is worthy of note, for in both cases paired ectodermal involutions meet and fuse with diverticula from the digestive tract.

Starfishes collected by the 'Hirondelle.'†—Prof. E. Perrier has a note on the starfishes collected by the Prince of Monaco in the Atlantic. Of the thirty-three species nine are new. Of these, four are types of new genera, and for them there are proposed the names *Prognaster Grimaldii*, *Calycaster monœcus*, *Scleraster Guernei*, and *Hexaster obscurus*. *Prognaster* has a dorso-central, five small underbasals, five large basals, and the first radials or "carinals." *Calycaster* is remarkable for the simplicity of its skeleton. *Hexaster* is one of the Pterasteridæ, allied to *Marsipaster* and *Calyptraster*, and is remarkable for having six arms, and a convex and relatively resistant dorsal surface.

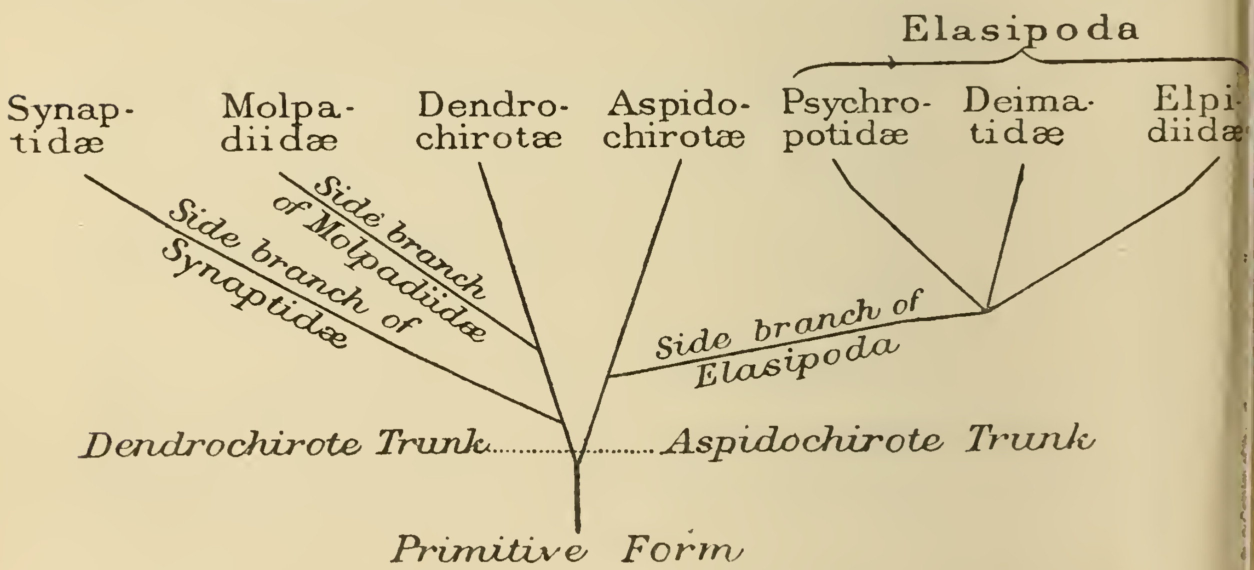
Classification of Holothurians.‡—Prof. H. Ludwig, after giving a detailed account of *Ankyroderma musculus*, a Molpadiid from the Mediterranean, discusses the arrangement *inter se* of the groups of Holothurians. He takes notice of various organs of the body, such as the tentacles, the corpuscles in the skin, musculature of the body-wall, retractors, calcareous ring, tentacular canals and ampullæ, stone-canal, intestine, branchial trees, Cuvierian organs, gonads and blood-vascular system. A review of all these leads to the conclusion that the Molpadiidæ are most closely related to the Dendrochirotæ; the presence of retractors, the structure of the stone-canal, the arrangement of the muscles of the wall of the intestine, and the feeble development of tentacular ampullæ indicate the affinity of the Synaptidæ to these other two groups. Prof. Ludwig believes that there was a primary dendro-

* John Hopkins Univ. Circ., x. (1891) p. 101.
† Comptes Rendus, cxii. (1891) pp. 1225–8.
‡ Zeitschr. f. Wiss. Zool., li. (1891) pp. 569–612 (1 pl.).

chirotous trunk which early gave off a Synaptid, and later a Molpadiid branch. As to the Elasipoda, he does not believe that they form a group equal to the Dendrochirotæ and Aspidochirotæ, but that they are an offshoot from the latter.

The primitive Holothurian would have ten simple cylindrical tentacles provided with feeble tentacular ampullæ, which sprang from the five radial water-vessels, as did also the pedicels, which were limited to the rays and provided with ampullæ; it would also have a calcareous ring formed of five radials and five interradial pieces; the transverse musculature of their body-wall formed an unbroken circular layer, the simple longitudinal muscles gave off no retractors; the stone-canal was simple, fixed in the dorsal mesentery, and directly connected with the exterior; the genital tubes were symmetrically developed on either side of the dorsal mesentery; auditory vesicles lay on the radial nerves; the respiratory tree and a simply arranged enteric blood-vascular system were developed, and the enteron took the course characteristic of Holothurians, while the integument was filled with fenestrated calcareous plates formed of hexagonal meshes.

Prof. Ludwig gives the following phylogenetic diagram:—



A criticism is made of the work of preceding systematists, some of whom fell into misleading errors. In all but the Synaptidæ all the feet and tentacles arise from the radial vessels which mark the rays of the plan of structure of the body, and they may, therefore, be called Actinopoda; in the Synaptidæ, however, some of the tentacular feet enter into relation with the circular canal, and they may, therefore, be called Paractinopoda. The following new classification of Holothurians is proposed:—

Class Holothurioidea.

1st Order, Actinopoda ..	1st Fam., Aspidochirotæ.		
	2nd „ Elasipoda	1st Subfam.,	Psychropotidæ.
		2nd „	Deimatidæ.
		3rd „	Elpidiidæ.
	3rd „ Dendrochirotæ.		
	4th „ Molpadiidæ.		
2nd „ Paractinopoda.	5th „ Synaptidæ.		

Comatulids of Indian Archipelago.*—In a preliminary communication Dr. C. Hartlaub confines himself to a description of twenty-four new species of *Antedon* and two of *Actinometra*; most of them were collected by the late Prof. Brock. A key to the new forms, much after the method of that adopted by Dr. P. H. Carpenter, precedes the descriptions.

British Species of Asterias.†—In the course of a discussion as to the specific distinctness of *Asterias violacea* from *A. rubens*, Prof. F. Jeffrey Bell brings forward a considerable amount of evidence as to the great variations which are to be seen when a large collection of British specimens of *Asterias rubens* is examined; these are shown not to depend on depth or station. A well-marked form called *A. Murrayi* sp. n. is described from the West Coast of Scotland, where alone has it yet been obtained.

Cœlenterata.

Protanthea—a new Actinian.‡—Herr O. Carlgren describes a new and simple Actinian—*Protanthea simplex* g. et sp. n.—which he found on Ascidians off the Swedish coast at a depth of 20–30 fathoms. The animal is 10 mm. in length, of a salmon colour, with thin smooth walls without warts or cinclides, but with longitudinal furrows corresponding to the insertions of the mesenteries. There are about 100 tentacles, apparently in six groups; the oral disc bears radial furrows; the œsophageal tube is marked by six longitudinal grooves, of which two form the siphonoglyphes. There are 24 mesenteries, 8 reaching the œsophageal tube and resembling those of *Edwardsia*, 12 arranged in six pairs with intraseptal muscles, and 4 so disposed that each pairs with one of the complete lateral mesenteries. All bear reproductive organs and mesenteric filaments. Herr Carlgren inclines to place the genus *Protanthea* between Hexactiniæ and Edwardsiæ, but would include it along with *Gonactinia* (if that be indeed an adult form) in a new tribe Protantheæ, which he defines as follows:—Actiniaria with paired mesenteries of which only eight are complete in the *Edwardsia*-stage, with two siphonoglyphes in the œsophageal tube, and with an ectodermic nervous and muscular layer.

Bolocera.§—Herr O. Carlgren has a contribution to our knowledge of *Bolocera*, of which he describes a new species, *B. longicornis*, from the west coast of Sweden. The most interesting point in the structure of the tentacles is the presence of a circular muscle to constrict them off. At the base of the tentacle there is an infolding of mesoderm towards the lumen of the tentacle; if this fold contracts strongly, the lumen is completely shut off from the cœlenteric space. If the tentacle is distended with water and there is a powerful contraction of the circular muscle, the tentacles break off at the point where the fold is formed. Nothing is suggested as to the cause of this self-mutilation.

The mesoderm of the upper part of the mesenterial filaments is

* Nachrichten K. Ges. Wiss. Göttingen, 1890, pp. 168–87.
† Ann. and Mag. Nat. Hist., vii. (1891) pp. 469–79 (2 pls.).
‡ Oefvers. af Förhandl. K. Svensk. Vet.-Akad., 1891, pp. 81–9 (4 figs.).
§ Ofvers. K. Vet. Akad. Förh., 1891, pp. 241–50.

provided with connective-tissue-cells rich in protoplasm; these are very numerous, particularly in the central parts, where they lie close to one another; in the lower part, where there is only one glandular band, the connective cells are less numerous, and the gland-cells are elongated and tubular. Elsewhere the gland-cells are large and ampullæform.

Relation of Septa of Parent to those of Bud in Blastotrochus.*—Dr. G. v. Koch has been able to determine that each of the two septa which lie in the plane that contains both the primary axis and the longest diameter are directly continuous with the two primary septa of the bud.

Cerianthus membranaceus.†—M. L. Faurot points out that the differences in length presented by the first eight mesenteries of *Cerianthus* call to mind the disposition of parts in the Rugosa. Although there is a want of bilateral symmetry in the development of the septa, the two sides of the animal always agree in the arrangement of the mesenteries in groups of four.

Antipatharia.‡—Prof. F. Jeffrey Bell gives a description of a very fine example of the "Black Coral" of the Mediterranean, lately added to the exhibition series of the Natural History Museum. It is more than six feet high and six feet wide, and its beauty is due to the closeness of the reticulation of the branches. The base spreads over an area of 350 by 200 mm., and from it spring two great trunks. The specimen was taken by sponge-fishers near Eubœa.

A remarkable Antipathid from Mauritius is also described. As the specimen is dry, it is not possible to say exactly what is its generic position; it is provisionally called *Antipathes*, while the specific name of *Robillardi* marks its discoverer. Several trunks arise abruptly from a small horny base; these soon divide and give rise to a number of greatly elongated stems, many of which are, henceforward, simple. As a result, the appearance of the whole colony is very unlike that of most Antipathids. Where the sclerenchyma is well preserved it has the appearance of being transversely striated, as its dark colour is relieved by narrower and lighter bands; the horny axis has a shagreen-like spinulation, and the spines are blunt and very numerous. There are, altogether, about forty-five stems, the longest of which measure almost exactly one metre. It is to be hoped that spirit specimens with the polyps preserved will enable us to complete our knowledge of this very remarkable form.

Ampullæ of Millepora Murrayi.§—Dr. S. J. Hickson has discovered that the ampullæ of *M. Murrayi* do not contain ova or embryos, but modified dactylozooids bearing very large sperm-sacs only. The ova of *M. Murrayi* are quite small, and similar to those of *M. plicata*. Every fact, as it is discovered, in the anatomy of Millepora separates it more and more from the other Hydrocorallinæ.

* Morphol. Jahrb., xvii. (1891) pp. 334-6 (8 figs.).
† Comptes Rendus, cxii. (1891) pp. 443-4.
‡ Trans. Zool. Soc. Lond., xiii. (1891) pp. 87-92 (2 pls.).
§ Rep. Brit. Assoc., 1890 (1891) pp. 863-4.

Male Gonangia of Distichopora and Allopora.*—Dr. S. J. Hickson finds that the spermatic cæcal diverticula of *Distichopora* are not as long and prominent as those of *Allopora;* they are usually grouped in threes and fours, and lie just beneath the surface, so that, when mature, they are quite visible before decalcification.

Structure and Development of Gonophores.†—Prof. W. K. Brooks and Mr. E. G. Conklin give an account of the structure and development of the gonophores of a certain Siphonophore belonging to the Auronectæ of Haeckel. One result of this investigation is to show that the so-called "polyovone gynophores" show no trace of medusoid structure and are merely pouches containing ova; such structures are therefore spoken of as egg-pouches.

The structure of the gonophores is so complicated that the authors find themselves compelled to describe their development in detail; in which course we have not space to follow them. The chief conclusions, however, are:—The egg-pouch must be regarded as a part of the stem, where the growth of the egg-cells may take place while the gonophore is developing. As soon as the gonophore is formed, one of the eggs, already quite large, passes into it and lies between the ectoderm and endoderm of the manubrium. The egg is rapidly nourished by the disintegration of the egg-cells remaining in the egg-pouch, and by the formation of large endoderm folds which have a secretory function. The whole contrivance is such as to secure as rapid a development of the sexual cells as possible, similarly to the cases described by Weismann in many Hydromedusæ and Siphonophores.

As female gonophores alone were found, it is possible that the male may be very different in form to the female, and it is thought very probable that the male of *Physalia*, if described, has been regarded as a very different genus to the female.

Halistemma in British Waters.‡—The Rev. A. D. Sloan records the first Siphonophore found in St. Andrews Bay. Prof. M'Intosh, in a note to the paper, remarks that Siphonophores are, as a rule, conspicuous by their absence, on the east coast of Britain. *Diphyes*, *Physalia*, and *Velella* are occasionally found in the British seas.

Development of Cyanea arctica.§—Prof. J. Playfair M'Murrich has had the opportunity of studying the development of *Cyanea arctica*, which was very abundant last May in Vineyard Sound. Segmentation is practically regular, and a blastula is formed; there is a transient pseudogastrula. A solid planula is formed by the immigration of cells, and this consists of an outer layer of columnar cells and a central mass, in which cell-outlines cannot be made out in sections. After some swimming about, the embryos settle down and inclose themselves in a circular plano-convex cyst. While within this the central mass becomes hollowed out and the endoderm is formed. After several days the embryo emerges from the cyst through an orifice formed apparently by solution.

* Rep. Brit. Assoc., 1890 (1891) p. 864.
† John Hopkins Univ. Circ., x. (1891) pp. 87–9 (1 pl.).
‡ Ann. and Mag. Nat. Hist., vii. (1891) pp. 413–6 (1 pl.).
§ Amer. Nat., xxv. (1891) pp. 287–9.

The mouth soon forms and four tentacles make their appearance; there does not seem to be any stomodæum, for the ectoderm and endoderm come into contact at the margin of the mouth-opening. Vogt has described the similar absence of a stomodæum in a form which he calls *Lipkea ruspoliana*, but which is, probably, simply a *Scyphistoma*. Mesenteries are not formed till eight tentacles have been acquired; this is a result at variance with the statement of Goette.

Physiology of 'Portuguese Man-of-War.' *—Mr. R. P. Bigelow has now published a more detailed account of his observations, a preliminary notice of which appeared last year.† *Caravella maxima* is an animal without any sense of sight, smell, or hearing, and with little or no sense of taste or touch. It has only a trace of co-ordination in its movements, in which there is a certain amount of rhythm, and every part is capable of originating an impulse. The only active part that it can take in its locomotion is to erect its sail when a breeze strikes it, or to heave to in a gale with its tentacles deeply extended into the water. If it rains, the float may be turned over so as to wash off the irritating fresh water.

From a few observations made on specimens still in the warm water of the Gulf Stream, it is clear that in observing specimens taken near shore, some allowance must be made for debility. In the warmer waters the animals usually hold their crests erect; the colours are much deeper and more brilliant than in the Woods Holl specimens, and the poison of the tentacles was very much more virulent; the merest touch of the back of the finger to one of the tentacles produced the most intense pain.

Four different fluids, at least, are secreted by *Caravella*; the surface of the float is covered by a mucous secretion; a very viscid fluid is secreted at the mouths of the siphons, by which they first attach themselves to foreign bodies. The siphons secrete a digestive fluid, as is evident from the effect produced on food substances. The cnidocells secrete a poisonous fluid which produces a very painful sensation on the human skin, and causes a temporary paralysis in a small animal, and in some cases death. The gas contained in the pneumatocyst is probably also a secretion.

New Family of Hydroida.‡—Prof. W. Baldwin Spencer proposes to establish a new family, that of the Hydroceratinidæ, which he thus defines:—"Hydrophyton consisting of a mass of entwined hydrorhiza, with a skeleton in the form of anastomosing chitinous tubes; the surface is studded with tubular hydrothecæ into which the hydranths can be completely retracted. Hydranths sessile, and connected with more than one hydrorhizal tube, claviform with a single verticil of filiform tentacles. Defensive zooids present, with a solid endodermal axis and nematocysts borne at the distal end."

This new family is established for a remarkable new form which is called *Clathrozoon Wilsoni*, and which was obtained in Bass Straits, close to the Victorian shore, and at a depth of from 20–22 fms. It appears to be very rare. The largest colony measures 10 in. by 4, and at

* John Hopkins Univ. Circ., x. (1891) pp. 90–3.
† See this Journal, 1890, p. 467.
‡ Trans. Roy. Soc. Victoria, 1890, pp. 121–9 (4 pls.).

first sight looks like a dark-coloured fan-shaped Gorgonid. In general appearance it is not unlike *Dehitella* and *Ceratella*, but these have the skeleton in the form of a horny network.

As the reproductive apparatus is as yet unknown, there is very considerable difficulty in speaking as to the affinities of the form; the gastrozooids call to mind *Clava*, the dactylozooids the Plumulariidæ, and the relationship of the gastrozooids to the cœnosarcal tubes the Hydrocorallinæ. The skeleton, though somewhat resembling that of the Hydractiniidæ and Ceratellidæ, differs by the presence of hydrothecæ and the possession of a thin layer of external perisarc, with projecting cylindrical tubes. The first of these differ in various points from those of any other Hydroid, and the second does not appear to be present in any other known form, and it is difficult to conceive how it arose.

Trembley's Experiments with Hydra.*—Dr. M. Nussbaum has repeated his observations on the behaviour of *Hydra* when turned inside out. He corroborates his previous conclusion that a *Hydra* thus treated and bored by a needle, recovers its normal arrangement of ectoderm and endoderm by a process of overgrowth and turning outside in, which may take effect at various places, and is associated with complex absorptive and formative changes. Some new details are added; thus, it is noted that a *Hydra* turned inside out may live in this state, at the expense of its own substance, for six days. Much of the paper has to do with an unfortunate discussion which has arisen in regard to the contributions which Nussbaum and Ischikawa have made to the solution of the problem of the restitution of an evaginated *Hydra*.

Protozoa.

Intracellular Digestion in Protozoa.†—M. Le Dantec has made experiments on intracellular digestion, following the same line as Metschnikoff, who showed that the chemical reaction of the contents of the vacuoles is acid, while that of the protoplasm is alkaline. The author used *Stentor polymorphus* and other Ciliata, and tested the vacuolar reaction with litmus grains. The secretion of the acid varied as to rapidity with the species examined, but in all cases appeared to be the same in kind.

Better results appear to have been obtained by using a sulphur compound of alizarin (alizarine sulfoconjuguée). This is a brown pigment soluble in water (1–500) which when acted upon by alkalies becomes violet and yellow by acids. The transition stage being pink, the slightest alteration in the reaction is instantly recognizable.

With this pigment two kinds of amœbæ were experimented on. A few minutes after the inception of the pigment-granules an acid reaction was observable within the vacuoles, for the contents, originally violet, changed to pink and sometimes to yellow. The pigment-granules were afterwards frequently eliminated, retaining the colour they had acquired while within the vacuole.

He finds that ‡ in all cases the solid particles taken in were accom-

* Arch. f. Mikr. Anat., xxxvii. (1891) pp. 513–68 (5 pls. and 1 fig.).
† Annales de l'Institut Pasteur, 1890, pp. 776. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 355–6.
‡ Ann. Inst. Pasteur, 1891, p. 163. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) p. 736.

panied by a certain quantity of the surrounding water. Those that form currents around their mouth ("Infusoires à tourbillon") only seem to stop taking in particles when a kind of plethora appears to mechanically stop the formation of fresh vacuoles. Those that seize their food ("Infusoires capteurs") appear to make a selection; non-nutrient substances are only taken when they are attached to those which are really nutritious. In all cases studied the digestive vacuole was the seat of an acid secretion which first neutralizes the alkaline water and then makes the contents of the vacuole acid. This secretion goes on with the same intensity whether the contents of the vacuoles are animal, vegetable, or mineral. This acid appears to be strong, but the rapidity with which it is secreted varies greatly in different species; and there is, also, a difference in the toxicity of chemical substances introduced into their bodies, which points to a considerable amount of difference in the constitution of the protoplasm.

Conjugation in Noctiluca.*—Dr. C. Ischikawa points out that in the conjugation of *Noctiluca miliaris* the two nuclei of the copulating cells do not fuse but remain lying against one another till the mass divides again; division of the nuclei then takes place in such a way that half of each nucleus passes into each of the two resulting pieces.

When conjugating, a connecting bridge is formed between two individuals, and the two protoplasmic masses become one. Fusion goes on till a single body is formed. After repose the author often noticed rounded protoplasmic spheres, which stained intensely with methyl-green, close to the poles of the axis in which the two cells touched. These bodies may be centrosomata. The binucleated individual differs in no other particular from a form with a single nucleus; it possesses a new mouth, tentacle and flagellum, and for two days it may show no inclination to divide; others divide directly after copulation.

Sporulation does not occur until after division, and not then always in the same way exactly. In budding the nucleus becomes more obscure, but does not disappear, and the whole of the nucleus gradually passes into the buds, so that at the end of the process no protoplasm or nuclear substance remains over.

Pathogenic Protozoa.†—Dr. L. Pfeiffer, in discussing the pathogenic protozoa in relation to our present knowledge of contagious and miasmatic diseases, seems inclined to award them a prominent position among the causes of infectious disorders, and this chiefly on account of the mobile swarming stage in juvenile conditions of Coccidia. This mobile period of the larval stage, described by Dr. R. Pfeiffer in 1890, the author is disposed to regard as having a peculiar significance, and as capable of explaining the malignancy of certain diseases. The actual number of facts at our disposal is, however, small, and many even of those are disputed; it is well, however, to have attention called to a few positive data pointing in a certain direction, as well as to the inability of bacteriology to explain numerous disorders.

* Zool. Anzeig., xiv. (1891) pp. 12-14 (4 figs.).
† Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 761 and 794.

BOTANY.

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

α. Anatomy.

Anatomy of Plants.*—In connection with a plan for forming collections, at the People's Palace at Brussels, for the popular elucidation of the different branches of Natural Science, M. A. Gravis has published a useful summary of the general facts connected with the anatomy of plants, with regard both to the structure of tissues and to their arrangement in the different organs.

Wiesner's Anatomy and Organography.†—In the most recently published part of the new edition of Prof. J. Wiesner's 'Anatomy and Physiology of Plants' he describes the newest researches on starch, chromatophores, plastids, cell-division, structure of the leaf and stem, absorption of fluid nutriment, movements of gases, influence of external forces on growth, movements connected with growth, &c. The sections on cell-division and secretion are new. The difficult questions relating to the anatomical changes during the growth of the stem, the connection between the anatomical structure and the physiological function of the stem and of the root are treated with great detail and clearness. In the volume on Organography and Classification a large portion is devoted to the sources of medicinal drugs.

(1) Cell-structure and Protoplasm.

Hygroscopic Swelling and Shrinking of Vegetable Membranes.‡—Herr C. Steinbrinck treats this subject from a mathematical and from an empirical point of view, and offers an explanation of various phenomena connected with swelling, especially of those which have to do with torsions. He discusses also the various hypotheses on the constitution of the vegetable cell-wall, and gives his adhesion to Nägeli's micellar theory.

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

Distribution of Starch at different periods of the year in woody plants.§—From a series of experiments made, especially on different species of Conifers, M. E. Mer finds the amount of starch in the leaves to be subject to a law of periodicity, and contests the ordinary view that the reserve-tissues of woody plants contain a large supply of starch throughout the winter. On the contrary, while, about the middle of October, the cortex, the phloem, and the xylem are, in general, filled with starch in all the organs, a month later it has almost entirely disappeared from the cortex and the phloem; and in another month this disappearance has advanced still further. The medullary rays are first

* CR. Soc. Roy. Bot. Belgique, xxx. (1891) pp. 8–23.

† 'Elemente d. Wiss. Bot. I. Anat. u. Phys. d. Pflanzen, 3. Aufl. (158 figs.). II. Organ. u. Syst. d. Pflanzen, 2. Aufl. (270 figs.),' Wien, 1890 and 1891. See Bot. Centralbl., xlv. (1891) p. 213.

‡ 'Zur Theorie d. hygroskopischen Flächenquellung u. -schrumpfung veg. Membranen,' Bonn, 1891, 128 pp. and 3 pls. See Bot. Centralbl., xlvi. (1891) p. 107.

§ Comptes Rendus, cxii. (1891) pp. 248–51, 964–6.

emptied of their starch, then the woody parenchyme, then the cells of the pith. In this state the wood remains stationary till the middle of March. About this time starch-grains begin to reappear in the green cortex of the branches, then in the phloem, spreading gradually to the xylem. The absorption of the starch in winter is, no doubt, due to respiratory combustion; and the winter is, in fact, the period of the year when there is the smallest quantity of starch in woody plants. The period of the greatest activity in the formation of starch is immediately after the close of the winter-rest, before the development of the buds and the activity of the cambium. After that, even under favourable conditions of a clear sky and high temperature, the amount of starch decreases, owing to its absorption in the formation of tissues and to respiration. In cloudy and rainy weather the decrease is still greater, especially in the parenchyme of the upper surface of the leaf.

Structure of Starch-grains in Maize.*—By boiling pieces of maize-grain in chloroform with a few drops of concentrated chromic acid, Dr. L. Buscalioni was able to produce a swelling in the starch-grains which showed a peculiarity in their structure. Some of the grains presented very numerous straight radial striæ, which, proceeding from the centre towards the periphery, were grouped in two systems crossing one another at an acute angle, so as to break up the surface into a number of minute regular rhomboid figures. At a later stage of swelling the striæ were resolved into punctations.

Spectrum of Chlorophyll.†—Mr. W. N. Hartley gives the result of fresh observations on the spectra of blue and yellow chlorophyll. The best solvents for leaf-green he finds to be chloroform and alcohol, but the former should be distilled off at once, otherwise a change takes place in the solution. Leaves of *Anacharis* were chiefly used where the quantity of foreign substances is comparatively small. In contrast to previous statements, Mr. Hartley asserts that yellow chlorophyll has a feeble but distinct absorption-band in the red, and a distinct fluorescence. It has also an absorption-band in the orange-red, and exhibits a very powerful absorption of all rays beyond the *b* group.

The leading characteristics of unaltered leaf-green are those of blue chlorophyll, viz. an intense absorption in the red, somewhat stronger even than in the violet and ultra-violet.

The author believes that the molecule of chlorophyll, or one of its transformation products, is actually capable of reducing carbon dioxide; and he supports the view that the first product of this reduction is probably formic aldehyde.

Aspergillin—a Vegetable Hæmatin.‡—M. G. Linossier gives an account of the pigment of the spores of *Aspergillus niger*, from which it seems that there is here a substance completely analogous with the hæmatin of blood. There is a resemblance in physical characters; both contain a distinct quantity of the same metal, iron; and both are capable of forming, under the action of a reducing agent, but not *in vacuo* or by

* Nuov. Giorn. Bot. Ital., xxiii. (1891) pp. 45–7.
† Journ. Chem. Soc., 1891, pp. 106–24.
‡ Comptes Rendus, cxii. (1891) pp. 489–91.

putrefaction, a reduction product which is oxidizable in contact with air, and thus reproduces the primitive substance.

It is probable that this similarity in properties is correlated with a similarity of function—in both it is respiratory.

In a subsequent communication * M. Linossier contests the assertion of Phipson † that aspergillin is identical with the palmellin obtained by him from *Palmella cruenta*.

(3) Structure of Tissues.

Variations in the Anatomical Structure of the same Species. ‡—Herr P. Schumann has undertaken a long series of experiments on a very large number of species, for the purpose of determining to what extent anatomical differences occur in different individuals of the same species grown in the same situations and under similar conditions, and especially whether the larger simply represent a magnified image of the smaller examples. The latter question is answered in the negative.

The difference between a large and a small specimen consists generally, in Monocotyledons, in an increase of the fundamental tissue; in Dicotyledons in an increase of the pith, the other tissues remaining nearly constant in dimensions. In *Hyoscyamus niger* and *Datura Stramonium* there is also an increase of the parenchyme between the primary vessels; and in *Carum Carui* the appearance of medullary bundles. Any considerable increase in the cortical system or the vascular-bundle system was observed only in a small number of examples. It may then be of three kinds:—(1) Increase in size and number of the separate bundles; (2) Formation of a continuous secondary ring of tissue; (3) Widening of a secondary ring, which occurs also in the smaller examples. The increase in the size of the root in larger specimens is almost invariably due to an increase of the woody cylinder, very rarely to that of the cortical tissue.

Wood of Conifers.§—Herr P. Schuppan has subjected to a critical examination the wood of various Coniferæ, especially that of *Pinus Laricio*, *P. sylvestris*, and *Picea excelsa*, with reference to the number of rows of bordered pits, the width of the annual ring, the distribution of the resin-passages, &c. He finds that the diameter of the cylinder of pith increases regularly from below upwards in comparison to the diameter of the stem. The width of the annual rings in the stem increases from below upwards, attains a maximum, and then again decreases. The distribution of the resin-passages is the same in the root as in the stem; near the apex of the stem and of the root, the number of resin-passages in a unity of surface attains a maximum and then again decreases.

Abnormal Structure of Annual Rings.‖—Herr L. Kny describes several instances in which, in contrast to what is usually the case, the elements of the autumn wood have distinctly thinner walls than those of

* Comptes Rendus, cxii. (1891), pp. 807-8. † T. c., p. 666.

‡ Bot. Centralbl., xlv. (1891) pp. 357-62, 391-4; xlvi. (1891) pp. 1-6, 65-81, 145-9, 177-83, 209-15, 242-50, 305-11, 337-43, 369-73, 401-5 (2 pls.).

§ 'Beitr. z. Kenntniss d. Holzkörpers d. Coniferen,' Halle, 1889, 53 pp. See Bot. Centralbl., xlvi. (1891) p. 120.

‖ SB. Gesell. Naturf. Freunde Berlin, 1890. See Bot. Centralbl., xlv. (1891) p. 183.

the preceding and succeeding spring wood. The libriform fibres of the spring wood showed, in some cases, five times greater thickness than those of the autumn wood; even the vessels of the spring wood had thicker walls than those of the autumn wood. This was especially the case in *Salix fragilis* and *cinerea* and *Pterocarya fraxinifolia*.

"Sanio's Bands" in the Coniferæ.*—By this term (*Sanioische Balken*) Herr C. Müller proposes to designate the beams or thickenings commonly found in the xylem-elements, chiefly in the tracheids of Coniferæ. In the twenty-eight species examined, he found no exception to their occurrence, but they are most frequent in *Araucaria brasiliana* and *Salisburia adiantifolia*. They occur in all the axial organs, in the stem, root, and branches, in both the older and younger parts, and not only in the xylem, but also in the phloem and cambium; they are most abundant in the tracheids and in the sieve-tubes. They extend radially through the elements in which they occur, either singly, or more often in a large number of successive elements in the same radial row. Wherever a series of bands occurs in the xylem, a corresponding series is to be found in the phloem. They are probably formed by an infolding of the radial walls of the cambium cells. They exhibit the same microchemical reactions as the walls themselves; in the xylem they are also lignified. Their physiological significance is at present uncertain.

Suberin and Bark-cells.†—M. Gibson has found, in the cork of *Quercus suber*, besides Kügler's phellonic acid, two other acids, which he calls suberinic acid and phloïonic acid. The mode of separation of the three acids is described in detail. For phellonic acid Gibson gives the formula $C_{22}H_{43}O_3$; it is insoluble in water, soluble in alcohol, ether, and boiling chloroform. Suberinic acid has the composition $C_{17}H_{30}O_3$; it is insoluble in water, readily soluble in alcohol, ether and chloroform, insoluble in petroleum-ether. Phloïonic acid, $C_{11}H_{21}O_4$, is insoluble in cold, slightly soluble in hot water, soluble in alcohol, very slightly soluble in ether and chloroform.

The author finds the so-called suberin-lamella of cork membranes to contain either no cellulose, or only a very small quantity. He believes it to consist of a mixture of compound ethers or products of the condensation or polymerization of the various acids.

Reactions of Lignin.‡—According to Herr T. Seliwanow, the characteristic reactions of lignin are due to the lignified membrane itself, and not to the vanillin. In lime-wood the presence of vanillin is very doubtful. Pine-wood he regards, from its chemical reactions, as a compound of cellulose and a gum having the nature of an ether.

Hypertrophy of Lenticels.§—M. H. Devaux states that the tuber of the potato normally possesses numerous lenticels; these lenticels are open and admit of free access of air to the internal tissues. If, however,

* Ber. Deutsch. Bot. Gesell., viii. (1891) pp. 17–46 (1 pl.).
† La Cellule, vi. (1890) pp. 63–14. See Bot. Centralbl., xlv. (1891) p. 111.
‡ Arb. S. Petersburg. Natur.-Ver. (Bot.), xx. (1889) (Russian). See Bot. Centralbl., xlv. (1891) p. 279.
§ Bull. Soc. Bot. France, xxxviii. (1891) pp. 48–50.

the tuber be partially plunged in water, a considerable development of the lenticels takes place, and they become hypertrophied.

Development of the Root.*—M. P. Lesage makes some observations on the root of a *Phaseolus* which he grew in a humid atmosphere. In a root of the second order which was much longer than the primary root, the following striking differences were noticed.

The portion outside the water was covered with numerous root-hairs; near the water these hairs elongated, while in the water they were much shorter, and finally disappeared altogether. In a transverse section it was seen that the cortical layers in the air contained smaller elements than those in the water, and in the central cylinder the xylem was proportionately more lignified in the aerial portion. The root of the bean was made the subject of similar observations. It was found that when the numerous secondary roots were suppressed, the primary root was covered with numerous absorbing hairs.

Differentiation of the Phloem in the Root.†—While studying the anatomy of the roots of *Allium Cepa*, M. P. Lesage was struck with the early differentiation of the phloem. This was also found to be the case in the roots of *Anthurium Andreanum* and *Odontoglossum citrosinum*, and the progress of the differentiation of the phloem was especially well marked in *Athyrium Filix-femina*. The author concludes by giving a list of plants in the roots of which the cells of the phloem are differentiated before those of the xylem.

Medullary Phloem in the Root.‡—M. J. Hérail calls attention to the fact that certain plants belonging to the Gamopetalæ possess phloem on the inside of their conducting bundles, and that these bundles are known as bicollateral bundles. The author proposes to give to this inner phloem the name of medullary phloem. M. van Tieghem, in one of his papers, describes this formation in the adventitious roots of *Cucurbita maxima*. It is also present in the roots of *Vinca major* and *V. media*, but seems to be absent in *V. minor*.

Anatomical Researches on Carex.§—M. Bordet has paid special attention to the anatomical structure of the genus *Carex*, and the following is a *résumé* of the author's conclusions:—(1) The genus can be divided into four groups by means of the structure of the rhizome; the two first being characterized by the presence of xylem-vessels which are either collateral or concentric; the two others by a cortex formed of cells with small intercellular spaces, or by aeriferous canals formed by the separation of cells. (2) The stem furnishes no characters applicable for purposes of classification. (3) Considerable variation is to be found in the leaves of the different species of *Carex*.

Structure of Apocynaceæ.‖—Herr M. Leonhard has examined the anatomical structure of a considerable number of species belonging to this order, and gives the following as the more important results:—

In the species specially examined in this respect (*Vinca major*

* Comptes Rendus, cxii. (1891) pp. 109–10.
† T. c., pp. 444–6.
‡ T. c., pp. 823–5.
§ Rev. Gén. de Bot. (Bonnier), iii. (1891) pp. 57–69 (3 figs).
‖ Bot. Centralbl., xlv. (1891) pp. 1–6, 33–40, 65–70, 97–104, 129–34 (2 pls.).

and *minor*, and *Nerium Oleander*), a broad annular zone of tissue is separated from the apical meristem immediately beneath the growing point, which furnishes an initial tissue for the primary vessels, the primary phloem groups, and the fibre-cells, and brings about a sharp separation between the pith and cortex. Intraxylary phloem was found in all the species, with scarcely an exception. Sclerenchymatous cells are a very common phenomenon in the pith. At the base of the leaves there are often very interesting emergences, as in the case of the oleander. The laticiferous vessels were wanting in only a single species (*Arduinia bispinosa*). The climbing species of the order may be arranged under three types, differing in the structure of the wood, of which illustrations are afforded by *Strophanthus scandens*, *Echites speciosa*, and *Lyonsia straminea*.

(4) Structure of Organs.

Influence of External Factors on the Formation and Form of Organs.*—Dr. F. Noll shows that external influences determine not only the direction of some organs, but also the position in which they are formed; as, for example, the development of gemmæ on *Marchantia*, of aerial roots on climbing plants, &c. In other and more numerous cases the formation of fresh organs appears to be independent of external forces, and to be determined only by internal forces in the plant, as, for instance, in the dorsiventral structure of many parts of plants. In *Bryopsis* the reversal of the plant brings about a corresponding internal organic transformation.

Epiphyllous Inflorescences.†—M. C. De Candolle has studied the morphology of epiphyllous inflorescences in *Helwingia japonica* (Araliaceæ), *Phyllonoma laticuspis* (Saxifragaceæ), and in some Chailletiaceæ, Celastrineæ, and Begoniaceæ. His conclusion is that, in most cases, the normal position of the stipules, and the anatomical structure of the leaf, show that the epiphyllous inflorescence is a product of the leaf and not an axillary bud carried up by a subsequent growth of the axis. He regards the leaf and inflorescence together as constituting a single phyllome homologous to an ordinary leaf; and the occurrence of sterile and fertile leaves on the same branch as an example of heterophylly.

Variations in the Flower.‡—Dr. D. Levi Morenos states that out of 164 flowers of *Gentiana Amarella* gathered by him in Venetia, no fewer than forty-nine exhibited variations from the normal type, in the number and degree of development of the divisions of the calyx, in the relative position of the stamens, the relative length of the filaments, and other points.

Formation of Flower-buds of Spring-blossoming Plants.§—Mr. A. F. Foerste has investigated the history of the formation of the flower-bud in twenty-eight species of American plants which flower in the early spring, and finds that, in all cases, the flower has attained a considerable degree of development by the preceding August or September. All the

* SB. Naturhist. Ver. Preuss. Rheinlande, xlvii. (1890) pp. 109–10.
† Mém. Soc. Phys. et Hist. Nat. Genève, 1890, 37 pp. and 2 pls. See CR. Soc. Roy. Bot. Belgique, 1891, p. 29.
‡ Nuov. Giorn. Bot. Ital., xxiii. (1891) pp. 196–200.
§ Bull. Torrey Bot. Club, xviii. (1891) pp. 101–6 (1 fig.).

elements of the future blossom can, in many of them, be readily recognized at that time. In some cases the buds are formed underground.

Inferior Ovaries.*—M. P. Duchartre bases most of his remarks on this subject on the ovary of the Pomifereæ. The structure of the cupular ovary can be demonstrated by the organogeny, the anatomy, and by certain teratological facts connected with that organ. The organogeny of *Pyrus malus* and *P. communis* has been carefully described, the five carpels being first seen as five projections on the internal curvature of the floral axis. The author concludes by stating that the view of Naudin and Decaisne appears to be the correct one, that of a carpellary ovary inclosed in a receptacular cupule and adhering to it.

Influence of Moisture on Dehiscent Fruits.†—Prof. B. D. Halsted and Mr. D. G. Fairchild describe the mode of dehiscence of the capsule or other form of fruit of a number of American plants, the dispersion of the seeds being greatly assisted by the hygroscopic properties of the pericarp, or of some organ attached to the fruit, as the awn in the case of some grasses, or the pappus of Compositæ.

Geocarpous, Amphicarpous, and Heterocarpous Fruits.‡—Herr E. Huth enumerates the various geocarpous and amphicarpous, as well as the "rhizocarpous" species of plants, understanding by the last term those woody plants which, in addition to the normal aerial, produce underground flowers and fruits, such as *Cynometra cauliflora*, *Theobroma Cacao*, and *Anona rhizantha*. He also gives a list of species, belonging to a great variety of natural orders, which produce two different kinds of fruit.

Porosity of the Fruit of Cucurbitaceæ.§—M. H. Devaux gives the details of some experiments on the fruits of *Cucurbita maxima* and *C. melanosperma*. The following are the principal conclusions:—(1) The internal atmosphere of the fruit of Cucurbitaceæ communicates with the external air by means of stomates and lenticels. (2) The proportion of oxygen present in the internal atmosphere is nearly the same as that in the air; the amount of carbon dioxide was, however, found to be less in the formula case, in the analyses performed by the author.

Development of the Integument of the Seed.‖— M. M. Brandza has made a detailed examination of the different modes of development of the integument of the mature seed from that of the ovule. These may be classified under two heads,—those in which the ovule has a single, and those in which it has a double integument. Under the latter head three different cases present themselves:—(1) The seed has only a single envelope, proceeding from the outer integument of the ovule, or, at least, from a part of it; (2) the two envelopes of the ovule develope into the two envelopes of the seed; (3) the nucellus enters into the composition of the inner integument of the seed. The first of these cases occurs only in the Ranunculaceæ, the Papilionaceæ, the

* Bull. Soc. Bot. France, xxxviii. (1891) pp. 28–38.

† Bull. Torrey Bot. Club, xviii. (1891) pp. 81-4 (1 pl.).

‡ Samml. Naturw. Vorträge, x. (1890) 32 pp. See Bot. Centralbl., xlv. (1891) p. 381.

§ Rev. Gén. de Bot. (Bonnier), iii. (1891) pp. 49–56 (1 fig.).

‖ Rev. Gén. de Bot. (Bonnier), iii. (1891) pp. 1–32, 71–84, 105–26, 150–65, 229–40 (10 pls.).

Amaryllideæ, and a large portion of the Liliaceæ; the second, though regarded as exceptional, is found in certain genera belonging to a large number of different natural orders; the third, in genera of Lythraceæ, Œnothereæ, Magnoliaceæ, and Aristolochiaceæ. In the greater part of the Gamopetalæ and Apetalæ, as well as in some Apopetalæ, the ovules are provided with only a single integument, and the envelopes of the seed are either developed from this integument alone, or the nucellus partakes in its formation. The latter case occurs in species belonging to the Linaceæ, Rhamnaceæ, and Compositæ. In most cases the inner layers of the integument of the ovule disappear in the course of development of the seed.

In opposition, therefore, to the view usually entertained, the author asserts that in those plants in which the ovule has a double integument, the inner envelope does not, as a rule, disappear in the course of development of the seed, but persists, and often constitutes the lignified portion of the seminal integument. The nucellus itself sometimes contributes to the formation of the mature envelope; and it is only in a few families that this is formed entirely from the outer integument of the ovule. In those plants in which the ovule has only a single envelope the lignified portion of the seminal integument has its origin, in some cases, in the epiderm of the nucellus.

Integuments of the Seed of Cruciferæ.*—M. J. d'Arbaumont has arrived at the following conclusions respecting the seminal integuments of the Geraniaceæ, Lythraceæ, and Œnothereæ:—(1) The two integuments of the ovule frequently remain in the ripe seed. (2) The nucellus frequently contributes to the formation of the seminal integuments. (3) The endosperm itself even takes part in this formation. The object of the present paper is to show that this last often takes place also in the Cruciferæ, and especially in *Brassica nigra* and *Sinapis alba*. A layer formed from the endosperm is also present in *Iberis pinnata*, *Conringia perfoliata*, *Biscutella ambigua*, *Cochlearia officinalis*, &c.; sometimes this layer is reduced to a thin lamellated pellicle, as in *Capsella bursa-pastoris*, *Camelina sylvestris*, *Thlaspi perfoliatum*, *Hesperis matronalis*, &c.

Stem of Zostera.†—M. C. Sauvageau has studied the structure of the stem in the five species of *Zostera*—*Z. marina*, *Capricorni*, *nana*, *Muelleri*, and *tasmanica*, *Z. marina* being taken as the type. The cortical parenchyme is composed of a close external and an internal zone containing lacunæ; in the internal zone are fibrous strands, which are either in contact with the epiderm, or are separate, and, in one of the species (*Z. Muelleri*), surround the central cylinder. There are always cortical foliar bundles, either one on each side (*Z. marina*, *Capricorni*, and *nana*), or two to five (*Z. Muelleri* and *tasmanica*). The central cylinder is always surrounded by an endoderm, the phloem-bundles are more frequently isolated and distinct, while the xylem-bundles are united. A knowledge of the structure of the stem greatly facilitates specific determination.

* Bull. Soc. Bot. France, xxxvii. (1890) pp. 251–7. Cf. this Journal, 1890, p. 737.

† Journ. de Bot. (Morot), v. (1891) pp. 33–45, 59–68 (9 figs.). Cf. this Journal, 1890, p. 741.

For instance, *Z. nana* and *Muelleri* are more easily distinguished the one from the other by the structure of their stem than by their leaves. Inversely, however, *Z. nana* and *Capricorni* show more difference in the structure of their leaves than in that of their stem.

Spiral Phyllotaxis.*—Herr B. Rosenplenter points out that in the germination of dicotyledonous seedlings there must be either a single primary leaf or a primary pair. In the first case there is only one plane of symmetry, which bisects the angle of the median planes of the cotyledons. In the second case there are either two planes of symmetry, or only one which corresponds with the common median plane of the cotyledons. The various special modifications of these cases are described in detail.

Leaf-spirals in the Coniferæ.†—Herr A. Weisse treats from a mathematical point of view the turning of the leaf-spiral and the nature of the pressure which causes it in the axillary buds of Coniferæ. In the axillary buds of by far the greater number of Coniferæ with spiral phyllotaxis, the third leaf faces the stem. The lateral deviations depend upon three causes—a lateral displacement caused by the supporting leaf, a lateral insertion of the supporting leaf, and the pressure of the bases of the adjacent leaves of the mother-shoot which stand above the supporting leaf.

Influence of Light on the production of Spines.‡—M. A. Lothelier, in a former paper, made some observations on the influence of the hygrometric state of the air on the production of spines, and in the present paper studies the influence of light in the same relationship. Various examples are taken, for instance :—*Berberis vulgaris*, *Robinia pseudacacia*, *Ulex europæus*, *Cratægus oxyacantha*, and *Ribes uva-crispa*, the general conclusion being that stronger light causes the formation of more numerous, better-developed, and more differentiated spines.

Bulbs and Tubers in the Juncaceæ.§—Herr F. Buchenau describes the formation of tubers and bulbs in various species of *Juncus* and *Luzula*. They are produced either by the larvæ of animals or by fungi. In the latter case the parasite is a species of *Schinzia* or *Entorrhiza*, *S. Casparyana* or *digitata*.

Growth of Root-hairs.‖—M. H. Devaux has already shown that light is favourable to the development of root-hairs. Observations on the root of *Lolium perenne* were made, and it was found that the minimum growth took place between midday and two o'clock. The maximum growth of the rootlets, however, took place in the region of the root formed during the day, and the minimum in that formed during the night. A certain equilibrium is thus maintained between the growth of the root-hairs and that of the root itself.

* 'Ueb. d. Zustandekommen spiraliger Blattstellungen b. dikotylen Keimpflanzen,' Berlin, 1890, 43 pp. and 1 pl. See Bot. Centralbl., xlv. (1891) p. 346.
† Flora, lxxiv. (1891) pp. 58–70 (1 pl.).
‡ Comptes Rendus, cxii. (1891) pp. 110–2. Cf. this Journal, *ante*, p. 214.
§ Flora, lxxiv. (1891) pp. 71–83 (2 figs.).
‖ Bull. Soc. Bot. France, xxxviii. (1891) pp. 51–2. Cf. this Journal, 1888, p. 995.

Anatomy of the Malvaceæ.*—Herr G. Kuntze finds the following characters common to all species of Malvaceæ examined:—Small, usually brown capitate hairs; strong bast-bundles in the cortex; and especially mucilage in the cortex and pith, as well as in the epiderm of the upper surface of the leaves. The leaves are bilateral, and have palisade-cells on their upper surface only; crystals, both solitary and in clusters, are common, but never raphides. The hairs are very commonly stellate, and occasionally chambered. Mucilage occurs in all organs, and results from the disintegration of the cell-walls. The Bombaceæ differ in so many respects from the typical Malvaceæ that they ought, perhaps, to be regarded as a distinct order. They rarely possess stellate or tufted hairs; and the wood is in general less lignified, and contains larger vessels; mucilage-passages occur almost invariably on the under side of the larger veins. The author was unable to lay down any anatomical character for the separation of the genera.

β. Physiology.

(1) Reproduction and Germination.

Results of continual Non-sexual Propagation.†—Prof. M. Moebius discusses this subject in detail as regards flowering plants, and decides against the Darwinian hypothesis that continual propagation by non-sexual method must result in deterioration and ultimate extinction. He agrees with Schleiden in dissenting from the popular theory that the offspring of such modes of propagation must be regarded as constituting but a single individual. In support of these views he refers to the length of time—extending in some cases to thousands of years—during which some plants have been continuously propagated by non-sexual methods without apparent deterioration or increased liability to disease —e. g. *Elodea canadensis*, the fig, the date-palm, the banana, the yam, the batatas, the olive, and many others. On the other hand, the weeping-willow and the Lombardy poplar do appear to have been threatened with extinction, owing to their abnormal liability to disease. But degeneration as the result of age cannot be affirmed as a general law in such cases.

Cross-fertilization and Self-fertilization.‡—Mr. E. G. Hill describes in detail the mode of pollination in three American plants:—In *Campanula aparinoides* the structure favours the occurrence of self-pollination when there is a lack of insect visitors. In *Sabbatia angularis* (Gentianaceæ) there is a very interesting mechanism to secure cross-pollination by the agency of insects. *Eleocharis mutata* (Cyperaceæ) is proterogynous and anemophilous.

Autogenetic and Heterogenetic Fertilization.§—Prof. Körnicke proposes these terms for the self-pollination and cross-pollination of plants; and adduces instances in which the former phenomenon is to all appearance constant and continuous, with abundant fertility, the flowers being in some cases open, in others cleistogamous.

* Bot. Centralbl., xlv. (1891) pp. 161-8, 197-202, 229-34, 261-8, 293-9, 325-9 (1 pl.).

† Biol. Centralbl., xi. (1891) pp. 129-60.

‡ Bull. Torrey Bot. Club, xviii. (1891) pp. 111-8.

§ Verhandl. Naturhist. Ver. Preuss. Rheinland., xlvii. (1890) Korr.-bl., pp. 84-99.

Proterandry in the Umbelliferæ.*—Herr A. Beketow states that in those genera of Umbelliferæ where the normal proterandry is most strongly developed, such as *Anthriscus* and *Carum*, the earliest central umbel has reached the female stage, while the later lateral umbels are still in the male stage; and that the lower position of the central umbel insures its pollination from the lateral ones. Where proterandry is not so strongly developed, the central umbel often stands at a higher level than the lateral ones.

Reproduction of Hydromystria.†—Sig. A. Bottini describes the structure of the male and female flowers of *Hydromystria stolonifera* (Hydrocharideæ), and the mode of the pollination, which seems to be altogether anemophilous. After impregnation the stalk of the female flower lengthens and then bends downwards, and the fruit is matured under water, very much as in *Vallisneria*.

Duration of the Life of certain Seeds.‡—M. H. de Vries states that most seeds, if kept in a dry state, lose their power of germination in a few years. A certain number of seeds were taken and kept seventeen years, and it was found that only two out of the number possessed the power of germination, viz. those of *Erodium cicinum* and *Nicandra physaloides*. In the first case only a single plant was raised. An experiment showing the rapidity of germination in *Œnothera Lamarckiana* is then described. Seeds were sown on the 14th of March, 1887, and between March and April 908 of these germinated; between April and May, 288; between May and June, 27; between June and July, 37; between July and September, 130; between September and October, 6.

Germination of the Sugar-cane.§—Mr. D. Morris describes the production of fertile seeds in the sugar-cane, which has very rarely been observed. All the spikelets observed were one-flowered, and the flower hermaphrodite. In germination the plumule and radicle emerge without the cotyledon.

Germination of Hydrastis Canadensis.‖—Mr. H. Bowers describes a singular phenomenon in the germination of this plant—one of the Ranunculaceæ. The complete germination extends over two, or even over three years. At the end of the first summer the seedling consists of the two foliaceous cotyledons, with a thick tapering radicle and a very small plumule. The rhizome and flowering stem develope only in the second or third year.

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

Biology of Parasites.¶—M. A. Chatin contests the prevalent view that leafless parasites can only make use of nutritive substances already elaborated by their hosts. The statements that the mistletoe of the oak contains tannin absorbed directly from the oak, and that the *Loranthus* parasitic on *Strychnos nux-vomica* contains strychnine, are founded on

* Arb. St. Petersb. Naturf.-Ver. (Bot.), xx., pp. 11 *et seq.* (Russian). See Bot. Centralbl., xlv. (1891) p. 381.

† Malpighia, iv. (1891) pp. 340–9, 369–77.

‡ Arch. Néerland., xxiv. (1891) pp. 271–7.

§ Journ. Linn. Soc. (Bot.), xxviii. (1890) pp. 197–201 (1 pl.). Cf. this Journal, *ante*, p. 218.

‖ Bot. Gazette, xvi. (1891) pp. 73–82 (1 pl.).

¶ Comptes Rendus, cxii. (1891) pp. 599–604; and Bull. Soc. Bot. France, xxxviii. (1891) pp. 124–8.

erroneous observations. Even leafless parasites (*Balanophora*, *Cytinus*, *Hydnora*, *Cuscuta*, *Orobanche*, &c.) contain abundance of starch in their parenchyme, which must have been formed in the tissues of the parasite. The carbon dioxide is formed in such plants, as in animals, by the consumption of their own carbon, this carbon being derived from the sap of the host-plant. But certain secondary products, such as the colouring matter of the flowers of *Cuscuta* and of some species of *Orobanche*, must be formed afresh in the tissues of the parasite. Many leafless parasites possess stomates and well-developed spiral vessels.

Assimilation of Leaves.*—Herr H. Vöchting describes an apparatus designed to determine the question whether the growth of each leaf is due to the energy of the assimilation in that particular leaf. The result of a number of experiments enabled the author to answer this question in the affirmative, both as regards the mature organ and the leaf in course of development, though this does not apply to the earliest stages of the development of leaves or of the leaflets of compound leaves.

Absorption of Atmospheric Nitrogen by Plants.†—Messrs. W. O. Atwater and C. D. Woods have carried out a long series of experiments in growing various plants—chiefly peas, lucerne, oats, and maize—in soils saturated with different infusions which promote the formation of root-tubercles. They find that, in all cases where tubercles are produced, there is a distinct absorption of nitrogen from the atmosphere. They assert that atmospheric nitrogen is undoubtedly acquired during the growth of peas and lucerne, and that the amount of nitrogen absorbed is in proportion to the number of tubercles. The addition of soil-infusion is not, however, necessary for the production of the tubercles. The cereals do not, as a rule, possess the power of acquiring nitrogen from the atmosphere, nor are root-tubercles formed on them as in the case of leguminous plants.

Perforation of Potatoes by the Rhizome of Grasses.‡—M. A. Prunet has investigated the perforation of the tuber of the potato by the rhizome of certain grasses, especially *Cynodon Dactylon* and *Triticum repens*, which is not an uncommon occurrence. He finds that it is not of advantage to the perforating organ in the way of obtaining nutriment from the reserve-materials in the tuber. In immediate contact with the perforating rhizome is a layer of disintegrated tissue of the tuber, and next to this a suberous sheath which completely cuts off the rhizome from the nutritive tissues of the tuber. The terminal bud of the rhizome presents no appearance of producing any substance of a diastatic nature, and the small roots which proceed from the rhizome are entirely destitute of root-hairs.

(3) Irritability.

Compass-plants.§ — In addition to the well-known instances of *Silphium laciniatum*, species of *Lactuca*, &c., the leaves of which present their two surfaces successively to different points of the compass in order to prevent excessive radiation, Prof. G. Arcangeli describes

* Bot. Ztg., xlix. (1891) pp. 113–25, 129–43 (1 pl.).
† Amer. Chem. Journ., xii. (1890) pp. 526–47; xiii. (1891) pp. 42–63.
‡ Rev. Gén. de Bot. (Bonnier), iii. (1891) pp. 166–75 (2 figs.).
§ Nuov. Giorn. Bot. Ital., xxiii. (1891) pp. 145–9.

another instance of a similar phenomenon in *Larrea cuneifolia*, a shrub from the Argentine Republic. He distinguishes two different varieties of the phenomenon, *politropism*, in which the position assumed is always a meridional one, the two surfaces facing east and west, and *parorthotropism*, in which the lamina assumes a vertical, but not necessarily a meridional position. The latter condition may be a stage of transition to the former. and either may be brought about by different causes, such as heliotropism or geotropism.

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

Respiration of Plants.*—In a long series of experiments Dr. C. Stich has carefully investigated the effects on respiration of a diminished pressure of oxygen, and of injuries to the tissue. As a general result it was found that the activity of the intramolecular was in inverse proportion to that of the normal respiration ; so that, even with a very great reduction of the proportion of oxygen in the surrounding atmosphere, no very great reduction ensued in the amount of carbon dioxide produced. In a general way also the effect of different kinds of injury on various parts of plants was to increase the activity of the respiring process. This is partly dependent on the increase of surface exposed to the air resulting from the injury.

Respiration in the interior of massive tissues.†—According to M. H. Devaux, such tissues as those of the beet and the potato are not so dense as to prevent the access of the atmospheric air to every cell in the interior of the organ. The gases imprisoned in such organs always contain a large proportion of oxygen, and respiration takes place in the normal way. The air gains access through a system of branching canals which permeate the tissue in every direction, and which allow of the rapid passage of gases, even when there is but a slight difference of pressure.

Composition of the internal Atmosphere of Plants.‡—According to a series of observations made by M. J. Peyron, the proportion of oxygen in the air contained in the tissues of plants is subject to great variations ; the amount is always less than that in the surrounding atmosphere, while that of carbon dioxide is considerably greater. The proportion of oxygen shows two minima, between 7 and 9 A.M., and between 4 and 5 P.M., and two maxima, about noon and between midnight and 1 A.M. The night maximum is usually greater than that in the day; and these variations are independent of the time of year, of the temperature, and of chlorophyllous assimilation. Young leaves usually contain less oxygen than mature leaves, and those fully exposed to light less than shaded leaves; evergreen generally contain more than deciduous leaves. Movements in the air increase the amount of oxygen in leaves.

Influence of the Carbohydrates on the Formation of Asparagin.§—Herr N. Monteverde has attempted a solution of this question by

* Flora, lxxiv. (1891) pp. 1–57 (2 figs.).
† Comptes Rendus, cxii. (1891) pp. 311–3.
‡ 'Rech. sur l'atmosphère interne d. plantes,' Corbeil, 1888, 89 pp. See Bot. Centralbl., xlv. (1891) p. 217.
§ Arb. St. Petersb. Naturf.-Ver. (Bot.), xx. pp. 28–30, 43–5 (Russian). See Bot. Centralbl., xlv. (1891) p. 379.

immersing the leafy portion of herbaceous stems or growing first-year branches of woody plants, partly in distilled water, partly in solutions of grape-sugar, cane-sugar, mannite, and glycerin, in the dark. He finds that, after soaking for fifteen days in distilled water or glycerin, there is a large accumulation of asparagin but no trace of starch or mannite in woody plants; in herbaceous plants the amount of asparagin formed is much less considerable; after immersion for a month in cane-sugar, grape-sugar, or mannite, no trace of asparagin is found, but abundance of mannite and starch. These facts point to the conclusion that the asparagin is the result of continued decomposition of the proteids.

Influence of Saltness on the Formation of Starch in Vegetable Organs containing Chlorophyll.*—M. P. Lesage comes to the conclusion that saltness has an influence on the formation of starch in vegetable organs. In extreme cases it hinders its formation. The author has shown that the presence of much salt is accompanied by a diminution of the chlorophyll and of the assimilation of carbon; subsequent processes will not therefore take place so rapidly.

Transformation of Starch into Dextrin by the Butyric Ferment.†—M. A. Villiers has undertaken the study of the action of certain ferments on the carbohydrates under various conditions. He gives the results of the action of the butyric ferment (*Bacillus amylobacter*) on potato starch, and states that under the action of this ferment it is easy to transform amylaceous matter into dextrin. The transformation is direct, maltose and glucose being completely absent; but further investigation is necessary in order to find out whether the dextrins so formed are identical with those obtained by the action of acids or through the influence of diastase. There is formed at the same time a small quantity of a carbohydrate, crystallizing in beautiful radiate crystals from the alcoholic solution, and having the composition $C_{12}H_{20}O_{10} + 3\,H_2O$. The author regards it as a new substance, and proposes for it the name *cellulosin*. Its physical and chemical properties are given.

Tannins and Trioxybenzols.‡—Referring to the observations of Waage § on the occurrence and mode of formation of phloroglucin, Dr. E. Nickel suggests that the trioxybenzols may be formed in the same way by the withdrawal of water from inosite, a substance of very wide distribution in the vegetable kingdom, having the empirical formula $C_6H_{12}O_6$, but not nevertheless a true carbohydrate. These trioxybenzols are then probably the source of tannins.

γ. General.

Influence of External Factors on the Odour of Flowers.‖—Prof. R. Regel states that while the odour of some flowers, such as those of the mignonnette, of *Stanhopea tigrina superba*, and of the stamens of *Philadelphus coronarius*, is due to the presence of a volatile oil, none appears to be present in the sweet-pea or in *Nycterinia capensis*. In both cases the

* Comptes Rendus, cxii. (1891) pp. 672–3.
† T. c., pp. 435–7, 536–8.
‡ Bot. Centralbl., xlv. (1891) pp. 394–7.
§ Cf. this Journal, *ante*, p. 209.
‖ Arb. St. Petersb. Naturf.-Ver. (Bot.), xx. pp. 32–7 (Russian). See Bot. Centralbl., xlv. (1891) p. 343.

odour is, as a rule, increased by heat and light. With *Nicotiana longiflora* the flowers are open and fragrant only at night; and here the darkening of the whole plant for three or four weeks is necessary to destroy the scent. *Nycterinia capensis* is peculiar in the fact that the odour is apparently dependent on the presence of starch in the parenchyme of the petals.

Relationship between Plants and Snails.*—Herr F. Ludwig gives a résumé of malacophilous plants, i. e. those that are fertilized by the agency of snails and slugs. He further describes the various modes in which plants are protected against the attacks of molluscs, especially by the presence in the cell-sap of raphides and of tannin. There can be no doubt that galls are a protection against the ravages of these and of other animals. Many spores and other germs do not lose their power of germination by passing through the intestinal canal of snails; and these animals probably play a considerable part in the dissemination of fungi.

Constitution and Formation of Peat.†—According to Dr. J. Früh, peat may be formed either above the surface of the water, when it is composed chiefly of remains of *Sphagnum*, *Eriophorum*, and *Calluna*, the latter being replaced in the West of Europe by *Erica tetralix*, or below the surface, when it consists chiefly of *Hypnum*, *Carices*, and grasses. But almost any plant except fungi and diatoms is capable of contributing to the formation of peat. The chief chemical characteristic of peat is the presence of large quantities of humic and ulmic acids, the latter very commonly in combination with lime, and forming the substance known as dopplerite.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Tmesipteris.‡—M. P. Dangeard describes in detail the five species which, according to him, constitute the genus *Tmesipteris*, three of which are new—*T. Vieillardii*, *T. elongatum*, and *T. lanceolatum*. The following are some of the more important general characters of the genus:—

All the species are rootless, the function of the root being performed by a rhizome covered with absorbing hairs. Most of the species grow on tree-ferns, but *T. Vieillardii* is found on moist soil. The walls of the cortical cells often become converted into mucilage, the cell-cavities being filled by a black substance. In the stem the tracheids which form the protoxylem occupy the centre of the vascular bundles, but are often replaced at an early period by a lacuna; these are surrounded by the protophloem. The centre of the stem is in some species occupied by a pith, which may be parenchymatous or collenchymatous, or may be occupied by fibrous cells. The sporange has the form of a two-chambered egg, and is situated on the upper part of a petiole; the author regards the sporangial leaf as the result of the fusion of two leaves. The cortical

* Bot. Centralbl., 1891, Beih. 1, pp. 35–9. Cf. this Journal, 1890, p. 486.
† Ber. Schweiz. Bot. Gesell., 1891, pp. 62–79.
‡ Le Botaniste (Dangeard), ii. (1891) pp. 163–222 (7 pls.).

cells of the rhizome of some of the species are infested by an endotrophic mycorhiza (*vide infra*, p. 504).

Archegone of Ferns.*—Prof. D. H. Campbell corrects his previous statement that the ventral canal-cell is wanting in *Struthiopteris germanica*. Sections with the microtome exhibit it very clearly, and show that it is derived from the central cell.

Rhizome of Ferns.†—According to Herr J. Velenovsky, the lateral branches of the rhizome of Ferns do not always originate in the axil of a supporting leaf, but frequently from a true dichotomy. In *Polypodium Dryopteris* and *Phegopteris* the branching is not perfectly dichotomous; but in *Aspidium Thelypteris* it is regularly so; both branches are equally provided with leaves of equal length and vigour, and spring from two terminal segments of equal size. The so-called adventitious buds of *Pteris aquilina*, *Struthiopteris germanica*, *Nephrolepis tuberosa*, &c., are not altogether homologous to the adventitious buds of flowering plants; since in the Ferns these structures are constant, arising regularly at definite spots, and are the sole source of the growth of the plant, there being no other mode of branching. The rhizome of most ferns divides without any regular law, often regularly monopodially or dichotomously, but the branches do not originate in the axil of a leaf.

Apical Growth of Osmunda and Botrychium.‡—Prof. D. H. Campbell finds considerable variation in the structure of the root-tip in the Osmundaceæ. In the common American species of *Osmunda*, while the structure of *O. cinnamomea* agrees, in the mode of growth of the root-tips, very nearly with that of *O. regalis*, that of *O. Claytoniana* approaches much more nearly to the appearance presented by ordinary leptosporangiate ferns.

In the Ophioglossaceæ, a similar difference was observed in the native American species of *Botrychium*, *B. ternatum* and *B. Virginianum*. Of these two species, the latter approaches much more nearly to the true Filices in the structure of its roots, as it does also in other respects.

Structure of Ophioglossaceæ.§—M. G. Poirault calls attention to the following points in the anatomy of the vegetative organs of the Ophioglossaceæ (*Ophioglossum vulgatum* and *lusitanicum* and *Botrychium lunaria*). The sieve-tubes are destitute of callus, presenting a contrast to the structure in the normal Filices. The root grows by the segmentation of a single tetrahedral cell. The roots have a remarkable power of producing buds, which is most strongly displayed in *Ophioglossum vulgatum*. This species is apparently always propagated in this way, the author never having seen a prothallium.

Sphenophyllum.‖—Prof. J. S. Newberry describes six American specimens of *Sphenophyllum*, which he regards as probably not the foliage of *Calamites*, but as representing a peculiar and extinct family

* Bull. Torrey Bot. Club, xviii. (1891) p. 16 (2 figs.). Cf. this Journal, 1888, p 618.

† SB. K. Böhm. Gesell. Wiss., 1890 (2 pls.). See Bot. Centralbl., xlvi. (1891) p. 32.

‡ Bot. Gazette, xvi. (1891) pp. 37–43 (1 pl.).

§ Comptes Rendus, cxii. (1891) pp. 967–8.

‖ Journ. Cincinnati Soc. Nat. Hist., xiii. (1891) pp. 212–7 (1 pl.). Cf. this Journal, *ante*, p. 73.

of plants that flourished in all parts of the world during the Devonian and Carboniferous periods, but disappeared at the close of the Permian, and has no nearer relative in our living flora than *Equisetum*. Of the ill-defined genus *Asterophyllites*, probably some species belong to *Sphenophyllum*, others to *Calamites*.

Muscineæ.

Influence of the hygrometric state of the air on the position and function of the leaves of Mosses.*—M. E. Bastit points out that when such a moss as *Polytrichum* grows in moist places, the leaves are expanded and the upper convex surface is at a considerable angle with the stem; while in dry situations the leaves are closed on themselves and on the stem. He found by experiment that, in accordance with the general law, respiration is considerably diminished, and the chlorophyll-function still more so, in the closed as compared to the expanded position. It is in winter, when the atmosphere is most saturated with moisture, that mosses elaborate with the greatest intensity their nutritive principles, owing to the expanded position of the leaves; and this accounts for the formation of the oosphere and the sporogone at that period of the year.

Sexual Organs and Impregnation in Riella.†—Dr. O. Kruch has followed out the development of the archegones and antherids in *Riella Clausonis*. The young cellular tissue was treated with eau de Javelle, washed with abundance of distilled water, and stained with congo-red. For the study of the archegones in the process of development, the best results were obtained with methyl-green, after clarifying with oil of marjoram. In the formation of the antherids a marginal cell divides by a transverse septum into two portions, the lower of which forms the foot, and the upper one the body of the antherid. In the formation of the antherozoids the process of nuclear division corresponds, in all essential respects, with that observed by Strasburger in the case of flowering plants. The number of nuclear filaments in the successive divisions of the mother-cells of the antherozoids is invariably eight; and during the process of impregnation the nucleus of the oosphere displays the same number of filaments. When the antherozoid penetrates the cytoplasm of the oosphere, it increases considerably in volume, and gives birth to the male nucleus, in which there are also evidently eight filaments; the two sexual nuclei possess therefore the same number of filaments, and nearly the same dimensions. The secondary nuclei proceeding from the division of the nucleus of the embryo-cell present sixteen filaments.

Characeæ.

Growth of the Cell-wall in Chara fœtida.‡—Herr E. Zacharias found that the thickenings of the cell-wall of the rhizoids of *Chara fœtida* are not caused by the excision of the node, nor by any mechanical irritation of the rhizoid, but are formed whenever the plant is placed in pure water not previously containing any *Chara*, or in solution of sugar or dilute glycerin. It is probable that the rhizoids grow by apical growth.

* Comptes Rendus, cxii. (1891) pp. 314–7.
† Malpighia, iv. (1891) pp. 403–23 (2 pls.).
‡ Ber. Deutsch. Bot. Gesell., viii. (1890) Gen.-Vers.-Heft, pp. 56–9.

Algæ.

Cystocarps and Antherids of Catenella Opuntia.* — Mr. R. J. Harvey-Gibson describes the hitherto but little known cystocarps and antherids of this species of red sea-weed. The cystocarps are immersed in ramifications of the erect branches; they are spherical, and each ramification contains from 50 to 150 procarps, of which, however, but few arrive at maturity. Each procarp consists of a single carpogenous cell, a single trichophore-cell, and a very long delicate trichogyne. After impregnation each carpogenous cell gives birth to from 12 to 20 carpospores. The antherids are also formed on special branches.

Galls on a Sea-weed.†—Miss E. S. Barton describes pathological structures found in the frond of *Rhodymenia palmata*, which appear to be the result of a stimulus caused by the attacks of a marine Crustacean, *Harpacticus chelifer*. They have the appearance of minute papillæ; and in the cells of these papillæ, as well as in diseased portions of the thallus in their neighbourhood, were found remains of the bodies of the attacking animal, and in some instances its eggs.

Structure and Development of Chylocladieæ.‡ — Pursuing his investigation of the structure of the genera *Chylocladia*, *Champia*, and *Lomentaria*, especially as regards their vegetative organs, M. F. Debray distinguishes, in all the species examined, between the primary and secondary axes. The former is often short and always solid; and its peripheral portion consists of dichotomously divided rows of cells which become smaller towards the surface. The attachment-disc increases on the whole of its upper side by division of the terminal cells of erect rows. The secondary shoots grow from the primary axis either by lateral growth near the apex, or by actual prolongation of the apex. Special peculiarities of structure are described in *Chylocladia reflexa*, *C. ovalis*, *Lomentaria clavellosa*, and *L. articulata*.

Conjugation of the Zygnemaceæ.§—Mr. W. West confirms the view taken by Bennett ‖ and others as to the sexuality of the filaments of the Zygnemaceæ; all the cells in the same filament appear to be invariably of the same character, either active or passive, in the act of conjugation. He has frequently observed lateral conjugation in cells of a filament, some of the cells of which are in scalariform conjugation with those of another filament. As regards the conjugation of more than two filaments, he finds, like previous observers, polygamy to be much more common than polyandry.

Clamp-organs of the Conjugatæ.¶—M. P. A. Dangeard describes root-like organs by means of which some species of Zygnemaceæ, which usually float free in the water, can attach themselves to a solid substance. They were observed in *Zygogonium pectinatum* and in an undescribed species of *Spirogyra*.

* Neptunia, i. (1891) pp. 5–6.
† Journ. of Bot., xxix. (1891) pp. 65–8 (1 pl.).
‡ Bull. Scient. France et Belg, xxii. (1890) pp. 399–416 (17 figs.). See Bot. Centralbl., xlv. (1891) p. 21. Cf. this Journal, 1888, p. 265.
§ Neptunia, i. (1891) pp. 81–5 (2 pls.).
‖ Cf. this Journal, 1884, p. 434.
¶ Le Botaniste (Dangeard), ii. (1891) pp. 161–2, and 228 (1 pl.).

M. E. De Wildeman * describes similar structures in species of *Mesocarpus*, *Spirogyra*, and *Zygogonium*, produced under normal conditions of growth.

Mode of Attachment of Cladophora.†—M. F. Gay describes the mode of attachment to the substratum of two species of *Cladophora*, a character which he thinks will be useful in the discrimination of species. In *C. glomerata* the organ of attachment is a creeping "rhizome," consisting of short branches composed of short round or elliptical cells, each of which contains several nuclei. From this rhizome the erect branches spring in the ordinary way, and it puts out slender "rhizines" for further attachment. Containing a large quantity of starch, and often protected by a calcareous incrustation, this rhizome serves also for the perpetuation of the species during winter. *C. fracta* possesses a similar rhizome, from which, in the variety observed (forma *dimorpha*), there spring branches much more slender than the ordinary ones, which themselves branch, and, breaking off readily from the rhizome, form a floating mass of slender filaments which might readily be mistaken for a *Rhizoclonium*.

Pleiocarpous Species of Trentepohlia.‡—M. P. Hariot unites all the species of *Trentepohlia* characterized by a number of stalked zoosporanges springing from a single large cell, viz. *T. uncinata*, *pleiocarpa*, and *arborum*, into one, to which he restores the name *T. aurea*.

De-Toni's Sylloge Algarum.—The first part of the second volume of this most important work is just published, consisting of a complete and valuable Bibliography of the Diatomaceæ by M. J. Deby. The first volume (1889), devoted to the Chlorophyceæ, contains a description of every species of green Algæ at present recognized. These are arranged under 4 orders—the Confervoideæ, Siphoneæ, Protococcoideæ, and Conjugatæ, which are again divided into 25 families, viz.:—1, Coleochætaceæ, 2, Mycoideaceæ, 3, Œdogoniaceæ, 4, Cylindrocapsaceæ, 5, Sphæropleaceæ, 6, Ulvaceæ, 7, Ulotrichaceæ (Ulotricheæ, Chætophoreæ, Conferveæ), 8, Chroolepidaceæ, 9, Hansgirgiaceæ (*Hansgirgia flabelligera*), 10, Cladophoraceæ (Cladophoreæ, Spongocladieæ, Microdictyeæ, Anadyomeneæ, Valonieæ), 11, Pithophoraceæ, 12, Gomontiaceæ (*Gomontia polyrhiza*), 13, Vaucheriaceæ, 14, Dasycladaceæ (Dasycladeæ, Acetabularieæ), 15, Derbesiaceæ, 16, Bryopsidaceæ, 17, Caulerpaceæ, 18, Spongodiaceæ, 19, Udoteaceæ, 20, Hydrogastraceæ (*Botrydium granulatum*), 21, Phyllosiphonaceæ (*Phyllosiphon Arisari*), 22, Volvocaceæ (Volvoceæ, Spondylomoreæ, Hæmatococceæ, Cylindromonadeæ), 23, Palmellaceæ (Cœnobieæ, Pseudocœnobieæ, Eremobieæ, Tetrasporeæ, Dictyosphærieæ, Nephrocytieæ, Coccaceæ), 24, Zygnemaceæ (Mesocarpeæ, Zygnemeæ), 25, Desmidiaceæ. Of *Œdogonium* 189 species are enumerated, of *Cladophora* 229, of *Caulerpa* 80, of *Spirogyra* 81, of *Closterium* 103, of *Cosmarium* 308, of *Staurastrum* 250. A complete phycological bibliography is appended.

* CR. Soc. Roy. Bot. Belgique, 1891, pp. 35–9 (3 figs.).
† Journ. de Bot. (Morot), v. (1891) pp. 13–6 (3 figs.).
‡ T. c., pp. 77–8. Cf. this Journal, 1890, p. 490.

Fungi.

Influence of Light on the Growth of Fungi.*—According to Herr F. Elfving, the results of experiments on mould-fungi show that light has in general a prejudicial effect on synthesis, both the visible and the ultra-violet rays having this effect. With the same organisms, light diminishes respiration when they are young, but has no influence when they are mature.

Dispersion and Germination of the Spores of Fungi.†—Dr. M. C. Cooke doubts whether there is any actual evidence to support the prevalent theory that the spores of some fungi, such as those of the mushroom, must pass through the intestinal canal of an animal before they can germinate. On the other hand it seems clear that the fœtid odour of *Phallus impudicus* and of other Phalloidei does attract flies and other insects which are serviceable in the dissemination of the spores.

Carbohydrates in Fungi.‡—M. E. Bourquelot points out that, in order to obtain a knowledge of the saccharine matters contained in fungi, it is necessary to submit both old and young specimens to the action of boiling water. The author has nearly always succeeded in isolating trehalose. It is to be found, for instance, in *Boletus scaber*, *B. versipellis*, *B. aurantiacus*, *B. edulis*, and *Hypholoma fasciculare*. If the fungus is fairly advanced, mannite will be found at the same time, while in still older fungi only mannite is found. Another point the author mentions is that the sugar contained in young fungi does not reduce the cupro-potash solution, but it acts as a reducing agent when the fungus becomes old, or when it is dried at a low temperature.

Endotrophic Mycorhiza.§—M. P. A. Dangeard describes the fungi which are found in the cortical cells of the rhizome of *Tmesipteris Vieillardii*. They are of two kinds, a *Cladochytrium* and an Ascomycetous fungus. The former is a new species which the author names *C. Tmesipteridis*, distinguished by its well-developed brown torulose mycele producing a great number of sporanges and oosperms. The author believes that we have not here an example of true symbiosis, but that the fungus is parasitic on its host and injurious to it. The Ascomycetous fungus was undetermined, no peritheces being seen, but it is probably nearly allied to *Nectria*; this latter is probably truly symbiotic, and of advantage to its host.

Chætostylum.‖—M. A. de Wevre identifies Klein's *Bulbothamnidium elegans* with the *Chætostylum Fresenii* of Van Tieghem, a small fungus belonging to the Mucorini found on horse-dung. He regards *Chætostylum* as sufficiently distinct generically from *Thamnidium*. A second species proposed by Sorokine under the name *Chætostylum echinatum* is identical with *Thamnidium chætocladioides*.

* 'Studien üb. d. Einwirkung d. Lichtes auf d. Pilze,' Helsingfors, 1890, 5 pls. See Biol. Centralbl., xi. (1891) p. 163.

† Grevillea, xix. (1891) pp. 84–6.

‡ Bull. Soc. Mycol. de France, 1890. See Rev. Mycol., xiii. (1891) p. 43. Cf. this Journal, *ante*, p. 77.

§ Le Botaniste (Dangeard), ii. (1891) pp. 223–8 (1 pl.).

‖ CR. Soc. Roy. Bot. Belgique, 1891, pp. 40–4.

Mycele and Protospores of Sphærotheca Castagnei v. humilis and of Pleospora herbarum v. Galii aparinis.*—Dr. E. Lambotte states that the myceles of both the above species are composed of a large number of anastomosing hyphæ, the only difference being that in *Pleospora herbarum* the septa simulate chains of cells. The life-history of each fungus is carefully traced. In *Pleospora* we have, at the beginning of winter, the conidial condition (*Cladosporium herbarum*), then a little later *Phoma herbarum* shows itself, and it is towards the end of winter when the *Phoma* is at its point of greatest activity that *Pleospora herbarum* first appears.

"Taumel-getreide."†—Herr M. Woronin has investigated this disease, which attacks the corn-crops, especially rye, in parts of Russia, Sweden, and Germany, causing the grains to shrivel up and turn black, and finds evidence of the presence of no less than fifteen species of parasitic or saprophytic fungi. The injurious effects resembling intoxication, observed in men or cattle which have eaten the grains attacked by the disease, are probably due to one or other of the four following species:—*Fusarium roseum*, *Gibberella Saubenetii*, *Helminthosporium* sp., and *Cladosporium herbarum*.

Musk-fungus.‡—Prof. G. v. Lagerheim identifies the *Fusisporium moschatum* of Kitasato, distinguished by its musk-like odour, with *Selenosporium* or *Fusarium aquæductuum*. It not uncommonly forms slimy masses where there is a continual dripping of water. Imperfect peritheces having been found upon it, it is doubtless a stage in the cycle of development of an ascomycetous fungus.

New Vine-disease.§—M. P. Viala describes a disease which has of late years been very destructive to the vines in the south and south-west of France. It makes its appearance in the form of black nodules on the stem, which are sclerotes belonging to the form of *Peziza* known as *Sclerotinia Fuckeliana*.

Atichia.‖—This singular organism, which has been separated as a distinct genus of Collemaceæ, is classed by Herr A. Minks along with *Myriangium* ¶ as forming a class presenting none of the true characters of the Collemaceæ or gelatinous lichens, but belonging to the Ascomycetes, and recognized as true lichens by the possession of gonids.

Chlorodictyon foliosum and Ramalina reticulata.**—Prof. C. Cramer identifies *Chlorodictyon foliosum*, described by Agardh as belonging to the Caulerpeæ, with the lichen *Ramalina reticulata*. It is probably a marine form.

Arthonia.††—Mr. H. Willey publishes a monograph of this genus of Lichens, of which he enumerates 348 species, seven of them being new.

* Rev. Mycol., xiii. (1891) pp. 1-4.
† Bot. Ztg., xlix. (1891) pp. 81-93.
‡ Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 655-9 (6 figs.) Cf. this Journal, 1889, p. 560.
§ Rev. Gén. de Bot. (Bonnier), iii. (1891) pp. 145-9 (3 figs.).
‖ Bot. Centralbl., xlv. (1891) pp. 329-32, 362-5.
¶ Cf. this Journal, *ante*, p. 383.
** Ber. Schweiz. Bot. Gesell., 1891, pp. 100-23 (3 pls.).
†† 'A Synopsis of the genus *Arthonia*,' New Bedford, 1890, 62 pp. See Bot. Centralbl., xlvi. (1891) p. 98.

Both the diagnosis of the genus and the discrimination of the species are attended with great difficulties.

Black-rust of Cotton.*—Prof. G. F. Atkinson describes this disease, which is very destructive to the cotton-crop in Alabama. The diseased spots show the presence of a considerable number of fungi, but the parasite to which it appears to be chiefly due is *Cercospora gossypina*.

New Genus of Tubercularieæ.†—L'Abbé I. Bressadola diagnoses the new genus *Kriegeria* as follows:—Sporodochia subinnata, mox superficialia, tremellinea læte colorata; conidia clavato-cylindracea, e continuo pluriseptata, ex sporophoris simplicibus, stipitem constituentibus, oriundis, apice, et ad septa conidiola simplicia vel subfasciculata gerentibus; conidiola oblonga vel clavata, fertilia, scilicet conidiola ipsis conformia germinantia. Hyphæ myceliales e conidiis septatis oriundæ. The single species, *K. Eriophori*, was found on the leaves of *Eriophorum angustifolium*.

Urocystis Violæ and Ustilago antherarum.‡—M. E. Roze has found *Urocystis Violæ* parasitic on *Viola odorata*. It is very easily recognized by the swellings it forms on the leaves and petiole of its host. The author also makes some observations on *Ustilago antherarum* parasitic on *Lychnis dioica*.

Gymnosporangium.§—Dr. C. v. Tubeuf gives a *résumé* of the present state of our knowledge of the native German species of *Gymnosporangium*, both in their teleutospore- and in their æcidio-form; and especially defines the distinctive characters of *G. Sabinæ*, *G. clavariæforme*, and *G. tremelloides* (= *G. conicum* and *G. juniperinum*). The latter is far the most destructive parasite to its host the juniper. The æcidio-forms of all these three species occur on a number of different trees and shrubs, all belonging to the Rosaceæ.

The same author ‖ points out that the Uredineæ cannot be determined specifically by their *Roestelia*- or æcidio-form alone, as these frequently vary according to the host. Thus *Gymnosporangium tremelloides* produces on *Cratægus* æcidia with long horn-shaped, on *Sorbus latifolia* æcidia with very short peridia. The same species of tree may act as host for more than one teleutospore-species, as species of *Sorbus* for both *G. tremelloides* and *clavariæforme*.

New Anthracnose of Pepper.¶—Under the name *Colletotrichum nigrum*, Prof. B. D. Halsted describes a newly observed destructive parasite of the fruit of the pepper (*Capsicum annuum*), characterized by a large number of long straight black bristles which are found among the basids.

Sigmoideomyces, a new Genus of Hyphomycetes.**—Among a number of new North American fungi, belonging to the Hyphomycetes, Mr. R. Thaxter describes a new genus, *Sigmoideomyces*, with the

* Bot. Gazette, xvi. (1891) pp. 61–5. † Rev. Mycol., xiii. (1891) pp. 14–5.
‡ Bull. Soc. Bot. France, xxxvii. (1890) pp. 233–4 and xxxviii. (1891) pp. 69–71.
§ Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 89–98, 167–71 (3 figs.).
‖ SB. Bot. Ver. München, Feb. 11, 1891. See Bot. Centralbl., xlvi. (1891) p. 19.
¶ Bull. Torrey Bot. Club, xviii. (1891) pp. 14–5 (5 figs.).
** Bot. Gazette, xvi. (1891) pp. 14–26 (1 pl.).

following characters:—Fertile hyphæ erect, septate, growing in sigmoid curves, intricately branched, the main branches subdichotomous or falsely dichotomous, the ultimate branches sterile. Spores solitary, thick-walled, borne on the surface of spherical heads. Heads borne at the apex of short lateral branches which arise from opposite sides of certain cells in the continuity of the hyphæ.

Sclerote-forming Fungi.*—Herr E. Fischer describes various sclerotic formations of Fungi, and discusses their connection with the hymenomycetous fructification-form.

Pachyma Cocos is a widely distributed sclerote attached to the roots of trees, especially Conifers. The internal white substance of the sclerote consists of slender hyphæ and very strongly refringent, often branched, coral-like masses of various sizes. From their reaction towards chemical reagents, and by tracing the continuity of the hyphæ, Herr Fischer has determined that the hyphæ belong to the fungus and not to a modification of the woody structure of the host. *Pachyma* is a true parasite, exercising a destructive influence on its host. Its fructification-form is in all probability a *Polyporus*, but the species cannot at present be determined.

Polyporus sacer from Madagascar is a long-stalked species springing from a large and well-developed sclerote, which the author identifies with that described as *Pachyma Malaccense*, and has determined their genetic connection by tracing the continuity of the hyphæ from one to the other. This sclerote also contains strongly refringent bodies which are obviously a store of reserve food-material.

Several exotic species of *Lentinus* spring from sclerotes, known as *Tuber regium* and *Pachyma Woermanni*, on which they have been regarded by some as parasitic; the author has, however, traced a genetic connection between the two.

Mylitta, *Sclerotium stipitatum*, and *Pietra fungaja* are sclerote-like structures, the true nature of which it is impossible at present definitely to determine, from the want of material.

Prof. F. Cohn and Dr. J. Schroeter † describe the various forms of *Pachyma* and *Mylitta*, which they regard as sclerotes. From *Pachyma Woermanni* a hymenomycete-form was obtained described as *Lentinus Woermanni* sp. n., and from *Mylitta lapidescens*, from Japan and the West Indies, a fructification which also represents a new species, *Omphalia lapidescens*.

Sclerotoid Coprinus.‡—Messrs. J. B. Ellis and B. Everhart describe a species of *Coprinus* found growing on a sclerote. To this the name of *Coprinus sclerotigenus* has been given, it being sufficiently distinguished from other sclerotoid species of *Coprinus* by its habit, its few spores, and its stipe.

Mycodendron, a new Genus of Hymenomycetes.§—Mr. G. Massee describes a remarkable new genus of fungi from Madagascar, allied to *Merulius*, characterized by the stipe bearing a large number of super-

* Hedwigia, xxx. (1891) pp. 61–103 (8 pls.).
† Abhandl. Naturwiss. Ver. Hamburg, xi., 16 pp. and 1 pl. See Hedwigia, xxx. (1891) p. 117.
‡ Rev. Mycol., xiii. (1891) pp. 18–20.
§ Journ. of Bot., xxix. (1891) pp. 1–2 (1 pl.).

posed pilei. The following are the characters of the genus:—Stipe erect, central, elongate-conical, expanding at the base into an irregular disc; pilei several, imbricated on the stipe, distant, acropetal in development, circular or irregularly reniform, thin, sub-gelatinous; hymenium inferior, tuberculose or with sinuous nodulose ridges, showing a radial tendency of arrangement; basids tetrasporous; spores continuous, brown.

Protophyta.

a. Schizophyceæ.

Polycoccus.*—According to M. P. Hariot, this obscure genus of Algæ, founded by Kützing, which that author regarded as a stage of development of higher algæ, and which has been described as the algal constituent of several lichens, must be abolished. The plant described by Kützing is nothing but a minute species of *Nostoc*, indistinguishable from *N. punctiforme* Ktz. (*N. Hederulæ* B. & F.).

Movement and Reproduction of Diatoms.†—Sig. L. Macchiati gives his adhesion to the view that the power of movement of diatoms has its source in the contractility of an external "perifrustular" layer of protoplasm. This layer he has observed in diatoms belonging to the most various families,—Naviculaceæ, Cymbellaceæ, Gomphonemaceæ, Achnanthaceæ, Nitzschiaceæ, and Surirellaceæ.

Sig. Macchiati thus describes an example of conjugation observed in *Cymbella Cistula*. Two frustules approached and placed themselves opposite to one another by the slightly concave parts of the valves. They then began to excrete a large quantity of hyaline mucilaginous substance, which completely invested them in an ovoid mass. The chromatophores of the two frustules then collected in the centre of each, in the form of an ellipsoid body, which after a time divided into two spherical masses; these increased considerably in size, and eventually escaped from the valves. The four masses then fused together into two, and finally into a single globular body. This last inclosed itself in a double membrane and became a sporange, within which was developed an auxospore. This auxospore, increasing in size, burst the membrane of the sporange, and gradually assumed the form of a frustule of *Cymbella Cistula*.

A different mode of multiplication was observed in a specimen of *Hantzschia Amphioxys*. The protoplasm here divided itself into two ellipsoidal masses with numerous oily drops. These masses became inclosed with a cellulose wall while within the parent-frustule, afterwards escaping from it, after which the membranes became silicified. The parent-frustule was not invested with a mucilaginous envelope preparatory to the division, as in the case of conjugation.

Schmidt's Atlas der Diatomaceen-Kunde.—The most recently published part (Hefte 41 and 42) of this magnificent work consists of eight plates, containing representations of different views and different forms of species of *Aulacodiscus*, *Coscinodiscus*, *Porodiscus*, *Anthodiscus*, *Stephanopyxis*, *Craspedoporus*, and *Triceratium*.

* Journ. de Bot. (Morot), v. (1891) pp. 29-32.
† Nuov. Giorn. Bot. Ital., xxiii. (1891) pp. 175-84.

β. Schizomycetes.

Influence of the Digestive Secretions on Bacteria.* —Herr G. Leubuscher, in an experimental examination of the intestinal juice, the pancreatic secretion, and the bile, made use of typhoid bacillus, cholera bacillus, Finkler-Prior's bacillus, potato bacillus, anthrax, *Bacterium coli commune*, *Proteus vulgaris*, *Bacillus acidi tartarici*, *B. butyricus*, *Saccharomyces cerevisiæ* and *ellipsoideus*.

In the secretion from the small intestine a diminution was first remarked, but this was soon followed by an enormous increase. The micro-organisms seemed to thrive better in the juice of the jejunum than in that from the ileum.

Trypsin solutions formed still better media for the cultivation of these organisms. In fresh bile some of the microbes flourished, but others did badly; among these latter were *B. butyricus* and the Saccharomycetes. Solutions of the biliary acids, however, possessed a decidedly inhibitory action, except for anthrax, the spores of which germinated.

From his experiments the author concludes that in the intestinal and pancreatic juices bacteria of the most various sorts thrive extraordinarily well, and that digestive ferments have no influence over living organisms. Fresh bile is devoid of antiseptic property, yet the free biliary acids possess a disinfecting power; and the old view of the antiseptic action of the bile would therefore hold good, provided conditions were present which rendered it possible for these acids to exist in a free state.

Presence of Bacteria in normal Vegetable Tissue.†—The experiments of Bernheim, which led that investigator to conclude that the presence of bacteria in vegetable tissue was a normal phenomenon, have been repeated by Buchner. This author failed to find bacteria under similar circumstances, except where there had been an accidental contamination.

On the only occasion on which a particle of matter (within a maize-grain) was found to increase in size, it was not composed of bacteria but of oil.

Bacillus hydrophilus fuscus.‡—This pathogenic micro-organism was isolated by Dr. G. Sanarelli from the laboratory water used for keeping frogs intended for experiments on immunity. The mortality among the frogs was found after a time to be constantly associated with the presence of a bacillus in the serum used for experimenting with the anthrax bacilli.

Grown on artificial nutrient media, this micro-organism was found to thrive well, especially on gelatin and meat-broth, but potato cultivations presented very characteristic appearances. Hereon the inoculation track in twelve hours presented an overlay of a straw-yellow colour, which in four to five days became brown. Gelatin was liquefied,

* Zeitschr. f. Klin. Medicin, xvii. (1890) No. 5. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 244–5.

† SB. Gesell. Morphol. Physiol. München, iv. (1889) pp. 127–30. See Beihefte z. Bot. Centralbl., 1891, pp. 15-16.

‡ Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) p. 193 (1 pl.)

the softened portion having a funnel-shaped appearance. When grown in glycerin-agar the bacilli presented a fairly constant form, mobile rodlets 1–3 μ long being the predominant variety, while on gelatin they were inconstant in appearance, varying from spheroidal forms to filaments 12 to 20 μ long, although 2 to 3 μ was the most frequent length.

Inoculation experiments with pure cultivations of this bacillus showed that it was pathogenic to cold and warm-blooded animals, such as frog, toad, salamander, lizard, eel, guinea-pig, rabbit, dog, cat, mice, bat, hedgehog, pigeon, and fowl.

From the rapid action of the injections on animals, the author supposed that the metabolic products of these bacilli were endowed with some specially toxic properties, yet he admits that the intravenous and subcutaneous injections of fluid obtained by filtering broth and gelatin cultivations through a Chamberland's filter failed to bear out his assumption. The author next notices the points of difference between this bacillus (*B. hydrophilus fuscus*) and that described by Ernst, *B. ranicida*, a form connected with an epidemic disorder to which frogs are liable in spring.

Variability of the Red Bacillus of Kiel Water.*—M. Laurent succeeded in depriving the Kiel water bacillus of its red pigment by exposing it to the action of sunlight, and the alteration thus induced was found to be constant, lasting for generations. This pigment is soluble in water and alcohol, less so in benzin, and insoluble in chloroform and sulphuric acid. In the presence of small quantities of acid the red pigment assumes a brighter hue, while alkalies have the contrary effect. The bacillus thrives between 10° and 42°, but the optimum temperature is from 30° to 35°. If air be excluded development may proceed, but without the formation of pigment.

Acid reaction of the medium (1 per thousand free tartaric acid) prevents development, the bacillus itself, in the presence of sugar, forming no inconsiderable quantity of acid, which eventually stops its growth. Before this has taken place the production of pigment has ceased, although a very feeble acid reaction seems to impart a more lively hue to the pigment. The temperature and the presence of carbonic acid have some determining influence on the shade of the pigment.

To light the bacillus is extremely sensitive ; exposure for three hours to sunlight falling vertically caused the large majority of the colonies to be quite colourless, a condition which was retained by successive generations. Exposure for one hour had only a transitory effect, while five hours killed the colonies. Control experiments made with cultivations from which air was excluded, or in atmospheres of hydrogen or carbonic acid, showed that the alterative effect of the sun's rays was only evinced in co-operation with air.

Differences in the action of the component rays of the spectrum were not made out.

The colourless generations obtained by exposure to light retained their condition up to the thirty-second transference on potato at from

* Annales de l'Institut Pasteur, 1890, p. 465. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 105–6.

25°–35°, while before this they had constantly shown a violet-red colour under these circumstances.

Alteration in the kind and character of the medium had no effect in recalling the pigment, but the red colour was found to return on potato at 10° to 25°, but was lost again if further cultivations were made at higher temperatures.

Pseudotuberculosis produced by a pathogenic Cladothrix.*—Herr H. Eppinger found in an old glass-grinder who had died of cerebro-spinal meningitis, consecutive to a chronic metastatic abscess of the brain, and in whom were also present lymphatic abscesses and pseudo-tuberculosis of the lungs and pleura, that a hitherto unknown pathogenic cladothrix was the cause of the first-mentioned disease. Cultivated on artificial media it presented its characteristic appearances, and on account of its stellate form the author designates it *Cladothrix asteroidea.* In guinea-pigs and rabbits the pseudotuberculosis cladothrichica was produced, and from their morbid products pure cultivations of *Cladothrix asteroidea* were obtained.

Effect of the Koch Treatment on the Tubercle Bacilli in Sputum.†—Dr. J. Amann records the results of his experience of the effects of the Koch injection treatment from the examination of the sputa of 288 patients.

(1) The quantity of sputa is as a rule increased after the reaction.

(2) The number of the tubercle bacilli considerably increased. In seventeen cases where numerous examinations had previously failed to reveal the presence of bacilli, the sputum was afterwards found to contain the tubercle bacillus. In four patients the number of bacilli was obviously diminished.

(3) The medium exerts an unmistakable influence on the shape of the bacillus. By this the author means that the bacilli are changed into micrococci, or are seen as shapeless lumps of quite short, often punctiform bacilli.

(4) In certain cases their specific resistance to decolorizing reagents is diminished.

(5) In forty per cent. of the cases the quantity of elastic fibres found in the sputum is markedly increased.

Spongy Cheese.‡—Dr. E. de Freudenreich gives the name of *Bacillus Schafferi* to a micro-organism which he has found to be the exciting cause of the swelling of cheese. The swelling is due to a large number of holes of variable size, and these holes are formed by the gaseous products of colonies of bacilli, whereby the cheese becomes larger, soft, and spongy (boursouflement, fromage mille trous). The bacillus is about 1 μ broad, and in length varies from 2–3 μ, although filaments of 20–25 μ were observed. It is extremely mobile, stains well with anilin dyes, and is easily cultivated on gelatin, agar, potato, and bouillon. It is somewhat sensitive to heat, desiccation, and antiseptics. It grows well in the absence of air, and in the presence of hydrogen,

* Ziegler's Beiträge zur Path. Anat. u. zur Allgem. Pathol., ix., No. 2. See Centralbl. f. Bakteriol u. Parasitenk., ix. (1891) p. 274.

† Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 1–3.

‡ Ann. de Microgr., iii. (1891) pp. 161–77 (1 pl.).

with copious evolution of carbonic acid gas, probably the result of its action on the sugar of milk. The optimum temperature is 36°. *Bacillus Schafferi* appears to possess several characteristics common to other bacteria, notably to *B. coli commune* Escherich, but is distinguishable therefrom by differences in mobility, pathogenic action, and capacity for existing in absence of air.

The action of this bacillus was tested on newly made cheeses, and the results seem sufficient to support the author's view, since the inoculated cheeses became spongy, while those kept as control specimens remained healthy. The milk was inoculated at the same time as the rennet was added.

New Bacillus in Bees.*—Sig. G. Canestrini describes a new bacillus the occurrence of which is associated with great mortality in bee-broods. He thought at first that he would find the *Bacillus alvei* already described by several bacteriologists, but the new species is entirely different. Thus it forms a wine-red spot when cultivated on the potato, becomes encapsuled in blood-serum, and produces no pathological effects on the rat and guinea-pig inoculated with it.

Fraenkel and Pfeiffer's Microphotographic Atlas of Bacteriology.†—Parts 6–10 of this Atlas have now appeared. These numbers comprise plates XXVII.–LI., and the explanatory text. The micro-organisms dealt with in Parts 6–8 are those of malignant œdema, tetanus, symptomatic anthrax, tubercle, leprosy, syphilis, glanders, and diphtheria.

Anti-bacterial Properties of the Gastric Juice.‡—Dr. R. Kianowsky, from a series of careful experiments, finds that the fasting stomach (14–18 hours after the last meal) contains numerous microbes. The number of bacteria colonies which can be obtained an hour after a meal appears to have no relation to the acidity or to the amount of hydrochloric acid; it depends directly on the quantity of microbes contained in the food.

With a moderate amount of acidity and moderate quantity of hydrochloric acid the gastric juice keeps killing off the micro-organisms in the stomach; in other words, the more the microbes are annihilated, the longer the gastric juice works. A strict ratio between the increase of the acidity of the gastric juice and the disappearance of the microbes does not exist. If the acidity of the gastric contents be very slight, the microbes increase in number.

Experiments on the sick whose gastric juice still contains a sufficient quantity of free acid show that their gastric juice possesses anti-bacterial qualities similar to those of healthy men.

New Bacillus from the Small Intestine.§—Dr. V. Boret describes a bacillus which was isolated from the small intestine of a patient dying of acute enteritis. The bacillus is from 2–4 μ long, and from 1–1·5 μ broad, usually single and occasionally in pairs; it is extremely mobile. It was best stained with phenolfuchsin, and also with safranin or

* Atti Soc. Ven.-Trent. Sci. Nat., xii. (1891) pp. 134–7 (1 pl.).

† 'Mikrophotographischer Atlas der Bakterienkunde,' Berlin, 1890, 91. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 204–5, 507–8.

‡ Wratsch, 1890, Nos. 38–41. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 420–1.

§ Ann. de Microgr., iii. (1891) pp. 353–8.

Bismarck-brown. It grows well in peptonized agar, in gelatin, in bouillon, in solutions of sugar, and on potato. The most favourable temperature was about 37° C.

The microbe does not liquefy the medium nor develope spores. It is essentially aerobic. It has little or no action on albumen, and though it will develope on starch, does not saccharize this substance. It decomposes sugar, forming carbonic acid, lactic acid, succinic acid, and alcohol. It does not possess apparently any specific pathogenic action.

Pathogenic Bacillus obtained from Floor-dust.*—Dr. Okada has isolated from dust from the floor a bacillus endowed with pathogenic properties. It grows in the usual media at ordinary temperatures in whitish colonies somewhat like the bacillus of typhoid. Examined microscopically it is found to be a short rod with rounded ends, about twice as long as broad. It was stainable with the ordinary anilin pigments, but Gram's method failed. The bacillus is immobile, and spore-formation was not observed. Inoculations in rabbits, guinea-pigs, and mice were made. The most marked post mortem appearance was the great swelling of the lymphatic glands and of the spleen. The micro-organisms were found, by means of the Microscope, in all the organs.

The author conceives that this bacillus resembles those described by Emmerich and by Brieger, but is not identical therewith, since the two latter grow well on potato, while the former does not.

Baumgarten's Report on Micro-organisms.†—Dr. P. Baumgarten's Annual of Pathogenic Micro-organisms, which embraces Bacteria, Fungi, and Protozoa, has recently been published. The present volume deals with the year 1889, and contains 632 pages. It presents similar features to the previous volumes.

Action of Light on Acetic Fermentation.‡—Sig. M. Giunti finds that direct sunlight prevents the development of *Mycoderma aceti*, and therefore of the acetic fermentation. Even diffuse daylight possesses an inhibitory influence if the surface of the fluid be not shaded. Prolonged exposure to the sunlight, however, is not sufficient to sterilize the fluid.

Bacteria in Sputum.§—Dr. S. Panzini's examination of sputum was conducted at three different times. It was examined directly by different microscopical methods; it was inoculated in animals. Pure cultivations of the various organisms were made.

Besides the microbes already known, the author isolated a new organism, *Bacillus tenuis sputigenus*. This is a diplococcus or diplobacillus which stains by Gram's method, grows on gelatin at the ordinary temperature, spreading out flat on the surface of the medium, and in this differing from Friedlaender's bacillus, which forms a distinct swelling. It grows well on potato, and coagulates milk with formation

* Centralbl. f. Bacteriol. u. Parasitenk., ix. (1890) pp. 442–4.

† Baumgarten's Annual Report on Pathogenic Micro-organisms, 5th year, 1889, Brunswick, 1890, 8vo, pp. 632. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) p. 605.

‡ Le Stazioni Sperimt. Agrar. Ital., xviii. p. 171. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 539–40.

§ Virchow's Archiv, cxxii. (1890). See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 566–9.

of acid. It is pathogenic to rabbits and white rats, but not to guinea-pigs (in small doses), nor to white mice.

Plate-cultivations were made from sputum of 52 different cases, and it is important to note that in all these instances there developed colonies indistinguishable from those of the Fraenkel-Weichselbaum pneumococcus, but which should be classed with that large family of cocci inhabiting the mucosa, the most important representative of which is the diplococcus of pneumonia.

Besides these mucosa-cocci the author describes 21 kinds of bacilli, 10 kinds of cocci, and 3 fungi.

Bacteria and their Products.*—This volume of about 400 pages, which are followed by an appendix giving a short account of the bacteriological methods and a diagnostic description of the commoner bacteria, and illustrated by twenty photomicrographs, is described by the author, Dr. G. S. Woodhead, as "an attempt to give some account of the main facts of bacteriology and of the life-history of bacteria," with special reference to fermentation, putrefaction, and disease.

From a careful perusal of the work we can recommend it very heartily to all who are desirous of learning the principles of bacteriology and ascertaining the facts on which these principles are founded. The style is extremely clear and easy of understanding.

If any exception can be taken to the book, it is the illustrations. Photomicrographs, unless very good indeed, are, in our opinion, very bad for teaching purposes.

Billroth, Dr. Th.—**Ueber die Einwirkungen lebender Pflanzen u. Thierzellen auf einander.** (On the Reciprocal Action of living Animal and Vegetable Cells.)
Vienna, Alfred Hölder, 1890, 43 pp.

Burgi, Dr. Einrigo.—**Contributo alla conoscenza dei caratteri biologichi e patogeni del Bacillus pyogenes fœtidus.** (Contribution to our knowledge of the Biological and Pathogenic Characters of *Bacillus pyog. fœtidus.*)
Pisa, Mariotti, 40 pp.

Charrin, A.—**Toxicité du sérum.** (Toxicity of Serum.)
Compt. Rend. de la Soc. de Biol., 1890, pp. 695–6.

Fokker, A.-P.—**Ueber backterienvernichtende Eigenschaften der Milch.** (On the Bactericidal Properties of Milk.) *Zeitschrift für Hygiene*, IX. p. 89.

Kirchner, M.—**Die Bedeutung der Bakteriologie für die öffentliche Gesundheitspflege.** (The importance of Bacteriology in Public Hygiene.)
(*Berliner Klinik*, 33 Heft.)
Berlin, Fischer's Med. Buchh., 1891, large 8vo, 36 pp.

Laurent, E.—**Expériences sur la réduction des nitrates par les végétaux.** (Experiments on the Reduction of Nitrates by Plants.)
Annal. de l'Instit. Pasteur, 1890, No. 11, pp. 722–44.

Laveran, —.—**Au sujet des altérations des globules rouges du sang qui peuvent être confondues avec les hématozoaires du paludisme.** (On the Alterations of Red Blood-corpuscles which can be confused with the Hæmatozoa of Marsh Fevers.) *Compt. Rend. de la Soc. de Biol.*, 1890, No. 39, pp. 733–5.

Müller-Thurgau, H.—**Ueber den Ursprung der Weinhefe.** (On the Origin of Wine-ferment.) *Weinbau und Weinhandel*, 1889, Nos. 40 & 41.

Phisalix, G.—**Étude expérimentale du rôle attribu aux cellules lymphatiques dans la protection de l'organisme contre l'invasion du Bacillus anthracis et dans l'immunité acquise.** (Experimental study of the part attributed to lymphatic cells in the protection of the organism against the invasion of *Bacillus anthracis* and in acquired immunity.) *Compt. Rend. de l'Acad. des Sciences*, CXI. p. 685.

* Contemporary Science Series, London, Walter Scott, 1891.

SMITH, DR. THEOBALD.—**Einige Bemerkungen über Säure u. Alkalibildung bei Bakterien.** (Some Remarks on the Production of Acids and Alkalies in Bacteria.) *Centralbl. f. Bakteriol. u. Parasitenk.*, VIII. p. 389.

TISSIER, P.—**Des moyens de résistance de l'organisme contre les infections—De la phagocytose.** (On the methods of resistance of the organism against Infection—of Phagocytosis.) *Annal. de Méd.*, 1891, pp. 73–5.

TRENKMAN, DR.—**Die Färbung der Geisseln von Spirillen u. Bacillen.** (The Coloration of the Flagella of Spirilla and Bacilli.) *Centralbl. f. Bakteriol. u. Parasitenk.*, VIII. p. 386.

VAUGHAN, V. C.—A new Poison in Cheese. *Med. and Surg. Reporter*, II. (1890) No. 21, pp. 584–5.

ZEIDLER, A.—**Beiträge zur Kenntniss einiger in Würze und Bier vorkommender Bakterien.** (Contributions to the Knowledge of some of the Bacteria present in Wort and Beer.) *Wochenschr. f. Brauerei*, 1890, Nos. 47, 48, pp. 1213–15, 1237–40.

ZÜLZER, W.—**Ueber ein Alkaloid der Tuberkelbacillen.** (On an Alkaloid of Tubercle-bacilli.) *Berlin. Klin. Wochenschr.*, 1891, p. 98.

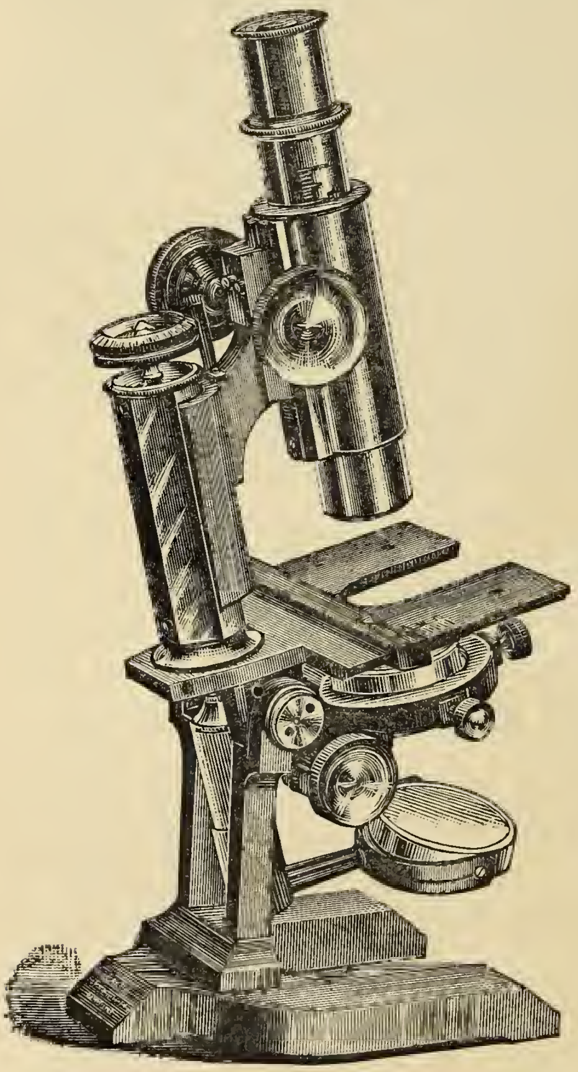
MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Baker's Student's Microscope.—We give a figure (fig. 53) of the Student's Microscope lately made by Messrs. Baker, to which Mr. E. M. Nelson called attention at the March meeting.†

Fig. 53.



Zeiss's Crystallographic and Petrographical Microscopes.‡—Dr. S. Czapski describes the three latest forms of the Zeiss petrographical model.

The base of the large model (fig. 54) is of the usual horseshoe form. The body-tube, &c., can be inclined and clamped in any position down to the horizontal. The illuminating apparatus, which is movable by rack and pinion, consists of the condenser and the diaphragm and polarizer holder.

The condenser has a numerical aperture of 1·4 and is movable in a socket, so that it can be easily removed and replaced by other illuminating arrangements, such as

(1) The achromatic condenser, or the special achromatic illuminating apparatus for photomicrography, by which a sharp image of the source of light is projected on the plane of the object.

(2) The Hartnack illuminating apparatus, for monochromatic light.

(3) The Engelmann microspectral objective.

(4) The spectro-polarizer of Rollet.

The polarizer holder carries the iris-diaphragm next to the condenser, and has the nicol P beneath. It is rotated by rack and pinion R, and the positions of 0°, 90°, and 180° are marked by a stop. To convert from polarized to ordinary light, the holder is simply pivoted aside (as represented in fig. 55).

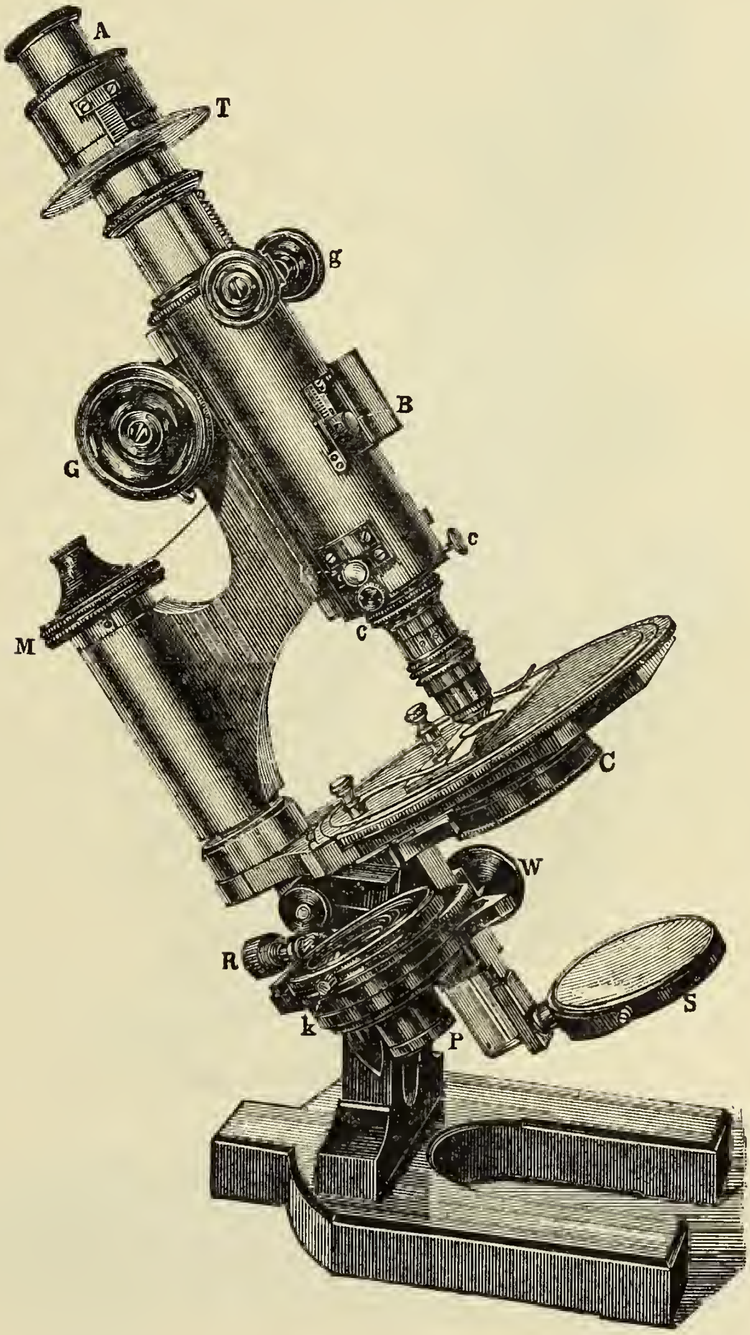
* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† See *ante*, p. 298.

‡ Zeitschr. f. Instrumentenk., xi. (1891) pp. 94–9 (3 figs.).

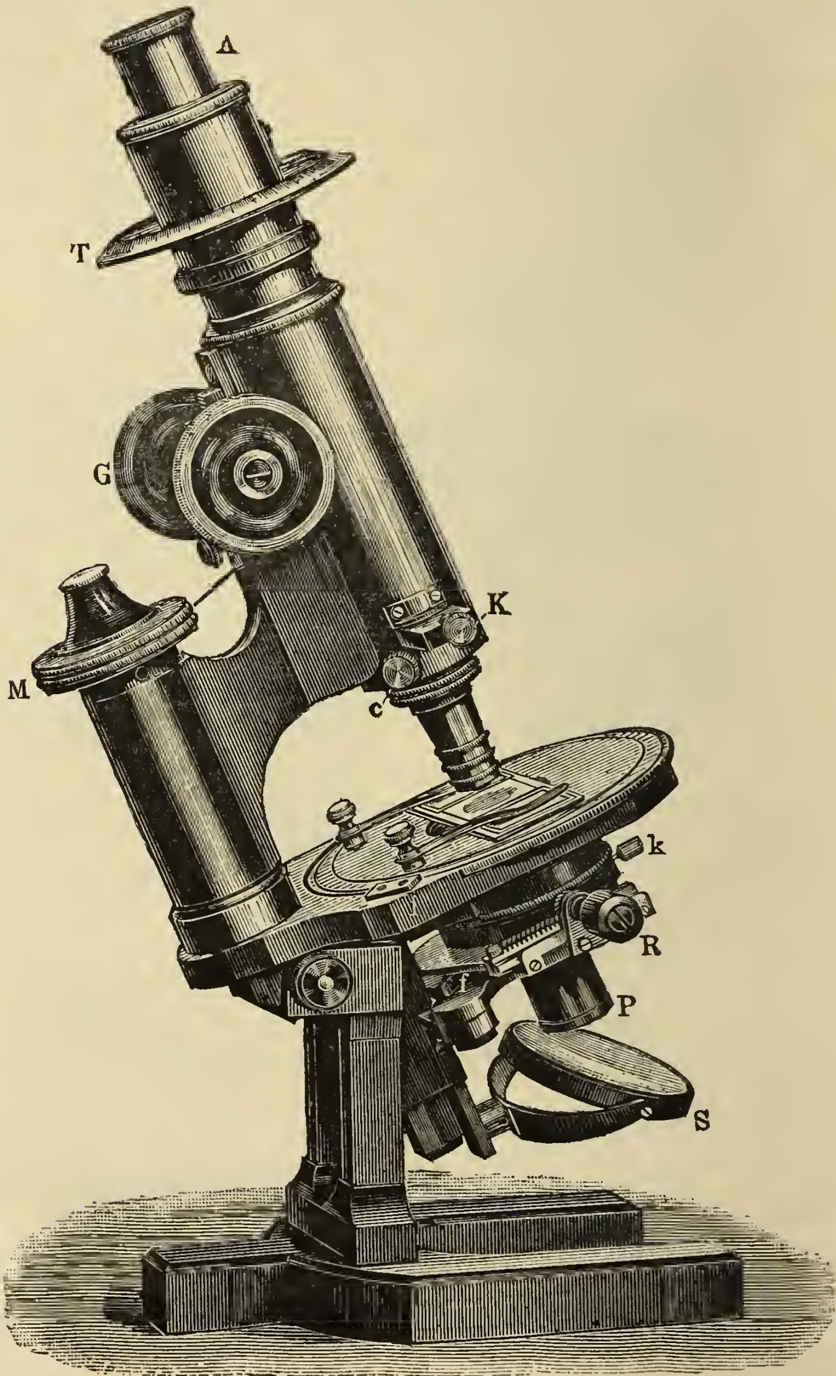
The circular stage, graduated in degrees, is about 120 mm. in diameter, and is rotated by hand. For the orientation of the object, it is provided with a millimetre scale (100 mm.) along two diameters at right angles, and the diameters inclined to these at 45° are also provided with a division. The upper part of the stand is of the same form as in other

FIG. 54.



Zeiss models. The lower part of the body-tube has a centering arrangement *c c* provided with the Society screw. Near the end of the tube is a side opening in which slides a frame by means of the knob K. In the frame are two apertures side by side, one of which serves for the reception of a quartz plate, quarter-wave plate, &c., while the other usually remains empty, but may be used to receive a second plate. The draw-tube is movable in the body-tube by rack and pinion *g*, and has a millimetre division giving the total tube-length. The eye-piece, which is provided with cross wires, is placed in the draw-tube from above. Above the eye-piece the analyser A (Hartnack-Prazmowski prism) is

Fig. 55.



applied, the mounting of which carries an index showing the orientation of the analyser on the divided circle T.

For observing the optic axial figures in convergent light, an Amici auxiliary objective can be applied by the knob B through an opening in the outer tube, and fitted into a slot at the lower end of the draw-tube.

The eye-piece forms with this objective an observing Microscope, which can be adjusted on the optic axial figure by means of the rack and pinion of the draw-tube.

Fig. 55 shows the medium size model which is generally similar to the preceding. It differs from it only in being of smaller size, and in having no Amici auxiliary objective. Instead it is arranged for the "axial image eye-piece," and consequently has no draw-tube.

The small model is of the English tripod form. The polarizer and condenser of aperture 1·0 are fastened in one socket, and can be rotated by an arm. When drawn down in the socket a few millimetres, so that the condensing lens comes beneath the stage-plate, they can be shifted to one side by a lever. The stage is movable, and is provided with a divided circle. The body-tube can only be moved by rack and pinion, but the mechanism is sufficiently rigid to allow of the use of objectives, up to a focal length of 4 mm. At the upper end of the tube is a divided circle for the analyser, and at the lower end are the centering arrangement and the slit for the Biot-Klein quartz plate.

(2) Eye-pieces and Objectives.

New Objective Changer.*—The firm of Klönne and Müller have recently brought out an apparatus which is intended for the rapid and easy substitution of objectives. The apparatus is constructed something like a pair of pincers, the upper limb of which screws on by means of an arrangement like that of the ordinary revolver nose-piece to the Microscope-tube. From the under side of this upper limb a conical piece, which is encircled by the adapter-ring screwed on to the objective, projects downwards.

The two limbs of the apparatus are kept firmly together by means of a spring. In order to insert or change an objective it is merely necessary to press the limbs together and then put the objective into the half-collar of the lower limb.

The apparatus can be used in any position of the Microscope, and can be fitted with a centering arrangement.

(3) Illuminating and other Apparatus.

On a new arrangement in Microscopes for the rapid change from parallel to convergent light.†—Herr R. Brunnée, of the firm of Voigt

Fig. 56.

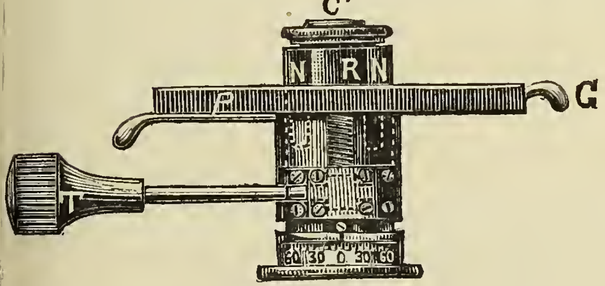
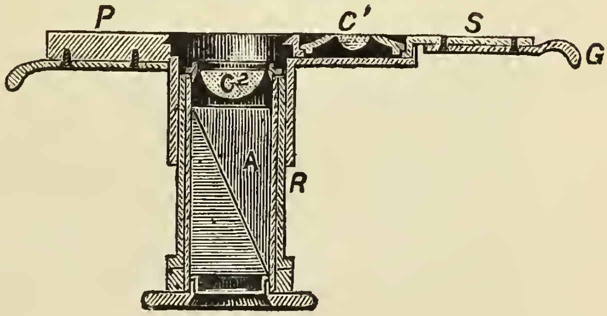


Fig. 57.



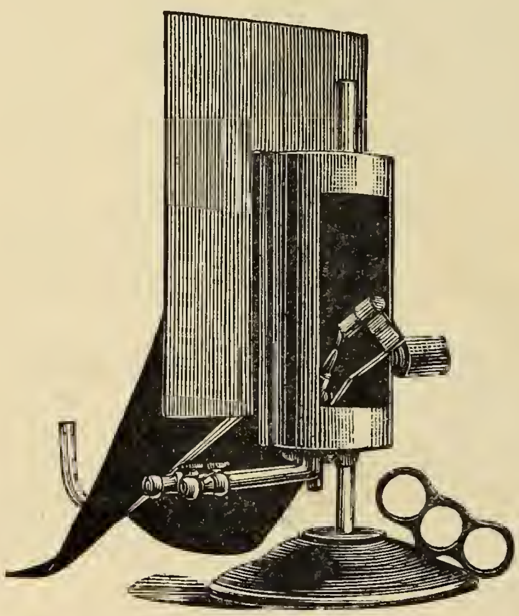
and Hochgesang, in Göttingen, has devised a method for the rapid change from parallel to convergent light, which he claims to be superior

* Central-Ztg. f. Optik u. Mech., xii. (1891) p. 46 (1 fig.).
† Zeitschr. f. Instrumentenk., xi. (1891) p. 136.

in simplicity and convenience of use to any other. In the plate P (figs. 56 and 57), by which the polarizer is connected with the instrument, is a slide S′, which, as soon as the tube R is lowered by the pinion T, has the effect of raising the lens C′ from the lens C^2. A pull on the arm G is then sufficient to move the lens C′ to one side into a depression in the plate P, and the polarizer, thus left only provided with the lens C^2, can be again adjusted in height and used for parallel light. To change again to convergent light, the tube R is lowered and the slide S pushed in, when the two lenses will again be connected together by means of the conical piece of the lens-holder C^3. To assure the correct position of the lens C′ in the ring of the slide S, the tube R is provided with four slots, in which fit four corresponding projecting pieces in the ring.

Kochs-Wolz Improved Microscope Lamp.* — The modifications introduced into the Kochs-Wolz lamp † are declared by Prof. P. Schiefferdecker, who describes the improvements, to make it an ideal lamp for microscopical purposes. The principal deviation from the original consists in a different form and method of illumination. In the present lamp a cylinder of zirconium is rendered incandescent by the combined action of an oxygen and coal-gas flame. The essential parts are fixed to a stand consisting of a heavy base supplied with a grip-handle and a vertical upright M S (fig. 59), up and down which they may be moved by means of a rack-work, the milled head of which is seen at S S. Within the metal case M C is fixed the zirconium cylinder L K, against the middle of which plays the flame from the burner B. The burner is connected with two tubes S *r* and G *r*, through which the coal and oxygen gases pass. Both these tubes can be stopped off by the cocks S *h* G *h*. The glass rod G is fixed in a tube-like prolongation on the front of the metal case M C, its inner end lying overagainst the zirconium cylinder, while its outer end, bent to a convenient curve, lies underneath the diaphragm of the Microscope. In order to intercept any heat or light from the lamp, a blackened screen S*ch* is placed in front, and from the lower end of this a dark cloth T hangs down over the glass rod. The correction glasses are cemented on to the outer end of the rod. To set the apparatus going the gas-jet is turned full on, lighted, and then the oxygen-tap turned on until the flame just hisses. When the zirconium is white hot, the tap is turned down carefully till the hissing ceases.

Fig. 58.

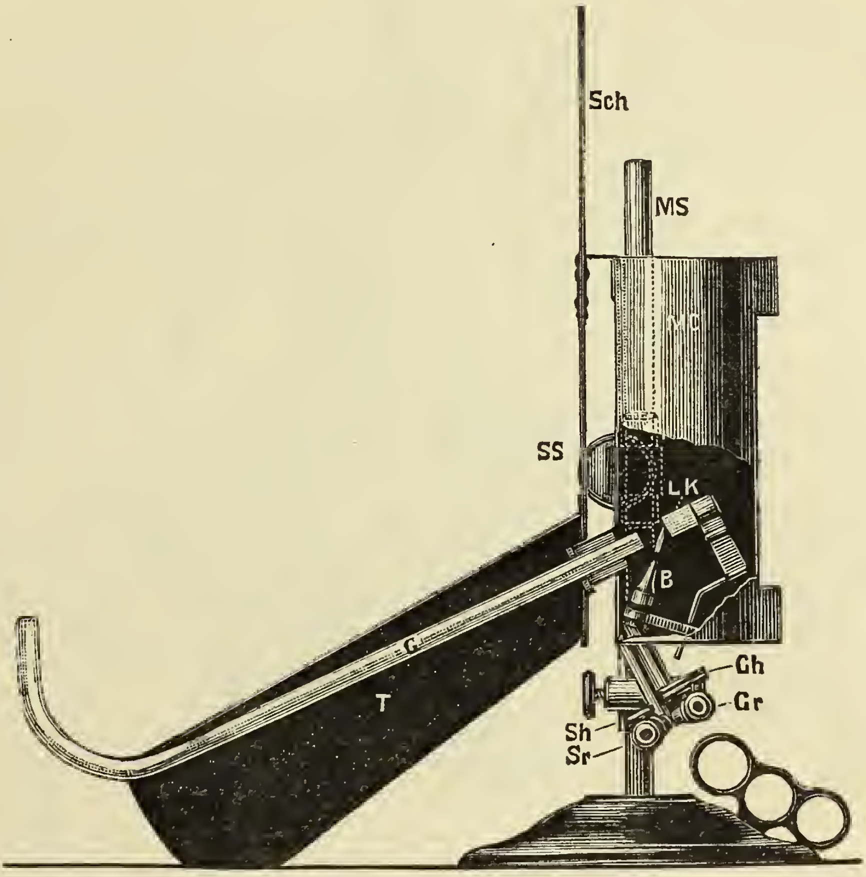


* Zeitschr. f. Wiss. Mikr., vii. (1891) pp. 450–7 (2 figs.).
† See this Journal, 1889, p. 126.

One of the chief advantages of this lamp is the facility with which the intensity of the light is graduated, an advantage which, coupled with the fact that it preserves the natural colours of pigments, renders it even superior to daylight.

If this lamp is to be used in conjunction with an Abbe condenser, then instead of the curved glass rod a straight and very thick one is used. The outer end is adjusted about 9–10 cm. from the centre of the concave mirror, so that the light may fall on the very middle—a procedure much easier in practice than might be expected.

FIG. 59.



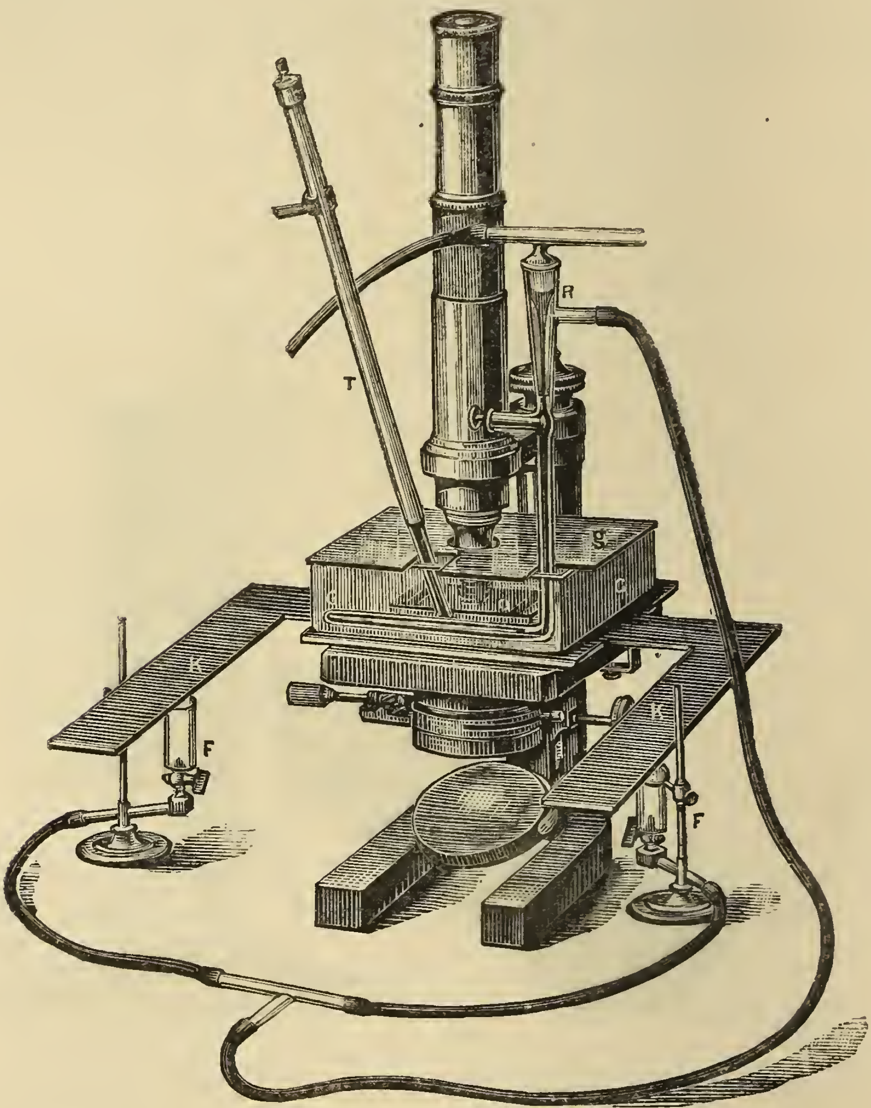
In a further communication * Prof. P. Schiefferdecker adds that the zircon cylinders have lately been rendered so much more durable that no cracking need be feared. It is advisable to use no more light than is absolutely necessary, otherwise the images are less well defined and the eye becomes fatigued. The glass rod should not be placed immediately beneath the diaphragm opening, but somewhat lower; and this is especially necessary when delicate colourless objects are under examination. Finally, new tubing should not be used for conveying the gas, since the dust which it usually contains will have the effect of partially stopping up the burner.

New Hot Stage and Accessories.†—Prof. W. Pfeffer describes a hot stage which keeps the temperature of the object and its environment

* Central-Ztg. f. Optik u. Mechanik, xii. (1891) p. 137.
† Zeitschr. f. Wiss. Mikr., vii. (1891) pp. 433–42 (4 figs.)

more constant than the ordinary apparatus. The general arrangement of the whole may be gathered from figs. 60 and 61. The water receiver is a rectangular box about 110 mm. long, 70 mm. broad, and 35 mm. high, and covered over with a glass plate *g*, perforated with three apertures for the Microscope, thermometer, and regulator. In this is placed

Fig. 60.

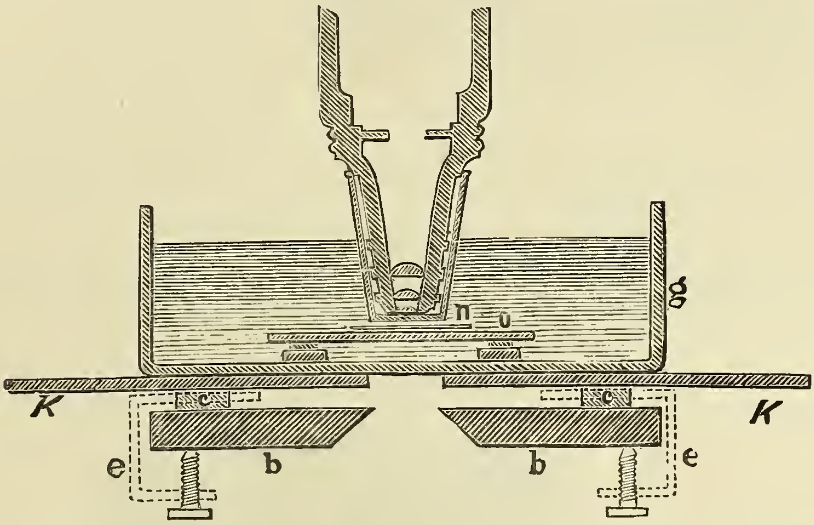


General arrangement of the apparatus when in working order.

the slide *o*, raised above the bottom from 4 to 8 mm. by strips of glass. The water is warmed by means of a copper plate *k*, heated by gas-jets *f*, the flame of which is regulated by a Stricker's regulator *r*. The pieces of vulcanite *c*, fig. 61, upon which the copper plate rests, are 3–4 mm. high, and are fixed on to the stage by the screw-clamps *e*. The thermometer *t* and the regulator *r* are kept in position by means of a stand (not shown in the illustration) to which they are clamped.

The light from the mirror is made to pass through a circular aperture in the copper plate, and then through the bottom of the glass trough on to the object. The bottom of the trough at this part is polished on both sides. For observing the object a water-immersion lens is be most appropriate and convenient, but if a dry lens is to be used then the objective is surrounded by a conical glass or metal case *n*, fig. 61, to the end of which a cover-glass is cemented on. The case is adjusted to the objective by packing it on with cotton-wool. For

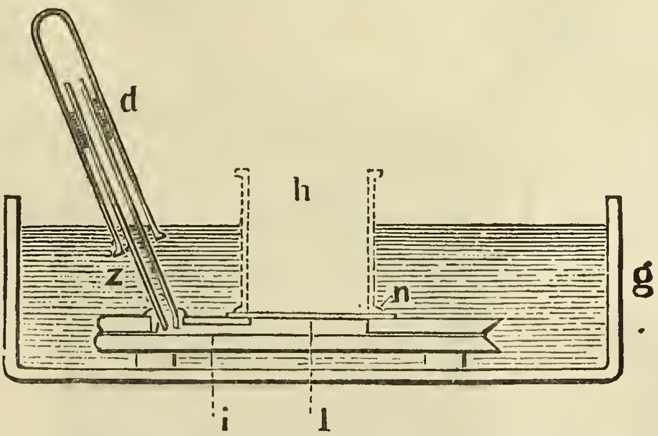
FIG. 61.



Vertical section through the objective, the water vessel *g*, the slide *o*, copper plate *k*, and Microscope-stage *b*. At *e* are shown the clamps, but these really lie in a different plane. About two-thirds natural size.

constructing an air-chamber suitable for most purposes, the author uses a couple of slides with central circular apertures. When these two slides are fixed or cemented together, and closed in above and below with a cover-glass, a fairly large air-chamber is obtained. If renewal of

FIG. 62.

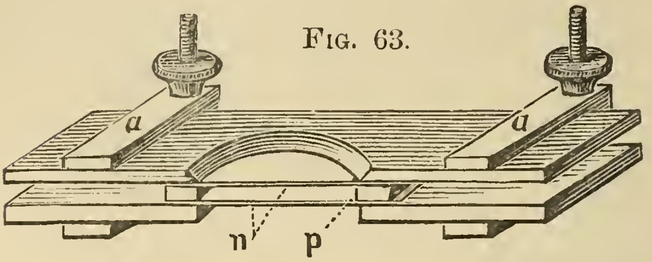


Vertical section through the water-vessel, as in fig. 61, showing the moist chamber with air-passage through *z*. The glass tube *b*, drawn in dotted line, is only used when the object is to be inspected through air. About two-thirds natural size.

the air be required, this is obtained in the manner depicted in fig. 62. A glass tube *z* communicates with the air-chamber by means of a passage *i* ground out of the uppermost slide. The tube is protected by inverting over it a test-tube.

The examination-chamber may be made of variable sizes by the method shown in fig. 63. Two cover-glasses separated by caoutchouc rings are fixed together by nickel plates with central circular apertures, and these plates are kept in position by the clamps *a*.

Fig. 63.

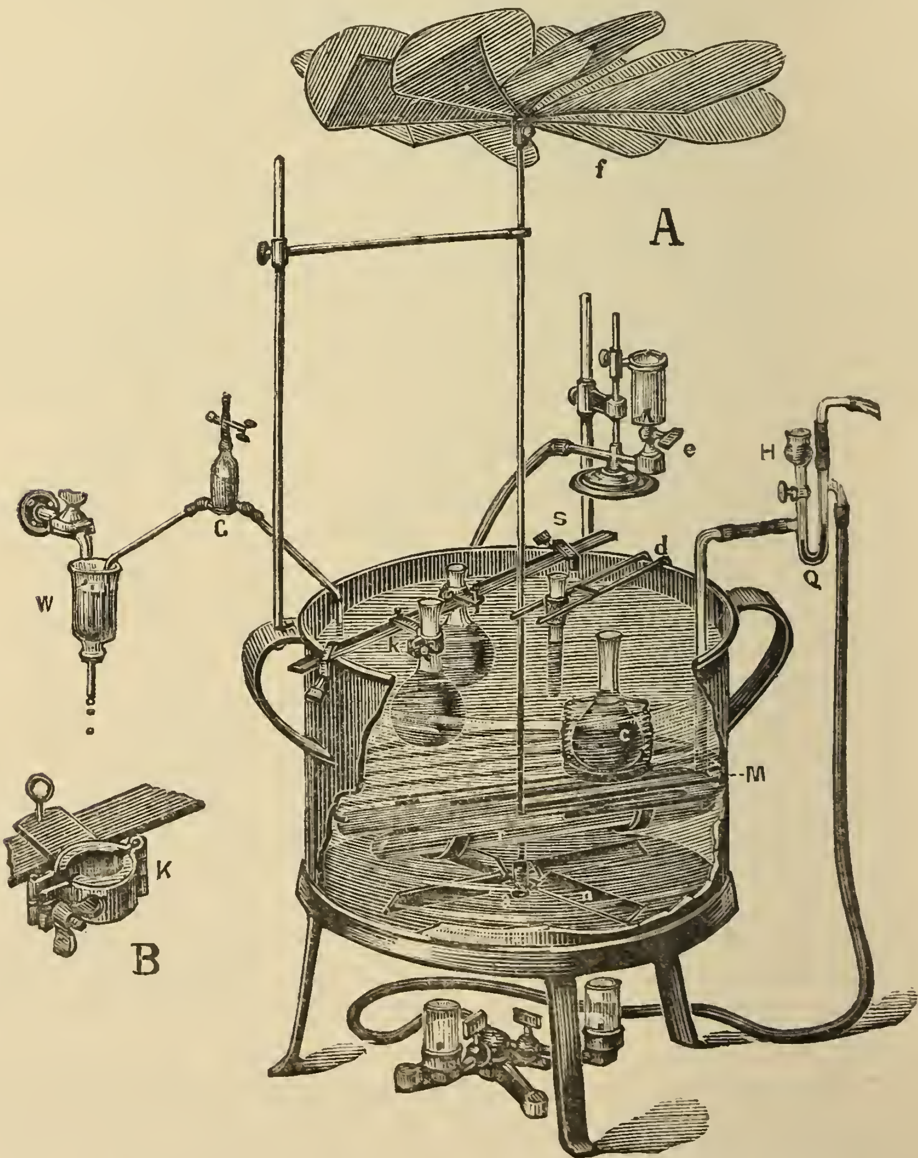


Chamber made with nickel plates. Bisected; natural size.

The temperature of the water-bath was found not to vary more than 0·1° C. in 12 hours when the water was kept throughout at 50° C.

Pfeffer's Water Thermostat.*—Prof. W. Pfeffer describes a water thermostat which, as it maintains a very constant temperature, is very

Fig. 64.



* Zeitschr. f. Wiss. Mikr., vii. (1891) pp. 442–7 (1 fig.).

useful for bacteriological and other purposes. The water-vessel, to hold 10–40 litres, is made of enamelled iron. Near the bottom is a floor made of brass bars M; beneath this is the U-tube, filled with 30 per cent. chloride of calcium solution, and the regulator *r*, which stops off access of gas to the flame in the usual manner by means of mercury.

An equable temperature of the water is effected by the working of the four scoops *n* driven by the fans *f*, which are set in motion by a gas flame *e*. The connecting-rod between the fans and the scoops is pivoted in an agate cup *a*. The water is maintained at a constant level by means of a siphon apparatus.

Flasks are fixed in position within the thermostat by means of the clamps shown in fig. B, or placed on the floor M, as at *c*. Test-tubes may be suspended by the device shown at *d*. Here they are placed in a cork which is jammed in between the two parallel bars.

Over the air thermostat this water thermostat possesses these advantages:—the cultivations are more rapidly brought up to the temperature of the surrounding medium, the water temperature is but little altered on the insertion or removal of the flask, and a greater constancy of temperature is attained.

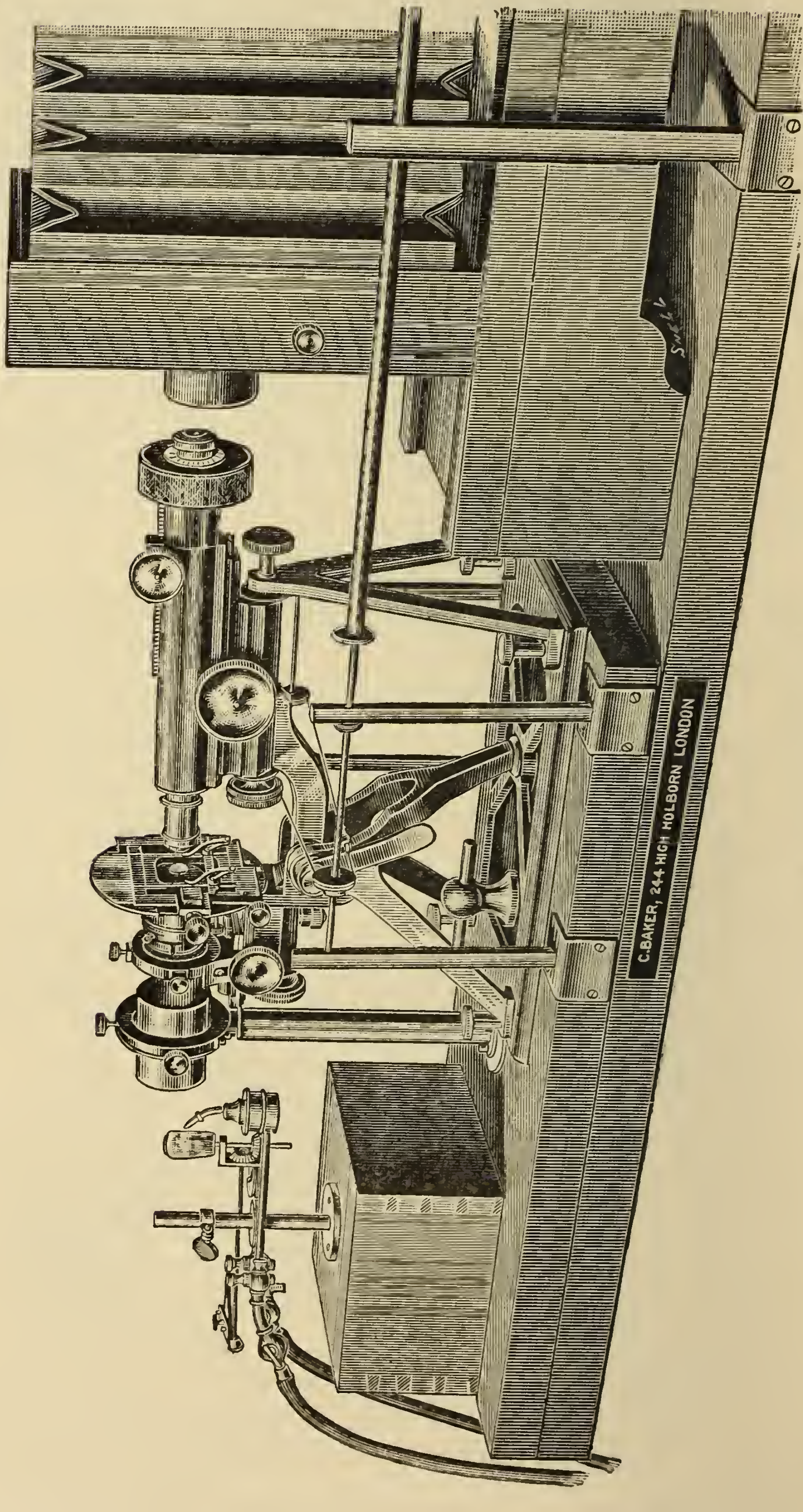
(4) Photomicrography.

Baker's Photomicrographic Apparatus.—This apparatus, as recently supplied to Mr. Andrew Pringle, is shown in fig. 65. It consists of a substantial teak base-board 6 ft. 11 in. long, and $1\frac{1}{2}$ in. thick, on which the camera with its support is placed, the other end carrying a teak-wood turntable clamping to the base. On the turntable a quadrangular metal frame is fixed, having a metal trestle to support the upper end of the limb of the Microscope when in the horizontal position, and two clamp-screws are fitted to receive the front feet of the Microscope. By this arrangement the instrument readily serves both purposes, either for ordinary observations or for photographing, the attachment in the latter case being easily and rapidly effected. The compound bull's-eye condenser, with centering adjustments, is carried by a pillar attached to the turntable; and beyond this is a support for the oxy-hydrogen lamp which is furnished with the usual mechanism for regulating the position of the lime-cylinder.

The Microscope is that known as the Nelson model, having the differential-screw fine-adjustment with actuating milled head at the lower end of the limb. It has a graduated rotating mechanical stage, and rackwork centering substage with differential-screw fine-adjustment. The body-tube is 150 mm. long, with racked draw-tube and an extra sliding draw-tube extending to 300 mm. An adapter with Society screw is fitted to the sliding draw-tube to allow the use of low-power objectives without racking the body-tube too far from its normal bearings, by which method the field of the objective is not cut off by the body-tube. The nose-piece is removable. The camera can be used at any length from 6–50 in.; it is provided with an exposure shutter and with a connecting tube sliding easily into a cap fitting on the eye-piece end of the Microscope. The camera can also be moved laterally and clamped to the base-board.

Focusing-rods run the whole length of the base-board, and con-

Fig. 65.



Baker's Photomicrographic Apparatus.

nect readily with the milled head of the fine-adjustment by means of a silk cord.

We are requested to note that in the woodcut the apparatus appears reversed from right to left.

(6) Miscellaneous.

A Method of Drawing Microscopic Objects by the Use of Coordinates.*—Dr. Cooper Curtice writes:—"The method which I am about to detail is one that I found in use by Dr. George Marx, of the Division of Illustrations, in the U.S. Agricultural Department, when I first engaged studying animal parasites in 1886, but it was originated some eight years earlier, as he informs me.

It is a method that has such obvious merits that I take pleasure in placing it before students of the Microscope, but I present it as a relater of a valuable method rather than of original work. Its simplicity, its cheapness, its accuracy, the ease with which a figure of any magnification or reduction may be made, and the rapidity with which a beginner adapts himself to its use, all serve to recommend it.

A small glass slide, of the size of an eye-piece micrometer, or a disc ruled into squares, is inserted into the eye-piece, so that the lines seem to rest upon the object. Tracing-paper is placed over cardboard ruled into squares. The drawing is then made freehand, the various points located in a symmetical position with respect to the lines underlying the paper that they occupy in the apparently ruled image. The drawing made on the tracing-paper may then be either transferred to drawing-paper without reduction or be reduced by applying the same methods that produced the picture, and then be worked up.

Dr. Marx prefers using the slide. It is ruled into squares 1 mm. on each side, every third line being slightly deeper, to make it prominent. I prefer for most uses the finder made by Zeiss. It is a circular disc, upon the centre of which are ruled two sets of ten lines at right angles to each other, the lines being 5/10 mm. apart. The lines are very neatly ruled, and covered by a thin cover-glass cemented to it with balsam.

It is apparent that the system has a wide application, so far as the magnifications to be attained are concerned. The equation giving the magnification is $x = \frac{b}{a} \times c$, a being length of object, b the length of image, c the ratio of the image to the drawn figure.

Suppose that the amplification of objective is 5 ×; that the lines on the eye-piece slide to 1/2 mm. apart, and those on the cardboard be 6 mm., then $x = 5 \times 6 \times 2$, or 60, for the unit of the card squares is twice those of the eye-piece squares.

To use a series of objectives, or of squares for the eye-piece and for the cardboard, are easy matters. A single glass ruled to half millimetres, made to fit a low-power eye-piece, is sufficient to try the plan. Cardboards, either of Bristol boards or heavy calendered Manilla paper, may be ruled into squares 3, 5, 7 mm., &c., until the student has all the combinations desirable.

By adopting this plan of drawing figures, I have found that objections

* Amer. Mon. Micr. Journ., xii. (1891) pp. 52–3.

which I find to using the camera are avoided. The lighting is not interfered with, the image moves but little, if any, with the movement of the head, and the image cannot be distorted. It is true that the accuracy of the figure depends on the skill of the artist, but a short trial of the method will satisfy most students that the actual variation of the drawing in symmetry from the image is less than that in figures made by the camera.

The objection now existing that American makers have not on hand necessary slides will be gladly removed by them as soon as they see a demand."

Carl Zeiss-Stiftung in Jena.—The following notice is of interest:—

"By the present official notice the undermentioned firm has the honour to announce that their former proprietors, Dr. E. Abbe and Dr. R. Zeiss, have this day withdrawn from the firm, after having made over, according to agreement, the optical workshops in their entirety to the Carl Zeiss-Stiftung in Jena. The latter enters into all the rights, and accepts all the liabilities of the late proprietors. The firm itself remains unchanged. Dr. E. Abbe has been appointed by the Carl Zeiss-Stiftung as its authorized representative in all matters pertaining to the optical workshops, and to him, in conjunction with Dr. S. Czapski and Dr. O. Schott, the whole internal and external management has been transferred. Power of procuration has been granted to the two last-named gentlemen.—Jena, July 1st, 1891. Carl Zeiss Optische Werkstätte.

Extract from No. 153, 2. Juli, 1891 (2te Beilage) des 'Deutschen Reichs- und Preussischen Staatsanzeigers.' By a decree of His Royal Highness the Grand Duke, the undermentioned institution, inaugurated by deed of May 19, 1889, by Dr. Ernst Abbe, has been by law established, and received the right of legal personality.

The objects of the Institution are:—(1) The cultivation of the branches of scientific industry which, by the efforts of the founder, have been established in Jena by the optical workshops of Carl Zeiss, and the glassworks of the firm of Schott and Genossen; while at the same time attention is paid to the economical maintenance of those two establishments, and to the continued fulfilment of the social duties imposed upon the founders of the institution towards those who belong to it. (2) The advancement of mathematical and scientific studies by research and instruction.

The institution bears for all time the name Carl Zeiss-Stiftung, 'in honour of the man who first laid the foundation for the above undertaking, and in lasting remembrance of his own peculiar merit in having in his field of work always aimed at the co-operation of science and technical skill.' The management of the institution is by law transferred to the Kultusdepartement of the Grand Ducal Ministry of State; its judicial seat is Jena.

To the preceding public announcement must be added the fact that, after the Carl Zeiss-Stiftung had become the proprietor of the optical workshops of Carl Zeiss and co-proprietor of the glass technical laboratory of Schott and Genossen, (*a*) Dr. Ernst Abbe was appointed as authorized representative of the Carl Zeiss-Stiftung, with right of signing for the firm in all matters pertaining to these two establishments, and Dr. Siegfried Czapski was allowed to act as deputy for him in his functions. (*b*) Privy Councillor Rothe, in Weimar, was appointed as commissioner of the management of the institution.—Weimar, June 24, 1891. Grossherzoglich Sächsisches Staatsministerium, V. Gross.

In our business register the following entries respecting this day's decree have been made:—in Fol. 49, Bd. 1, for the firm Carl Zeiss in Jena, and under the headings—

(*a*) Proprietor:—No. 5. The two proprietors named under No. 2 and No. 4, Dr. Med. Roderick Zeiss and Dr. Ernst Abbe, have withdrawn. No. 6. The Carl Zeiss-Stiftung in Jena is the sole proprietor of the firm.

(*b*) Representative:—No. 2. Dr. Ernst Abbe in Jena is the authorized representative of the Carl Zeiss-Stiftung in Jena, with the right of signing for the firm. No. 3. The power of procuration granted to Dr. Otto Schott in Jena, named under No. 1, has been renewed by the Carl Zeiss-Stiftung. No. 4. Dr. Siegfried Czapski in Jena is procurator.—Jena, June 30, 1891. Grossherzoglich S. Amtsgericht, Abtheilung IV. Dr. Jungherr."

Death of Mr. Mayall.—It is with the greatest regret that we have to announce the death, on July the 27th, of Mr. John Mayall, jun., one of the Secretaries of the Society. His death will be felt as a severe loss wherever the Microscope is studied scientifically. We must postpone till the next number a detailed account of the services rendered by our deceased friend to science, to the Society, and to this Journal.

The late Mr. Tuffen West, F.R.M.S.—Tuffen West, whose death at the age of sixty-eight we have recently had to lament, was one who has had few equals in devotion to natural history, and especially to its microscopic side. He was unrivalled as a draughtsman and a manipulator, and his love for his subject supplied him with never-failing energy. Severe bodily illness had for the last twenty years secluded him from contact with his fellow-workers, and robbed him of that public recognition of his services which he was about to reap. There are, however, still living many who well remember him, and can testify to the importance which was attached to securing his services in the production of any work requiring illustrations. As he was possessed of but a small income, and in the earlier part of his career of none at all, he made his dexterity with his pencil the source of his support. It was not, however, by any means solely for his artistic ability that his collaboration was eagerly sought by authors, for it was well known that he was both able and willing to give help in the most varied directions of scientific and pathological research. Work by others which had passed through his hands not only obtained a very considerable security against error, but not infrequently received important additions and elucidations. His good nature in these matters was occasionally somewhat imposed upon, and papers and books were published which really owed quite as much to the man whose name appeared only as artist, as they did to him who assumed the rôle of author. In a general way he rendered these services with pleasure and because he delighted in his work, but there were instances of this kind of partnership which he felt to be unfair, and concerning which he would remark with a smile, "My poverty, but not my will, consents."

Tuffen West was the eldest son of a not undistinguished man. William West, of Leeds, his father, was F.R.S., and in a foremost position as a consulting chemist in the northern counties. He was one of the founders of the British Association for the Promotion of Science and of the Leeds Philosophical Society. He was much engaged as a medical jurist in cases requiring chemical knowledge, and it is said that his son's devotion to microscopic work was, when quite a youth, much developed by his being employed in the examination of blood stains in a case of murder which was tried at the York Assizes.

Those interested in tracing the hereditary descent of special faculties may hold it not superfluous to record that William West's father was cousin to Benjamin West, the distinguished President of the Royal Academy. Artistic taste had shown itself also in other members of the family.

West's parents were members of the Society of Friends, and Tuffen was educated at an excellent school at York belonging to that sect. There was a museum in the school, and much attention was given to the study of botany and zoology. The name of its master, John Ford, deserves to be recorded as one to whose kindly assistance Tuffen West, in common with many others, owed much in the development of his early tastes. As a schoolboy he was an indefatigable collector, and every moment that could be stolen from his lessons was devoted to insects, plants, and skeletons. Not far from the bottom of the school cricket-ground ran the Foss, a stream which yielded to the young naturalist uncounted treasures. In connection with this river an anecdote is told which illustrates alike West's habits and his character as a boy. The head-master having found that his boundary rules were often broken, proceeded on one occasion to make inquisition of his pupils. Calling them in succession before him, the question was put, "How many times hast thou been out of bounds during the last fortnight?" Some denied the charge altogether; some owned to once, some to more, but when it came to Tuffen's turn he replied frankly, to the astonishment alike of his comrades and the master, "Please, John Ford, every day."

After leaving school Tuffen West was apprenticed to Mr. Henry Brady, of Gateshead, a surgeon of scientific attainments himself, and who had the singular, possibly unique, good fortune to see three of his sons in succession elected into the ranks of the Royal Society. Although not much is known as to the details of his Gateshead life, it may well be supposed that in such a family a taste for natural science would certainly be fostered. Towards the end of his apprenticeship an accident occurred which put an end to his prospect of a medical career. By some inadvertency in a chemical experiment in his father's laboratory an explosion occurred, and in addition to other injuries Tuffen West incurred the irreparable loss of hearing. Through the whole of his subsequent life he was so deaf that in spite of mechanical aids it was impossible for him to listen to ordinary conversation. This was a terrible deprivation to him, for it not only excluded him from the profession for the practice of which he had been trained, but it shut him off almost wholly from social converse. This to a man fond both of society and societies, was a most heavy blow. Thrown back on himself, Tuffen West now turned with increased zeal to his Microscope and his pencil. The result was that he rapidly developed unrivalled excellence in the use of both. Neither, however, offered much prospect of remunerative occupation, and for long Tuffen West lived in the most frugal manner. During some years he was engaged in continuous work in connection with the Queen's University at Belfast, and resided there. Subsequently he came to London, where a younger brother was in business as a lithographer, and was able to put scientific work into his hands. He now became well known, and his services were soon in great request. The Transactions of the various learned societies were year after year constantly illustrated by his hand. He was at the time of his first sudden illness in receipt of a good income, and overwhelmed with work. This was twenty years ago, and although he afterwards repeatedly resumed his pencil he was never able to undertake much. He resided during the latter part of his life in a house which he had built for himself in the beautiful neighbourhood of Frensham, near Haslemere. In personal appearance Tuffen West was thought by some to bear a resemblance to our present Prime Minister, Lord Salisbury. He was, however, of slighter build, and the regularity of his features had been somewhat marred by the accident to which reference has been made. He was a man of an affectionate disposition and of singular simplicity of character. He was twice married, but had the misfortune to lose his only son. Although an ardent Darwinian he retained an orthodox creed, and on one occasion protested with vehemence that nothing should ever make him give up his belief in the literal truth of the narrative of Jonah's escape. He took no part in politics; he read but little in poetry or fiction; he was deaf to music; he never in his life handled either rod or gun, nor did he often wear skates or mount a horse. He was, however, an invaluable companion in a country excursion, and could make himself and others happy anywhere if only a magnifying glass and a pencil were at hand. His Microscope and its accompaniments were his invariable companions. He was a diligent note-taker, and his memorandum books were crowded with pencil sketches of the objects which he described. The writer of this was on very intimate terms with him during the busiest part of his career, and often accompanied him in country excursions. On one of these they reached their destination, a lone farm-house close to the sea, a few miles from Hunstanton, near midnight and in darkness. Both were up by daybreak. They met at breakfast. "Well, Tuffen, how do you like the sea?" "To tell the truth, I haven't seen it. I got into a ditch at the back of the house, and I found it so full of interest that I did not go any further." On the same occasion, pockets crammed and arms burdened with specimens, he was stopped while trespassing by a landowner, attended by two gamekeepers. This was a not infrequent occurrence, and West on such occasions was accustomed to oppose to his enemies two deaf ears, with the result of much display of temper on their part and victory with little loss on his. He had a great contempt for the exclusiveness of proprietors, and took a pride in going wherever he wished. His taste for natural scenery was not probably great, but his determination to secure any botanical or entomological specimen which he coveted was such as no gamekeeper could thwart.

From the nature of his occupations it almost followed as a matter of necessity that West did not do much work in his own name. He had to earn his livelihood in a very ill-paid and most engrossing occupation, and although he loved it in all its branches he yet felt somewhat keenly the fact that it took up all his time. He was accustomed to rise early and to work long into the night, yet his work was often in arrears and his employers clamorous. Nothing that he undertook was ever scamped. Thus it follows that but few original papers are to be credited to his pen. His work stands chiefly in other men's names. A paper on the mechanism of the feet of insects was of his own contributions to science the one in which he took most pride. Four years of his life were devoted to the illustrations of Blackwall's volumes on English spiders, and five to those of Smith on Diatomaceæ.

He was a fellow of the Linnean Society from the year 1861, and also of the Royal Microscopical Society. He was an honorary member of the Zoological and Botanical Society of Vienna, of the Tyneside Field Naturalists' Club, and of the Leeds Naturalists' Club.

Joseph Leidy.*—The following is part of a sympathetic notice of our late Honorary Fellow:—Dr. Joseph Leidy, the eminent comparative anatomist, zoologist, and palæontologist, died at Philadelphia on the 30th of April. He was born in the same city on the 9th of September, 1823. His father was a native of Montgomery County, Pa., but his ancestors on both sides were Germans from the Valley of the Rhine. While yet a schoolboy, minerals and plants were eagerly collected and studied, and also anatomical dissections were begun. He entered the Medical School of the University of Pennsylvania in 1840, and devoted his first year to practical anatomy. Having taken his medical degree in 1844, he became the next year, then twenty-one years of age, prosector to Dr. Horner, professor of anatomy in the university; and at the death of Dr. Horner, in 1853, he was appointed his successor.

In 1844 he made the many remarkable dissections of terrestrial molluscs, the drawings of which cover sixteen plates and illustrate thirty-eight species, in Dr. Binney's fine work on the Terrestrial Molluscs of the United States, showing in all not only remarkable power as an anatomist, entitling him to high rank, as Dr. Binney remarks, among philosophical zoologists, but also great skill as a draughtsman. Thus from the first Dr. Leidy was the thorough, minutely accurate, and untiring investigator.

After the publication of Dr. Binney's work in 1845, Leidy was elected a member of the Academy of Natural Sciences of Philadelphia, and from that time he was its most active member, hardly a volume of its publications appearing without one or more papers on the results of his researches. His contributions to zoology and comparative anatomy have a wide range. The lower invertebrates occupied a large share of his time. Besides multitudes of short papers, he published in 1853 a

* Amer. Journ. of Science, xli. (1891) pp. 523-5.

work of sixty-seven pages, illustrated by ten plates, on 'A Flora and Fauna within Living Animals,' of the botanical part of which Dr. Gray said in this Journal, "A contribution of the highest order, the plates unsurpassed if not unequalled by anything before published in the country." In 1879 appeared his large quarto volume on the freshwater rhizopods of North America, containing forty-eight coloured plates, the material of which was in part collected during two seasons in the Rocky Mountain region. As a portraiture of the doctor over the little memberless species, we quote from his concluding remarks:—"The objects of my work have appeared to me so beautiful, as represented in the illustrations, and so interesting, as indicated in their history which forms the accompanying text, that I am led to hope the work may be an incentive, especially to my young countrymen, to enter into similar pursuits. 'Going fishing?' How often the question has been asked by acquaintances as they have met me, with rod and basket, on an excursion after materials for microscopic study. 'Yes,' has been the invariable answer, for it saved much detention and explanation; and now, behold, I offer them the result of that fishing. No fish for the stomach, but as the old French microscopist, Joblet, observed, 'Some of the most remarkable fishes that have been seen, and food-fishes for the intellect.'" He delighted in his work because he knew that there was no fact in connection with the structure and functions of the simplest living things that was not profound and comprehensive, that did not reach up through all species to the highest. The vertebrates described by him were mainly fossil species. Dr. Leidy has the honour of having opened to geological science a general knowledge of the remarkable mammalian fauna of the country, and especially that of the Rocky Mountain region. Species had been before described, but through him the general range of North American species began to be known. In 1847 he published on the fossil horse; in 1850, on the extinct species of the American ox; 1852 and 1854, on the extinct Mammalia and Chelonia from Nebraska Territory, collected during the survey under Dr. D. D. Owen; in 1855 on the extinct sloth tribe of North America; in 1869, on the extinct mammalian fauna of Dakota and Nebraska, a thick quarto volume published by the Philadelphia Academy of Sciences, based on materials that had been gradually and continuously accumulating for the last years; and in 1873, contributions to the extinct fauna of the Western Territories, making the first quarto volume of the Hayden Survey. The last two works mentioned contain over eight hundred pages of text and nearly seventy of plates. Besides these large works numerous short papers from time to time appeared.

Dr. Leidy retired from this field when questions of priority began to start up, it being no part of his nature to quarrel, and having the firm belief, as he said, that the future would award credit where it was deserved. His work among the fossil vertebrates extended also to fishes, batrachians, and reptiles of different geological periods. Dr. Leidy's zeal never flagged; his labours came to an end only with his sudden death. Eight days before it he delivered his last University lecture. Beginning original work before he was twenty, his published papers and larger books continued to appear through half a century, and number over nine hundred. As is well said in one of the many tributes to him published in the Philadelphia papers after his decease, "He possessed to the end of a long career the freshest capacity of seeing the opportunities and openings for discovery and research offered by familiar phenomena. His vast store of exact and diverse knowledge in the whole wide field of animate nature was under the command of a logical judgment and synthetic powers which saved him from vagaries. These high intellectual powers were served by an untiring capacity for work and equal skill of eye and hand. These are rare gifts; but they are none of them, nor all of them put together, as rare as his character. His simplicity, his transparent sincerity, his ingenuous anxiety to serve science and to serve science alone, his freedom from all desire for the rewards, the honours, and the recognition after which lesser men go a-wandering, were as remarkable as his scientific powers." Never were words more truthful. Honours came to him from all parts of the civilized world, and more because unsought.

β. Technique.*

(1) Collecting Objects, including Culture Processes.

Preparing Tuberculin.†—Herr O. Bujwid prepared tuberculin by cultivating the bacilli in glycerin-bouillon at a temperature of 38° C., after a period of three weeks the cultivation fluid was sterilized thrice, being kept for ten minutes each time at intervals of ten hours at 100° C. The fluid was then filtered and the filtrate inspissated in a water-bath to one-fourth its previous volume. At a pressure of 20 mm. the boiling-point was found to lie between 30°–34° C. A fine precipitate which then formed was filtered off and the fluid further inspissated to the consistence of syrup. Thus obtained, the tuberculin was thinner and lighter than Koch's lymph. Experiments were then made on healthy and tuberculous guinea-pigs: the former bore well the injection of 1/2 ccm., while the latter manifested a general and local reaction. In two lupus patients who had been already treated with Koch's lymph the characteristic reaction occurred after injection of 10 mg., but without any rise of temperature.

The author considers that his tuberculin is about half as strong as Koch's fluid, and does not believe it is a toxalbumin, but is rather inclined to hold that it is a ptomaine, or an intermediate between a ptomaine and an enzyme.

Preparing Pepton-agar for studying Pyocyanin.‡—M. Gessard gives the following ready method for making the pepton-agar so useful in studying the formation of pyocyanin. In each test-tube is placed 0·25 grm. of finely-chopped agar, and then 5 ccm. of neutral 2 per cent. pepton solution and 5 drops of glycerin are added. The tubes are then

* 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.

† Gazeta Lekarska (Polish), 1891, No. 4. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 579–80.

‡ Annales de l'Institut Pasteur, 1891, p. 65. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 541–2.

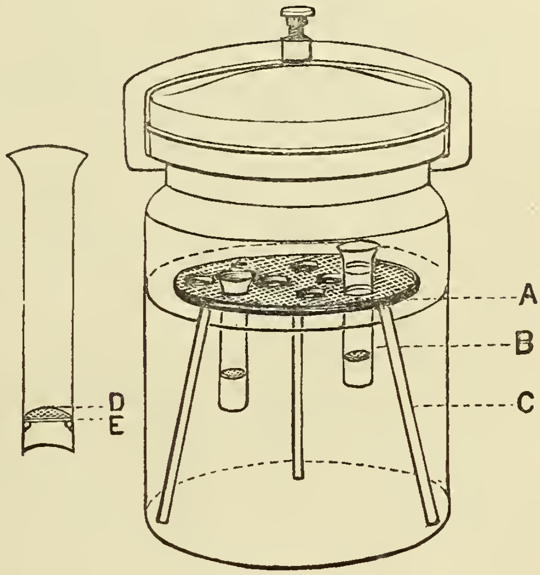
heated for some time to boiling-point in a water-bath in order to drive out the air from the agar. After this they are sterilized for five minutes at 120° C., and allowed to set in oblique position.

Simple Method for sterilizing Catgut.*—Mr. G. R. Fowler sterilizes commercial catgut by boiling it for an hour in 97 per cent. alcohol. The control experiments were made with anthrax and suppuration cocci. It was found that catgut which had been soaked in these germs was rendered perfectly sterile in an hour.

(2) Preparing Objects.

Dehydrating Apparatus.†—Mr. M. B. Thomas writes:—"A very convenient form of Schultze's dehydrating apparatus can be made as follows:—In a 9 × 9 in. Whittall-Tatum museum jar a disc of plaster of Paris is supported about 2 cm. from the top by means of legs made of glass rods (fig. 66, A and C). The disc is perforated to allow tubes of sizes varying from 2 to 4 cm. in diameter to pass through. These are the so-called dehydrating tubes (fig. 66, B). The plaster of Paris diaphragm can be made by first making a mould of the desired size with a paper bottom and a cardboard hoop for the outside. This must be placed on a level surface. The plaster of Paris is then softened with water and poured into the mould to about the depth of 1½ cm. While it is yet soft the three legs can be inserted near the edge, and holes for the dehydrating tubes cut in the disc with a knife, or pressed out with glass tubing of convenient size. When the plaster of Paris is thoroughly dry the hoop can be removed and the disc placed in position in the jar.

Fig. 66.



The jar is then filled with alcohol to about 2 cm. of the under side of the disc. The dehydrating tubes should be about 12 cm. long, and can be made by cutting off the bottom of large test-tubes. At the bottom is placed a diaphragm of chamois skin, which can be fastened in place by means of a spring made of steel wire, and forced inside of the chamois skin in the tube, thus pressing the former firmly against the latter (D, E). A rubber band around the tubes prevents them from falling through the holes in the disc, and enables them to be lowered to any desired depth in the alcohol.

The tissue to be dehydrated is packed closely in the dehydrating tube, and enough 50 per cent. alcohol poured over it to just cover it. It is then lowered through the hole in the disc until the two liquids are

* New York Med. Record, 1890, pp. 177–9.
† Amer. Mon. Micr. Journ., vii. (1891) pp. 7–8.

just at a level. After from 12 to 24 hours the two liquids will be of the same strength. The tissue can then be taken out and placed in the infiltrating bath at once.

This method for hardening has been tried in the botanical laboratory at Cornell University on nearly all kinds of plant-tissue, and in every case it was found to be successful. For the most delicate tissues, where slow hardening is desired, 5 per cent. alcohol can be placed in the dehydrating tube and thick chamois skin used for a diaphragm, and for some of the more delicate algæ it has been found advisable to use as low as 1 per cent. alcohol in the tube. The strength of the alcohol in the jar can be kept up by adding to it from time to time some calcium chloride. This will not injure the alcohol in the least.

The jar should be tall enough to allow the cover to be kept on while the tubes are in position, and thus prevent evaporation of the alcohol. An apparatus of such a form, having thirteen dehydrating tubes, has been in constant use in the botanical department for a year without changing the alcohol, and is yet in good working order.

Experiments have been made with one of smaller size, and it is found that all hardening agents, such as picric, chromic, acetic, or osmic acid, can be used in it with equal success.

The advantages claimed for the apparatus are these:—Not more than 24 hours is necessary for dehydrating and hardening nearly all kinds of plant-tissue. The apparatus does away with the transferring of the tissue from bottles containing alcohol of different strengths, and as no sudden transition from solutions of different strengths occurs, the tissue is less liable to shrink. The simplicity of the apparatus places it in the reach of all.

Many different materials may be used for a diaphragm, and almost any desired speed of dehydrating obtained. The apparatus can also be made of any size to adapt it for private or general laboratory work.

It would seem that such an apparatus would work equally well for animal tissue, but as yet I have not been able to make an extended trial of it; however, in the case of some insects hardened in it, it was found to be admirably adapted to the purpose."

Method for fixing Preparations treated by Sublimate or Silver (Golgi's Method).*—Sig. A. Obregia gives a method for rendering preparations treated by Golgi's sublimate or silver procedure so permanent that they may be afterwards stained and protected with a cover-glass.

The sublimate or silver preparations are sectioned without any imbedding or after having been imbedded in paraffin or celloidin. In the latter case care must be taken not to use alcohol weaker than 94 or 95 per cent., at any rate for the silver preparations. The sections are then transferred from absolute alcohol to the following mixture:—1 per cent. gold chloride solution, 8–10 drops; absolute alcohol, 10 ccm., which should have been made half an hour previously and exposed to diffuse light. After the sections are deposited therein the vessel containing them is placed in the dark. The silver is gradually replaced by gold, and

* Virchow's Archiv, cxxii. (1890) pp. 387 *et seq.* See Zeitschr. f. Wiss. Mikr., viii. (1890) pp. 97–8.

the mercury changed into gold amalgam. Finally, black delicate designs appear on a white field. According to the thickness of the section, the fluid is allowed to act for 15 to 30 minutes, but even longer is not harmful. Thereupon the sections are quickly washed first in 50 per cent. alcohol, then in distilled water, and finally in a 10 per cent. solution of hyposulphite of soda, in which, according to their thickness, they remain for 5 to 10 minutes. A longer immersion bleaches too much, so that the finer fibres disappear. Last of all they are thoroughly washed in distilled water twice renewed.

Sections thus fixed can afterwards be stained by any method—e. g. Weigert's, Pal's, &c.—after which they are cleared up with creosote, imbedded in dammar, and protected with a cover-glass.

Throughout the procedure the sections must be manipulated with glass instruments, and not allowed to touch any metallic substance.

Decalcification of Bone.*—In discussing various methods for decalcifying bone, and after indicating the shortcomings of the different solutions, most of which have been in vogue for a long time, Dr. R. Haug points out the advantages of phloroglucin in combination with acid. The introduction of this reagent was due to J. Andeer, who used it with a solution of hydrochloric acid.† According to the author this method was not altogether satisfactory, since the results were not invariable. By substituting nitric acid for hydrochloric a decalcifying fluid is obtained which effects its purpose very rapidly. Days and hours are only required where formerly weeks and months were necessary, and this without any damage to the tissues generally.

The solution is prepared by warming 1 grm. phloroglucin in 1 ccm. of pure non-fuming nitric acid (sp. gr. 1·4). This must be done slowly and very carefully, with slight agitation. After a very lively reaction a clear, dark ruby-red solution is obtained. To this combination of nitric acid and phloroglucin, which may be called nitrate of phloroglucin, 50 ccm. of water are to be added. In order to obtain a sufficient quantity of decalcifying fluid, to this stock solution 50 ccm. of water and 10 ccm. of acid are again added, and further additions of like percentages of water and acid may be made until the quantity reaches 300 ccm., which is the limit of the protective influence of the phloroglucin. Of course, if a further quantity of the decalcifying fluid be required, a fresh stock of solution must be made, and so on.

Fœtal or young bones of lower Vertebrata are completely softened in half an hour; older and harder bones, such as femur, temporal bone, &c., require a few hours. Of course, the pieces are small and the material previously washed. For teeth the amount of acid may be increased to 35 per cent.

When sufficiently decalcified, the preparations are to be placed in running water for about two days, in order to thoroughly remove all traces of acid. The after-treatment is as usual. If a less rapid decalcification be desired, the following formula suffices to give very good results:—Phloroglucin, 1; nitric acid, 5; alcohol, 70; distilled water, 30.

Other decalcifying methods are also discussed by the author; these

* Zeitschr. f. Wiss. Mikr., viii. (1891) pp. 1–11.
† See this Journal, 1887, p. 504.

are those most in use, and it will not be necessary to recount them. But it may be useful to give the formulas of solutions made with hydrochloric and nitric acids:—Hydrochloric acid, 2·5; alcohol, 500; distilled water, 100; sodium chloride, 2·5. A variation of the preceding is:—Hydrochloric acid, 1–5; alcohol, 70; distilled water, 30; sodium chloride, 0·5. These solutions decalcify somewhat slowly, but the structural relations of the tissue are well preserved.

The formula for the nitric acid combination used by the author is:—Nitric acid (sp. gr. 1·5–1·2), 3–9; alcohol, 70; distilled water, 30; sodium chloride, 0·25. This solution decalcifies rapidly, but without destroying the tissues, and may be used for bone of all ages and densities. Its action may be hastened by using an incubator. Preparations stain remarkably well after this method.

Demonstrating Mucin in Tissues.*—From a very thorough examination Herr H. Hoyer shows that the mucin in mucous glands of goblet-cells of Vertebrata and Invertebrata can only be demonstrated by the basic anilin dyes, the acid salts having no effect. The various carmine solutions behave like the acid anilins, and the aluminated hæmatoxylin solutions like the basic.

Double staining with methylen-blue and triamido-benzol, known as Bismarck or Vesuvin brown, are found even in dilute solution to impart a deep stain very resistant to alcohol; other pigments named as giving satisfactory results being methylen-green, dimethylphenylen-green, metamidomalachit-green, and safranin. This last produces a metachromatic staining of the mucin, imparting thereto an orange colour, while the tissue and nuclei are red.

Another pigment giving excellent results is thionin or Lauth's violet, a derivative of indamin containing sulphur. To the tissue Lauth's violet imparts a bright blue colour, while the mucinous elements are red-violet.

For demonstrating mucin the author treated fresh pieces of tissue for two to eight hours with 5 per cent. sublimate solution, and then with 80 per cent. spirit. After imbedding in paraffin and cutting the tissue, the sections, stuck on a slide, were stained with dilute watery solutions (2 drops of a saturated watery solution of the pigment to 5 ccm. of water) for 5 to 15 minutes. Other details relative both to the pigments and to the technique are given.

Preparing and Examining Glandular Epithelium of Insects.†—Dr. V. Grandis recommends insects, and especially *Hydrophilus*, for studying glandular epithelium during secretion. After the animal's legs and wing-cases have been removed a cut is made down the whole length of the back, and then two others perpendicular to the first, one on either side. In making these incisions care must be taken not to tear the abdominal air-sacs or the tracheæ. The animal is then laid on a piece of cork, in the centre of which is a circular hole with a diameter of about 1 cm., on the under side of which is cemented a cover-glass,

* Arch. f. Mikr. Anat., xxxvi. (1890) pp. 310–74. See Zeitschr. f. Wiss. Mikr., viii. (1891) pp. 67–70.

† Atti R. Accad. Sci. Torino, xxv. (1890) pp. 765–89 (8 pls.). See Zeitschr. f. Wiss. Mikr., viii. (1891) pp. 86–7.

and it is so disposed that the abdomen lies in the cell. The lymph flows into the cell, and after adding to it some 0·7 per cent. salt solution, the viscera are placed therein, and the intestine, having been spread round the edge of the hole, is fastened down with needles. By this means the Malpighian vessels can be observed in the living condition.

To iodine-green they behave during life in a manner quite different from that after death. In the first case the nucleus does not stain at all, while the protoplasm assumes a purple-violet hue. After death the nuclei, which have then acquired an acid reaction, stain green, and the protoplasm bluish-green. Another differential stain is the Ehrlich-Biondi solution, which colours the nuclei green and the protoplasm orange. The other stains mentioned imparted a diffuse coloration or were otherwise imperfect.

Preparing and Staining the Ova of Chironomus.*—Herr R. Ritter obtains the ova of *Chironomus* from the water in which they have been laid during the twilight. The secretion which holds the eggs together swells up into a gelatinous mass. The egg-mass is then killed with hot 30 per cent. alcohol to which some sublimate has been added, and afterwards treated successively with 70, 90, and 100 per cent. spirit. It is then imbedded in paraffin after having been soaked in chloroform.

The author succeeded in staining the ova (a very difficult task) by placing the whole egg-mass for at least four days in picrocarmine, the transference from the absolute alcohol to the staining fluid being made very gradually. The sections may be contrast stained with hæmatoxylin.

Preserving Larvæ of Lepidoptera with their Colour.†—Sig. F. Crosa places the caterpillars in a 5 per cent. solution of chloride of zinc, and then heats the fluid almost to boiling. This hastens the process and prevents putrefaction. The objects are then placed successively in 10, 15, 20 per cent. solutions of the same salt, and remain therein until they sink to the bottom. For a caterpillar of medium size eight to ten days are necessary. After the last solution they are placed in glycerin. The zinc chloride must be perfectly neutral and contain no trace of iron salts. For this purpose commercial zinc is dissolved in pure hydrochloric acid, taking care that the zinc is always in excess, in order to prevent the formation of iron chloride; afterwards it is filtered. If commercial zinc chloride be employed, this is dissolved in water acidulated with hydrochloric acid and then boiled for some time with zinc.

It is advisable that before the treatment is commenced the caterpillars should be made to fast, and that they should be killed with chloroform. It is stated that, prepared by this method, caterpillars retain their colours (even the green and yellow hues) for quite two years, and that they are quite suitable for histological purposes.

Method of observing Pectinatella gelatinosa.‡—Mr. A. Oka states that this Polyzoon is remarkable for the ease with which it can be killed in an expanded condition. When 70 per cent. alcohol is gradually

* Zeitschr. f. Wiss. Zool., l. (1890) pp. 408–27 (1 pl.). See Zeitschr. f. Wiss. Mikr., viii. (1891) pp. 87–8.
† Boll. Mus. Zool. ed Anat. Comp. Torino, v. (1890) No. 85. See Zeitschr. f. Wiss. Mikr., viii. (1891) p. 86.
‡ Journ. Coll. of Science, Imper. Univ. Japan, iv. (1891) pp. 91–2.

poured into a vessel containing the colonies, more than half the polypides die protruded. With such reagents as chloral hydrate or cocain chloro-hydrate every polypide dies expanded. Some colonies were fixed with a saturated solution of corrosive sublimate or a weak (0·1 per cent.) solution of chromic acid. Borax-carmine and picrocarmine were chiefly used for staining. Sometimes a whole colony was imbedded.

The development of the polypide within the statoblast was thus studied: a statoblast was hardened in alcohol, and its edge was then cut between two pieces of elder-pith so as to make an opening in the chitinous shell; it was then stained and kept in alcohol until cut. In cutting the statoblast celloidin was indispensable, owing to the hardness of the shell. Fresh specimens were put on a slide after stupefying with cocain. The habits of the colonies may be studied by keeping them in vessels through which water is always flowing.

Demonstrating Tactile Papillæ of Hirudo medicinalis.*—In order to show well, says Dr. S. Apáthy, the tactile papillæ of *Hirudo medicinalis*, strong spirituous solutions of sublimate should be added to the water in which the starved animal is kept until it moves no longer. Having been stretched out with pins, 10 per cent. sublimate or 70 per cent. alcohol is poured over it. This makes the tactile papillæ stand out from the smooth ventral surface.

Examining Ova of Gordius.†—In examining the yolk-stalk of *Gordius*, Sig. L. Camerano fixed this animal in one-third alcohol or picric acid. Mayer's carmine stained germinal vesicle and spot well. For ova the author recommends as fixative 3 per cent. nitric acid or a mixture of equal parts of absolute alcohol and acetic acid, and as stain, borax-carmine or a mixture of malachite-green and vesuvin.

Study of Nematodes.‡—Mr. N. A. Cobb recommends the following method:—"On capturing a worm with the medicine-dropper, I eject it forcibly into 20 ccm. of concentrated solution of corrosive sublimate, kept at 50°–60° C. by floating it in a porcelain dish on the surface of hot water. If the sublimate solution is much hotter than 60°, the bodies of some species burst. The worms should remain in the hot sublimate solution at least an hour, better longer. When a sufficient number of worms has been captured, pour the sublimate solution, worms and all, into a flat glass dish placed on a black background, and pick out the worms with the aid of a magnifying glass and a fine-pointed medicine-dropper, and put them into the preparéd object-glass of a differentiator. Stain and bring into balsam by means of the differentiator. Most of the smaller species stain readily in borax-carmine, which is one of the best of stains for this work. *Oxyuris vermicularis* (adults, not the young) and a number of other parasitic species, however, do not stain in borax-carmine. Mayer's carmine rarely fails to stain these exceptional species. Overstaining is corrected by adding hydrochloric acid to the proper differentiator fluids. I can recommend this method very highly, not

* Zool. Anzeig., viii. (1890) pp. 320–2. See Zeitschr. f. Wiss. Mikr., viii. (1891) p. 81.

† Mem. della R. Accad. di Torino, xl. (1890) pp. 1–19 (2 pls.). See Zeitschr. f. Wiss. Mikr., viii. (1891) pp. 80–1.

‡ Proc. Linn. Soc. N.S.W., v. (1890) pp. 451–2.

only for Anguillulidæ, but also for numerous other groups of the smaller animals and plants."

Mode of Studying Phagocata.*—Mr. W. M. Woodworth found that the best reagent for killing these worms is hot corrosive sublimate; an excess of the salt is added to the saturated aqueous solution, and the whole is heated to the boiling point; by this means a very strong solution can be obtained. A modification of Kennel's process, viz. a cold saturated solution of corrosive sublimate in 50 per cent. nitric acid, was used with entire success. For the study of the intestinal tract, unstained specimens were cleared in clove oil. For staining, Grenacher's alcoholic borax-carmine, followed by differentiation with acid alcohol, proved to be the most useful method. Good sections for topographical study were obtained by staining in this carmine for twenty-four hours, and cutting, in the horizontal plane, sections 30 μ in thickness. With this light staining the nerve-tissue takes none of the colour, and in such comparatively thick sections the finer branches show as white lines against a red background. Orth's picrocarminate of lithium is a valuable reagent for all glandular tissues, as the picric acid brings them sharply out; this is also an excellent reagent for macerating. The osmic-acetic method of maceration was also successful. Isolated living pharynges were killed in hot 1 per cent. silver nitrate for the purpose of demonstrating the epithelium. Depigmenting was accomplished by the use of a 1 per cent. solution of potassic hydrate, which was allowed to act for a few minutes on sections fixed to the slide with Schällibaum's clove-oil collodion fixative.

Study of Rhizopods.†—Mr. S. H. Perry recommends the mounting of testaceous Rhizopods in glycerin-jelly rather than balsam, as the specimens do not become too transparent, and the protoplasm is preserved. Examples should be picked out singly with a fine camel's-hair brush, under powers of from 25 to 125 diameters, and transferred to a drop of glycerin, where they can be kept till required for mounting.

Demonstration of Cilia of Zoospores.‡—Prof. J. E. Humphrey recommends for this purpose, especially in the case of Fungi, a 1 per cent. solution of osmic acid, which is left for a few minutes to fix the spores thoroughly, and then drawn off by means of filter-paper. A staining-fluid is then applied, consisting of a drop of a moderately strong solution in 90 per cent. alcohol of Hanstein's rosanilin-violet composed of equal parts of fuchsin and methyl-violet. This stains both the cilia and the body of the zoospores very quickly and deeply. By this method the author was able to demonstrate that the zoospores of an *Achlya* allied to *A. polyandra* are ciliated.

(3) Cutting, including Imbedding and Microtomes.

Preparation and Imbedding of the Embryo Chick.§—Messrs. S. H. Gage and G. S. Hopkins write:—"An excellent method of preparing blastoderms of the chick, of from 1 to 96 hours incubation, both for

* Bull. Mus. Comp. Zool., xxi. (1891) pp. 6–7.
† Amer. Mon. Micr. Journ., xii. (1891) p. 80.
‡ Bot. Gazette, xvi. (1891) pp. 71–3.
§ Proc. Amer. Soc. Micr., 1890, pp. 128–131.

surface views and for sectioning, is given in Whitman's 'Methods in Microscopical Anatomy and Embryology' (p. 166).

With slight modifications, the method is as follows:—

(1) Break the shell by a sharp rap of the scissors at the broad end; then carefully break away the shell, beginning at the place of fracture and working over the upper third or half.

(2) After removing as much of the white as possible without injury to the blastoderm, carefully turn the yolk into a dish of nitric acid (10 per cent.) deep enough to float the yolk, taking care to have the blastoderm on the under side of the yolk.

(3) The coagulated white should next be removed from the blastoderm by the aid of a brush or feather, and the egg then allowed to remain in the acid from 20 to 30 minutes.

(4) Cut around the blastoderm with sharp-pointed scissors, taking care to cut quickly and steadily. After carrying the incision completely round, float the blastoderm into a watch-glass, keeping it right* side up and flat.

(5) Remove the vitelline membrane by the aid of dissecting forceps and the yolk by gently shaking the watch-glass and by occasional use of a needle.† The yolk can sometimes best be washed off by means of a pipette.

(6) Wash in water (several times changed).

(7) Colour deeply with carmine or hæmatoxylin.

(8) Remove excess of colour by soaking a few minutes in a mixture of water and glycerin in equal parts, to which a few drops (about 1 per cent.) of hydrochloric acid have been added.

(9) Wash and treat 30 minutes with a mixture of alcohol (70 per cent.) 2 parts; water, 1 part; glycerin, 1 part.

(10) Transfer to pure 70 per cent. alcohol, then to absolute alcohol (95 per cent. alcohol answers every purpose), clarify with creasote or clove oil, and mount in balsam.

For sectioning, blastoderms prepared by this method should be dehydrated, either before or after staining, as is thought best, and immediately transferred to a thin solution of collodion ‡ (2 per cent.), after which they are placed in a thick solution of collodion (5 per cent.) and then arranged for imbedding and sectioning. To accomplish this, the following procedure has been found useful:—

With a camel's-hair brush transfer the blastoderm from 95 per cent. alcohol to a paper box. It is better to fill this box partly full of alcohol (95 per cent.) before transferring the blastoderm to it, as the alcohol partially floats the blastoderm and thus facilitates its removal from the brush. As soon as the blastoderm is safely in the box, remove the alcohol with a dropper (do not try to pour it off, otherwise the blastoderm will curl up), and carefully pour in enough thin collodion to cover the

* We find it more convenient to remove the yolk from the blastoderm when it is kept ventral (or wrong) side up.

† We find that a small camel's-hair brush is the best thing with which to remove the yolk.

‡ We have found collodion more satisfactory, on the whole, than celloidin, and it is less costly. To make a 2 per cent. solution, dissolve 2 grams of gun-cotton in 100 ccm. of sulphuric ether and 95 per cent. alcohol, equal parts of each. For a 5 per cent. solution use 5 grams of gun-cotton instead of 2.

blastoderm to the depth of about 1/2 cm. The box is now placed in a tightly covered jar to prevent too rapid evaporation and the consequent solidification of the collodion. After the blastoderm has remained a sufficient length of time (from one to three or more hours, depending on the size of the blastoderm) in the thin solution, the collodion is removed with a dropper, and the thick solution poured on. After infiltrating sufficiently with thick collodion, 2–10 hours, open the jar and allow a film to form on the surface of the collodion, then fill the paper box with alcohol (60–80 per cent.) and allow it to remain till the collodion becomes firm and tough; 2–4 hours is usually sufficient. Now with a sharp knife a square or rectangular piece of collodion including the blastoderm is cut out and arranged on the cork in any position desired; the block is fastened to the cork, as any ordinary tissue, by simply pouring over it thick collodion, which is hardened by immersing in alcohol (60-80 per cent.) for from 5 to 15 hours.

For holding the corks under the alcohol the following apparatus has been found more economical and convenient than the method of attaching

Fig. 67.

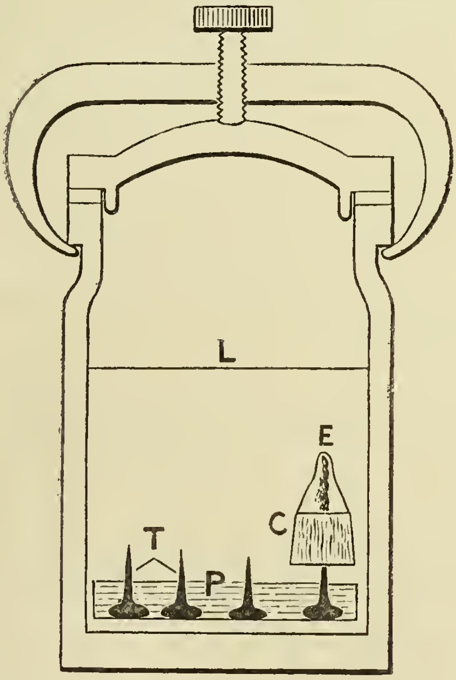


Fig. 68.

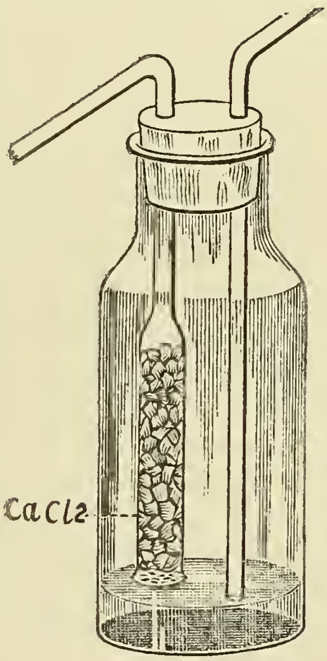


Fig. 67, jar for hardening the collodion of collodion-imbedded objects. P, plaster of Paris disc, in which are imbedded the glass tacks. The cork C, on which the embryo E is imbedded, is pushed down upon a glass tack T, and is held in position under the liquid L, alcohol or chloroform, while the collodion is hardening. Fig. 68, ether wash-bottle for blowing ether vapour upon collodion or celloidin sections to fasten them to the side. The tube of calcium chloride ($CaCl_2$) is for dehydrating the ether vapour.

weights to the corks. The apparatus consists simply of a glass jar, in the bottom of which are fastened several rows of glass tacks. The materials necessary for its construction consist of a wide-mouthed jar, a few pieces of glass rod, and a little plaster of Paris. The tacks are made by heating the glass rod and drawing it out to a rather sharp point. It is then cut off at the right length and the cut end softened by heat and then quickly pressed upon some hard surface, so as to form a sort of head. The tacks are then arranged in rows in some shallow dish, previously oiled, and enough plaster of Paris poured around them to form a layer from $1\frac{1}{2}$ to 2 cm. deep. When this hardens, the tacks are firmly held in an upright position, and all that remains to be done is to place the plaster disc in the bottom of the glass jar.

To use the apparatus, fill it partly full of alcohol (60–80 per cent.). As the specimens are imbedded on the corks, transfer them to this jar, sticking each cork upon a tack."

An improved Method of preparing large Sections of Tissues for Microscopic Examination.*—Mr. J. C. Webster writes:—"Hitherto we have employed two methods of preparing large sections for microscopic study, viz. the freezing and the celloidin. In the former the Hamilton or Bruce microtome is used, and in the latter the Schanze. Each of these processes has connected with it certain difficulties which limit the range of its employment.

The objections to the first method are the following:—

(*a*) It is impossible to prepare delicate or friable tissues in large thin sections, because, after being cut, they either break into pieces when placed in water, or during the mounting process get torn and destroyed. The placenta, for example, cannot be cut into sections suitable for the finest microscopical work, as the villi and the blood-corpuscles in the maternal sinuses are almost entirely scattered when placed in fluid.

(*b*) The relations of parts cannot be preserved. Thus, for example, one cannot mount undisturbed a section through bladder and uterus, or through brain and membranes.

(*c*) The difficulties and discomforts connected with the working of a large freezing microtome are considerable.

The objections to the second method are:—

(*a*) It is impossible to prepare sections thin enough for examination by high powers. Those which can be made are only fit for study with low powers, or for lantern demonstration. This is the case with even the most easily cut tissues.

(*b*) The microtome employed—the Schanze—is complicated and expensive; its knife is with great difficulty kept sharp, and does not always cut large sections in slices of uniform thickness.

(*c*) The materials used in preparing the tissues for cutting are expensive.

The method which I am about to describe is not only free from these important objections, but possesses several distinct advantages.

(1) *Preparation of Tissues.*—Tissues may be hardened by any of the known methods, the last stage, however, being a twelve or eighteen hours' soaking in absolute alcohol.

The following method gives splendid results:—

Place the fresh tissue in a boiled saturated solution of corrosive sublimate for one night. Then wash in water, and place for 24 hours in a mixture of one part of methylated spirit and two of water; then in a mixture of equal parts for two days. Gradually increase the propor-

* Rep. Lab. R. Coll. Physicians Edinb., iii. (1891) pp. 266–70.

tion of spirit in the mixture, and at the end of eight or ten days place the tissue in pure spirit, and leave it until it is desired to examine it. A slice is then cut 3/16 to 1/16 in. in thickness, and placed for 12–18 hours in absolute alcohol. It is then soaked in pure naphtha for 24 hours. It is then placed in a mixture of equal parts of naphtha and soft paraffin, and exposed to a temperature of about 115° to 120° F. in a water-bath for 18–20 hours. The advantage of naphtha over turpentine is that it dissolves paraffin at a much lower temperature, thereby allowing the water-bath to be kept in such a condition that there is no danger of overheating the specimen. Throughout this process the temperature is kept lower than in the ordinary methods. The advantage of naphtha over chloroform and xylol is its cheapness. It is next placed in melted soft paraffin, and kept in the bath at about the temperature mentioned above for 24 hours. Then it is changed to a mixture of one part of soft and four or five parts of hard paraffin for the same length of time at a higher temperature. Care must be taken that the thermometer does not rise above 140° F.

(2) *Imbedding.*—Paper on thin cardboard boxes, about 1 in. in depth, and slightly more than large enough to hold the tissue, may be used. Nearly fill with a warm melted mixture of soft and hard paraffin in the proportions already mentioned. This mixture is better than the hard paraffin alone. The sections do not curl up as they generally do when pure hard paraffin is used; they can be cut in a much lower temperature, and they are not so brittle. With a pair of warmed forceps place the piece of tissue in the box, the face to be cut to be laid on the bottom. The paraffin should now almost fill the box which is at once placed in a flat dish of cold water. This is an important step; rapidly cooled paraffin makes a better bed, and is less apt to retain air-bubbles than the slowly cooled material. The boxes are removed from the water after a few hours, and can be kept until it is wished to cut them.

(3) *Cutting of Sections.*—This should be done in a room only moderately warmed. The Bruce microtome is employed. Having removed the box from the block of paraffin, pare away the upper surface of the latter, keeping always parallel with the lower surface, until there is left only the thickness of 3/16 in. above the tissue. Then place this surface on the microtome plate, gently heating the latter until a thin layer of the paraffin melts. This is then allowed to cool, and the block becomes firmly attached to the plate.

The plate is then screwed to the microtome, and the sections are cut in the usual manner. As the sections are thrown off they are caught in a dry tray. They may be mounted at once or preserved in boxes or bottles in a cool place. Some of the sections will be rolled up, others being wavy or flat. When the sections are very large, I prefer to mount the former; they can be unrolled on the slide over a very gentle heat, without any wrinkling taking place, or without air-bubbles being caught beneath the tissue.

(4) *Mounting.*—A clean dry slide is covered with a thin layer of fixing-fluid by means of a glass rod. The fluid which I have found most suitable is a mixture of collodion and clove oil. The section is flattened out on the slide by a soft hair brush above a very gentle flame.

Excess of fixing-fluid and paraffin can now be wiped from the slide. Staining can be at once proceeded with, or the slides can stand for a time protected from dust.

(5) *Staining.*—Dissolve the paraffin from the section by two or three washings of naphtha, which is allowed to stand on the slide for about a minute. Then wipe the slide, and wash off the superfluous naphtha with methylated spirits.

The following stains give splendid results:—Logwood, logwood and eosin, logwood and Bismarck brown, and alum-carmine. To get the best results with logwood, the following method should be used:—Stain the section for three minutes or more in the Ehrlich's hæmatoxylin solution. Then place it in a bowl of distilled water containing a few drops of hydrochloric acid until it appears of a pale port wine colour. The acid dissolves the stain from all parts save nuclei. Then place in a very dilute alkaline solution (sodium bicarbonate) until it turns blue. The alkali deepens the stain in the nuclei.

If eosin is to be used as a contrast stain, wash the section in water and place it in 1/3 per cent. eosin solution (if Bismarck brown, in a 1/4 per cent. solution) for two minutes. Wash in water, then in methylated spirits, and finally dehydrate in absolute alcohol. Clear up in clove oil or xylol; mount in balsam dissolved in xylol, naphtha, or benzol. It is to be observed that naphtha serves for the early stage of soaking in paraffin, for dissolving the paraffin from the mounted sections, and for dissolving the balsam which covers them.

If it is desirable to stain the tissue *en masse* before cutting, the following method is valuable:—Stain the spirit-hardened tissue for 18–24 hours in a borax-carmine solution prepared as follows:—Add 4 grm. borax to 100 ccm. aq. dest., and heat to boiling point. Add 2½ grm. carmine, and boil for 12 minutes. Allow it to cool, and add an equal bulk of a 70 per cent. solution of alcohol. After allowing it to stand for three or four days, filter.

The now deeply stained tissue is partly decolorized by being placed for 12 or 15 minutes in a mixture of acid. hydrochlor. 4 drops, abs. alcohol 70 ccm., aq. dest. 30 ccm.

It is then placed in methylated spirit for three hours, and afterwards in alcohol for 18–24 hours. Clear up in clove-oil—denoted by its sinking.

It is now ready for the paraffin process, being first soaked in naphtha, &c. When the sections are cut they are fixed on the slide in the usual manner, the paraffin dissolved out with naphtha, and the mounting completed with balsam."

Sections of Staminate Cone of Scotch Pine.*—Mr. Charles E. Bessey sends the following contribution from the Botanical Laboratory of the University of Nebraska to show what can be done by the paraffin imbedding process in cutting and mounting objects which otherwise would fall to pieces. The preparation was as follows in detail:—

The cone was first put into 35 per cent. alcohol for 12 hours. Then successively 12 hours each in 50 per cent. alcohol, 75 per cent. alcohol, hæmatoxylin, 90 per cent. alcohol, absolute alcohol, alcohol and turpen-

* Amer. Mon. Micr. Journ., xii. (1891) p. 56.

tine, pure turpentine, cold paraffin and turpentine. It was then put into warm paraffin and turpentine for 6 hours, then into melted paraffin (50°–55°) for 6 hours. It was then imbedded in the paraffin and cut into ribbons upon a Reichert-Thomé microtome, the sections being 20 μ (1/250 in.) thick. The ribbons were fixed on the slide with white of egg and glycerin. The slide was warmed to melt the paraffin, which was then washed away with turpentine, washed next with absolute alcohol, then 90 per cent. alcohol, then water (distilled), then stained with fuchsin about two seconds, next washed with distilled water, 90 per cent. alcohol, absolute alcohol, and turpentine in succession. Canada balsam in chloroform was then poured over the specimen and the cover-glass laid on. I have given every step taken in the operation. The hæmatoxylin did not penetrate, hence the staining by fuchsin was necessary."

(4) Staining and Injecting.

New Method of Injecting Fluids into the peritoneal cavity of animals.*—Dr. A. F. Stevenson and Dr. D. Bruce describe a method for injecting fluids into the peritoneal cavity without danger of wounding the intestines with the point of the hypodermic needle. The needle is curved, its anterior half being solid, while the posterior part is hollow, the opening being in the middle, i. e. at the junction of the two halves. It may be fitted to any syringe. When using it, the abdominal wall of the animal is pinched up with thumb and forefinger of two hands, and then the needle plunged through until the middle (the opening) is in centre of the pinched-up tissue. Hence when the skin is relaxed the opening of the needle is freely within the peritoneal cavity.

Demonstrating the Cerebral Vessels of Mammalia.†—For studying the distribution of the cerebral vessels of Mammalia at various periods of intra- and extra-uterine life, Sigg. G. Valente and G. d'Abundo found that an aqueous solution, not stronger than 0·5 per cent., of silver nitrate, was more suitable than all other injection masses. By the injection of coloured gelatin the vessels, especially in the embryo, were dislocated from their normal position. This inconvenience is avoided by the silver solution, while at the same time, owing to its penetrating the walls of the vessels, the endothelium and the perivascular lymphatic sheaths are made clear. Brains injected in this way cannot, of course, owing to the precipitation which would ensue, be treated with the ordinary fixative media. After being exposed for twenty minutes to direct light they were at once transferred to alcohol. For staining, Meynert's method was preferred, and it is advised to stain the sections on the slide.

Three useful Staining Solutions.‡—Dr. R. Haug gives three formulæ for staining solutions which are stated to be extremely effective.

(1) Hæmatoxylin in acetic acid-alum. 1 grm. of hæmatoxylin is dissolved in 10 ccm. of absolute alcohol, and this mixed with 200 ccm. of liquor aluminis acetici (German Pharmacopœia—see also "Extra

* Brit. Med. Journ., June 6, 1891, p. 1224 (2 figs.). See also Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 689–90.

† Atti Soc. Scienze Nat. Pisa Mem., xi. (1890) 14 pp., 1 pl. See Zeitschr. f. Wiss. Mikr., viii. (1891) p. 92.

‡ Zeitschr. f. Wiss. Mikr., viii. (1891) pp. 51–2.

Pharmacopœia"). The fluid, at first violet-black, becomes brownish-black in the course of a few weeks, and its maturation may be hastened by the addition of a few ccm. of saturated lithium carbonate solution. It is advised to overstain the preparation with this solution, and to decolorize with hydrochloric acid-alcohol. The sections are then placed in tap water until they become blue. Any contrast dye may be used afterwards.

(2) Alum-borax-carmine with acetic acid-alum. This gives similar but better results than alum-carmine. It is prepared by rubbing up 1 grm. carmine with 1 grm. borax and 2 grm. ammonia-alum, and then boiling this with 100 ccm. of liq. aluminis acetici for half an hour or longer. It is then decanted, and after 24 hours filtered.

(3) Ammonia-lithium-carmine with ammonium chloratum. This gives a fine deep strawberry red colour in 1–3 minutes. Overstained sections may be differentiated with hydrochloric acid-alcohol. Afterwards they are placed at once in absolute (picric) alcohol. It is prepared by rubbing together 1 grm. carmine with 2 grm. ammonium chlorate, and boiling in 100 ccm. water. When cold, to the solutions are added drop by drop 15–20 ccm liq. ammonii caustici and lithium carbonicum from 0·3 to 0·5. Filter. The solution is ready for use at once, and is very permanent.

Fixation of the Stain in Methylen-blue Preparations.*—Prof. A. S. Dogiel finds that the addition of osmic acid to the picrate of ammonium solution used for fixing methylen-blue is attended with several advantages, not the least of these being that it hardens the tissue just a little, and, secondly, that it stains the medullary sheath of nerves black. The solution is made by adding 1 or 2 ccm. of a 1 per cent. osmic acid solution to 100 ccm. of a saturated aqueous solution of ammonium picrate. The stain is fixed by immersing the preparation for 18–24 hours in the mixture. It is then transferred to glycerin, diluted with water, in which the colour of the nerves will keep for quite a long time. Should it be necessary to impart a consistence to the object so that it may be sectioned, the author uses a greater quantity of osmic acid (25–30 ccm. ammonium picrate solution; 1–2 ccm. 1 per cent. osmic acid). In this solution the object remains for 24 hours, after which it may be imbedded e. g. in elder-pith, liver, &c., and sectioned.

Hints on Preparation of Tumours injected during life with anilin pigments.†—In order to examine sections made from malignant tumours which have been treated by injection with aqueous solutions of chemically pure anilin dyes, it is necessary, says Dr. R. Haug, to adopt a certain procedure. The dyes usually injected *intra vitam* by the surgeon are methyl-violet and methylen-blue. If, therefore, a piece of a tumour injected with these dyes be excised before their absorption, a blue-violet mass is obtained. This mass must be hardened, and for this purpose alcohol must be altogether excluded. Hardening may be effected in Erlitzki's fluid or some other combination of chromic acid salt and copper, or picric acid; better than these is cold saturated solution of sublimate. In this pieces, the sides of which are about 0·75 cm., are left for about 24 hours. The sublimate crystals are removed by

* Zeitschr. f. Wiss. Mikr., viii. (1891) pp. 15–9.

† T. c., pp. 11–15.

immersion in the following solution, which must be renewed until all traces of sublimate have disappeared :—Tincture of iodine, 2; iodide of potash, 1; distilled water, 50; glycerin, 50. After this the piece is placed in pure glycerin, to every 100 ccm. of which 2 grm. of anhydrous sulphate of copper are added, Herein it remains for 24–48 hours. The preparation is then to be imbedded. For this it is first saturated with glycerin-jelly or transparent soap, and then inclosed in pretty hard paraffin; but before this inclosure is made, the object must be immersed merely for a moment in quite absolute alcohol. Instead of inclosing in paraffin the object may be stuck on cork with thick jelly or jammed in liver. While sectioning it is necessary to cover both knife and preparation with a mixture of equal parts of water and glycerin, otherwise the section will be torn to pieces. The sections are then removed to water on a brush. The next step is to contrast stain, and for this purpose some of the various carmine solutions are most suitable. It is advised to place the sections for a quarter of an hour before staining in a saturated solution of lithium carbonate. If a single stain be desired, then alum-carmine or cochineal are suitable; if a double stain, then neutral carmine followed by differentiation with weak acetic acid. The sections are then placed in glycerin and water (equal parts), and then saturated solution of picric acid is added.

The sections are then transferred to pure glycerin and there examined. In successful preparations a triple stain is obtained, and we are enabled to ascertain how the pigment has acted during life, that is to say, what has been its distribution and effect; whether it has penetrated within the vascular channels, among the stroma of the tissue, whether it has obtained access to the interior of the cells, and what action it has had upon the epithelial cells.

Preparing and Staining Sections of Spinal Cord.* —In a contribution to the technique required for spinal cord, Dr. A. Ciągliński enunciates some apparently heterodox opinions, such as the uselessness of hæmatoxylin for staining, and gives with copious details his method of procedure. The spinal cord is to be cut up into pieces 1 cm. long, and these immersed in Erlitzki's fluid (3–4 weeks), or in Müller's fluid (3–4 months). As the former solution is prone to throw down a copper precipitate, the latter is preferred. When sufficiently hard, the pieces are carefully washed in water, and then placed for a day or two in 70 per cent. spirit, and finally for one day in absolute alcohol. Thus dehydrated, the object is immersed for 24 hours in anilin oil, then for 2 or 3 hours in xylol. Then for 20 hours in a mixture of equal parts of xylol and paraffin, and kept at a temperature of 37° C., after which it is imbedded in pure paraffin. The paraffin, which for winter should have a melting-point of 45° C., and for summer of 52° C., is melted over a gas flame. To the first paraffin imbedding are added some drops of cedar oil to make it more elastic, and the preparation left in the oven for 24 hours. The second imbedding is only incubated for 15–20 minutes, and then the preparation is turned out into a watch-glass smeared with glycerin. It is important to know which side is uppermost. The

* Zeitschr. f. Wiss. Mikr., viii. (1891) pp. 19–28.

paraffin is then set in cold water. The sections are then stuck on a slide and placed in a thermostat at 37° C.

The author then stains with safranin and anilin-blue as follows:—After the preparations have been freed from paraffin by means of xylol they are washed with absolute alcohol, and then for half an hour with distilled water. They are then covered with a watery 0·2 per cent. solution of safranin and kept moist by being put inside some glass vessel. After 1–3 days the safranin solution is poured off and the preparations thoroughly washed with distilled water, whereupon they are further stained for 1–5 minutes with anilin-blue (a saturated aqueous solution diluted with an equal volume of distilled water). The deeper the safranin stain, the longer the anilin-blue solution is allowed to act, and *vice versa*. The preparation, having been washed, is then dehydrated, cleared up with oil of cloves, treated with xylol, and finally mounted in xylol-balsam.

By this method the medullary sheath of nerves is stained orange-yellow; axis-cylinders, deep blue; ganglion-cells and their processes, blue; neuroglia-cells and their connective tissue, bright blue; walls of blood-vessels blue, while the elastic membrane and nuclei of the muscular fibres are red; pia mater, blue; white substance of cord, red; grey substance, pale blue; but if any morbid changes have occurred the degenerated parts stain deep-blue.

Manipulating and staining old and over-hardened Brains.*—M. J. Honegger, who has been making researches on the brains of Mammalia, communicates the interesting fact that old over-hardened brains, always provided that decomposition has not occurred before or during hardening, can be rendered perfectly sectionable and stainable by immersing them for several days in water which has been made nearly boiling and is frequently renewed.

For staining brains preserved in bichromate of potash an ammoniacal solution of carmine is very suitable, and the author makes his solution as follows:—The carmine is rubbed up to a thick pap with only just as much ammonia as is absolutely necessary, and having been spread all round the inside of the mortar, is allowed to thoroughly dry, and then finely powdered. After 24 hours' exposure to the air the powder is dissolved in cold water, and thus a very satisfactory staining solution is obtained.

Staining with acid-fuchsin and gold impregnation may also be adopted. In the latter case the sections are kept for 3/4 hour in 1/2 per cent. gold solution in the dark. They are then transferred to water slightly acidulated with acetic acid and exposed to full sunlight, and then kept for two days more in daylight. In this way a strong reduction is attained, and after-darkening quite avoided.

Staining Bacillus of Glanders.†—Herr E. Noniewicz advises a combination of Löffler's and Unna's method for staining *B. mallei*. The procedure, which is stated to give excellent results, is as follows:—The

* Rec. Zool. Suisse, v. (1890) pp. 201–310 (5 pls.). See Zeitschr. f. Wiss. Mikr., viii. (1891) p. 99.

† Deutsch. Zeitschr. f. Thiermed. u. Vergleich. Pathol., xvii. pp. 196–208. See Zeitschr. f. Wiss. Mikr., viii. (1891) pp. 109–10.

sections are transferred from alcohol to Löffler's methylen-blue solution (caustic potash 1: 10,000). They are then washed in distilled water and placed in the decolorizing fluid (75 parts 1/2 per cent. acetic acid and 25 parts 1/2 per cent. watery tropæolin O O). The time for decolorizing depends on the thickness of the sections, the thick ones requiring from 2 to 5 seconds, the thin ones much less. The preparations are then thoroughly washed in distilled water; this removes the acetic acid and a good deal of the stain. The sections are then put on a slide, and the water having been removed with blotting-paper, are dried in the air or over a spirit-lamp. Xylol is then dropped on and allowed to remain till the section is quite clear. They may now be examined or mounted in balsam. Oil of cloves, origanum oil, and anilin oil are not to be used. In this way the glanders bacilli are stained almost black, while the tissue is bluish.

Staining Pathogenic Fungus of Malaria.*—Surgeon J. Fenton Evans has found it possible to stain the organisms of malaria with an anilinized alkalized solution of rosanilin hydrochloride after treatment with bichromate of potash, and after treatment with dilute sulphuric acid by an anilinized alkalized solution of Weigert's acid fuchsin. Another method is the saturation of the tissue with a copper salt, and its reduction by sulphuretted hydrogen previous to coloration with anilinized alkalized acid fuchsin.

Characteristics of some Anilin Dyes.†—Dr. C. Vinassa, in a contribution to "pharmacognostic microscopy," communicates the results of a number of experiments made with fifty-one different anilin pigments. These results are displayed in two tables. In the first are noticed the behaviour to acids and alkalies, and the stain imparted to the microscopical preparation. Some of the dyes showed a capacity for double staining, the most noticeable of these being "Solidgrün" and "Deltapurpurin." By these the vessels were stained green and the parenchyma red.

Many other useful staining qualities and characteristics may be gathered from a perusal of the table, but for these the original must be consulted. Table 2 gives the chemical derivation, the peculiar microscopical stainings of the various tissue-elements, and the behaviour as dyes to certain commercial products, such as silk, wool, &c.

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

Mounting Botanical Preparations in Venetian Turpentine.‡—Herr F. Pfeiffer highly recommends Venetian turpentine for mounting botanical preparations, and states that it possesses qualities which render it capable of superseding glycerin-gelatin. On the whole, its manipulation is extremely simple. Sections of firm vegetable tissue are merely transferred from strong spirit (92–100 per cent.) to a drop of turpentine placed on a slide. After the cover-glass has been put on, the preparation can be ringed round. But if the sections are thin, liable to wrinkle up, and are to be stained, then certain eventualities have to be

* Proc. Roy. Soc. Lond, xlix. (1891) pp. 199–200.
† Zeitschr. f. Wiss. Mikr., viii. (1891) pp. 34–50.
‡ T. c., pp. 29–33.

borne in mind. These are, that the preparation while standing dehydration in strong spirit is distorted when transferred to the turpentine; for such preparations, though properly fixed and hardened, will not bear the transference to strong spirit. To obviate these inconveniences the author has adopted the principle of Overton's method.* The objects, already stained, are removed from alcohol to a solution of 100 parts 94 per cent. spirit and of 10 parts Venetian turpentine. The preparation is then placed in an air-tight glass capsule in the presence of chloride of calcium, by which means the turpentine is slowly concentrated by the removal of the spirit and water.

The glass capsules and other vessels employed in the manipulation should have tall sides, e. g. 2 cm. high to 1·5 cm. diameter, and 2·5 cm. high to 2 cm. diameter. The edge inside and out should be smeared with paraffin; this is easily done by just dipping the top of the capsule into molten paraffin and allowing it to set; the width of the paraffin rim should be 3–4 mm. These precautions prevent the turpentine from running up the inside and then down the outside of the capsule.

In these small capsules the object is immersed in the turpentine solution, and then these placed inside a larger closed capsule, the diameter of which is 8–10 cm., and the height 3·5–4 cm. In a few days the object will be found saturated and surrounded by thick turpentine, and suffering from no distortion.

Tissues which crumple up when placed in strong alcohol are treated by Overton's glycerin method. The object is placed in a mixture of 90 parts of water and 10 parts of glycerin; by slowly extracting the water the glycerin is inspissated, and this in its turn is removed with strong or absolute alcohol. The concentration is hastened by using the sulphuric acid exsiccator.

Preparations thus treated may, after 12–24 hours' immersion in spirit, be mounted straight away in the Venetian turpentine. If, however, they will not bear this, the procedure originally noticed must be adopted.

(6) Miscellaneous.

An Inexpensive Reagent Block.†—Prof. J. H. Pillsbury says:—"A frequently expressed need of some convenient and inexpensive block or case in which to place the reagents and apparatus used in the biological laboratory, leads me to describe the form I have used for some time (fig. 69).

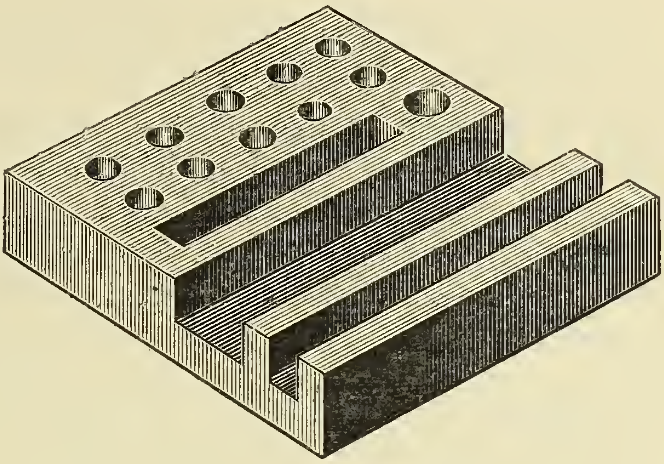
It is a plain whitewood block, 15 cm. square and 4 cm. thick. On the upper side of this three grooves are cut, each 1·5 cm. deep. The first is 1 cm. from the edge, and 1 cm. wide. The second is 1 cm. from it, and 3·5 cm. wide. The third is 1 cm. from it, and 2 cm. wide. Into one end there is glued a closely-fitting block 1 cm. long, and in the other end one 5 cm. long, leaving a trough for slides about 9 cm. long. In the place where this last block is glued is bored a hole 1·5 cm. in diam. and 1 cm. deep, into which tightly fits a paper pill-box for covers. The remainder of the block is provided with two rows of five

* See this Journal, 1890, p. 535.

† Amer. Mon. Micr. Journ., xi. (1890) p. 2.

holes, each 2 cm. in diam. and 3·5 cm. deep, for reagent phials. The first groove is used for razor, and the second for pencils, pipette, forceps, &c. The block is easily made, costs very little, is very neat in appearance, and convenient in work."

Fig. 69.



Microscopic Diagnosis of Citric Acid in Plants.*—M. E. Belzung states that, according to Schultze, citric acid may be recognized in the ripe seed of *Lupinus luteus* by treating the seeds with alcohol, evaporation, and treating the residue with water; from this solution citric acid can be separated. The author, however, endeavours to diagnose the acid by means of the formation of citrate of calcium. Young plants were grown in a weak solution of nitrate of calcium, sections of the plant were made, and examined microscopically; after a short time, numerous acicular crystals appeared, which were found to be those of citrate of calcium.

Artificial Preparation of the Sphæroliths of Uric Acid Salts.†—Herren W. Ebstein and A. Nicolaier say that if some uric acid be dissolved on a Microscope-slide in a dilute alkaline solution, and watched with the Microscope, there is, after slight concentration, a formation of round particles of urates varying in diameter from 2–100 μ. These are mixed with needles, either singly or in bundles. As solvents, sodium hydroxide, potassium hydroxide, lithium carbonate, borax, ammonia, and piperazine were used; the best results were obtained by using the uric-acid sediment from human urine.

With the polarizing Microscope between crossed nicols the sphæroliths showed a right-angled, black interference cross, the arms of which lay parallel to the polarization planes of the nicols, and, concentric with the middle point of this cross, coloured interference rings were seen.

Similar sphæroliths were obtained with sodium hydrogen carbonate, so that they may consist either of acid or normal urates.

The interest of such an observation, as bearing on the formation of urinary calculi, is pointed out.

* Journ. de Bot. (Morot) v. (1891) pp. 25-9 (3 figs.).
† Virchow's Archiv, 123, pp. 373-6; see Journ. Chem. Soc. Lond., cccxliii. (1891) pp. 760-1.

PROCEEDINGS OF THE SOCIETY.

Meeting of 17th June, 1891, at 20, Hanover Square, W., the President (Dr. R. Braithwaite, F.L.S.) in the Chair.

The Minutes of the meeting of 20th May last were read and confirmed, and were signed by the President.

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

	From
De Toni, J. B., Sylloge Algarum, vol. i. pts. 1 and 2. (8vo, Patavii, 1889)	*The Author.*
Parker, T. J., Lessons in Elementary Biology. pp. xxii. and 408, text illust. (8vo, London, 1891)	*The Author.*
Monograph of the Palæontographical Society, vol. xliv. Report of the British Association, 1890	*Mr. F. Crisp.*
A series of figures illustrative of Geometrical Optics. Reduced from F. Engel and K. Schellbach. By W. B. Hopkins. Text, pp. iv. and 56; atlas, 13 pls. (8vo and fol., Cambridge, 1851)	*Mr. J. Mayall, junr.*
A slide containing Tubercle Bacilli	*Dr. G. H. F. Nuttall.*
Woodhead, G. S., Bacteria and their products. pp. xiii. and 459, text illust. (8vo, London, 1891)	*The Publisher (Mr. W. Scott).*
Slides (4) of *Artemia fertilis*, and (1) of desert sand from the Great Salt Lake, Utah	*Dr. J. E. Talmage.*
Photographs (2) of Diatoms	*Mr. B. W. Thomas.*

The President called attention to the volumes presented by Dr. J. B. de Toni as being the commencement of a most important work upon the marine algæ. The portion now before them contained one section only—the green seaweeds, every known species of which was fully described. The other two great sections, the red and the brown varieties, would be afterwards dealt with, and the whole, when completed, would form the most valuable work of reference on the subject yet contemplated.

Prof. F. Jeffrey Bell referred to the book, 'Lessons in Elementary Biology,' presented by Prof. Jeffery Parker, of Otago, N.Z., as one likely to be of interest, an extract from the preface being read to show the aim of the author in seeking to assist the amateur microscopist as well as the professional student.

Mr. J. Mayall, junr., said he had much pleasure in presenting to the Society a copy of the English edition of Engel and Schellbach's optical diagrams, together with an explanatory volume by Mr. W. B. Hopkins, which he thought would prove of use to those who were giving attention to the passage of pencils of light through various forms of lenses. The original work was a recognized text-book in Germany and other parts of the Continent; but it had become very scarce and expensive. The English edition did not differ essentially from the original, though the diagrams were reduced in size, and in some cases, where the rays were symmetrical on both sides of the optic axis, they were figured on one side only. Prof. Schellbach's was recognized as the most perfect work of the kind known.

The President announced the death of Prof. P. Martin Duncan, F.R.S., who, as a past President of the Society, was well known to most of the Fellows on account of the active and efficient manner in which he performed his duties during his occupation of the chair, and was equally well known to others through his great work on the Echinodermata. His sad death occurred on May 29th.

Prof. Bell said that, as the only officer of the Society present who held office during the presidency of Prof. Duncan, he rose to give expression to the regret which he felt at the loss the Society had suffered by Prof. Duncan's death. Prof. Duncan was one of the few remaining naturalists who were not merely specialists. His early contributions to botanical science were succeeded by very important contributions to geology, in which he not only dealt with fossils as such, but also in their relation to the fauna of Australia and elsewhere. The work to which the President had alluded was produced later on. His work as a Fellow of the Society was that of one of the older microscopists who laid great stress upon the use of the lower powers. The appreciation in which he was held was best shown by the fact that the ordinary bye-laws of the Society were suspended in order to keep him in office for a longer period than usual. Those who knew him personally would regret that there had passed away from among them one whom they could not meet without feeling the happier for the meeting, and it would add to the sorrow of those who thus knew him in health to know that he lay for many months previous to his decease in a condition of almost intolerable suffering. His name would be remembered with affection by all who had come intimately into association with him.

A negative of *Amphipleura pellucida*, recently produced with Zeiss's new 1/10 of 1·6 N.A. and sunlight, by Mr. T. Comber, of Liverpool, was exhibited, and his letter was read suggesting that the want of sharpness was due to the employment of a projection eye-piece for a tube-length of 160 mm., whereas the objective was made for a tube-length of 180 mm. The illumination was axial with a Zeiss achromatic condenser of 1·2 N.A. Mr. Comber thought the resolution showed indications of so-called "beading," and hence he inferred that the ultimate resolution would be shown to be similar to that of its congener *Amphipleura Lindheimeri*. The mounting medium had a refractive index of 2·2, but was very unstable, granulations appearing in a very short time. The negative showed these granulations, though the object had only been mounted two or three days.

Mr. Mayall expressed his surprise at the want of sharpness in the definition, especially as the manipulations were conducted by so careful and accurate a microscopist as Mr. Comber. He regretted that Mr. Comber had not had a projection eye-piece corresponding precisely with the tube-length of the objective, so that his trial of that particular objective might have been regarded as authoritative. This was the more regrettable from the fact that so few microscopists in England had their photomicrographic apparatus installed for use with sunlight. The difficulties involved in obtaining suitable objects for examination with Zeiss's new objectives of 1·6 N.A. were very great, due, as he understood, to the chemical action of the dense mounting medium on the flint-glass covers. So far the Society had not received a slide of a kind that could be regarded as satisfactory for testing such an objective.

Mr. C. L. Curties exhibited in its finished form Mr. Nelson's apparatus for obtaining monochromatic light, a specimen of *Rhomboides* being shown under a dry 1/6-in. objective.

Mr. Mayall said Mr. Curties had had the apparatus made entirely of metal, and had hit upon an inexpensive design, though the construction seemed rather too light to be steady enough for general use. He thought there was no absolute necessity to employ a high-class photographic lens for projecting the spectrum; any moderately good achromatic lens of suitable focus would answer the purpose. He understood from Mr. Nelson that for observation work with the Microscope the optical combination at the lantern or slit end of the apparatus was not needed, the slit screen being sufficient; but for photomicrography, by means of artificial light, this optical combination was important to increase the light. The apparatus was so devised that the microscopist might employ any prisms or photographic lenses he possessed. He thought the pierced cardboard on which the spectrum was projected would soon warp out of shape, and that it might be replaced with advantage by a metal plate coated white, which would retain its shape. If a prism had to be made specially, one of light crown-glass would probably answer better than the dense flint.

Mr. T. T. Johnson exhibited and described a new form of student's Microscope which he had devised.

Mr. Mayall said the special point was in the application of a screw movement instead of the usual rack-and-pinion to raise and lower the substage, the screw being in the axis of the bearings of the substage and tail-piece, and the actuating milled head projecting slightly at the back of the stage. He thought this was a very economical way of applying focusing mechanism to the substage. The position of the actuating milled head seemed to him most happily chosen for convenience, though it would probably be necessary to make the head larger so as to provide more grip for the finger, as the movement would be certain to become less free in course of time. When he saw the instrument on the previous day he pointed out that the mirror was connected with the substage and went up and down with it; this defect had since been corrected. He thought this substage adjustment would commend itself to notice, and that if it was not already registered it would certainly be taken up by other opticians for the less expensive forms of Microscopes. It seemed to him that Messrs. Johnson had undoubtedly "scored 1" by bringing out this screw-focusing arrangement for the substage.

Mr. W. Johnson said the arrangement had been devised by his son with very small encouragement from himself. He had to thank Mr. Mayall for calling his attention to the mistake of connecting the mirror with the adjustable substage. His son recognized the error the moment it was mentioned, and at once removed the mirror to a separate sliding-piece.

The President said they were favoured by the presence of Dr. J. E. Talmage, of Salt Lake City, Utah, U.S.A., a recently elected Fellow, who had not only made a special effort to attend the meeting, but had also brought and exhibited some specimens of organic life found in the Great Salt Lake, which he would describe.

Dr. Talmage having expressed his thanks to the President for the kind way in which he had introduced him, and also to the Fellows of the Society for the cordiality of their reception, said that he left Salt Lake City rather hurriedly in order to avail himself of the opportunity of being present at the meeting. On this account he had not brought over as many specimens as he could have desired, but he had placed under some Microscopes in the room several examples of the brine shrimp, *Artemia fertilis*, from the Great Salt Lake, which he thought might prove of some interest. He found these objects rather difficult to mount for permanent observation. It was, for instance, almost useless to use glycerin, because it rendered the structure indistinct by transparency. He had at present discovered no way better than by putting them into some of the lake water with a 5 per cent. solution of alum. The structure was also so very delicate that it was very difficult to spread them out upon a slide, but by the use of the medium named the creature could be transferred to the slide and it spread itself out as it died. In addition to slides of these shrimps, prepared in the manner described, he also exhibited specimens of the calcareous sand from the lake shore.

Dr. Talmage, speaking of the occurrence of life in the Great Salt Lake, said it would seem to be a difficult task to determine the mean composition of the lake. An examination of the water by Dr. Gale, forty years ago, showed the solid contents to be 22·282 per cent., and the density 1·17. In 1869 Mr. Allen reported the water as containing 14·9934 per cent. solids. He (Dr. Talmage) had analysed the water in December 1885, and found 16·7162 per cent. solid matter, with a density of 1·1225. A later analysis, in August 1889, gave the density as 1·1569, and the total solids in solution as 19·5576 per cent. It is fairly safe to assert that under the conditions now prevailing in the Great Basin, the waters of the lake average from 16 to 18 per cent. solid contents. As would be expected, few species of living things have been found in its waters; yet the assertion that no life exists therein is entirely unwarranted. He vouched for the occurrence of each of the following, most of which were abundant:—(1) Larvæ of a species of the Tipulidæ, described as *Chironomus oceanicus* Pack. (2) Larvæ and pupæ of *Ephydra gracilis* Pack. The pupa-cases of this insect accumulate in great numbers upon the shores, where they undergo decomposition, with emanation of very disagreeable odours, recognizable at a distance of miles from the lake. (3) One species of *Corixa*, probably *C. decolor* Uhler. (4) But by far the most abundant is *Artemia fertilis* Verrill, commonly called the brine shrimp. These are often present in such numbers as to tint the water over wide areas. The structure and habits of the *Artemiæ* would prove a most interesting subject of investigation. They are capable of adapting themselves to a wide range of conditions as regards the composition of the water. He (Dr. Talmage) had kept them alive for days in the lake water, diluted 25, 50, and even 75 per cent. with fresh water; and for periods varying from 8 to 18 hours in fresh water only.

Prof. Bell said a paper was read at the February meeting, in which Dr. W. B. Benham described a new earthworm from Central Africa under the name of *Eminia equatorialis.* It was found some time afterwards that the name *Eminia* had already been appropriated, Dr. Hartlaub, of Bremen, having given it to a bird previously found by Emin Pasha. In a letter received Dr. Benham proposed to alter the name given to the new earthworm to *Eminodrilus.*

Prof. Bell also noted that after the last number of the Journal went to press, a letter was received from Mr. Pringle containing additional particulars with regard to the approaching Bacteriological Congress, and giving notice to intending exhibitors as to the conditions under which objects would be received. As might be supposed in anything which Mr. Pringle had to do with, a special feature was made of photography.

Mr. Mayall said it would doubtless be remembered that at the last meeting of the Society Dr. Van Heurck's new Microscope was exhibited, and the design had been somewhat severely criticized. Having seen a report of what was then said, Dr. Van Heurck had written a rejoinder requesting that it might be read at the meeting:—

"I have just read in the 'English Mechanic' of May 29th, the criticism of the instrument which Messrs. Watson and Sons have constructed to my specification. I appeal to your impartiality to allow me to refute the assertions made, and I trust you will authorize the reading of my reply. (1) Defect of the fine-adjustment.—Mr. Mayall wrongly compares the Watson system to Zentmayer's. If the latter was defective, it was because it wanted a certain amount of play to work, as the small steel plate at the bottom, acting as a spring in the Zentmayer-Ross, was incapable of a quick action. It is not the same in Messrs. Watson's instrument, on account of the tightening pieces which allow of remedying the wear and tear which inevitably results in every machine, whatever it be, after some time. Besides, in Watson's system there is a strong counter-spring at the back coiled round a spindle having an action sufficiently strong to perfectly counter-balance the friction of the tightened sliding pieces. That the fixing of this fine-adjustment sliding between guide-pieces is not as bad as Mr. Mayall represents it, is also proved to me when I see that some other approved makers have adopted it for their best Microscopes, such as Messrs. R. and J. Beck, who, in their catalogue for 1890 declare this adjustment 'at once certain and decided.' I have, moreover, had a long experience with Messrs. Watson's system of fine-adjustment, and I know that when it gets out of order, which every fine-adjustment is liable to do in time, it can be put right in a few moments. This is not the case in several large Microscopes much praised. (2) The application of the fine-adjustment to the substage is entirely defective, and seems even to prove, according to

Mr. Mayall, that I have a totally wrong idea of the essential principles of practical microscopy.—I regret I cannot accept Mr. Mayall's decision. I have my own method of working, a method too long to be described in this letter, and as this method enables me to produce work which is said not to be wholly valueless, I shall persevere in my errors. (3) Mr. Mayall says that the milled head of the fine-adjustment of the substage prevents the full rotation of the stage.—Here it is Mr. Mayall who seems to misunderstand the use of this rotating movement. We are no longer in the time when the illuminating apparatus consisted of a simple mirror, and the complete rotation might be of some utility. The condenser really is so arranged as to permit of a luminous pencil being moved all round the object. The rotation is therefore no longer necessary, except for adjusting the object in a convenient position for drawing or photography, or according to the astigmatism of the observer's eye. For all these purposes, the movement which the stage of my instrument possesses is more than sufficient. (4) Mr. Mayall criticizes as wrong the size of the milled heads of the movements of the stage.—It is, however, an elementary principle in mechanics that the larger the lever used, the better it will effect small, easy, and precise movements. If Mr. Mayall had tried oftener to put a diatom in the best possible position, either for photography or to make one of its striæ correspond with the micrometer, he would not recommend the small milled heads of the Mayall-Zeiss stage. This latter, with which I have worked for some time, can be used for finding an object, but it is very tiring to the fingers for continuous work, and cannot be used for work of precision. The displacement produced by the least motion of the milled head is far too rapid. (5) I am in the habit of photographing in the vertical position, and if one pillar gives me a sufficient stability, I do not see why I should have a second one, which would only hinder the handling of the mirror and parts of the substage. A second pillar only adds to the stability when it is put at a considerable distance from the other, as Messrs. Powell and Lealand make it. (6) The centering of the substage, described as of a cheap kind by Mr. Mayall, completely answers its purpose. It is the same as is used for the centering of the stage in Wenham's radial and Zeiss's Microscopes, &c. It would have been quite useless to spend money in superfluous complications. (7) The small screw to clamp the Microscope in the horizontal position was added by Messrs. Watson of their own accord. As I use only vertical cameras, I did not require it. It is possible that they took the idea from one of Swift's Microscopes; this, however, does not matter. The Mayall stage is nothing but Wenham's, constructed about 1878, but rendered independent of the Microscope-stage. No apparatus is now constructed, the suggestion of which cannot be found in some former Microscope. I believe I have replied to all the points criticized by Mr. Mayall. None of them seem to stand, and as for over two years I have used a similar instrument (which I had modified according to my experience) for my most delicate researches with the best results, I thought that others might use it with the same advantages. But one must not forget the conditions I prescribed: combine the convenience for everyday work with the greatest precision possible, at a relatively low price. I now maintain that the instrument fills these conditions; it allows of the use of Continental as well as English objectives; its price is less than the large Continental stands; and, lastly, I challenge Mr. Mayall to make, with any Microscope he chooses, a delicate observation or any photograph which I cannot just as easily, conveniently, and perfectly make with my instrument."

Mr. Mayall said, with reference to Dr. Van Heurck's communication, there appeared to be only one matter calling for a detailed reply from him, and that was the oblique thrust given by Dr. Van Heurck in stating that the Mayall mechanical stage was nothing but the Wenham stage of 1878 rendered independent of the Microscope-stage. In assisting Mr. Frank Crisp in the preparation of the illustrated and descriptive catalogue of his Microscopes, &c., examples of nearly every Microscope and piece of accessory apparatus known had passed through his hands, and he had not only examined them all with considerable attention, but had taken many of them to pieces in order the better to understand and describe the mechanism. He thought, therefore, it might reasonably be supposed that if Mr. Wenham had preceded him in embodying the principle of the Mayall stage, the fact would not have escaped his own notice. Further, he might say that when he decided to have his stage made he went to Ross & Co., in whose house Mr. Wenham was engaged, and assuredly Mr. Wenham would at once have pointed out that the stage was a plagiarism if such had been the case. The fact was that Dr. Van Heurck had made a random guess at the matter without special knowledge, and had missed the point. In the course of years there had been a process of evolution going on in mechanical stages as in other parts of the Microscope. At first they were very elaborately made by the Duc de Chaulnes and by B. Martin in the last century, and were far ahead of the optical appliances to be used with them; then they were simplified, and brought into more general use; then, with the general introduction of achromatism, altogether superior mechanism was employed, and so important was it found to secure steadiness of motion, that stages were made of considerable thickness. Later on, attempts were made to reduce the thickness, and Mr. Wenham devised a stage using one plate only to carry the object. Mr. Tolles, the eminent optician of Boston, sent over a beautifully made stage, having two plates each of about 1/50 in. thick, which Mr. Wenham modified by getting rid of one of the plates; and later still, he (Mr. Mayall) suggested that the plate might be removed and a frame substituted, by which the object could be moved about on the surface of the stage proper of the Microscope. The idea was found practicable and was taken up by various opticians, most recently by Zeiss, of Jena. So far, therefore, as regarded Dr. Van Heurck's imputation that he had plagiarized Mr. Wenham's stage of 1878, he could only regard that oblique thrust as, in fencing phrase, a "coup de Jarnac," and he did not feel under any sort of obligation to acknowledge that he was "hit." His remarks at the last meeting were intended to apply only to Dr. Van Heurck's specification and from what he then said he did not abate a word. He thought much of Dr. Van Heurck's defence of the Microscope was actuated by his not distinguishing between the design and the actual construction. On several points too, Dr. Van Heurck appeared not to have followed the criticism. He must add that the instrument itself had since been in his hands for trial, and he must frankly say that the fine-adjustment worked smoothly and truly; but it should be noted that it had only just left the mechanician's hand. Other parts of the construction were not so well put together; but the defects might well be due to haste in finishing the work, some unavoidable delay having occurred in Messrs. Watson's workshop, in consequence of which the instrument was only ready for inspection a few hours before the meeting of the Society.

The President said that he noticed on the former occasion that Mr. Mayall expressly limited his criticism to the design of the Microscope, and that the manner in which he conveyed his adverse criticism was marked by great courtesy throughout, and it would be admitted that, with the experience he possessed, no one was more competent than he to give an opinion on either the design or the workmanship; hence he thought Dr. Van Heurck had been a little too hard upon Mr. Mayall in his remarks. At their meetings it was undoubtedly their duty to put before one another exactly what they thought with regard to matters brought to their notice.

Dr. W. H. Dallinger said he should like also to say that what impressed him so much at their last meeting was the fact that Mr. Mayall especially dissociated the workmanship of the instrument, and the plan as suggested by Dr. Van Heurck, keeping carefully apart two things which were totally and entirely distinct from each other, and dealing only with that which so intimately affected all who were accustomed to work with high powers. On those points of the principles of construction, apart from the way in which they were carried out, Mr. Mayall had said what, from his experience and his knowledge of the subject, was of great value to them all. They, in this country, were regarded as standing in the highest position as to the opportunities they possessed in forming correct judgments upon matters of that kind, and their judgment was regarded with respect by those who sought its expression. That being so, it was undoubtedly a serious thing for them to pass over lightly, or by their silence to appear to sanction, that which they believed to be inaccurate, simply for fear of offending the sensibilities of any one concerned. Whenever, therefore, a Microscope was brought before them for inspection, their duty was to express, just as a judge would express, a calm and fearless conviction of what was true and what was false. If, therefore, it was a fact that Microscopes were often brought before them, it was because their judgment was held in esteem, which esteem would not be longer valued as it was were they to express themselves loosely without the most absolute regard for that which was in itself perfectly true. Makers who regarded these matters in their true light should not consider themselves attacked when the principles of construction, and not the mechanical processes, were called into question.

Mr. Watson said he might mention that he came to their last meeting with a great deal of assurance because, knowing that much credit had been given to various Continental Microscopes which was not accorded to those of English makers, he thought he had achieved a position when the most competent of Continental microscopists had said with regard to this form of fine-adjustment, that it was the best he had ever seen, and that he was so well satisfied that after long trial he desired to have an instrument made specially for him on the same lines. When, therefore, he brought it to the meeting, he thought he had a thing which would certainly be able to hold its own; and yet, on producing it, he found it was utterly condemned. Naturally, he felt very much hurt. He had nothing to complain of as regarded anything said about the workmanship, but what he still said was that the people who undertook to criticize it should be those who had had it in use and could speak from knowledge and experience, rather than a gentleman who had never seen it before. He said this because Dr. Van Heurck, after some years of actual use, had stated that it worked perfectly well. He would not add anything further on that occasion, except that he was much obliged to those present for listening to what he had said.

Dr. Dallinger, having suggested that they were not a debating society, and in no way bound by the rules of a debating society, expressed a hope that if any one had a truth to state he would feel at perfect liberty to speak further.

Mr. Mayall said he could not for a moment admit Mr. Watson's contention that no valuable opinion could be given of a Microscope unless the instrument was actually tried. The design was one thing and the construction another. The design might be good or bad, and the construction might also be good or bad, hence it was evident that one might be considered apart from the other. In condemning the design of the Van Heurck Microscope he had had no thought of hurting Mr. Watson's patriotic feelings. Until Mr. Watson stated the fact, he (Mr. Mayall) was not aware that any sort of patriotism was involved in the manufacture of a Microscope. He did not follow Mr. Watson in supposing that the approval given of the Microscope by Dr. Van Heurck would almost necessarily involve its being approved by those Fellows of the Society who were known to have made a special study of such matters. It was, perhaps, quite natural that Dr. Van Heurck and Mr. Watson should approve of their bantling, and say what they could in its defence; but he must claim for himself exactly the same liberty that was possessed by all other Fellows of the Society to decline to measure his criticism to suit the particular crotchets of this or that amateur, or the interest of any particular manufacturer of Microscopes. In dealing with such matters he was not acting in the name of the Society, but in his individual capacity as a Fellow. His approval or disapproval of a specification or of a construction had no other claim to serious consideration than in so far as it fairly represented opinions based on experience. It had been no satisfaction to him to condemn Dr. Van Heurck's Microscope, for he could only anticipate what had actually happened—that Dr. Van Heurck would defend himself vigorously. He had, however, been somewhat perplexed by the line of defence taken by Mr. Watson in asserting that the "principal points" in the Van Heurck Microscope existed already in a Microscope supplied by his firm to Dr. Van Heurck three or four years ago. The question seemed naturally to follow: Why, under these circumstances, was Dr. Van Heurck's name attached to the instrument? There seemed some sort of mystery in the matter. For his own part, he was practically certain that if Dr. Van Heurck had sent him the specification, with a drawing, asking his opinion, he should have dealt with the technical details as he had done at their last meeting. It was no new opinion of his to condemn the Zentmayer system of fine-adjustment, and he had not condemned it until Messrs. Ross had gone through a most exhaustive series of experiments with the system, resulting in the abandonment of their patent rights, and in their adopting other systems for their best Microscopes. The fact that Messrs. Ross allowed the patent to lapse was the severest condemnation of Zentmayer's system of fine-adjustment. He might add that Messrs. Ross had submitted all their experimental devices to himself for trial, and that every step that had been taken in the matter was thoroughly discussed by Mr. Wenham and others before the Zentmayer system was given up. After this experience, he had felt justified in condemning the system frankly in his Cantor Lectures at the Society of Arts, and his criticism was published five years ago in the Journal of that Society. Dr. Van Heurck had received a copy of the reprint of those lectures, and might at any time have asked him for fuller details if he had thought proper to do so. It was hardly to be expected that he should seek information of that kind from Dr. Van Heurck, who had hitherto been totally unknown as taking any special interest in the design of Microscopes or microscopical apparatus; and he must confess that the recent discussion on the design of the "Van Heurck" Microscope had not impressed him with Dr. Van Heurck's knowledge of the mechanism of high-class Microscopes. It was, surely, a matter of common knowledge that a skilled manipulator could execute extremely delicate work with a Microscope of very inferior construction. Dr. Van Heurck's challenge to himself to a competition in manipulation would, if accepted, really end in no useful result. Whether one Microscopist could or could not do with inferior means what another had done with the best means available, would not advance the construction of the Microscope a jot. Instead of an idle competition of that kind, it would be infinitely preferable that experts in microscopical manipulation should frankly compare notes of past experience, and join in the promotion of the highest excellence attainable in the mechanical and optical construction of the Microscope. He thought the question of their right to freedom of discussion of the matters brought before them had been admirably laid down by Dr. Dallinger, who, in writing to him on the subject, had expressed himself as follows:—

"Our criticisms of instruments and apparatus are judicial—absolutely unbiased, and wholly on the merits of the subject, or they are of no value —nay, they are pernicious. If ours were a debating club there might be limits to the 'right of reply.' We are a society seeking truth on a special subject. If a man happens to be able to add to or elucidate a truth by rising four or five times, and before or after any one else, I take it that he may and should do so. But as a matter of fact, I rose to criticize a principle, not a thing. My remarks on the thing were incidental. I merely demanded our right to criticize favourably or adversely, as our judgment dictated; and that carried with it the consequent impropriety of any attempt to *retort*. A modest reply would be different." He thought he need not read the remainder of the letter, though it emphasized Dr. Dallinger's agreement with the adverse criticism of the Van Heurck Microscope. He desired it to be clearly understood that when he criticized a Microscope, he did so in his individual capacity, and certainly not as speaking with authority on behalf of the Society, and he hoped that opticians who brought instruments to the Society would not ask them as a Society to pronounce opinions either in praise or blame. Such matters could only be properly dealt with by the Fellows in their individual capacity, and the Society must not engage collectively to hold the balance steadily and weigh the merits of the various commercial interests involved in bringing new Microscopes to the notice of the public. Those Fellows who had had special experience in examining and testing Microscopes and Microscopical apparatus must be left to use their own discretion as to what they commended to the notice of the Society, and provided the principle laid down by Dr. Dallinger were kept in view—that the criticism was wholly and sincerely on the merits of the subject—the result must be to forward the best interests of microscopy and of the Society. As to what might be done in future cases, he trusted the principle advocated by Dr. Dallinger would be always maintained.

Mr. T. D. Aldous exhibited the eggs of a water-snail which were attacked by a hexapod parasite which seemed to be destroying the gelatinous matter to get at the eggs.

The President announced that the next meeting of the Society would be held on 21st October.

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

Mr. T. D. Aldous:—Eggs of Water-snail.

Mr. T. Comber:—Negative of *Amphipleura pellucida.*

Mr. C. L. Curties:—Nelson's apparatus for producing monochromatic illumination for the Microscope.

Mr. T. T. Johnson:—New form of Student's Microscope.

Dr. G. H. F. Nuttall:—A slide containing Tubercle Bacilli.

Dr. J. E. Talmage:—Slides of *Artemia fertilis* and Calcareous Sand.

Mr. B. W. Thomas:—Photographs of Diatoms.

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. John Hunt, Lemuel Benjamin Lilley, Charles Henry Southwell, Edwin Terry, and Miss Ida Agnes Sharpe. *Honorary* Fellow:—Prof. Thomas Henry Huxley, F.R.S. *Ex-officio* Fellow:—The President of the Scottish Microscopical Society.

F. Chapman del.
E. C. Knight. Lith.

West, Newman imp.

Folkestone - Gault Foraminifera.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

OCTOBER 1891.

TRANSACTIONS OF THE SOCIETY

IX.—*The Foraminifera of the Gault of Folkestone.*—I.

By Frederick Chapman.

(*Read* 21*st October*, 1891.)

Plate IX.

Our knowledge of the Foraminifera occurring in the Gault of England has hitherto been derived from collections of organisms from clay-washings of unknown horizons. The list published in the Geological Survey Memoir,* though comprising many varieties, has in some instances the disadvantage of uncertainty regarding the precise locality. The valuable paper of Dr. von Reuss † was based on specimens collected from clays of uncertain horizons.

Finding that the facies of Foraminifera from the Upper and Lower Gault beds showed marked differences, it seemed desirable that not only should the microzoa of the Gault be worked out at some definite locality, but that they should be collected at various levels throughout its thickness.

The section of Gault exposed at Copt Point, Eastwear Bay, Folkestone, being the most favourable, and one which has received most attention from stratigraphists, the author has, since December

EXPLANATION OF PLATE IX.

Fig. 1.—*Nubecularia depressa* sp. n.
„ 2. „ *nodulosa* sp. n.
„ 3*a*, *b*.—*Biloculina unduluta* sp. n.
„ 4*a*, *b*.—*Spiroloculina asperula* Karrer.
„ 5*a*, *b*.—*Miliolina venusta* Karrer sp.
„ 6. „ „ „ broad variety.
„ 7. „ *agglutinans* d'Orb. sp.
„ 8. „ *Ferussacii* d'Orb. sp.
„ 9*a*, *b*. „ *tricarinata* d'Orb. sp.
„ 10.—*Ophthalmidium tumidulum* Brady.
„ 11*a*, *b*.—*Cornuspira cretacea* Reuss.
„ 12*a*, *b*. „ *involvens* Reuss.
„ 13*a*, *b*. „ *foliacea* Philippi sp.

All the figures × 60.

* W. Topley, 'Geology of the Weald,' 1875, pp. 423–4.

† "Die Foraminiferen des norddeutschen Hils und Gault," Sitzungsb. K. Ak. Wiss. Wien, xlvi. pp. 5–105, pls. i.–xiii.

1885, employed himself in collecting and studying the Foraminifera from that locality.

The Gault at Copt Point has been divided into eleven zones by Messrs. C. E. De Rance, F.G.S.,* and F. G. Hilton Price, F.G.S.† The divisions described by the latter author have been adopted in the present work.

Specimens of Gault were taken from each zone, and in some cases, where the same zone presented lithological differences, materials from more than one level were obtained. Thus from zone XI., which is 56 ft. 3 in. in thickness, specimens were taken at intervals of 5 ft. or more. In this work of collecting the clay samples I had the advantage of the assistance of John Griffiths, who has collected for very many years from all parts of this formation. The number of clay samples worked out was twenty-three.

My best thanks are due to my friend Mr. C. D. Sherborn, F.G.S., for his ready assistance at all times; to Professor J. W. Judd, F.R.S., for his counsel and for drawing my attention to the presence of borings of parasitic plants in the prisms of Inoceramus shells; to Professor T. R. Jones, F.R.S., for much useful advice; to Dr. D. H. Scott, for the information regarding the forms of parasitic plant-borings in the shells and fish remains from the Gault beds; and to Mr. J. W. Gregory, F.G.S., for the examination of many spines and other parts of Echinoderms. For the analyses of the various specimens of clays I am indebted to my friend Mr. S. Young. Mr. E. Halkyard, F.R.M.S., has kindly allowed me to examine his choice collection of Foraminifera from the Folkestone Gault, in which, however, I did not notice any forms new to my own series.

The following are the descriptions of the clays and their washings, given consecutively from the base to the top of the Gault.

Zone I. specimen *a*. From the greensand seam, above the line of nodules of sulphide of iron, with rolled fossils. A very dark green glauconitic clay. Residuum after washing, 33 per cent. of glauconitic sand, not including the rolled fossils intermingled. Many of the glauconitic grains are perfectly distinct casts of Foraminifera. The washed material consists mainly of bright green glauconite, with a few grains of quartz and chalcedony; also a small shark's tooth. The microzoa are scarce. There are prisms of Inoceramus (found in every bed throughout the Gault from the base to within 20 feet of the top), and fragments of other shells; these prisms and shell-fragments are tunnelled, the former in all cases, by borings of parasitic plants which Dr. D. H. Scott thinks may be referred to the genera *Ostracoblabe*, *Ostreobium*, and *Lithopythium*; ‡ there is also a stelliform organism met with in the fish remains, shell fragments, and in *Nubecularia nodulosa*, which has been previously noticed by C. B.

* C. E. De Rance, Geol. Mag., 1868, p. 163.
† Q.J.G.S., xxx. p. 342; and 'The Gault: a Lecture,' London, 1879.
‡ MM. Bornet et Flahault, Bull. Soc. Bot. France, xxxvi. (1889) p. 147.

Rose * and Professor Kölliker.† These minute borings are not confined to any one stratum, but are well distributed throughout the whole of the Gault. The finest washings ‡ consist of glauconite, angular quartz-grains, and *Anomalina ammonoides* Rss. sp.

Zone I., specimen *b*. From the level of 5 ft. above the base of the Gault. A greenish-grey clay, splashed with lighter markings. The proportion of sandy and shelly material remaining after washing is $1\frac{1}{4}$ per cent. The organisms are all very small. The washed material consists of glauconite, prisms of Inoceramus, fragments of Nucula and other testacea, spines of Hemiaster, numerous Ostracoda,§ Foraminifera, and fish remains. The fine washings consist of glauconite grains, angular quartz-grains, and prisms of Inoceramus; also *Bolivina textularioides* Rss. (generally filled with glauconite), very common; *Ramulina* sp., very rare; *Globigerina cretacea* d'Orb., very common; and *Anomalina ammonoides* Rss. sp., very common. The rotaline forms throughout the Gault are in very many cases filled with carbonate of lime, and each chamber of the shell shows a black cross between crossed nicols.

Zone II., specimen *a*. From the band of crushed Ammonites. A dark-green tenacious and fossiliferous clay; the fossils of a bright colour. Residuum after washing $12\frac{1}{2}$ per cent. The washed material consists of shelly sand, with some entire shells in a flattened condition. It is of great interest to note that although these larger shells show the effects of pressure, the microzoa remain intact. Spines of Pseudodiadema also occur here. The microzoa are not common. The finest washings consist of glauconite grains, prisms of Inoceramus, and angular quartz; also the following Foraminifera,—*Bolivina textularioides* Rss., frequent; *Globigerina cretacea* d'Orb., frequent; and *Anomalina ammonoides* Rss. sp., very common.

Zone II., specimen *b*. 11 ft. from the base of the Gault, from a bed 1 ft. thick. The clay is of a dark greenish-grey colour, full of shells. Residuum 4 per cent. consisting of shelly sand and containing crushed Gastropods and spines of Hemiaster. Microzoa are not common. The fine washings are glauconitic, and show a marked scarcity of quartz-grains; *Anomalina ammonoides* Rss. sp. is frequent.

Zone II., specimen *c*. A very dark clay from the level of 13 ft. above the base of the Gault, highly fossiliferous, with shells of rich colours. Residuum $6\frac{1}{2}$ per cent. of shelly material, containing Gastropods which are slightly crushed, and numerous fragments and prisms of Inoceramus. Ostracoda are common, with the valves frequently

* C. B. Rose, Trans. Micr. Soc. Lond., new series, iii. (1855) p. 7, pl. i.

† Kölliker, Quart. Journ. Micr. Sci., viii. p. 171.

‡ The fine washings referred to throughout this paper were all mounted in Canada balsam.

§ The Ostracoda of the Gault as already known have been described and figured in the Monograph of the Palæontographical Society for 1849 and 1889. See p. 572 of this paper.

united; the Foraminifera are not common. There are also numerous spines of Hemiaster. The fine washings consist almost entirely of glauconite, with a few grains of quartz; *Globigerina cretacea* d'Orb. frequent.

Zone III., "Crab Bed." The clay is of a pale brown or fawn colour, fine in texture, but not close. Residuum 5 per cent., of pale brown dusty sand with occasional shell fragments. There are also spines of Hemiaster. The specimens of Globigerina in this bed are of a whitish and weathered colour differing from those of other beds, where they are dark with a metallic lustre due to the infilling of their shells with pyrites. The Foraminifera are fairly common, and the Ostracoda are very abundant; the valves of the latter are often united. The fine washings contain a large proportion of tiny brown granular spherules, a little glauconite, occasional angular grains of quartz, and prisms of Inoceramus. The little brown spheroidal bodies are composed of carbonate of iron and appear to be casts of Anomalina, as a series may be made out, graduating from the infilled shell of the Foraminifer to the roughly spherical cast with its iron-stained umbilical depression. The fine washings on analysis yield 26·61 per cent. of metallic iron in the state of ferrous oxide. The following Foraminifera occur in these washings:—*Textularia pygmæa* Rss., common; *Bolivina textularioides* Rss., common; *Globigerina cretacea* d'Orb., very common; and *Anomalina ammonoides* Rss. sp., very common.

Zone IV. A dark green clay, very fossiliferous. The washed material consists of a brown shelly sand, 1¾ per cent. of the whole, with spines of Hemiaster. The Foraminifera are tolerably abundant and very small. The fine washings consist of glauconite, angular grains of quartz, and innumerable prisms of Inoceramus; also casts of Anomalina like those found in Zone III., though here very rare. The following Foraminifera occur in the washings:—*Lagena lævis* Montagu sp., one specimen; *Globigerina cretacea* d'Orb., frequent; and *Anomalina ammonoides* Rss. sp., frequent.

Zone V. "Coral Bed." A grey-blue clay. The residuum consists of 4½ per cent. of somewhat sandy material, with a few shell fragments. The Foraminifera are very abundant; and the larger specimens are frequently filled with pyrites. Ostracoda are common. The fine washings consist of glauconite with numerous distinct casts of Foraminifera, a few angular grains of quartz, Inoceramus prisms, and numerous casts (in carbonate of iron) of Anomalina; also *Textularia pygmæa* Rss., frequent; *Bolivina textularioides* Rss., rare; *Globigerina cretacea* d'Orb., common; and *Anomalina ammonoides* Rss. sp., common.

Zone VI. "Mottled Bed." A blue-grey clay with dark-greenish spots and streaks; some of these markings are surrounded by rings of pyritous stain. The microzoa are very abundant, and *Rotalia spinulifera* Rss., is the commonest Foraminifer. The washed clay gives a residuum of 7 per cent., which is composed mainly of glauconite and shell fragments. The fine washings consist of glauconite, a few Inoceramus prisms, shell fragments, many casts of Anomalina, a few angular grains of quartz, and the following Foraminifera:—*Lagena hispida* Rss., one specimen; *Globigerina cretacea* d'Orb., very common; and *Anomalina ammonoides* Rss., very common.

Zone VII. "Dark Bed." A dark-green clay, with a residuum of $6\frac{3}{4}$ per cent. after washing, consisting of sandy material with iridescent shell-fragments. The microzoa are fairly common; *Rotalia spinulifera* Rss. is excessively abundant; spines of Hemiaster and arm-joints of Pentacrinus also occur. The fine material consists of glauconite, a few angular quartz-grains, Inoceramus prisms, a very few granular casts of Anomalina, and the following Foraminifera:—*Nodosaria simplex* Silvestri, one specimen; *Globigerina cretacea* d'Orb., frequent; and *Anomalina ammonoides* Rss. sp., frequent.

Zone VIII. "Junction-bed" or "Nodule-bed." A pale-grey clay with an even texture. A residuum after washing of $4\frac{3}{4}$ per cent., of a dark colour, with a few shell fragments and spines of Hemiaster. The microzoa are common, with *Rotalia spinulifera* Rss. extremely common. The fine washings consist of glauconite, a few angular quartz-grains, prisms of Inoceramus, and the following Foraminifera:—*Globigerina cretacea* d'Orb., frequent; and *Anomalina ammonoides* Rss. sp., frequent. The granular casts of Anomalina are absent from this zone.

Zone IX. At 65 ft. below the top of the Gault. A somewhat dark blue-grey clay, with a residuum of $2\frac{3}{4}$ per cent. after washing. The washed material is of a grey colour, and contains many shell particles and spines of Hemiaster. Microzoa are common; the Bulimines very common. The fine washings contain an abundance of granular casts of Anomalina, a large quantity of Inoceramus prisms, many glauconite grains, and a very few angular grains of quartz; *Textularia pygmæa* Rss., one specimen; *Bolivina textularioides* Rss., frequent; *Nodosaria Jonesi* Rss., one specimen; *Globigerina cretacea* d'Orb., very common; and *Anomalina ammonoides* Rss. sp., very common.

Zone X. "Plicatula-bed." One foot in thickness, and 60 ft. from the top of the Gault. The clay is of a pale greenish-grey with shelly particles scattered throughout. The residuum after washing is $8\frac{1}{2}$ per cent., and consists almost entirely of shelly material, with two shark's teeth and joints of the stems and arms of Pentacrinus. The microzoa are very abundant. The fine washings consist of numerous Inoceramus prisms, some glauconite, granular casts of Anomalina, angular grains of quartz, which are scarce, and the following Foraminifera:—*Textularia pygmæa* Rss., rare; *Bolivina textularioides* Rss., rare; *Bulimina* sp., one specimen; *Cristellaria* sp., one specimen; *Globigerina cretacea* d'Orb., common; and *Anomalina ammonoides* Rss. sp., very common.

Zone XI. 55 ft. from the top of the Gault. A pale-grey marly clay, somewhat tenacious. The residuum after washing, 5 per cent. of greenish-grey sandy material, with numerous prisms of Inoceramus. The Foraminifera are not very common, and rather small; Ostracoda are frequent. The fine washings contain prisms of Inoceramus, glauconite, angular grains of quartz, rather scarce, granular casts of Anomalina, and the following Foraminifera:—*Textularia pygmæa* Rss., frequent; *Ramulina globulifera* Brady, rare; *Globigerina cretacea* d'Orb., very common; and *Anomalina ammonoides* Rss. sp., very common.

Zone XI. 50 ft. from the top of the Gault. A tenacious marly clay, of a pale-grey colour, containing 40·69 per cent. of $CaCO_3$. A residuum after washing, $1\frac{1}{2}$ per cent. of grey shelly material, with many brown cylindrical stem-like casts? Foraminifera are common; Bulimines very common. Ostracoda are fairly common. The fine washings consist largely of Globigerina and other Foraminifera. There are also some shell fragments, a very few prisms of Inoceramus, a few granular casts of Anomalina, angular grains of quartz (extremely rare), and glauconite (rare). The following Foraminifera also occur in the fine washings:—*Miliolina venusta* Karrer sp., frequent; *Textularia pygmæa* Rss., frequent; *Bolivina textularioides* Rss., frequent; *Nodosaria* sp., one specimen; *Dentalina catenula* Rss., one specimen; *Dentalina communis* d'Orb., frequent; *Globigerina cretacea* d'Orb., very abundant; and *Anomalina ammonoides* Rss. sp., very common.

Zone XI. 45 ft. from the top of the Gault. A pale-grey marly clay. The residuum after washing, 3 per cent., consists of fine sandy material with some spines of Pseudodiadema. Microzoa are very abundant; Globigerinæ are excesssively abundant in the fine washings. The fine washings contain shell fragments, granular casts of Anomalina in abundance, many Inoceramus prisms, some scattered grains of glauconite, and very few angular grains of quartz, also the following Foraminifera:—*Nubecularia nodulosa* sp. n., one specimen; *Miliolina venusta* Karrer sp., frequent; *Textularia pygmæa* Rss., common; *Bolivina textularioides* Rss., common; *Lagena apiculata* Rss., one specimen; *Lingulina semiornata* Rss., one specimen; *Ramulina aculeata* d'Orb. sp., frequent; *Globigerina cretacea* d'Orb., extremely abundant; *Spirillina vivipara* Ehrenb., one specimen; and *Anomalina ammonoides* Rss. sp., very common.

Zone XI. 40 ft. from the top of the Gault. A pale-grey marly clay. The residuum after washing, 1 per cent. of sandy material with brown stem-like fragments. Microzoa are common. During disintegration by washing, this clay shows a tendency to separate into distinct laminæ, possibly due to intervals of rest during deposition. The Globigerinæ are not so abundant as in the last two samples. The fine washings contain shell fragments, and the parasitic borings in those of this bed are very well developed and abundant. There are also many Inoceramus prisms, a few glauconite grains, and very few angular grains of quartz, but no casts of Anomalina. The following Foraminifera are also met with in the fine washings:—*Miliolina venusta* Karrer sp., frequent; *Textularia pygmæa* Rss., very common; *Textularia conica* d'Orb., frequent; *Bolivina textularioides* Rss., common; *Dentalina communis* d'Orb., frequent; *Ramulina globulifera* Brady, frequent; *Globigerina cretacea* d'Orb., very common; and *Anomalina ammonoides* Rss. sp., very common.

Zone XI. 35 ft. from the top of the Gault. A pale-grey marly clay, with 37·58 per cent. of $CaCO_3$, and a residuum of sandy material $1\frac{1}{4}$ per cent. with the brown cylindrical fragments. Microzoa are fairly common. The fine washings consist chiefly of Globigerina; with a few angular quartz-grains and Inoceramus prisms; glauconite common in the interior of Foraminifera, but scarce as free casts or grains; a few of the granular casts of Anomalina, and the following Foraminifera:—*Textularia pygmæa* Rss., common; *Bolivina textularioides* Rss., frequent; *Lagena hispida* Rss., one specimen; *Lagena lævis* Montagu sp., one specimen; *Ramulina globulifera* Brady, frequent; *Globigerina cretacea* d'Orb., very common; and *Anomalina ammonoides* Rss. sp., very common.

Zone XI. 30 ft. from the top of the Gault. A pale-grey marly clay. A residuum of sandy material, $1\frac{3}{4}$ per cent. Microzoa are not very common. The fine washings contain a little glauconite, a few prisms of Inoceramus, very few angular quartz grains, and the following Foraminifera:—*Textularia pygmæa* Rss., common; *Bolivina textularioides* Rss., frequent; *Lagena apiculata* Rss., one specimen; *Lagena lævis* Montagu sp., one specimen; *Polymorphina sororia* var. *cuspidata* Brady, one specimen; *Ramulina globulifera* Brady, frequent; *Globigerina cretacea* d'Orb., very common; and *Anomalina ammonoides* Rss. sp., very common.

Zone XI. 25 ft. from the top of the Gault. A heavy pale-grey marly clay. A residuum of fine sandy material, $4\frac{3}{4}$ per cent. Microzoa are very common. The fine washings consist almost entirely of the shells of Globigerina, with a few glauconite grains, a few angular quartz-grains, shell fragments, a very few casts of Anomalina, a few prisms of Inoceramus, fish remains, and the following Foraminifera:—*Nubecularia nodulosa* sp. n., one specimen; *Miliolina venusta* Karrer sp., rare; *Textularia pygmæa* Rss., common; *Bolivina textularioides* Rss., frequent; *Lingulina semiornata* Rss., one specimen; *Globigerina cretacea* d'Orb., very common; and *Anomalina ammonoides* Rss. sp., very common.

Zone XI. 20 ft. from the top of the Gault. A dull grey-green rock, or argillaceous greensand; when struck with a hammer presenting a bright-green surface, due to the fractured particles of glauconite. A residuum of a dark-green sand with a few shelly particles, 30 per cent. Microzoa are frequent, and spines of Pseudodiadema. The fine washings consist of a little more than one-half green glauconite grains, nearly all the remainder being beautifully preserved Foraminifera; there are also numerous fish-bones and teeth, frequently exhibiting very fine borings of parasitic plants; the shell fragments also show very good examples of the plant-borings; and angular grains of quartz, more abundant than in the zones previously mentioned. In the fine washings are also the following Foraminifera:—*Textularia conica* d'Orb., one specimen; *Textularia pygmæa* Rss., very common; *Bolivina textularioides* Rss., very common; *Pleurostomella eocæna* Gümbel, frequent; *Lagena gracilis* Will., one specimen; *Globigerina cretacea* d'Orb., very common; and *Anomalina ammonoides* Rss. sp., very common.

Zone XI. 12 ft. from the top of the Gault. A pale-grey marly clay. A residuum after washing, $2\frac{1}{4}$ per cent. The washings consist of a pale-grey sand, with numerous fish remains and coprolites; microzoa are tolerably common. The fine washings consist almost entirely of well-preserved Foraminifera, with a few glauconite grains, numerous angular quartz-grains, fish-bones, and calcareous fragments with good parasitic plant-borings, and the following Foraminifera:—*Textularia pygmæa* Rss., very common; *Textularia gramen* d'Orb., one specimen; *Bolivina textularioides* Rss., frequent; *Ramulina globulifera* Brady, frequent; *Globigerina cretacea* d'Orb., very common; and *Anomalina ammonoides* Rss. sp., very common.

Zone XI. 6 ft. from the top of the Gault. A pale-grey marly clay, with a residuum of 1 per cent. of pale-grey sandy material, containing fish remains and tiny coprolites. Microzoa are common. The fine washings contain glauconite, much angular quartz, fish remains with plant-borings, and a fish-tooth; also the following Foraminifera:—*Textularia pygmæa*, Rss. frequent; *Ramulina globulifera* Brady, rare; *Globigerina cretacea* d'Orb., common; and *Anomalina ammonoides* Rss. sp., common.

The new species of Ostracoda will be described, and all the species of the Gault will be tabulated in a paper shortly by Mr. C. D. Sherborn and myself. (See also *ante*, p. 567.)

On the Foraminifera I now proceed to speak.

Family MILIOLIDÆ.

Sub-family NUBECULARIINÆ.

Nubecularia Defrance [1825].

Nubecularia depressa, plate IX. fig. 1.

This form consists of six more or less flask-shaped chambers, disposed in a curved line; slightly depressed, and adherent, in this example, to a fish-scale. The test has the true porcellanous appearance, being milky white. At the junction of the two last chambers the stoloniferous tube divides. Only one specimen was found. Zone XI., 35 ft. from the top of the Gault.

Nubecularia nodulosa, plate IX. fig. 2.

A free-growing form, having nodulous chambers united by slender stoloniferous tubes, and rectilinear in growth. All the specimens found are apparently fragments; the longest consisted of four chambers. This form resembles in some points *N. divaricata* Brady; but, on the whole, it appears to be a distinct form, and confined to the Gault. The aperture is a simple orifice, and not phialine, as in the form described by Dr. Brady. It occurs in zone iv., rare; zone v., frequent; zone x., rare; zone xi., 55 ft. from the top, rare; 50 ft., frequent; 45 ft., common; 35 ft., common; 25 ft., common; 6 ft., very rare.

Sub-family MILIOLININÆ.

Biloculina d'Orbigny [1826].

Biloculina undulata, plate IX. figs. 3 *a* and *b*.

A form which resembles *B. depressa* d'Orb. in contour, but with both surfaces of the test ornamented with concentric undulating ridges. One specimen only, from zone xi., 25 ft. from the top.

Spiroloculina d'Orbigny [1826].

Spiroloculina asperula Karrer, plate IX. fig. 4.

Spiroloculina asperula Karrer, 1868, Sitzungsb. k. Ak. Wiss. Wien, vol. lvii. p. 136, plate i. fig. 10.

Recorded by Dr. Karrer from the Miocene of Kostej; and by Dr. Brady as a recent, comparatively shallow water form. One very fine specimen, from zone xi., 55 ft. from the top.

Miliolina Williamson [1858].

Miliolina venusta Karrer sp., plate IX. figs. 5 *a* and *b*, and 6.

Quinqueloculina venusta Karrer, 1868, Sitzungsb. k. Ak. Wiss. Wien, vol. lvii. p. 147, plate ii. fig. 6.

Recorded from the Miocene of Kostej (Karrer), from the London Clay of Piccadilly (Sherborn and Chapman), and noted by Dr. Brady as an essentially deep-water form. This variety is a very distinct one in the Gault series of Miliolines; with but one exception, however, which presents a broader aspect than the type, and of which a figure is given. This Foraminifer makes its appearance in the Gault in zone x., where it is very common; also in zone xi., 55 ft. from the top, very common; 50 ft., very common; 45 ft., frequent; 40 ft., frequent; 35 ft., frequent; 30 ft., frequent; 25 ft., very common; 20 ft., common; 12 ft., common; 6 ft., very rare.

Miliolina agglutinans d'Orbigny sp., plate IX. fig. 7.

Quinqueloculina agglutinans d'Orbigny, 1839, Foram. Cuba, p. 168, plate xii. figs. 11–13.

It is, perhaps, worth noting that this variety has only before been found in the fossil condition in the Post-tertiary clays of Norway and the west of Scotland. It is a scarce form in the Gault, one example only having occurred in each of the levels in which it is found. Zone xi., 55 ft. from the top; 20 ft.; and 12 ft.

Miliolina Ferussacii d'Orbigny sp., plate IX. fig. 8.

Quinqueloculina Ferussacii d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 301, No. 18; Modèle, No. 32.

The Gault specimens are very variable, but can be readily assigned to this species. The figure is from a good type specimen, the variation tending towards depression of the ribs. In its occurrence it shows a tendency to supersede *M. venusta*, as it increases in frequency towards the top of the Gault, whilst *M. venusta* becomes less common. This variety appears in zone xi., 45 ft. from the top, very rare; 35 ft., rare; 12 ft., very common; 6 ft., common.

Miliolina tricarinata d'Orbigny sp., plate IX. figs. 9 *a* and *b*.

Triloculina tricarinata d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 299, No. 7; Modèle, No. 94.

Hitherto this species has not been obtained from any formation earlier than the Eocene. Found in zone xi., 45 ft. from the top, rare; 30 ft., very rare.

Sub-family HAUERININÆ.

OPHTHALMIDIUM Zwingli and Kübler [1870].

Ophthalmidium tumidulum Brady, plate IX. fig. 10.

Ophthalmidium tumidulum H. B. Brady, Chall. Rep., 1883, p. 189, plate xii. fig. 6.

This interesting Foraminifer resembles Cornuspira in external appearance, but when rendered transparent the Spiroloculine arrangement of the later segments can be clearly made out. Zone iv., very rare; zone xi., 55 ft. from the top, rare; 40 ft., rare; 35 ft., very rare.

Sub-family PENEROPLIDINÆ.

CORNUSPIRA Schultze [1854].

Cornuspira cretacea Reuss, plate IX. figs. 11 *a* and *b*.

Operculina cretacea Reuss, Verstein. d. böhm. Kreideform., 1845, p. 35, plate xiii. figs. 64 and 65. *Cornuspira cretacea* Reuss, Sitzungsb. Ak. Wiss. Wien, 1860, vol. xl. p. 177, plate i. fig. 1.

This species is easily recognized by the thickened growth of the wall of the shell, especially in the last few whorls, which are generally superficially puckered. Moreover, the sections in some of the older specimens show the shell to be markedly biconcave. It appears both in the Lower and Upper Gault, but is more characteristic of the higher beds, where it is also better developed in point of size. Zone iii., very rare; zone iv., common; zone ix., very rare; zone x., very rare; zone xi., 55 ft. from the top, frequent; 50 ft., common; 45 ft., very rare; 40 ft., common; 30 ft., very rare; 25 ft., very rare; 12 ft., frequent; 6 ft., rare.

Cornuspira involvens Reuss, plate IX. figs. 12 *a* and *b*.

Operculina involvens Reuss, 1849, Denkschr. k. Ak. Wiss. Wien, vol. i. p. 370, plate xlv. fig. 20. *Cornuspira involvens* Reuss, 1863, Sitzungsb. k. Ak. Wiss. Wien, vol. xlviii. p. 39, plate i. fig. 2.

The shell of this species is biconcave, and the whorls increase rapidly in size towards the margin. A variation may be traced from this form to *C. cretacea* by the shell losing its roundness, consequently less embracing, and the surface becoming puckered. The earliest strata in which it has hitherto been found are the Septaria clays of North Germany, the Baden Beds of the Vienna Basin, and the *Clavulina-Szabói* Beds of Hungary. Zone iii., very rare; zone v., very rare; zone vi., very rare; zone xi., 55 ft. from the top, rare; 50 ft., very rare; 12 ft. very rare.

Cornuspira foliacea Philippi sp., plate IX. figs. 13 *a* and *b*.

Orbis foliaceus Philippi, 1844, Enum. Moll. Sicil., vol. ii. p. 147, plate xxiv. fig. 26. *Cornuspira foliacea* Parker and Jones, 1865, Phil. Trans., vol. clv. p. 408, plate xv. fig. 33.

The shell is uniformly thin. The Gault specimens do not exhibit so sudden an increase in the width of the last turn or so of the shell as do the typical recent specimens. Zone iv., very rare; zone xi., 55 ft. from the top, very rare; 45 ft., very rare; 30 ft., very rare.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

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

α. Embryology.†

Origin of Vertebrata.‡—Prof. A. Lameere does not agree with those who think that the ancestor of the Vertebrata is to be found among Worms; he thinks that everything shows that they are derived from an Actinozoon in which the neural face remained superior in position. It was probably pelagic in habit, and did not, like most of its allies, become fixed after a free larval stage. For such an animal it would be a great advantage to be provided with a thickening of the endoderm which would give rise to a rigid axis; it would be still more advantageous if the tentacles were, as organs of locomotion, provided with proto-vertebræ; it is, in fact, in *Amphioxus* and Fishes that derivates of these are used as locomotor organs, the fins serving only as directing organs. There would appear to be no direct relationship between the Chordata and the Echinodermata or Vermes.

Fertilization of Newts.§—Dr. E. Zeller observes that the females of *Triton* (*T. alpestris*, *T. tæniatus*, &c.) are active in availing themselves of the spermatophores. But it is not true, as he formerly believed, that the female removes the mass of sperms by the open lips of the cloaca. The female brings herself into contact with the end of the tag of sperms, and these attach themselves to the closed cloacal slit. The spermatozoa actively insinuate themselves through the slit of the cloaca, and are collected in the receptaculum seminis.

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

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

‡ Bull. Soc. Belge de Microscopie, xvii. (1891) pp. 91–121.

§ Zeitschr. f. Wiss. Zool., li. (1891) pp. 737–41 (1 fig.).

The Blastopore in Meroblastic Ova.*—Herr N. Cholodkovsky seeks to unify the various forms of blastopore in meroblastic ova. In the crayfish, the endodermic disc is surrounded by an annular groove and is gradually invaginated into the yolk. In birds, the homologue of the blastopore is the sickle-shaped groove from which the primitive groove extends forward. In *Chalicodoma muraria*, according to Carrière, the median part of the germinal area is bordered laterally by two furrows, which pass at either end into the originally superficial but subsequently invaginated endodermic rudiments. In Muscidæ and in *Phyllodromia*, besides the primitive groove, there are two pairs of lateral furrows or pits which are separated by uninvaginated spaces, and seem rudiments of the complete annular groove of *Astacus* and *Chalicodoma*. "In *Phyllodromia* the primitive groove, extending from behind forwards, bears to the posterior pair of lateral invaginations the same relation that the primitive groove in birds bears to the sickle-shaped groove, which is probably the remains of an original annular groove. In Muscidæ, the primitive groove which begins at the anterior end, bears a similar relation to the anterior pair of lateral invaginations, which are probably remains of the anterior half of the annular groove." The broad and flat primitive groove of *Hydrophilus* recalls the lateral grooves in Apidæ; it is formed from lateral grooves which begin anteriorly and posteriorly, and represent both halves of the original annular groove. The forms of primitive groove in insects are not all homologous. "While the blastopore of *Hydrophilus*, *Apis*, and *Chalicodoma* is nearly related to the typical form in meroblastic ova, and represents the entire endodermic disc of *Astacus*, the primitive groove of Muscidæ and of *Phyllodromia* (like that of birds) represents only a median outgrowth of the rudimentary annular groove, and perhaps serves solely for the formation of mesoderm, the endodermic rudiments perhaps arising (as Graber suggests) from the complementary lateral invaginations. In some insects, therefore, the primitive groove represents the whole blastopore, in others only a part."

The Eggs and Embryos of the Crocodile.†—Dr. A. Voeltzkow has studied these in Madagascar, where *Crocodilus niloticus* is very common. The egg-laying lasts from the end of August to the end of September. The number of eggs in a nest varies from twenty to thirty. The nest is dug about two feet deep in the dry white sand; the bases of its walls are gouged out, and into the lateral excavations thus formed the eggs roll from the slightly raised centre of the nest-floor. Externally the nest is not discernible, but the parent sleeps upon it. The eggs differ greatly in form; the shell is white, thick, and firm, either rough or smooth; the double shell-membrane is so firm that the egg keeps its form after the shell has been removed; the albumen is a jelly firm enough to be handled, and the vitelline membrane is also very strong. When newly laid the eggs are very sensitive, and are readily killed by damp or by heat; the older eggs, however, are quite hardy. When the young embryos are about to be hatched, they utter very distinct notes. These calls the mother hears, even through two feet of sand, and proceeds to dig open the nest. Even the natives were unaware of the

* Zool. Anzeig., xiv. (1891) pp. 159-60 (1 fig.).
† SB. K. Preuss. Akad. d. Wiss., 1891, pp. 115-20.

manner in which the attention of the mother is called to her young. Before hatching the embryo turns, and in so doing partially tears the fœtal membranes. With the tip of its snout turned to one end of the egg, the young animal bores through the shell with a double-pointed tooth comparable to that which young birds possess. This tooth appears very early—by the time the embryo is six weeks or two months old; it may still be seen a fortnight after hatching. Through the small perforation made by the tooth the embryonic fluid flows out, softening the adjacent parts, and the whole is widened into a cleft. The process of creeping out may take about two hours. The young animal seems large in comparison with the egg; thus one measuring 28 cm. in length came out of an egg 8 cm. long and 5 cm. broad. The young crocodiles are very wild little animals and are led to the water by the mother. They utter sounds, especially when hungry, but the pitch of their call is not so high as it was within the egg. Of the development, which takes about three months, some account is promised; but the embryos are extraordinarily delicate and their investigation is proportionately difficult.

Development of the Optic Nerves.*—Prof. A. Froriep finds from his investigation of the embryos of *Torpedo ocellata* that the first nerve-fibres of the optic nerve originate in the rudiment of the retina, whence they grow centralwards along the stalk of the optic vesicle. Keibel has observed the same in the embryos of Reptiles, but of this Froriep was unaware until he had completed his researches.

Histogenesis of the Neuroglia.†—Prof. P. Lachi finds that there are two important periods in the development of the neuroglia of the chick's spinal cord,—one limited by the 8th or 9th day of incubation, the other extending from this until the first few days after hatching. In the first period, the neuroglia is represented solely by ectodermic spongioblasts; in the second period these are joined by mesenchyme elements, which appear first in the white matter, but afterwards insinuate themselves into the grey. The new mesenchyme elements increase rapidly by indirect division, and towards the end of incubation they exhibit the prolongations characteristic of neuroglia cells. To these mesenchyme cells others of vascular origin—either endothelial cells or leucocytes—are added. From the twelfth day of incubation, Lachi observes the transformation and destruction of the spongioblasts, but their definite fate still requires investigation.

Development of Blood in Embryonic Liver.‡—Dr. O. Van der Stricht has studied the development of blood in the embryonic liver of representatives of various groups of Vertebrates. The hepatic cells themselves present special characters by which they may be easily distinguished from the adjoining blood-cells; they are rich in fatty granulations, and their protoplasm has a reticulated structure. In the first stages of intra-uterine life the liver of Mammals has a close resemblance to that of lower Vertebrates, and like theirs is formed of rows of hepatic cells arranged in a plexus; later on a fresh capillary plexus is intercalated on the course of the one already present, and while the

* Anat. Anzeig., vi. (1891), pp. 155–161 (12 figs).
† Atti Soc. Tosc. Sci. Nat., xi. (1891) pp. 266–310 (3 pls).
‡ Arch. de Biol., xi. (1891) pp. 19–113 (2 pls.).

latter is inter-, the former is intra-trabecular. This latter attains an extraordinary development and the contents of the vessels of the two sets is quite different. The intra-trabecular plexus serves as a substratum for the multiplication of red cells, and the author proposes, therefore, to call it the hæmatopoetic capillary plexus.

Within the vessels are found, firstly, erythroblasts; these give rise to the red cells and have the form of elements with a characteristic, rounded nucleus, abundance of chromatin, arranged in a plexus; there is not much protoplasm, and what there is is homogeneous. The first erythroblasts of the liver are derived from young nucleated red cells which exist from the time of the appearance of blood in the embryo; they are more or less charged with hæmoglobin, but, later on, the products of their multiplication are colourless erythroblasts. The formation of new erythroblasts is effected by indirect division of pre-existing elements of the same kind; as long as the liver has its primitive character this multiplication is not very active. It becomes more marked on the appearance of the hæmatopoetic plexus. The conversion of erythroblasts into adult red corpuscles is effected by a series of changes of the nucleus and protoplasm which end with the removal of the nucleus.

After leaving the blood-corpuscle the free nucleus undergoes a series of changes; these are modifications of retrogression or normal degeneration; they end with the complete destruction of the nucleus which is effected either by chromatolysis or by phagocytosis. On the whole it would appear that the embryonic liver is just as much a hæmatopoetic organ as the osseous medulla of Birds.

The next of the contents of the vessels are the white cells; the leucoblasts are said to be characterized by the structure of their nucleus, the appearance of their protoplasm, and by the great delicacy of their cell-membrane; in the early stages of hepatic development the white cell is a phagocyte, and takes part in destroying the freed nuclei of the erythroblasts. The liver has probably some influence on the multiplication of leucoblasts; especially in very young embryos.

The last constituent is represented by the giant-cells; their protoplasm is often differentiated into distinct layers; vacuoles are present; the cellular contours are sometimes very irregular; the cells may exhibit prolongations in the form of pseudopodia or of finer processes; the cell is not bounded by a true membrane. These giant-cells take part in the destruction of the nuclei of the red corpuscles, being absorbed by phagocytosis. Some of the cells bud but they take no part in forming the red corpuscles. The giants multiply by direct division into two or into several daughter-cells similar to the parent cell; they are not retrograding elements, but cells with an independent existence, with a definite part to play, and multiplying like other cells; they appear to be derived from the leucoblasts.

β. Histology.

Structure of the Cell.*—Dr. C. C. Schneider has studied the ova of *Strongylocentrotus*, *Ascaris*, *Tiara*, &c., the young male-cells of *Astacus* and *Ascaris*, besides *Trichoplax adhærens*, *Vorticella*, &c. The cells

* Arbeit. Zool. Inst. Univ. Wien (Claus), ix. (1891) pp. 179–224 (2 pls.).

investigated have a framework of fine fibres; these are uniformly thick, optically distinguishable from the matrix, and have a coiled course; they form a meshwork but are not connected at their intersections. The fibres are seen to be movable (in the cilia of *Trichoplax*), and they may assume a straight course (in cilia and in division). Nucleus and protoplasm have a similar framework, the connectedness of which is not hindered by the nuclear membrane. The membranes of nuclei, vacuoles, and many cells arise from the coalescence of parts of the fibres. The chromatin-masses and nucleoli observed consisted of chromatin-granules fused in the meshes of the framework and around the fibres. A nucleolus is characterized by the presence of a membrane formed from the framework, the stainable granules are incapable of movement, but are displaced by the movement of the framework. "Chromatophores" arise from the attachment of chromatin-granules to a support formed from coalesced fibres. The attraction-sphere is at first an arbitrary, subsequently a spherical portion of the cell, in which the fibres are fixed by a homogeneous connecting mass. The "polar sun" and spindle arise from an extension of numerous fibres proceeding from the sphere; the extension is perhaps associated with the division of the sphere and the transport of its halves to the poles of the spindle, as also with the formation of "chromatophores." Neither attraction-sphere nor "polar sun" are essentially characteristic of division, nor is a homogeneous circular space untraversed by fibres a constant characteristic of the attraction-sphere. The spindle-fibres which unite sphere and "chromatophores" secure by their contraction the division of the latter. In the segmentation-spindle of *Ascaris megalocephala* the mass connecting the fibres in the spheres arises from the conical body of the spermatozoon. In the growing zone of the ovarian and testicular tubes of *Ascaris megalocephala univalens*, the diffuse chromatin material is collected into a more or less defined clump, which, by division into four, forms the chromatin elements of four spermatozoa, or the single element of the ripe ovum and three polar bodies. Finally, Herr Schneider seeks to explain the import of the nuclear membrane in keeping the chromatin together, and the numerical constancy of the "chromatophores" in the reproductive cells.

Pigment-cells.*—Dr. B. Solger finds in the dermic pigment-cells of the pike's head most admirable illustrations of attraction-spheres. They are very well seen in the pigment-cells of the frontal and ethmoidal regions; in the supra-orbital region, however, the individual cells are not readily defined. Sometimes there were several nuclei, but never more than one attraction-sphere in the cells; and Solger thinks that the presence of several nuclei without hint of more than one attraction-sphere must imply that amitotic nuclear division occurs.

Minute Structure of Spermatozoa of Mammalia.†—Dr. E. Ballowitz has continued his researches on the minute structure of the spermatozoa of Mammals. About a score of species have been studied, several Bats having first been examined. He finds confirmation of the view that the axial filament consists of two apposed bundles of the finest elementary fibrils held together by a connecting substance; these fibrils which,

* Anat. Anzeig., vi. (1891) pp. 162-5 (2 figs.).
† Zeitschr. f. Wiss. Zool., lii. (1891) pp. 217-93 (3 pls.).

again, are connected with one another by a substance, traverse the whole of the flagellum of the spermatozoon from the beginning to the end of the axial filament. These fibrils are the contractile elements, and they have exactly the same relations as in the spermatozoa of other Vertebrates and of Invertebrates.

The relations of the axial cord to the neck vary considerably. In some, as in the Rat, the terminal knob is continuous with the anterior limit of the investment of the connecting piece; no "neck-piece" is therefore present, and the "neck" is only occupied by connecting substance. In most Mammals the anterior end of the axial cord passes freely through the "neck" as a "neck-piece," and is inserted, by means of its terminal knob, in the pit at the hinder edge of the head by means of a very small quantity of connecting substance. In other species, lastly, the "neck-piece" of the axial cord is divided into its two halves in the "neck" itself; these are attached to the hinder margin of the head by means of a small quantity of connecting substance.

The head of the mature mammalian spermatozoon consists of the true head and the head-cap; the latter often, and very probably always, persists. The true head is made up of the anterior and the posterior piece which are, in the course of development, derived from the nuclear hemispheres detected by Merkel. Between these two portions there is, in some Mammals, an internal body in the form of a semilunar and sharply-bounded area.

B. INVERTEBRATA.

Prof. Haddon's Collections in Torres Straits.—Some reports have now been issued on the zoological collections made by Prof. A. C. Haddon in Torres Straits in 1888–9. Mr. E. A. Smith* writes on the land Mollusca, of which only a few specimens were collected; their interest lies in the additions made to our knowledge of their geographical range, and, in one or two cases, they exhibit considerable variations in size. Sixty-six specimens of Lepidoptera, which represent twenty species and varieties, are recorded by Mr. G. H. Carpenter;† Australian, Austro-Malayan, and Oriental forms were all found. Mr. R. Kirkpatrick‡ reports on the Polyzoa and Hydrozoa; of the former twenty-seven species were collected, of which four are new, and there are also four new varieties; in the somewhat smaller collection of Hydrozoa there were also four new species.

Mollusca.

α. Cephalopoda.

Changes in the Retinal Pigment of Cephalopods.§—Dr. B. Rawitz has experimented with *Eledone moschata*, *Sepia officinalis*, and *Sepiola Rondeletii*, and finds that the disposition of the pigment about the retinal cells changes when the animals are kept in darkness. It disappears from the free, inner ends of the rods, retreating to the posterior basal parts.

* Scientific Proc. Roy. Dubl. Soc., vii. (1891) pp. 5–13.
† Tom. cit., pp. 1–5.
‡ Op. cit., vi. (1890) pp. 603–26 (4 pls.).
§ Zool. Anzeig., xiv. (1891) pp. 157–8.

The retreat is proportionate to the time in which the Cephalopods are kept dark. Thus, what is true of Arthropods and Vertebrates is true of Cephalopods also. Full details are promised.

γ. Gastropoda.

Anatomy of Daudebardia and Testacella.*—Dr. L. Plate has investigated five species of *Testacella* and two species of *Daudebardia*, but his memoir describing these also contains numerous observations on the comparative anatomy of other Opisthopneumatous Pulmonates. He signalizes the following as the three most important general results of his work. Many structural peculiarities of *Testacella* occur in less differentiated form in *Daudebardia*, the latter thus linking the *Hyalina*- and *Testacella*-types. The divergent position of the kidney and heart on the roof of the pulmonary chamber may be referred to two conditions, both associated with the carnivorous diet, to the displacement of the mantle-cavity to the hind end of the body, and to the formation of an air-reservoir in connection with the pulmonary chamber; the *Testacella*-types are derived from prosopneumatous forms, their opisthopneumatous characteristic being secondarily acquired. The hypothesis of the diphyletic origin of the Pulmonata (von Ihering's Branchiopneusta and Nephropneusta) is not reconcilable with the fact that the *Testacella*-types have in the hindmost corner of the pulmonary cavity a smelling organ obviously homologous with the sense-organ which Spengel has demonstrated in other Gastropods.

Geographical Distribution of Slugs.†—Mr. T. D. A. Cockerell is of opinion that the "Slugs" are a polyphyletic group, and that five of the six constituent families are more nearly allied to as many testaceous groups than to one another. The families recognized are the Succineidæ, the Vaginulidæ, the Arionidæ (allied to the Helicidæ), the Limacidæ (allied to the Zonitidæ), the Testacellidæ (allied to the Oleacinidæ), and the Selenitidæ. The paper gives only a detailed statement of facts.

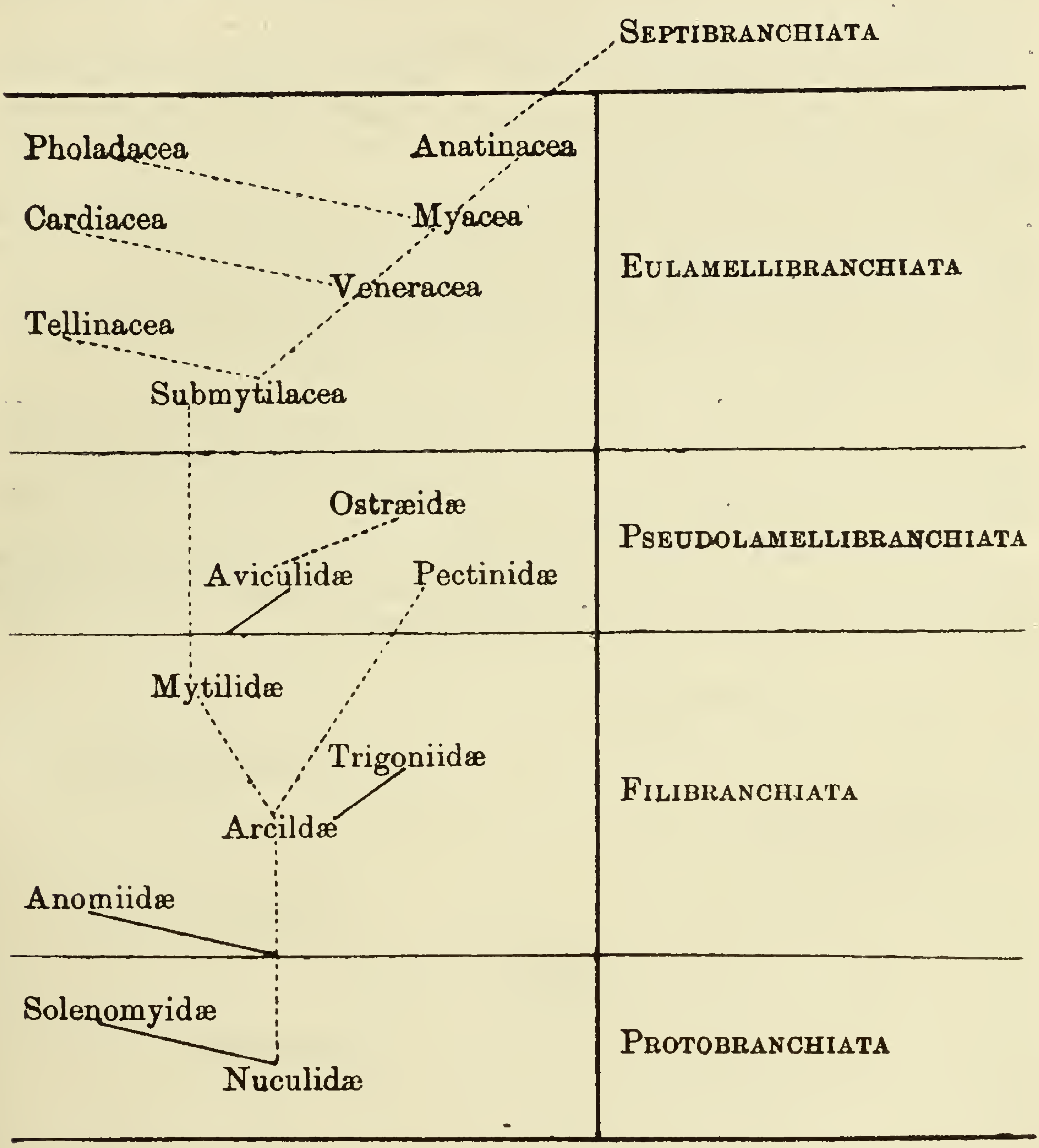
Larval Form of Parmophorus.‡—M. L. Boutan discovered near Suez some small black masses a few millimetres in diameter; these were Gastropods, the shell of which was partly covered by the lobes of the mantle; he was fortunate enough to find a series of forms which led at last to the adult. The author has already shown that the larva of *Fissurella* passes through stages at which other generic types rest, and the present discovery confirms that view.

δ. Lamellibranchiata.

Lamellibranchiata.§—Dr. P. Pelseneer treats very fully of this class, giving first details of descriptive anatomy, then a comparative anatomy of the organs under nine heads, and lastly discussing their relations to one another and to other Molluscs. He has convinced

* Zool. Jahrb., iv. (1891) pp. 505-630 (6 pls.).
† Proc. Zool. Soc. Lond., 1891, pp. 214-26.
‡ Comptes Rendus, cxiii. (1891) pp. 94-5.
§ Arch. de Biol., xi. (1891) pp. 147-312 (18 pls.).

himself that the complication of the gill indicates the degree of specialization of the different groups of Lamellibranchs, and he offers the following classification.



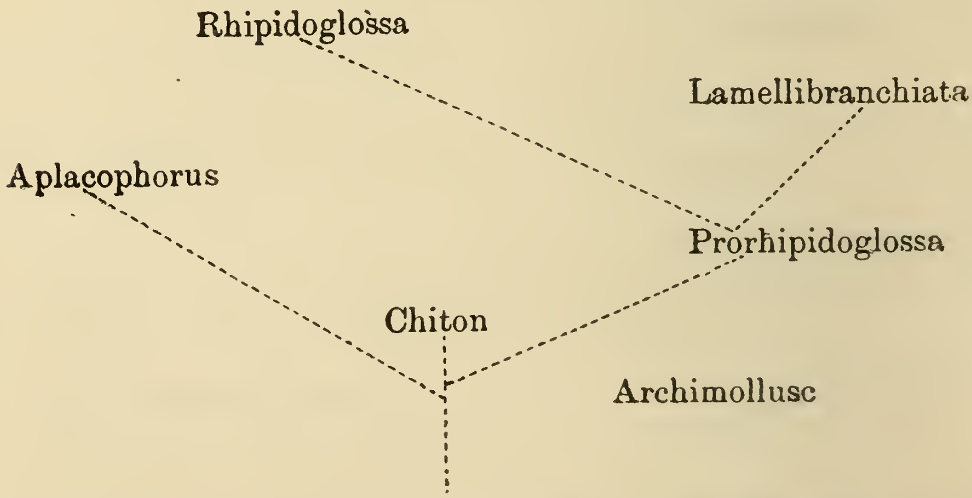
If we compare the Lamellibranchs with other groups of the Mollusca we find that they are much more specialized than the Amphineura, very different from the Cephalopoda, by no means so allied to the Scaphopoda as has been suggested by Lacaze-Duthiers, but showing many points of resemblance to the Rhipidoglossa. Of these last the least specialized show a marked symmetry of gills, osphradia, auricles, and renal organs; the edge of the mantle is free; some archaic forms, such as *Haliotis*, have well-developed hypobranchial glands; *Fissurella* and *Trochus turritus* have a crystalline style. The structure of the gills in dibranchiate Rhipidoglossa is absolutely similar to that of the Nuculidæ and Solenomyidæ. The crossing of the ventricle by the rectum is found only in Lamellibranchs and some Rhipidoglossa; pericardiac glands are also found; the osphradia of the primitive Rhipidoglossa are found on the branchial nerve; the sexes are generally separate, and in archaic forms of both groups there are no accessory glands or copulatory apparatus.

In discussing the origin of the Lamellibranchiata it is as well to bear in mind that they cannot have given origin to the Rhipidoglossa, for the group of anisopleural Gastropods is, phylogenetically, more ancient than that of the Lamellibranchs; this is shown by morphology, individual and phyletic development.

Of all the Anisopleura the Rhipidoglossa are the most ancient; this is shown not only by their bilateral symmetry and the freedom of the edge of the mantle, but by the absence of centralization of the nervous system, the embryonic character of the eye, in some of which the invagination-cavity remains open, and by the opening of the gonad into the right kidney.

On the other hand, a number of characters show that the Lamellibranchiata are more specialized than the Anisopleura in general, and the Rhipidoglossa in particular; morphology, palæontology, embryology, may all be summoned to testify to this.

On the whole, Dr. Pelseneer concludes that the Lamellibranchiata are derived from forms of the rhipidoglossal type which have undergone no torsion, and he exhibits the relations thus:—



The Bulbus Arteriosus and Aortic Valves of Lamellibranchs.*—Prof. C. Grobben describes the post-ventricular bulbus arteriosus of *Cytherea chione*, *Venus verrucosa*, *Mactra stultorum*, and some other bivalves, and in part corroborates the recent investigations of Menegaux. The bulbus consists of interwoven smooth muscle-fibres extending through a matrix of connective tissue, and it contains a long valve which prevents regurgitation. Like Rankin and Menegaux, and others, Grobben finds a valvular arrangement at the beginning of the anterior aorta. In all the bivalves investigated there is a single semilunar valve, the nature of which in *Pecten Jacobæus* is described in detail. In the posterior aorta of *Pecten Jacobæus*, and probably in other Asiphoniata, there is, besides the sphincter described by Dogiel, another valvular structure.

* Arbeit. Zool. Inst. Univ. Wien (Claus), ix. (1891) pp. 163–73 (1 pl.).

Molluscoida.

α. Tunicata.

Classification of the Tunicata.*—Prof. W. A. Herdman has an essay on the classification of the Tunicata in relation to evolution. The exceptional diversity of opinion exhibited by systematists is probably due to the complex relations which obtain between the compound forms and the other Tunicata. He thinks that the only rational explanation of the protean forms and labyrinthine interrelations of the Ascidians is to be found in regarding the group as one in process of evolution, where many species, genera, and higher divisions have not yet become markedly differentiated by the elimination of intermediate forms; he thinks, moreover, that the animals are so much at the mercy of their environment that a special premium is set upon useful characters, so that the relations between modifications of structure and conditions of existence brought about by the action of natural selection are exceptionally evident.

The author becomes more and more convinced that it is necessary to regard the compound Ascidians as having had a polyphyletic origin, and to represent the group as linked on to the Ascidiæ Simplices by at least three points; moreover, if we attempt to arrange the families and genera in a series diverging from any one of these points alone, we must not be surprised if we arrive at obviously unnatural arrangements.

Prof. Herdman points out various objections to the scheme of classification lately propounded by M. Lahille, and urges that if the use of the modifications of structure of one organ are especially unsafe, it is the more so when, as in this case, the organ (the branchial sac) is of great physiological importance, and is therefore liable to be considerably modified in accordance with the mode of life of forms which are otherwise closely related.

Some interesting details are given as to the variation exhibited by the *Botrylli*, and the author concludes with pointing out that the theory of evolution has given taxonomy and speciography an additional and a very real interest. We know now just how much and how little the term species indicates, and it has, therefore, become of great importance that species and varieties should be restudied from the evolutionary standpoint, that the relations of allied forms should be carefully investigated, the limits of their variation determined, and the effect of their environment ascertained.

β. Bryozoa.

Loxosoma annelidicola.†—Dr. H. Prouho gives a detailed account of this Bryozoon, to the preliminary notice of which we have already called attention.‡ The creature varies from 35 to 80 hundredths of a millimetre, and its integument is colourless. In this integument there are no glandular cells. The stalk ends in an adhesive disc which may attain considerable size, but there is no trace of the pedal gland which has been seen in other members of the genus; nor is there need of one, for the disc can act as a sucker. The arrangement of the muscles of the stalk is such that the animal is enabled to rotate on its

* Nature, xliv. (1891) pp. 130-3.

† Arch. Zool. Expér. et Gen., x. (1891) pp. 91-116 (1 pl.). ‡ *Vide ante*, p. 29.

base through 180°. The author describes in detail the calyx and the crown of tentacles ; what is ordinarily known as the epistome is nothing more than that region of the floor of the lophophore which fuses with the upper edge of the buccal orifice. In some points Dr. Prouho's investigations enable him to confirm the results of Harmer ; in the case of the nephridia he is able to make some additions to our knowledge. He regards the nephridium of *Loxosoma annelidicola* as being a group of two or three excretory cells placed in a definite space in the midst of the parenchyma ; in this space there is also a vibratile area (the true structure of which is still unknown), which opens to the exterior by a ciliated canal. The space inclosing the excretory cells communicates with the exterior ; the products excreted by these cells fall into the space and are carried outwards by cilia. The author cannot agree with Foettinger in thinking that there is any intracellular canal in these cells.

After some observations on budding, attention is drawn to the adaptation of *Loxosoma annelidicola* to its habitat ; the Clymenid on which it lives is lodged in a thick and solid tube, between which and the worm there is but little space ; we can understand, therefore, that in its normal position the *Loxosoma* is sharply inclined on its peduncle, while its calyx is extended transversely as if it had been flattened between the worm and its tube. As the Clymenid moves up and down its tube, it swells some of its rings ; to avoid the danger to which it is thus exposed, the guest twists itself on its axis ; and we may well suppose that the helicoidal muscles of the stalk are specially developed with regard to these movements. The Clymenids on which this species of *Loxosoma* has as yet been observed are *Nicomache lumbricalis* and *Petaloproctus terricola.*

Characters of Melicertitidæ and other Fossil Bryozoa.*—Mr. A. W. Waters calls attention to certain cheilostomatous characters in *Melicertites* and other fossil Bryozoa ; such are the presence of aviculariæ, the large size of the pores, the plates on the apertures of the zoœcia. He urges the importance of a thorough comparison of Palæozoic with Cretaceous genera, as the latter form an excellent stepping-stone between the rich Carboniferous fauna and the recent. In the Cretaceous Melicertitidæ the characters are in the main cheilostomatous but some are cyclostomatous, while in many Palæozoic fossils there are important structures similar to those in recent Cheilostomata.

Marine Polyzoa.†—The Rev. T. Hincks continues his "appendix" to his "Contributions towards a General History of the Marine Polyzoa" ; in this new species are described and additions and corrections made to our existing knowledge.

Arthropoda.

Circulatory and Respiratory Organs of some Arthropods.‡—M. A. Schneider has some scattered notes on these organs in Amphipods, Arachnids, and Araneids ; the lung of the last has not the chitinous envelope which has lately been described as investing it.

* Ann. and Mag. Nat. Hist., viii. (1891) pp. 48–53 (1 pl.).
† Tom. cit., pp. 86–93.
‡ Comptes Rendus, cxiii. (1891) pp. 94–5.

a. Insecta.

Minute Structure of Muscle-columns in Wing-muscles of Insects.*—Prof. E. A. Schäfer has made a study of the muscle-columns, or sarcostyles, as he prefers to call them, of the wing-muscles of Insects. For the more or less cylindrical disc which forms the dark band the author retains the name of "sarcous element"; the fine line which bisects the light band he terms the "transverse membrane," while the light space which separates the ends of the sarcous elements from the transverse membranes may be called the clear interval; it corresponds with the isotropous substances of authors. The segment of a sarcostyle comprised between two transverse membranes may be termed muscle-segment or sarcomere. Prof. Schäfer finds that the sarcous elements are not made up of a bundle of rods, but are formed of a continuous substance (sarcous substance), staining with hæmatoxylin and with gold after hardening in alcohol; this substance is pierced by tubular canals which open at each end of the sarcous element, and in its middle abut against one another at the plane of Hensen's line. The optical section of each sarcous element shows a dozen or more of these canals, the contents of which are, apparently, freely continuous with the transparent, colourless substance of the clear intervals. The longitudinal striation of the sarcous element is due to this canalization; that of the clear interval to a prolongation of delicate lines of the sarcous substance through the clear interval to the transverse membranes. The whole sarcostyle seems to be inclosed by a membrane of extreme delicacy. Prof. Schäfer has been able to take photographs of his preparations which illustrate these points with great clearness.

If this view of the structure of muscle be accepted it is possible to form an idea of what happens when the muscle contracts or extends. In the latter case the sarcous elements are narrowed and laterally compressed by the extending force, and the fluid which is contained in their canals is squeezed out and passes into the clear intervals; furthermore, the process of extension elongates the sarcous elements and separates them further from the transverse membranes. When, on the other hand, the extended sarcostyle is retracted, the sarcous elements swell and the clear intervals become shortened so as eventually almost to disappear. This can only be effected by absorption of the homogeneous substance of the clearer intervals into the sarcous elements; in all probability it is imbibed into the canals or visible pores of the sarcous substance.

The author believes that the structure of the wing-muscles of insects furnishes the key to the comprehension of muscular structure in general, and that comparisons may be drawn, detail for detail, between them and the more intricate structures seen in Vertebrates and elsewhere.

Origin of the Blood and Fatty-tissue in Insects.†—Prof. V. Graber discusses the complex tissue found in the body-cavity of most insects. It includes (1) blood-corpuscles, (2) the fatty-body, (3) the yellow "œnocytes," which Wielowiejski finds to be usually arranged in segmental groups, and (4) the pericardial cells which lie near the dorsal vessel. All these Graber would include under the title "hæmosteatic tissue." From sections of the young larvæ of *Stenobothrus*, he finds that

* Proc. Roy. Soc. Lond., xlix. (1891) pp. 280–6 (2 pls.).
† Biol. Centralbl., xi. (1891) pp. 212–24.

the partially reticular fatty-body arises from the gradual vacuolation of œnocytes. Groups of these œnocytes occur in the eight anterior stigma-bearing segments of the abdomen. They arise from a proliferation and subsequent delamination of the ectoderm. Furthermore, in *Hydrophilus*, Graber has discovered that the parastigmatic groups of œnocytes arise in a hitherto unobserved fashion by an invagination of the ectoderm, which is, however, associated with a proliferation and delamination.

Signs of Copulation in Insects.*—Prof. F. Leydig has collected, partly from his own observations, partly from those of others, a number of cases in which female insects bear traces of copulation, in the form of tags or plates attached to the body, and apparently formed from material secreted by the male. Such probably is the "pouch" on the abdomen of *Parnassius Apollo*, and a somewhat similar structure in *Fulgora laternaria*, and such is the plate which is found on the posterior abdomen of *Dytiscus latissimus* and *D. marginalis*. Leydig compares these things with the white plate in *Astacus fluviatilis*, and with a little white lid on the spider *Argenna*, and finds analogues among Vertebrates.

Morphology of Lepidoptera.†—In the first of his communications under the above title Mr. W. Hatchett Jackson deals with two subjects—the external anatomical marks by means of which the sex of a chrysalis may be determined, and the mode in which the azygos oviduct or vagina of the female butterfly with its accessory organs developes between the close of larval life and the assumption of the imago-state. As we gave a full account of the preliminary notice of his results ‡ we must, in calling attention to their publication, confine ourselves to one or two points. It would appear that, in Germany, some "practical Lepidopterists" were able to discriminate the sexes of Lepidopteran chrysalids, though none in England did so before Mr. Jackson's work became known. Some experiments on colour-variation which were undertaken by the way seem to bear out the conclusions of Poulton. The anatomy of the genital ducts in the Microlepidoptera should be studied as it may bring to light transitional or primitive stages, just as Walter's researches have clearly shown that a primitive biting condition of the mouth-parts exists in some of them at this day.

Morphology of Lepidopterous Pupa.§—Mr. E. B. Poulton, in describing the morphology of the lepidopterous pupa, discusses its relation to that of the other stages and to the origin and history of metamorphosis. He points out the error of naming the various appendages and other organs of the pupa as if they were mere cases for the corresponding parts of the imago; the appendages or organs are parts of the pupa, and should be spoken of as such; they are far more ancestral than the imaginal organs, and are remnants of a time when the last stage of metamorphosis in the ancestors of Lepidoptera was something very different from a butterfly or moth; the fault of the old terminology was that it obscured the fact that the pupa has a morphological meaning of

* Arbeit. Zool.-Zoot. Inst. Würzburg (Semper), x. (1891) pp. 37–55 (2 figs.).
† Trans. Linn. Soc. Lond., v. (1890) pp. 143–86 (5 pls.).
‡ This Journal, 1890, p. 29.
§ Trans. Linn. Soc. Lond., v. (1890) pp. 187–212 (2 pls.), 245–63 (2 pls.).

its own, and that traces of an extremely remote past can be deciphered by the study of its structure.

In investigating the persistent traces of larval structures upon the pupa, the author describes the claspers, the caudal horn of the Sphingidæ, and other structures, the larval tufts of hair indicated on the pupa, and the larval markings. He next discusses the number of abdominal segments and their relation to those of the larva, and concludes that both possess ten abdominal segments; even if this be shown to be incorrect it will not affect the segmental relations of the external reproductive organs, for they only come into relation with the eighth, ninth, and ventral (anal) part of the tenth abdominal segments.

The external generative organs are next described, and it is suggested that the median prolongation of the tenth abdominal and the relation of its apex to one of the generative apertures represents an ancestral ovipositor, now represented only by its external cuticular layer.

The relation of the pupal to the imaginal antennæ, and the history of the degeneration of the antennæ in female imagines form the subject of the next (fourth) part of the memoir; and the pupal wings are afterwards examined. In the course of an interesting discussion it is pointed out that when the two sexes seem to approach most closely in competition, flying together and both apparently exercising the powers of active selection—when, in fact, courtship appears to be mutual—then the differences between the antennæ of the two sexes become very small, and in the cases of most complete equality disappear altogether. The antennæ are in all probability sense-organs of very general use, although their sexual function is by far the most important, while free and active flight gives abundant opportunity for their exercise in all possible directions, so that these organs may be sometimes equally developed in the two sexes.

Phylogeny of Lepidopterous Larvæ.* — Prof. A. S. Packard publishes some very interesting observations on the larvæ of Lepidoptera; his studies have led him to believing, provisionally at any rate, that the butterflies have originated from moths which resembled the Bombyces more than any other group; at any rate the ancestors were hairy or spiny caterpillars. The Nymphaliidæ may have originated from Arctian-like forms, and the Papilionidæ from Attacids. They certainly show no signs of descent from the Sphingidæ, the Castniidæ, Agaristidæ, Cossidæ, or Hepialidæ.

The Hesperidæ appear to be the most generalized butterflies, but their origin is not apparent. The Papilionidæ probably stand next above them, as they seem to have descended from an earlier and lower type than the Nymphaliidæ. The Lycænidæ appear to be the most extremely modified, and form a shoot perhaps parallel to the last; they are a more modern and highly modified family, though somewhat degenerate as regards their larval form; they thus recall the Cochliopodidæ, which are highly modified Bombyces.

Sound-Organs of Dytiscidæ.†—Herr P. Recker, after a historical account of our knowledge of the sound-organ of *Pelobius*, a genus of

* Proc. Boston Soc. Nat. Hist., xxv. (1891) pp. 82–114 (2 pls.).
† Arch. f. Naturg., lvii. (1891) pp. 105–12 (1 pl.).

Dytiscidæ, in which its characters are very well marked, describes in order the apparatus as found in the German species of *Cybister*, *Dytiscus*, *Acilius*, *Graphoderes*, and other representatives of the family.

β. Myriopoda.

Ocelli of Lithobius.*—M. V. Willem has made a study of the ocelli of *Lithobius forficatus*, on which Graber, Grenacher, and Sograff have published more or less discrepant reports; M. Willem confirms, in the main, the results of Grenacher. He finds that each ocellus has the form of an elongated cylinder, bounded externally by the cornea, and enveloped by a connective membrane which is traversed by the optic nerve; in the grooves which separate the corneæ from one another, this membrane is thickened and contains a mass of small pigmented cells. The cavity of the eye is occupied by two kinds of cells; some, the Haarzellen of Grenacher, are pigmented, and separate the cornea from the true retina. They end internally in delicate cilia which in the author's sections did not exhibit the regularity ascribed to them by the drawings of Grenacher; they are, rather, aggregated into irregular tufts.

The base of the optical section is occupied by a score of retinal cells, which Grenacher was only able to detect in exceptional cases. Each of these has a basal segment, which incloses the nucleus, pigment granulations, and Grenacher's rod; this last is distinctly striated transversely. In a few favourable sections the author was able to detect, between the striated segments of adjoining cells, elongated elements which present the same appearance as the lateral rods of the retinal cells of the larvæ of *Acilius*. Some of the author's preparations explained the cause of Graber's errors of interpretation, which he thinks due to preconceived notions and too thick sections.

δ. Arachnida.

Classification of Mites.†—Prof. G. Canestrini proposes the following classification:—

Class Acaroidea.

Order 1.	Astigmata ..	Suborder Vermiformia.	Demodicidæ, Phytoptidæ.
		„ Sarcoptina ..	Cytoleichidæ, Psoroptidæ, Linocoptidæ, Listrophoridæ, Dermoglyphidæ, Analgesidæ, Tyroglyphidæ.
„ 2.	Hydracarina ..	Halacaridæ, Limnocharidæ, Hydrachnidæ.	
„ 3.	Prostigmata ..	Suborder Trombidina.	Tarsonemidæ, Cheyletidæ, Erythræidæ, Tetranychidæ, Raphignathidæ, Eupodidæ, Bdellidæ, Alychidæ, Rhyncholophidæ, Trombidiidæ.
		„ Holopina ..	Hoplopidæ.
„ 4.	Cryptostigmata.	Oribatidæ, Nothridæ, Hoplophoridæ.	
„ 5.	Metastigmata ..	Ixodidæ, Argasidæ.	
„ 6.	Mesostigmata ..	Nicoletiellidæ, Uropodidæ, Zerconidæ, Lælaptidæ, Gamasidæ, Dermanyssidæ.	

* Comptes Rendus, cxiii. (1891) pp. 43–5.
† Atti R. Ist. Veneto, ii. (1891) pp. 699–725.

Coxal Glands of Arachnida.*—Dr. R. Sturany describes these organs which occur in all the orders of Arachnida, though with great diversity of form and size. In *Limulus* there is a four-lobed mass between appendages 2–5; the scorpion has a roundish packet at the base of the third and the fourth walking legs; in the Pseudoscorpionidea there are tubes in the region of the last three appendages; in the Solifugæ there is on each side a single long and much coiled tube; in the Pedipalpi there are packets of considerable size in the region of the last three legs; the spiders have diffuse coiled tubes in the Tetrapneumones, simple or quite rudimentary sacs in the Dipneumones; the Phalangiidæ have much coiled tubes, which open in spacious ventral sacs; finally, the mites have only traces of tubes. The glands have a striated cortex and a granular nucleated internal layer. The coxal glands of *Limulus*, Scorpions, Pseudoscorpionidea, Tetrapneumones, and Phalangiidæ are homologous and may be derived from a pair of nephridia opening on the fifth appendage; but the glands of the Dipneumones lie in the region of the third appendage. Therefore two pairs of nephridia may be represented in Arachnida.

ε. Crustacea.

Eyes of Crustacea.†—The results of the studies of Wanda Szczawinska may be shortly stated thus. The eye of *Gammarus* is provided with a hypodermis which is formed by a single layer of flattened cells not differentiated for each retinophore. In *Astacus* the cells of the hypodermis are grouped in pairs and cover the whole of the outer surface of a retinophore. The calyx and style in *Gammarus* and *Branchipus*, the calyx, style, and pedicel in *Astacus*, unite to form a continuous hyaline axis which reaches from the cornea as far as the basal membrane, to which it is attached by means of hyaline filaments.

In *Gammarus* three kinds of pigment-cells are grouped around each hyaline element of the eye, and are arranged in whorls of five each; these cells are provided with very distinct nuclei, which are arranged in three rows set in different planes. In *Astacus* the three kinds of pigment-envelope are arranged thus; the first covers the anterior part of the retinophore; it is formed by four cells placed at the four edges of the calyx; they give off filaments, one anteriorly and one posteriorly which serve to attach them to the cornea and to the basal membrane. The second envelope, or retinula of Grenacher, is formed of a verticil of seven cells, the nuclei of which are large and are placed at their anterior, enlarged extremity; four of these cells are shorter than the other three. The cells of the third set are placed near the basal membrane, and are distinguished from the first by their yellow crystalline contents; they appear to be seven in number.

From the experiments that were made it would seem that in the pigment-cells which surround the calyx and the style, the pigment, in darkness, is placed in the distal part of the eye; in the cells which surround the pedicel the pigment is in the proximal part and near the basal membrane. In light, the pigment of the cells which surround the calyx and style moves toward the optic nerve, so as to become more

* Arbeit. Zool. Inst. Univ. Wien (Claus), ix. (1891) pp. 129–50 (2 pls.).
† Arch. de Biol., x. (1891) pp. 523–66 (2 pls.).

extended, the cells themselves moving in the same direction; the pigment of the cells which surround the pedicel advances towards the cornea, and reaches as far as the outer pigment zone, so as to form a continuous layer of pigment which extends from the distal extremity of the retinophore as far as the basal membrane.

As the results now reached support those of Patten there does not seem to be any justification for regarding the eyes of *Branchipus*, *Gammarus* or *Astacus* as compound eyes; they are, rather, simple eyes the cornea of which is differentiated in a special manner, and the pigment-cells of which are grouped more regularly than in Vertebrates, where the adaptation of the optic organ to the changes in the surrounding media are produced by means of special organs, which are wanting to the Crustacea.

In the Crustacea this adaptation is effected by the movement of the granular pigment, and the pigment-cells. The eye of *Gammarus*, by the possession of a smooth cornea and an undifferentiated hypodermis—characters which distinguish the simple eyes of Arthropods—as well as by the structure of its calyx and style, approaches the eye of lower Crustacea; while, by the possession of pigment-cells which are not found in them, it affords an intermediate stage between the ocelli of Arachnids and the larval form of Arthropods on the one hand, and the so-called compound eyes of Crustacea on the other.

Notwithstanding some differences in detail the present researches, taken with those of Madlle. Stefanowska on Insects and those of Engelmann on Vertebrates, allow us to formulate the following generalization; in eyes exposed in darkness the pigment tends to occupy the smallest surface, while in light it spreads considerably, so as to protect the receptive elements against the influence of light.

Development of Mesoderm of Crustacea.*—M. L. Roule has a note on the development of the mesoderm of Crustacea, and that of the organs derived therefrom. His investigations have been carried out on *Porcellio scaber* and *Palæmon serratus*. At the time when the cells of the blastoderm are increasing on the medioventral line to produce the nerve-centres, and at the sides of the anterior end of the body to give rise to the foundations of the endoderm, two new bands of proliferation appear on either side of the ventral nervous band. The peripheral blastoderm becomes ectoderm; the central cellular mass represents the mesoderm; the cells of this mass are converted into muscular fibres. Similar cell-multiplications are found in most of the remaining portion of the blastoderm, but they are less active; they only produce elements which penetrate into the subjacent yolk, and gradually destroy the nutrient materials which it contains. These elements correspond to the vitelline cells of authors, as to which opinions of such different kinds have been expressed. They are all derived from the blastoderm alone, and are to be regarded as part of the mesoderm of the body.

The further development of the mesoderm is on the mesenchymatous type; the mass in each young appendage commences to form a central cavity, two or three being sometimes juxtaposed; the cells around the cavity break away from their neighbours, and become free in the interior. This process of dissociation leads to the formation of a network of meso-

* Comptes Rendus, cxiii. (1891) pp. 153-5.

dermal elements; the spaces are filled by a liquid or by unchanged cells, and become the vascular sinuses of the appendage. There is nothing in this mode of development which is comparable to the portioning-off of the cœlom as seen in Annelids and Vertebrates; there is only the formation of clefts which become blood-lacunæ.

A similar mode of development is seen in the mesoderm of the body; its elements, while destroying the nutrient yolk, give rise to the formation of spaces which communicate with one another, and become blood-lacunæ. One of these, that around the intestine, is isolated from its fellows, and becomes the circumintestinal cavity. But, before this separation is effected, a group of mesodermal cells situated above the proctodæum elongates, and is pierced by a central cavity which unites two mesodermal spaces.

Renal Secretion in Crustacea.*—M. P. Marchal gives a short account of the excretory apparatus of *Nika edulis*, *Alpheus ruber*, and *Caridina Desmaresti*. He thinks that the production of the urinary liquid is not, in Crustacea, due to a simple filtration as the limpidity and abundance of the liquid which fills the bladder might lead one to suppose; it is a real secretion with separation of parts of cells. In the Paguridæ the clear liquid which fills the abdominal bladder contains more or less granular vesicles, often of large size, and sometimes containing more or less numerous secondary vesicles. When indigo has been injected into the animal blue granulations are found in the vesicles. It is evident that the bladder takes an important part in secretion.

The white substance of the Crayfish secretes in the same way as the bladder; its cells are likewise swollen at their extremity into large, clear vesicles, distinct from the cell-body. Several vesicles may be found at once in one and the same cell of the cortical substance of the Crayfish and the labyrinth of other Crustacea; they give the appearance of a sort of palisade, covering the cells. The sacculus also secretes and expels parts under the form of vesicles which are often coloured yellow.

Morphology of Isopod Feet.†—Dr. J. Nusbaum has observed in the embryos of Isopoda that all the thoracic feet have the biramose structure which is so characteristic of other Crustacea; it is well known that in the adult there is a considerable reduction; the young type approaches most closely that of *Nebalia*—two-jointed protopodite, five-jointed endopodite, unjointed exopodite, and simple lamelliform epipodite.

The first foundation of every thoracic foot appears in the form of two closely connected papilliform processes of the ectoderm. Simultaneously there appears outside each a small disc-like ectodermal thickening. The gradual differentiation of the appendages goes on, as usual, from before backwards. The inner process of each foundation soon becomes longer than the outer, and the foundation of the protopodite is differentiated somewhat later. The lateral foundation divides into a distal and broader part and a proximal and more delicate, which becomes intimately connected with the basal joint of the protopodite. It is very probable that this not only merely takes part in the formation of the pleura, but

* Comptes Rendus, cxiii. (1891) pp. 223-5.
† Biol. Centralbl, xi. (1891) pp. 353-6.

has also a considerable share in the constitution of the epimera. In the later stages of development the parts in question cannot be distinguished in the ventral wall of any segment. This share of part of the appendage (probably a homologue of the epipodite) in the formation of the ventral wall appears to be general in Isopods.

Urothoe and Urothoides.*—The Rev. T. R. R. Stebbing gives a monographic account of these genera of Amphipods, the second of which is new and is established for *Urothoe lachneëssa*, described by the author in his 'Challenger' Report. Of the former, eight species are recognized, which are more remarkable for their likeness to one another than for any differences that can be discerned. The size of the eyes and the structure of the lower antennæ vary greatly with the age and sex of the animal: the most constant feature is the possession by the female of a two-jointed flagellum on the antennæ. One characteristic of the genus is a vast number of gland-cells found all over the body, while others are the transparent caps to the tips of all the fingers, a peculiar spine-row on the wrist of the first gnathopods, and the long plumose setæ on some of the appendages.

New British Amphipods.†—The Rev. T. R. R. Stebbing and Mr. D. Robertson give descriptions of four new species of British Amphipods, which are called *Sophrosyne Robertsoni*, *Syrrhoë fimbriatus*, *Podoceropsis palmatus*, and *Podocerus cumbrensis*; they were all found in the Clyde.

New and Rare French Crustacea.‡—In the thirty-eighth of his communications on this subject M. Hesse describes a new Lepadid which he calls *Cirrhipedes pedunculatus laciniatus*, and in the thirty-ninth a Lernean found in the mouth of *Cottus bubalis*; in the latter he offers some observations on the metamorphoses of Cirripeds during their embryonic period.

Goniopelte gracilis—a new Copepod.§—Prof. C. Claus describes a new member of the family Peltidiæ—*Goniopelte gracilis*—characterized by the seven-jointed anterior antennæ, the unjointed simple outer branch of the first pair of legs, and the marked reduction of the accessory branch of the posterior antennæ. The similar form described by Brady as *Goniopsyllus rostratus* and referred to the Harpacticidæ, is insufficiently characterized, and with it the species which Lazar Car described as *Sapphir rostratus* and referred to the Sapphirinæ, is identical.

New Pelagic Copepoda.‖—Dr. W. Giesbrecht continues his list of pelagic Copepods collected on the "Vettor Pisani" expedition, adding four new genera, *Mormonilla*, *Ægisthus*, *Conæa*, and *Corina*, and forty new species belonging to the above and other genera.

* Trans. Zool. Soc. Lond., xiii. (1891) pp. 1–30 (4 pls.).
† Tom. cit., pp. 31–42 (2 pls.).
‡ Ann. Sci. Nat., xi. (1891) pp. 179–86 (1 pl.); and 187–95 (2 pls.).
§ Arbeit. Zool. Inst. Univ. Wien (Claus), ix. (1891) pp. 151–162 (2 pls.).
‖ Atti R. Accad. Lincei—Rend., vii. (1891) pp. 474–81.

Vermes.

a. Annelida.

Homology of Pedal and Cephalic Appendages in Annelids.*—M. A. Malaquin is of opinion that the cephalic appendages of Annelids are morphologically comparable to the pedal appendages; he finds that the dorsal and ventral setigerous rami may undergo modifications and be converted into cirriform appendages which may be sensory; the cephalic lobe is regarded as a single segment, the appendages of which, though profoundly modified, may be homologized with the different parts that make up the parapodia of normal segments.

Development and Morphology of Parapodia in Syllidinæ.†—M. A. Malaquin has made an examination of the appendage in this group of Polychæta. He looks on the organ when at its maximum size as being composed of, in the order of their development—a ventral branch, a dorsal cirrus, a ventral cirrus, and a dorsal branch. This is sometimes found, but only in segments provided with swimming setæ. The most general composition of the parapodium is ventral branch, dorsal and ventral cirri. Reduction may result in the loss of the last of these, or may, as in *Procerastea*, go further, so that there is merely a ventral swelling whence emerge setæ. In this genus, however, there is, at the time of reproduction, a series of complications due to the tardy development of the appendages in sexual forms.

A comparison of the morphology and development of the parapodia shows that the phenomena of retrogression of the constituent parts in the Syllidinæ follow the inverse order of their embryological appearance. These facts confirm the view of Hallez, that in the development of an organ which has begun to retrograde the organ goes through a reduced number of stages; so that, in place of passing through stages *a*, *b*, *c*, and *d*, it only reaches *c*, then *b*, and finally *a*.

Reproductive Organs of Diopatra.‡—Mr. E. A. Andrews had his attention attracted by peculiar strings of green cells which occur abundantly in the body-cavity of *Diopatra magna* sp. n. and *D. cuprea* Bosc, found at Beaufort, North Carolina. On investigation they were found to be ovarian cells liberated along with the ova, and remaining for a time attached to them as peculiar processes. It is difficult to imagine what the function of these bodies can be. There is no reason for supposing that the ova derive nourishment directly from them, for a firm egg-membrane, which would prevent the ingestion of entire cells, is early developed, and, later on, they are entirely absent. Mr. Andrews suggests that the cell-strings may be mechanical supports which serve to keep the ova separate and well surrounded by the nutrient fluid while floating about. The most similar case is to be found in *Bonellia*, where the ovum is armed at one point of its periphery with a collection of cells of no apparent use.

A diagnosis is given of *D. magna*, the young of which often construct small tubes on the outside of those of the adult.

* Comptes Rendus, cxiii. (1891) pp. 155–8. † Tom. cit., pp. 45–8.
‡ Journ. of Morphology, v. (1891) pp. 113–22 (2 pls.).

Earthworms of Berlin Museum.*—Dr. W. Michaelsen devotes the first of a series of articles descriptive of the Terricolæ of the Berlin zoological collection to those from the African region. *Kynotus madagascariensis* g. et sp. n. is remarkable for the want of congruence between the internal and external segmentation. In a layer of the anterior part of the body an internal segment is exactly twice the size of an external; it is clear, however, that the internal arrangement is secondary, for the various systems of organs are only to a certain extent adapted to it.

Dichogaster mimus sp. n. is doubtfully assigned to this systematic position, and only a single specimen was available for examination; in a comparative table the points of difference and similarity between it, *D. Damonis*, and *Benhamia rosea* are exhibited. *Eudrilus pallidus* is another new species also founded on a single example, and the same is the case with *Preussia* (?) *lundaensis*, *Paradrilus ruber*, *P. purpureus*, *Benhamia intermedia*, and *Perichæta madagascariensis;* a new species of *Allolobophora* is described from Madeira. The *Lumbricus Kerguelarum* of Gruber is removed to the genus *Acanthodrilus*.

New Form of Excretory Organ in an Oligochætous Annelid.†—Mr. F. E. Beddard observed in a new genus of Eudrilids that nephridia appeared to be absent in the genital region. But sections through the body-wall showed that the longitudinal and transverse muscular layers were traversed by a system of peculiar canals not at all like nephridia in appearance. They are arranged in a longitudinal and a transverse series, with numerous branches and interconnections; there are four principal longitudinal trunks which run through several segments without a break; they are connected with a metamerically repeated system of transverse vessels, which appear to run right round the body. They give off numerous branches and form a finer meshwork of tubules; those that run towards the epidermis open there by small orifices.

This arrangement may shortly be defined thus:—The nephridial system of the genital segments of this Eudrilid consists almost entirely of a complex system of tubes, which ramify in the thickness of the body-wall, open by numerous pores on to the exterior, and are connected by a few short tubes with the body-cavity.

This system is perhaps comparable to the nephridial network of Flat Worms, but its presence in the body-wall suggests a comparison with the Round Worms.

Naidiform Oligochæta.‡—Prof. A. G. Bourne describes some new species of the genera *Pristina* and *Pterostylarides*, and offers some remarks on cephalization and gemmation as generic and specific characters among the naidiform Oligochæta. The author takes the opportunity of pointing out that a monograph of the British species of this group is still a desideratum.

A certain amount of cephalization is almost always, if not always, exhibited by the Oligochæta; that is, there is in the anterior region a segment or a number of segments which differ in their organization

* Arch. f. Naturg., lvii. (1891) pp. 205–28 (1 pl.).
† Proc. Roy. Soc. Lond., xlix. (1891) pp. 308–10.
‡ Quart. Journ. Micr. Sci., xxxii. (1891) pp. 335–56 (2 pls.).

from the segments which follow; this difference may be exhibited by peculiarities of the alimentary canal, the circulatory system, the arrangement of the septa, the absence of nephridia, and so on. Prof. Bourne's remarks and diagrams illustrative of the processes of gemmation, which could not be reproduced otherwise than *in extenso*, should be studied by all microscopists who have the opportunity of observing worms of this group.

The author gives a system of the Naidomorpha, with definitions of the genera and notes on the species.

Histology of Nervous System of Hirudinea.*—Dr. E. Rohde has specially investigated the minute structure of the nervous system in *Aulostomum gulo* and *Pontobdella muricata*. All the parts of this system consist of a more or less distinctly fibrillar spongioplasm, and an inclosed and apparently homogeneous hyaloplasm; the former is intensely, the latter hardly at all stained by colouring matters; osmic acid reduces the spongioplasm, but leaves the hyaloplasm almost untouched.

As to the ganglia he notes that each ganglion is divisible into a central substance and a peripheral layer of ganglionic cells; this last consists of cells imbedded in a fibrillar supporting tissue; these fibrils are the processes of supporting cells, of which there are six in each ganglion. Each of these six cells incloses by its processes a definite number of ganglionic cells; each ganglion is consequently divided into six pockets which are sharply separated from one another. The spongioplasm of the central substance is formed of irregularly distributed fibrils; that of the ganglion-cells form a plexus of fibrils. The processes of these cells are, as a rule, finely fibrillated, and appear to pass gradually into the stronger fibrils of the central substance; only a proportionately small part pass directly into the commissures and nerves. The nerves contain three different elements, which are distinguished by the characters of the fibrils of their spongioplasm. The chief part (the central substance) is the continuation of the central substance of the ganglion, and consists of fibrils of equal size to its. Nerve-tubes are differentiated from the central substance, at definite points; these are ensheathed in circular fibrils. The nerves of *Pontobdella* contain fewer and thicker fibrils than those of *Aulostomum*.

The spongioplasm of the commissures which connect the ganglia with one another is made up of fibrils of about the same size as those in the central substance of the nerves; those fibrils unite at definite points to form thick radial septa.

A number of the nerve-cells in the nervous system differ essentially in their structure from the central ganglionic cells. For example, there are peripheral ganglionic cells, visible to the naked eye, which are not unipolar but have a large number of processes, and their fibrils are much larger than the ordinary.

Evidence is offered to show that the spongioplasm is only a supporting substance; the identity of the fibrils of the central substance of the ganglia, commissures, and nerves on the one hand, and of the central ganglionic cells on the other, is shown by certain structural characters

* Zool. Beiträge, iii. (1891) pp. 1-68 (7 pls.).

in some of the ganglion-cells of *Pontobdella*, by the median cells, some of the fibrils of which form a plexus of thick fibres, and by the structure of the ganglionic-cell-processes which pass directly into the nerves.

The hyaloplasm is the sole nervous constituent; in consequence of its homogeneity and its resistance to colouring matters it is only rarely detected in sections between the closely packed fibrils of the spongioplasm; in teased preparations, however, it is distinctly seen not only in the ganglionic cells, but in the central substance of the ganglia, nerves, and commissures.

All the three last-mentioned parts are surrounded by a firm neurilemma, formed of connective tissue, almost homogeneous in appearance and often divided into lamellæ. In the ganglia it forms an inner layer which separates the central substance and ganglionic cell-layer, and an outer which marks off the cœlom. In *Pontobdella* the neurilemma remains as an outer layer, while in *Aulostomum* it makes its way into the interior. The radial septa of the commissures have nothing in common with the neurilemma, and they are not to be regarded, as they generally are, as internal continuations of it.

Anatomy and Histology of Sipunculus nudus.*—Mr. H. B. Ward has made a study of some points in the anatomy of *Sipunculus nudus*. He deals largely with the histology of the body-wall, the tentacular fold, and the nervous system.

Though there is a general similarity to *S. Gouldii*, correspondence in details is wanting; for example, bicellular dermal glands are entirely wanting in the latter, and the multicellular glands of the two species are different. Indeed, if the two are to be retained in one genus, some modification of Selenka's diagnosis of *Sipunculus* is needed.

In the nervous system of Sipunculids and Annelids there is, it is true, a striking similarity, but there are at the same time certain characteristic differences. In the former the peripheral system of plexuses is very highly developed and consists almost entirely of fibres, whereas the dermal plexus of Capitellids, Nemertines, and Polychæta is largely composed of ganglionic cells.

The minute anatomy of the central nervous system of *S. nudus* bears a close resemblance to that described by Rohde for Chætopods and by Bürger for Nemertines, but the Sipunculids have no "giant cells"; the Echiurids, on the other hand, have giant fibres, and it is very probable that they are more closely related to the Annelids than are Sipunculids.

β. Nemathelminthes.

Stylet of Heterodera Schachti.†—M. J. Chatin points out that it is incorrect to say that this Nematoid of the beetroot and other plants is unarmed, for, as a matter of fact, it has a very interesting stylet. This is formed of a plate and an apophysis to which muscles are attached. Brownish in colour and very elastic the stylet is pierced by a central canal; it is moved by protractor and retractor muscles. The remarkable dimorphism exhibited by this worm is seen even in the stylet, for, among

* Bull. Mus. Comp. Zool., xxi. (1891) pp. 143–82 (3 pls.).
† Comptes Rendus, cxii. (1891) pp. 1516–8.

other points of difference, that of the female is smaller and weaker than that of the male. In the former, indeed, it has only to prick the plants to draw out the liquids necessary for food; in the latter it has to help a delicate worm to make an active passage through the tissues of the plant when a parasitic is about to be exchanged for a free mode of life. Similar differences, due to similar causes, are to be seen in the stylets of the first and second larvæ; the first is very agile and lives for a time freely in the earth; the second is sedentary or parasitic, and has a smaller flexible stylet. The changes are effected in the organ when the worm sheds its chitinous cuticle.

γ. Platyhelminthes.

Organization of Accelous Turbellaria.*—Prof. L. Graff has a preliminary notice of the results of his work on this group of worms. He has been led to form a new classification, in which the first family, that of the Proporida, consists of Accela with one genital orifice; *Proporus* has no bursa seminalis, *Monoporus* (g. n.) has one; the type of the last is *P. rubropunctatus.* The second family—the Aphanostomida—contains three genera, all of which have two genital orifices and a bursa seminalis; *Aphanostoma* has no chitinous piece to the bursa, *Convoluta* has one, and *Amphichærus* (g. n.) has two; the type of the last genus is *C. cinerea.*

If the epidermis be fixed by chrom-aceto-osmic acid and stained with hæmatoxylin, it is possible to perfectly preserve unicellular glands, the nature of which has been generally misunderstood. It is certain that all Accela have the three layers of muscular fibrils described by Delage in *Convoluta roscoffensis.* All forms studied in the fresh state were seen to have a ventral mouth and a simple pharynx; hitherto its presence has been denied in some members of the group. Three types of structure may be distinguished in the parenchyma; in some it is reticulated, and there is a large number of free cells; in others the central parenchyma is a syncytium very rich in nuclei, but without any free cells, while the peripheral portion is a tissue of rounded cells closely packed against one another. In the third type the body is filled with a nucleated syncytium, in which amœboid cells swim.

From the morphological point of view the free cells are considered as mesodermal elements still inclosed in the endoderm; they have a digestive function. In more advanced forms (*C. paradoxa*) they lose this function, and become peripheral elements of support, while the reticulum alone performs the digestive functions.

Prof. Graff made use of Delage's gold method and found that it gave the best possible results; the want of certainty, however, is a serious objection. On the whole, the author agrees with the results of Delage, but he cannot find the cerebral cavity described by the latter. *Proporus* or *Monoporus* show some remarkable differences in the structure of the central nervous system.

The frontal organ of Delage is not an organ of sense, but part of a gland; the "nerve-cells" and "fibres" are merely formed by parenchymatous tissue distributed among the excretory ducts of this gland. It

* Arch. Zool. Expér. et Gen. ix. (1891) pp. 1–12.

is the homologue of the packet of rod-forming and mucus-producing glands which open at the anterior end in many Turbellaria.

The Zoochlorellæ of *Convoluta* are Algar in nature, and this worm exhibits in a high degree the phenomena of symbiosis.

Nervous System of Monocotylidea.*—M. G. Saint-Remy has examined the disposition of the nervous system in *Pseudocotyle squatinæ* and *Microbothrium apiculatum.* He gives a detailed account of the former, which is not unlike that which is found in the Tristomidæ. In the latter it is more complicated than in any observed member of the group. The brain, which is greatly reduced, gives off anteriorly two branches, which correspond to the first pair in the Tristomidæ. Posteriorly it is prolonged on either side of the pharynx into a branch which goes to the pharyngeal ganglion, and gives off two small branches which are, perhaps, homologous with the second and third pairs of *Pseudocotyle.* The pharyngeal ganglia are two large masses connected by a transverse branch; from this last there arises a pair of very short nerves which correspond to the later dorsal nerves of the Tristomidæ; two ventral longitudinal nerves are given off from each ganglion as well as two accessory nerves which are lost in the parenchyma. Lastly, from the extremity of the nerve there is given off an anterior nerve, which seems to be a continuation of the external ventral nerve; it extends as far as the mouth, and on its way unites with the branch which goes from the brain to the pharyngeal ganglion; this nerve appears to represent the third anterior pair of the Tristomidæ. The two ventral nerves are connected with one another by commissures as in *Pseudocotyle.* On the whole the nervous system of Monocotylidea exhibits an unexpected complication of the plan seen in the Tristomidæ.

Hymenolepis.†—Prof. R. Blanchard gives a zoological and medical account of the Tæniidæ of this genus, to which belongs the minute form often called the *Tænia nana* of Man; the author gives a full description of the structure and development of this parasite, and also deals fully with *H. diminuta.* The fourteen species of the genus are divided into two groups—one armed and one unarmed. The chorology of the species is also discussed.

δ. Incertæ Sedis.

Contribution to the Study of Rotifers.‡—M. J. Masius gives some details, without any generalizations, as to the structure of *Asplanchna helvetica* and *Lacinularia socialis.* Of the points described we may note that, in the first, the author observed the evaginated pharynx, where he was able to distinguish two large contractile cells with prolongations; these last were so distributed as to surround the pharynx with a kind of contractile plexus. Between the stomach and the hinder end of the body there is a cell of connective tissue; this cell is stellate, and its prolongations are directed in opposite directions and are inserted, some into the outer surface of the base of the stomach, others into the cuticle of the end of the body, and others into the generative apparatus.

* Comptes Rendus, cxiii. (1891) pp. 225–7.

† 'Histoire zoologique et médicale des Téniadés du genre Hymenolepis Weinland,' Paris, 1891, 8vo, 112 pp., 22 figs.

‡ Arch. de Biol., x. (1891) pp. 651-82 (2 pls.).

The function of this cell is to prevent the stomach moving too far towards the head of the animal, on the contraction of the muscles of the œsophagus.

The vibratile flame of the terminal organ of the nephridial apparatus is covered with longitudinal striæ, each of which begins by a small thickening; as a consequence of this the base of the flame is bounded by a row of small dots. In the living animal the vibratile flame and its filaments exhibit a continuous undulatory movement, which moves in a centripetal direction. The author thinks that the filaments serve merely to make the organ firmer, and that one of them, more powerful than the rest, is the seat of a movement analogous to that of the vibratile flame, and is perhaps destined to aid the movement of the fluid of the general cavity from the body towards the kidney. There is no valve at the opening of the duct into the bladder; it is possible that the numerous folds of the nephridial tube are sufficient to stop the reflux of the fluids.

The large, spherical bladder contracts ten times a minute; its wall is formed by large, very flat cells; in addition to these there are two large stellate cells with numerous prolongations which cover the whole of the bladder with a contractile plexus.

The winter eggs are covered with three membranes; a delicate internal membrane, most clearly visible when it becomes folded, owing to some alteration in the egg; the next membrane is very thick, striated and divided into two concentric zones; the striation is due to a number of fine canaliculi, radially arranged; they are thickened towards the interior, and it is these thickenings that give the appearance of a division of the membrane into two zones. The outermost membrane is homogeneous and yellowish.

The male efferent duct is remarkable for its enormous diameter; this is related to the presence of a large spermatophore. This last is of a yellowish-brown colour, and is formed by the union of a large number of chitinous elements, polyhedral in form and varying in size. The contained cavity is circular, but eccentric in position. As a canal which contains a spermatophore loses its glandular appearance, we may suppose that the product of its secretion has been used in the formation of the spermatophore.

In a somewhat shorter notice on *Lacinularia*, M. Masius calls attention to some groups of cells which form organs the significance of which is not as yet understood. At the sides of the dorsal part of the salivary glands there are two rows of cells which converge towards the mediodorsal line. In the place of the posterior extremity of the vitellogenous gland, placed very superficially, there are always to be seen two small rows of cells which trend backwards and nearly meet in the medioventral line. These cells appear to have no relation to the adjoining organs. On the ventral surface there is a mass of multinucleate protoplasm without any visible cell-boundaries; the nuclei are arranged symmetrically, in fives.

Anatomy of Rotifers.*—Mr. R. Vallentin has made serial sections of *Melicerta ringens*, *M. conifera*, *Brachionus rubens*, and *Lacinularia*

* Ann. and Mag. Nat. Hist., viii. (1891) pp. 34–47 (2 pls.).

socialis; and he now publishes notes of his observations. He has failed to find any traces of the circular muscular bands which so many observers have seen in optical section in *Melicerta* and *Lacinularia*. He has only found one pair of muscles in the mastax; these appear to draw the rami upwards and inwards, and on their relaxation the rami are forced upwards by a semicircular band, which arches over the dorsal region. In *Brachionus rubens* the flame-cells are of considerable size; each consists of a hyaline cylinder, the extremity of which is rounded and closed, while a single nucleated cell forms the distal termination. A tapering broad-edged cilium springs from the centre of this cell and projects forwards about as far as the junction of the flame-cell with the lateral canal; this junction is marked by a fine granular deposit on the walls of the canal. These notes are fully illustrated. The author remarks that while he found Rotifers in abundance in Epping Forest, he was astonished at the absence in any quantity of all but *Brachionus rubens* in the neighbourhood of Falmouth.

Dasydytes bisetosum.*—Mr. P. G. Thompson calls attention to the neglect of the order Gastrotricha in England, and describes a new species which he found in a pond near Leytonstone in Essex. It appears to be most nearly allied to *D. longisetosum*, but is nearly twice the size, and has much more conspicuous caudal bristles. It is quite colourless, and, exclusive of the caudal setæ, measures 1/170 in.

A Multicellular, Infusorium-like Animal.†—Prof. J. Frenzel has found in the Argentine Fauna a somewhat remarkable organism. With a general resemblance to one of the Ciliates, it has a well-differentiated enteric tract and a single cell-layer. Tubular in form, tapering anteriorly and posteriorly, it is so flattened from above downwards as to be bilateral; the lower surface is flat, and the upper slightly curved; the former has fine cilia, by means of which the creature moves actively forwards, while it is also capable of worm-like or snake-like coils. The dorsal and lateral parts are not ciliated, but carry some short setæ. There is an anterior oral and an exactly terminal finer anal orifice. Longer and stronger cirri surround the former. There is no definite cuticle, but the cell-membrane is thicker externally than elsewhere.

The wall of this tubular organism is formed of a single layer of rather large, almost cubical cells, which leave a cylindrical lumen closely packed with foreign bodies; this is the enteric cavity. The face of the cells turned towards the lumen is finely ciliated. The mouth, which is not terminal, is overhung by a cell.

These animalcules were found of various sizes; growth is effected by doubling of the cells by division. Reproduction is effected by transverse division or by conjugation and encystation, when the contents of the cyst become all similar cells.

Echinodermata.

Classification of Echinodermata.‡—Prof. F. Jeffrey Bell in his observations on the arrangement and inter-relations of the classes of the

* Sci.-Gossip, 1891, pp. 160–2 (2 figs.).
† Zool. Anzeig., xiv. (1891) pp. 230–3.
‡ Ann. and Mag. Nat. Hist., viii. (1891) pp. 206–15.

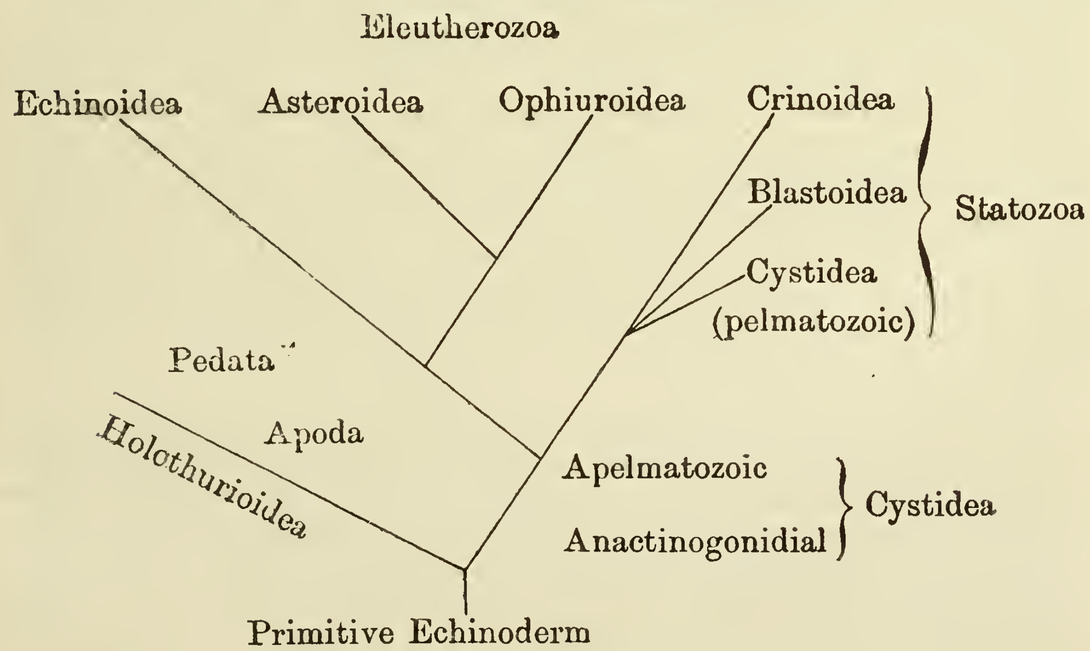
Echinodermata, commences with discussing the relations of the Holothurioidea to the rest of the Echinodermata.

He points out various characters which indicate the primitive nature of the Holothurians; for example, the genital apparatus is not arranged quinqueradially, so that, whereas all other Echinoderms may be said to be actinogonidiate, the Holothurians are anactinogonidial; again, they alone have no system of plates corresponding to those that form the calycinal area in other Echinoderms, or, in a word, they are non-caliculate. Part of the diffused nephridial system, which there is every reason to suppose was possessed by the ancestors of the Echinoderms, has been retained by Synaptids, and part by other Holothurians. Prof. Bell revives the use of the word podia for tube-feet, and points out (*pace* Prof. Ludwig) that there are apodal and pedate Holothurians.

He concludes the argument, which is very briefly stated, by remarking, "the position, then, that the Holothurians are primitive forms, is spoken to (1) by the possession of characters certainly possessed by their ancestor, and (2) by the absence of characters seen in other Echinoderms, and evidently differentiations of structures developed after the ancestor of the Echinoderm had become separated from the ancestors of other phyla."

The relations of the remaining Echinodermata are next considered; the Cystids are recognized as the most primitive, and it is urged that some were probably anactinogonidial, while others had no stalk, or were apelmatozoic. The apelmatozoic actinogonidial Cystids divided into two main branches, one of which led to forms that are truly pelmatozoic, that is, forms that are fixed or had ancestors that were fixed—these are the Statozoa. The others which remain free are Eleutherozoa; such as Echinoids, Asteroids, and Ophiuroids.

The following diagram expresses the author's views:—



The Eleutherozoa either have, as in the Echinoidea, the ambulacra extending from the mouth to the boundaries of calycinal area, and such may be said to be zygopodous; or the ambulacra are, as in Asteroids and Ophiuroids, confined to the oral surface; they are called azygopodous. Put in the ordinary linear way the proposed arrangement stands thus:—

Branch A. Incaliculata.
  Stage α. Anactinogonidiata.
    Class 1. Holothurioidea.
Branch B. Caliculata.
  Stage α. Anactinogonidiata.
    Class 2. Some Cystidea (?)
  Stage β. Actinogonidiata.
    1st Subbranch. Statozoa.
      Substage i. Apelmatozoic.
    Class 3. ? Some Cystidea. Class 4. ? Some Crinoidea.
      Class 5. ? Some Blastoidea.
      Substage ii. Pelmatozoic.
    Class 6. Crinoidea. Class 7. Cystidea. Class 8. Blastoidea (s.s.).
    2nd Subbranch Eleutherozoa.
      Division 1. Zygopoda.
    Class 9. Echinoidea.
      Division ii. Azygopoda (s. Stelleridea sens. em.)
    Class 10. Asteroidea.
    Class 11. Ophiuroidea.

Concise definitions of the divisions and classes, in which the new terms freely proposed by the author are made use of, complete the paper.

Echinodermata from South-west Ireland.*—Mr. W. Percy Sladen gives an account of the Echinodermata collected in 1888 by a Deep-sea Dredging Committee of the Royal Irish Academy. The cruise was made off the south-west coast of Ireland, and the most interesting forms were obtained from 345 and 750 fathoms. At the latter station the Elasipod *Lætmogone violacea* was obtained, as well as *Phormosoma placenta* and *P. uranus*, and a new species of *Porocidaris*, which is called *P. gracilis*. Of the Asteroidea *Pentagonaster balteatus* and *P. concinnus*, *Pteraster personatus*, *Hymenaster giganteus* were new. Mr. Sladen contests the view of Canon Norman, that *Nymphaster protentus* Sladen is a synonym of *P. subspinosus*. As only eight stations were dredged at and forty species were found, it is obvious that the collectors, of whom the Rev. W. S. Green was the head, hit on a rich locality.

Development of Holothurians.†—Prof. H. Ludwig has made a study of the development of *Cucumaria planci*, specimens of which were kept for one hundred and sixteen days; after the eighth or ninth day development proceeds very slowly. The larvæ and young are quite opaque and so full of calcareous bodies that the ordinary methods of preparing sections were quite useless. Owing to the small size of the cellular elements and the close approximation of the foundations of the various organs it was necessary to have sections no more than 5–7 μ thick.

* Proc. Roy. Irish Acad., i. (1891) pp. 687–704 (5 pls.).
† SB. K. Preuss. Akad. d. Wiss. Berlin, 1891, pp. 179–92.

The author is not able to confirm the general belief that in Holothurians the plane of symmetry of the young Echinoderm corresponds with that of the larva; they rather cut one another at acute angles. The circular and radial canals have taken up their permanent position by the eighth day; the latter arise from the former with a wide lumen, and there is no constriction or formation of valves. The distribution of the first five tentacular canals is neither radial nor bilaterally symmetrical, but asymmetrical in this way that the two tentacles of the two ventral interradii receive their water-canals from the median ventral radial canal, while the tentacle of the median dorsal, as well as that of the left dorsal interradius, is supplied by the left dorsal radial canal, while the tentacle of the right dorsal interradius receives its supply from the right dorsal radial canal. All the tentacular canals arise from the radial canals by a narrow piece which is at first very short, but which elongates later; this opens by a valve into the wider part of the canal which lies in the tentacle itself. Notwithstanding its small size this valve may be seen to be formed of two semilunar valves, such as are already known in the tentacles of *Synapta*. On either side of the valve the enlarged portion of the tentacular canal widens out into a short cæcum; this is the foundation of the homologue of the tentacular ampulla which Hérouard discovered in the adult animal. On the fifteenth day the tentacles begin to show signs of their future arborescence.

The first two feet are laid down on the eighth day; they are first in a pit-like depression of the skin, and have the form of a hemispherical projection. On the succeeding days they become more and more tubular, and on the fifteenth a well-developed terminal disc becomes apparent. Their musculature is a direct continuation of that of the radial canal, and is exclusively formed of longitudinal muscular fibres. At the origin of the foot-canals there is a valvular arrangement, but it is much less well developed than that of the tentacular canals. A third foot does not make its appearance till the forty-fifth day, and a fourth not until the eighty-fourth. Further increase in the number of feet does not occur till the one hundred and eleventh day.

Prof. Ludwig does not confirm Selenka's statement that the Polian vesicle lies on the right half of the body, but always on the left, and without exception in that left dorsal interradius where Hérouard constantly found it in the adult. The young stone-canal has a vesicular enlargement, which is the commencement of the future madreporic head of the permanent stone-canal, and which may, therefore, be called the madreporic vesicle; this is the anterior enterocœl of Bury. On the ninety-eighth day of development the vesicle opens by its thin-walled side, and so puts the stone-canal into communication with the cœlom.

By the eighth day the central parts of the nervous system are laid down; both the circular nerve and the radials given off from it consist at this stage solely of closely packed cells, set in several layers one above another. On the next day a finely fibrous layer becomes apparent, the fibres of which run parallel with the long axis of the circular nerves. From the thirteenth day onward separate cells may be found irregularly scattered between these fibres. The circular nerve now consists of an outer cell-layer, and an inner fibrous layer which contains scattered cells. As early as the eight day the nervous system ceases to have any connection with the surface, and is everywhere separated from the ectoderm by an intermediate layer of mesenchym. Although the author made a careful search he was unable to find at any stage any indications of auditory organs.

The musculature of the body-wall is formed by cells of the parietal enterocœl. The first formed is the median ventral longitudinal muscle which may, on the ninth day, be made out as a fine simple layer of longitudinal fibres on the inner side of the median ventral radial canal. The separation of the retractor muscles from the longitudinal is not even indicated till the one hundred and eleventh day.

The ectoderm and mesenchym form in the young Cucumariæ a continuous tissue which does not till later on become differentiated into a distinct epithelium and an underlying layer of connective tissue. The blood-vascular system is derived from the remains of the cleavage cavity, or from clefts in the mesenchym. A distinct space appears between the visceral layer of the enterocœl and the endodermal wall of the mid-gut on the thirteenth day; this partly forms the marginal vessels of the intestine, and partly the blood-spaces which are found in the wall of the intestine. Lacunar vessels are similarly developed between the parietal wall of the enterocœl and the mesenchym of the body-wall. There is a vestibule in front of the mouth which is invested by a unilaminate and very low epithelium; this is continuous with the outer covering of the tentacles. On the eighth and ninth days the mouth is very narrow and cannot take in food. The coiling of the intestinal tract is obvious on the ninth day; on the fifteenth the mid-gut is considerably widened, and on the seventeenth diatoms were observed in it.

Bathybiaster vexillifer.*—Prof. F. Jeffrey Bell gives a description of the type of this rare and incompletely known form which has for many years since the cruise of the 'Porcupine' been inaccessible, and a comparison is instituted between it and its since described generic allies.

Cœlenterata.

Phylogeny of Actinozoa.†—Prof. J. Playfair M'Murrich discusses various groups of the Actinozoa from the phylogenetic point of view; he points out certain facts which tend to confirm the hypothesis that the Actiniaria are descended from ancestors which possessed an arrangement of the mesenteries similar to that which is found in existing *Edwardsiæ;* explanations are offered of a few points which do not seem to support it.

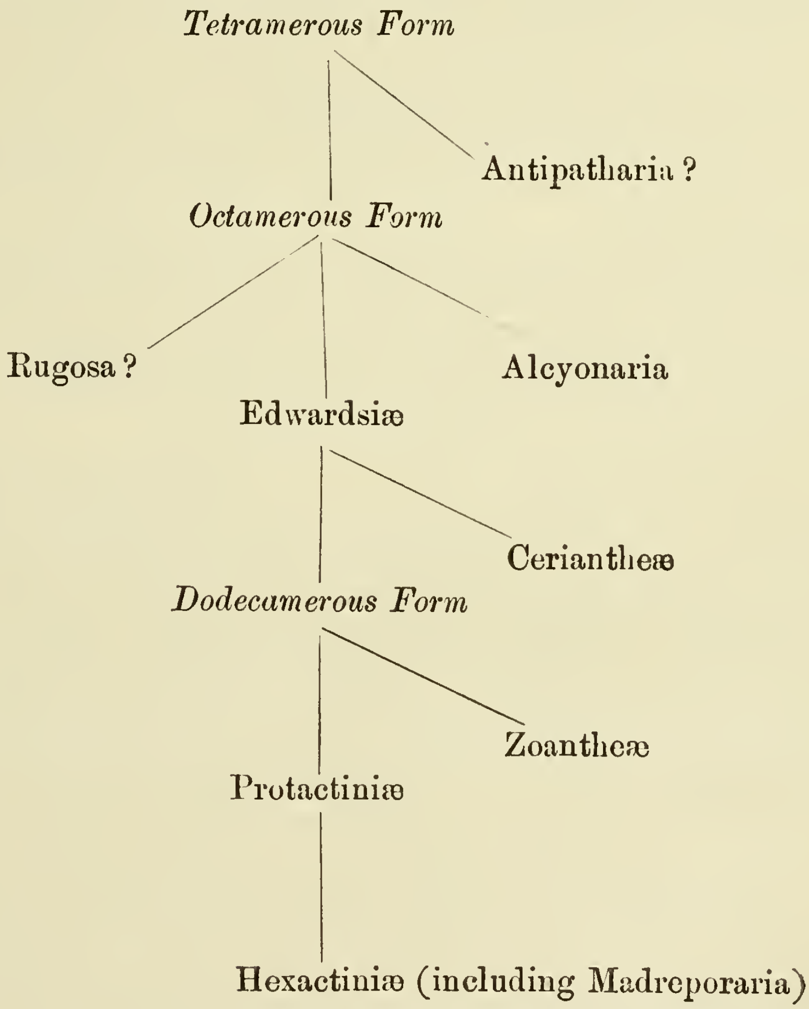
It is probable that the Actinozoa are to be traced back to an ancestor which possessed only four mesenteries. The Edwardsia-stage, in which there are eight, is repeated in the ontogeny of the Ceriantheæ, the Zoantheæ, and the Hexactiniæ. The first of these come off close from the Edwardsia stock. The direct line of descent leads to a stage in which twelve mesenteries are present; the four additional are imperfect and are arranged in two pairs; so far as we know, this stage is now only larval, but it seems to represent an important epoch in development.

A second offset from the main line gave rise to the Zoantheæ, while a third leads to such forms as *Scytophorus*, in which there is, in addition

* Proc. Zool. Soc. Lond., 1891, pp. 228–31 (2 pls.).
† Journal of Morphology, v. (1891) pp. 125–64 (1 pl.).

to the twelve primary mesenteries, a single mesentery present on each side of the dorsal directives. A fourth offset leads to *Gonactinia*, which presents a stage in advance of *Scytophorus*. Further on *Oractis* is reached, in which there are two pairs of imperfect secondary mesenteries.

All the forms hitherto mentioned are strictly bilateral; so in reality also are the Hexactinian, as may be shown if their structure be regarded as a development from the plan seen in *Scytophorus*, *Gonactinia*, and *Oractis*. An explanation is offered of the difficulties presented by the Halcampæ, some of which have, and some of which have not, secondary mesenteries; the latter are looked on as derivates of the former in which



there has been an arrest of the development of the secondaries. The *Peachiæ* appear to have arisen from forms which possessed a complete cycle of secondary mesenteries, one pair of which—the dorso-lateral—has been lost.

Recent observations have taught us that the Madreporaria are constructed upon essentially the same plan as the Hexactiniæ; the author quotes and accepts Hertwig's opinion on this point. He sums it up in saying that the arrangement of the mesenteries and the order of their appearance demonstrate conclusively that the majority, if not all of the Hexacoralla are closely related to the Hexactiniæ.

There does not seem to be much room for doubt that the mesenteries of the Rugosa increased in a bilateral manner, but it is still a matter for doubt whether the primary plan of the organism was hexamerous or tetramerous. In any case, the mode of formation of the septa in the Rugosa seems to have been entirely different from that which obtains in the Hexacoralla, and it is, therefore, unlikely that there is any intimate relation between the two groups.

The Alcyonaria were, possibly, antecedent phylogenetically to the *Edwardsiæ;* the arrangement of the mesenterial musculature seems to the author to be simpler, and the slight development of the siphonoglyphs a point of considerable importance. At any rate, the group is one that is very highly specialized. A pressing need is the careful and comprehensive study of the filaments of the Alcyonaria. Provisionally they are regarded as forms which branched off from an Octactinian ancestor which they had in common with the Edwardsiæ.

It is still difficult to suggest the history of the Antipatharia, but Prof. M'Murrich is inclined to regard the six-mesenteried condition as the more primitive.

The phylogenetic diagram given in the preceding page is offered.

The term Protactiniæ denotes an order consisting of forms with twelve primary mesenteries; and with one or a pair or two pairs of secondary mesenteries on each side of the sagittal axis; this order includes *Scytophorus*, *Gonactinia*, and *Oractis*.

Coral-Studies.*—Dr. A. R. v. Heider discusses under the above title a coral which Heller described as *Madracis pharensis*, *Astrocœnia pharensis* n. sp. It belongs to the family Oculinidæ and to the genus *Madracis*, to which should also be referred *Axohelia* M. Edw. et H., *Astræa decactis* Lyman, *Stylophora incrustans* Duch. et Mich., and *Reussia lamellosa* Duch. et Mich. The genus *Madracis* includes two species—*M. decactis* Verrill from the Atlantic and *M. pharensis* Heller from the Adriatic, which differ in the marking and colouring of the polypes.

Medusæ of Millepora Murrayi and Gonophores of Allopora and Distichopora.†—Dr. S. J. Hickson finds that the male gonads of *M. Murrayi* are borne by medusæ which escape from the ampullæ in which they are developed before the spermatozoa are matured; the ova, as in *M. plicata*, are extremely small and alecithal. They move in an amœboid manner in the cœnosarcal canals, and do not ultimately rest in gonophores or in any specialized portion of the system. The medusæ have no radial or ring canals in the endoderm of the umbrella, no velum, no sensory organs, and no mouth; they are formed by the metamorphosis of either a dactylozooid or a gastrozooid. The sperm-cells originate in the ectoderm of the cœnosarc and wander into the ectoderm of the zooids, where they fuse into aggregations to form a spermarium. This last causes in time a retrograde metamorphosis of the tissues of the dactylozooid, at the distal extremity of which it is formed. A cup-shaped outgrowth next appears which forms the umbrella of the medusa, and subsequently a conical growth of the endoderm penetrates into the substance of the spermarium and forms the manubrium.

* Zeitschr. f. Wiss. Zool., li. (1891) pp. 677-84 (1 pl.).
† Quart. Journ. Micr. Sci., xxxii. (1891) pp. 375-407 (2 pls.).

The male gonophores of *Distichopora* occur in groups of two or three in each ampulla, in different stages of development. The gonad is supported by a small cup-shaped trophodisc and inclosed in a double sac of ectoderm and endoderm. At the distal pole of the ripe gonophore there is a short seminal duct. The male gonophore of *Allopora* differs from that of *Distichopora* in being provided with a club-shaped endodermal manubrium.

The author does not regard the gonophores of the Hydrocorallinæ as degenerate Medusæ, but as special organs of the colony bearing the gonads. This may puzzle those who believe they should draw a sharp distinction between the idea of the "individual" and the "organ" in the Animal Kingdom, but Dr. Hickson is not inclined to believe that it is possible to draw this sharp distinction; they are, as Claus maintains, relative ideas.

Although the classification of the Hydrocorallinæ with the Hydroidea was perfectly justifiable at the time it was made, the progress of our knowledge seems to point to the separation of the former from the latter, that is from the Tubulariæ and Campanulariæ.

Craspedota of the Plankton Expedition.*—Dr. O. Maas concludes as to the Craspedote Medusæ of the Plankton, (1) that the Aglauridæ occur chiefly in the northern part of the Atlantic Ocean, (2) that these are replaced in the median region by the Trachynemidæ, (3) that the Geryoniidæ have a more southern distribution and increase in the number both of species and individuals towards the equator. But there are many individual exceptions.

Development of Hydra.†—Dr. A. Brauer finds that the ova of *Hydra* are developed in the interstitial cell-layer; one cell of the ovary becomes the egg-cell, while the others are broken up and their substance converted into yolk-grains, the so-called pseudo-cells; these are taken up by the growing cell. Cleavage is total and equal and leads to the formation of a large hollow blastula. The formation of the endoderm, which is multipolar, is effected by immigration and division of the blastoderm-cells. After the disappearance of the cleavage cavity the two germinal layers are sharply separated from one another. The ectoderm gives rise to an outer envelope, the chitinous shell, and an inner one which is the internal germinal envelope. The ectoderm is retained and passes into the permanent ectoderm. While the germ is still surrounded by the shell the layer of interstitial cells is formed from the ectoderm. The differentiation of tissues begins after this, the supporting lamella becomes recognizable, and the body-cavity begins to be formed. At the same time the shell disappears. When the embryo has become free the processes of development go on rapidly, the tentacles are formed and the mouth appears. The oral pole is identical with the pole of the directive corpuscle.

It would appear that the method of multipolar endoderm-formation is limited to the Cœlenterata, and, among them, is seen only in those forms in which there is no free-swimming blastula stage; all the forms that have a free-swimming blastula exhibit a polar formation of the

* SB. K. Preuss. Akad. d. Wiss., 1891, pp. 333–8.
† Zeitschr. f. Wiss. Zool., lii. (1891) pp. 169–216 (2 pls.).

endoderm, whether it be hypotropic or by invagination. If this generalization be just it would follow that the mode of movement of the unilaminate vesicle is of importance; multipolar endoderm-formation presupposes that the blastula is made up of cells that are physiologically and morphologically equivalent; but this can only happen if the vesicle rotates all round and has no movement in any given direction.

The author is inclined to regard the multipolar as the more ancient of the two modes of endoderm formation, and he attaches great importance to its presence in *Hydra*, as that animal is universally allowed to be very primitive. In addition to its adult structure, evidence in support of this view is to be found in the great regularity of its cleavage and the large size of the hollow blastula.

Porifera.

Victorian Sponges.*—The first part of Dr. A. Dendy's projected monograph of the Victorian Sponges treats of the organization and classification of the Calcarea homocœla, with descriptions of the Victorian species. A short description is given of the Olynthus-type, and the histology is next discussed. For, as it seems, the first time, the ectoderm of the Homocœla is described; it is found to agree precisely with what Schulze has found in *Sycandra raphanus;* unless specimens are at once immersed in a sufficient quantity of strong spirit and the sections carefully prepared by the paraffin method, it is difficult to make out satisfactorily the structure of the ectodermal epithelium; when well seen in section the ectoderm appears as a delicate but sharp outline, with a moniliform or beaded appearance due to the swelling caused by the presence of the nucleus in each cell; the cells are thin, flattened and plate-like, polygonal in outline and about 0·0136 mm. in diameter. Dr. Dendy throws some doubt on Lendenfeld's statement that the ectodermal cells are ciliated.

The ground-substance of the mesoderm is usually but feebly developed in the Homocœla; as yet the different kinds of mesodermal cell-elements that have been recognized are—(1) the ordinary multipolar or stellate connective-tissue-cells, which are the most abundant; (2) amœboid cells, which are difficult to distinguish from the first; (3) the author is not able to certainly say whether or not subdermal gland-cells are present; and (4) in some there are more or less plate-like endothelial cells of two kinds, and found in two distinct situations. The fifth form of cell is the reproductive, but spermatozoa have not as yet been distinctly seen; the ova are extraordinarily complex in structure, and especially is this the case with their nucleus.

In addition to these various cell-elements the author calls attention to the presence in the mesoderm of yellow granules, which are probably symbiotic algæ.

The constitution of the skeleton is next considered, and it is found to contain the three main forms of spicule alone found among the Calcarea—the biradiate, the quadriradiate, and the oxeote. Considerable attention is given to the canal system.

The author proposes to divide the Homocœla into three sections; in

* Trans. Roy. Soc. Victoria, iii. pp. 1–81 (11 pls.).

the first—*H. simplicia*—the Ascon-persons either remain solitary and do not fuse or they form simple colonies in which the component Ascon-persons may branch but never form complex anastomoses nor give off radial tubes, so that the individuality of the different members of the colony is easily recognizable; the H. reticulata have a sponge-colony which forms a more or less complex network of branching and anastomosing tubes, so that it is no longer possible to distinguish the individual Ascon-persons of which the colony is composed; in the H. radiata, or third group, the sponge consists of a single central Ascon-tube, from which secondary tubes are budded off radially.

Leucosolenia is the only genus recognized in the order; fourteen Victorian species are described, in most cases fully, and three are regarded as doubtful.

Synute pulchella.*—Dr. A. Dendy has a preliminary notice of a new genus of Calcareous Sponges from Port Phillip Heads, which may be imagined as a colony of the Sycon genus *Ute*, in which the component members have become fused together completely, so that the whole colony forms a single vallate mass, in which the individuals can only be recognized externally by their oscula; there is a thick common cortex formed chiefly of huge oxeote spicules.

System of Calcareous Sponges.†—Dr. R. v. Lendenfeld publishes a revised scheme of classification of the Calcareous Sponges; a new Adriatic Syconid, the chambers of which open by groups into the oscular tube, is made the type of a new sub-family of Sycanthinæ, while the Syconids with unjointed tube-skeleton form the new sub-family Amphoriscinæ.

Sponge-Fauna of the Red Sea.‡—Prof. C. Keller, who has made an exhaustive investigation of the sponge-fauna of the Red Sea, finds that fifty-three genera are represented by eighty-eight species, fifty-four of which belong to the Monactinellidæ. Among these the Chalinidæ are best represented; the Renieridæ are remarkable for the new genus *Dasiuria*. It is remarkable that there should be no representative of the widely-spread genus *Geodia*. No Hexactinellids are yet known from the Red Sea. The chorographical relations of the fauna are worked out, and there is a discussion of the vertical distribution, and its influence on the mechanical construction of the Sponge-body. He finds that purely mechanical characters will explain many of the morphological peculiarities of the sponge-organism—not only the necessity of primary and connecting fibres, but of spongin structures in general. The mechanical cause which led to the formation and successive development of Monactinellids and horny sponges is the influence of the pressure of moving water. It would be interesting to make observations on the thickness and elasticity of fibres in a given species, and to correlate them with variations in locality and depth.

Protozoa.

Dictyochida.§—Herr A. Borgert regards these forms not as Radiolarians, as Haeckel, Hertwig, and others do, but as an order of Mastigo-

* "Roy. Soc. Victoria," 1891, pp. 1–6.
† SB. K. Akad. Wiss. Wien, c. (1891) pp. 4–19.
‡ Zeitschr. f. Wiss. Zool., lii. (1891) pp. 294–368 (5 pls.).
§ Op. cit., li. (1891) pp. 629–76 (1 pl. and 2 figs.).

phora. He suggests that they might be called Silicoflagellata, and defines them as follows:—"Flagellate-like organisms, with a radially symmetrical shell composed of hollow siliceous elements, with an unensheathed body and a long thin flagellum, with a nucleus (observed only in *Distephanus speculum*) vesicular in form and consisting of a central nucleolus and a vacuolar cortex." The shells do not consist, as Hertwig and Haeckel believed, of the isolated skeletal elements of various species of Phæodaria, but are the true "houses" of independent individual organisms. What Hertwig and Haeckel observed were originally skeletonless Phæodaria which had taken up the shells of Dictyochida into their substance. Herr Borgert gives a detailed account of *Distephanus speculum*—a species whose variations cover eighteen forms, to which specific rank has been granted. His memoir also includes an account of the minute structure of the parapyla in the central capsule of Phæodaria and a note on *Sagenoarium Chuni* g. et sp. n. from the Atlantic.

Pelomyxa viridis.*—Prof. A. G. Bourne gives an account of a new species of *Pelomyxa* found in a pond at Madras, and takes the opportunity of making some remarks on the vesicular nature of protoplasm. The new species is about 1/10 in. in diameter, and is interesting not only from being larger than any known form of the Lobosa, but because of the presence of chlorophyll and symbiotic Bacteria. It should be noted that the bodies which Prof. Bourne regards as Bacteria were described by Greef as crystals of unknown composition, and by Leidy as exhibiting transverse striations.

In describing the structure of his new form, the author uses the word protoplasm in the sense in which Bütschli uses the word plasma. It designates the substance which Leydig calls spongioplasma, as distinguished from hyaloplasma. He is inclined to support the view of Bütschli that the plasma is the substance which forms the envelopes of the vesicles, and that it does not include their contents. He finds that he can distinguish in *P. viridis* between two varieties of non-contractile fluid-containing spaces, the vacuoles containing water, and the vesicles having chlorophyllogenous contents.

The protoplasm of *P. viridis* appears to be perfectly homogeneous, and small portions of it may at times be observed at the periphery of the organism free from all contents, but the great mass of it forms a mere scaffolding for the numerous vesicles, and is, moreover, densely packed with Bacteria, to say nothing of its various other contents. The vesicles contain a fluid substance impregnated with chlorophyll. The vesicles and the Bacteria are to be regarded as bodies contained in the protoplasm, and the latter may flow out, leaving all its contents behind. When the protoplasm does flow out in this way some of the Bacteria soon follow, and may be seen to start an active movement; and, if the outflow continues, the superficial vesicles leave the central mass and may be seen isolated in the hyaline protoplasm.

The author discusses the protoplasmic movements, and states that the large pseudopodia are protruded at a velocity of about ·75 mm. a minute; Engelmann regarded a velocity of ·5 mm. as exceptionally rapid. The number of nuclei in *P. viridis* is enormous; a large individual may, it is estimated, have as many as 10,000. He suggests that

* Quart. Journ. Micr. Sci., xxxii. (1891) pp. 357–74 (1 pl.).

there may be some connection between the bulk of nuclear matter and the bulk of protoplasm connected with it; it is pointed out that all these nuclei occupy 1/60 of the total bulk of the organism, and that the same proportion holds in the mammalian ovum.

Other contents of the organism are small globular refractive bodies, which appear to be of a fatty nature, and food-debris.

In conclusion the author directs attention to the views of the late Dr. Gulliver, published in a paper in our 'Transactions.'* Dr. Gulliver believed that the exoplasm was permanently differentiated from the endoplasm, and that the latter was composed of a number of cells. Though not accepting these views, Prof. Bourne allows that *Pelomyxa* may exhibit appearances which justify them. The phenomenon of the breaking away of the exoplasm is a mere accident in the hardening process. The appearance of several cells may be due to an accidental rounding off of portions of protoplasm, which takes place during the hardening process.

Unfortunately the author is unable to throw any light on the reproductive processes which may obtain in *Pelomyxa*.

Foraminifera of Hammerfest.†—Mr. E. W. Burgess gives a list of fifty-one species of Foraminifera found in mud from the bottom of Hammerfest Harbour; some are very rare, such as *Cassidulina crassa*, *Lagena striato-punctata*, *Lagrina dimorpha*, and *Spirillina limbata*.

New Monocystidea.‡—Sig. P. Mingazzini describes from the Gulf of Naples—*Cytomorpha Diazonæ* g. et sp. n. from *Diazona violacea*, *Lecudina* (g. n.) *pellucida* Köll. from *Nereis cultrifer*, *Lecudina Leuckartii* sp. n. from *Sagitta*, *Köllikeria Staurocephali* g. et sp. n. from *Staurocephalus Rudolphi*, *Lobianchella beloneides* g. et sp. n. from *Alciope*, *Ophioidina elongata* g. et sp. n. from *Lumbriconereis*, *Ophioidina Hæckelii* sp. n. from *Sapphirina*, *Oph. heterocephala* sp. n. from *Nephthys scolopendroides*, and *Oph. Discocelides* from *Discoscelis tigrina*.

Tudor Specimen of Eozoon.§—Mr. J. W. Gregory has had the opportunity of making a close examination of the so-called "Tudor specimen of *Eozoon*." The importance of this specimen lay in the fact that the opponents of the organic nature of *Eozoon* argued in favour of the mineral origin of specimens from the fact that the appearances of organic structure were seen only in serpentinous limestones, whereas the Tudor specimen was found in pure carbonate of lime. It has always been agreed that this example, therefore, was of great value as a crucial test.

Mr. Gregory finds himself unable to recognize any trace of the "proper wall," "canals," or "stolon passages" which are claimed to occur in *Eozoon*, or any reasons for regarding the calcite bands as the "intermediate skeleton" of a foraminifer. The bands in the specimen appear to be of secondary origin. Other authorities who have had an opportunity of seeing this specimen appear to all agree that the "Tudor specimen of *Eozoon*" at any rate is not of organic origin.

* See this Journal, 1888, p. 11. † Midland Naturalist, xiv. (1891) pp. 153–8.
‡ Atti R. Accad. Lincei—Rend., vii. (1891) pp. 467–74.
§ Quart. Journ. Geol. Soc. Lond., xlvii. (1891) pp. 348–55 (1 pl.).

BOTANY.

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

α. Anatomy.

(1) Cell-structure and Protoplasm.

Function of the Nucleus.*—Herr J. Gerassimoff has found that cells without nuclei occur in *Sirogonium* and in various species of *Spirogyra*. As the neighbours of the non-nucleated cells have two nuclei, the absence of the nucleus is explained by supposing that in cell-division one of the daughter-cells retains both of the daughter-nuclei. Herr Gerassimoff was able to study these non-nucleated cells in their natural conditions, and found that they were short-lived. In the binucleated cells the nuclei lay opposite one another in the peripheral protoplasm and on a line bisecting the cell transversely. The author's theory is that the nucleus is the seat of a specific energy, such that two nuclei repel one another.

"Attractive Spheres" in Vegetable Cells (Tinoleucites).†—M. L. Guignard calls attention to the fact that, in studying the phenomena accompanying nuclear division in animals, especially at the moment of fecundation, and later in the embryonic tissues, a special element known as an "attractive sphere" has been observed. Hitherto the presence of these bodies has not been noticed in plants, but the author states that they exist in the primordial mother-cells of the pollen of certain plants (*Lilium*, *Listera*, *Naias*), in the mother-cell of the embryo-sac, &c. These bodies rather merit the name of "directing spheres," since they govern the division of the nucleus, and are transmitted from cell to cell without discontinuity during the whole life of the plant.

M. E. De Wildeman ‡ confirms M. Guignard's observations on all important points, and finds the phenomena to agree closely with those observed by Van Beneden in the ovum of *Ascaris megalocephala*. In its typical condition the attractive sphere consists of a small central mass or centrosome, which is coloured somewhat more strongly than the surrounding protoplasm by staining reagents. This mass is surrounded by a delicate hyaline zone, and this again by a thicker granular zone; in certain cases the granulations of the latter have a radial arrangement, especially during the phases of division. When the cell is at rest, the attractive sphere is situated near the nucleus; when the cell is dividing, the sphere divides into two, one of the new spheres being placed at each pole of the spindle. Very typical examples of these attractive spheres occur in *Spirogyra*, especially *S. nitida*; they have also been observed in the mother-cells of the spores of *Anthoceros lævis* and *Isoetes Durieui*, and in those of several mosses, *Funaria hygrometrica*, *Ceratodon purpureus*, and *Bryum cæspitosum*. For the observation of these structures the fixing material used should not be alcohol,

* Bull Soc. Imp. Nat. Moscou, 1890 (1891) pp. 548–54 (3 figs.).
† Comptes Rendus, cxii. (1891) pp. 539–42.
‡ Bull. Acad. Roy. Sci. Belgique, lxi. (1891) pp. 594–602 (1 pl.).

but chrom-acetic acid (0·7 parts chromic acid and 0·3 parts glacial acetic acid, in 100 parts water).

For these "attractive spheres," which have the property of inciting and directing the binary division of nuclei, M. P. Van Tieghem * proposes the term "directing leucites" or *tinoleucites*.

Nature of Callus.†—Mr. S. Le M. Moore has investigated the chemical nature of the stoppers of callus in the sieve-tubes of the vegetable marrow and of *Ballia callitricha*. The following is a summary of the chief results.

The callus of the vegetable marrow gives all the three chief proteid reactions; it is also dissolved by a peptonizing fluid, and is therefore a typical proteid. The callus cannot be pressed from the sieve, both because it is a proteid, and because, when it undergoes digestion, the sieve-plate is "cleared," and is then left in its pristine condition. The stoppers of *Ballia* give all three proteid reactions, but are not attacked by a peptonizing fluid; they stain in the same way as does callus, except that they take a rich brown with iodine alone, and are untouched by anilin-blue. The stoppers react altogether differently from the wall of the cell-tubes, and to a very large extent similarly to the cell-protoplasm.

The callus of the vegetable marrow has many of the characters of the coagulated proteids, and should probably be classified with them; the substance of the stoppers of *Ballia* most closely resembles lardacein. The function of the callus, in both cases, is to moderate the flow of proteids, and direct it so that all the growing points shall receive their due amount of the necessary food-material. Many of the phenomena presented by the dissolution and renewal of the masses of callus on sieve-plates call to mind the action of ferments.

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

Aleurone-grains in Papilionaceæ.‡—The following is a *résumé* of M. E. Belzung's researches on the above subject:—(1) The aleurone-grains of Leguminosæ arise at the periphery of the cells; they are small and insoluble in water, and are formed of legumin. (2) Their deposition begins when the cell-sap is sufficiently concentrated, and the proportion of free acid large enough to cause the precipitation of the albuminoid principle. (3) The aleurone-grains enlarge rapidly, and then, in virtue of their osmotic property, vacuoles arise. (4) The mature aleurone-grain consists of a regular or irregular network containing in its meshes a sap rich in dissolved albuminoids. A circular wall borders a large central aquiferous vacuole. Both network and circular wall are insoluble in water. (5) In the species examined the aleurone-grains contain no inclosed substances. (6) When the grain is completely mature, an albuminoid principle, soluble in water, and precipitated by heat or by certain acids, more or less completely fills the vacuoles. (7) In the presence of water, and with a tempera-

* Journ. de Bot. (Morot), v. (1891) pp. 101–2.
† Journ. Linn. Soc. (Bot.), xxvii. (1891) pp. 501–26 (1 pl.).
‡ Journ. de Bot. (Morot), v. (1891) pp. 85–93, 109–16 (14 figs.).

ture insufficient to induce the commencement of germination, vacuoles again form in aleurone-grains.

Chlorophyll.*—From a spectroscopic examination of the chlorophyll of *Spirogyra*, *Ulva latissima*, and several Ferns and Flowering Plants, Mr. G. Mann has come to the following conclusions:—Chloroplasts consist of a green protoplasmic ground-substance, which is rendered spongy by the presence of an oily material secreted by the ground-substance, and enclosed in a clear protoplasmic envelope. The oily material in *Spirogyra* is partly given off directly into the surrounding protoplasm, partly consumed by the ground-substance. Chlorophyll does not consist of a mixture of a yellow and a blue colouring matter, but is a green substance, which readily decomposes into a yellow and a blue substance. The first absorption-band of Kraus really consists of two bands. The fourth band of Kraus is probably a decomposition-product. Measurements are given of the position of the six bands in the various examples examined, the following being the variations:—Band 1 = λ 686·69–661·5; Band 2 = λ 656·86–640·93; these two constitute together Kraus's Band I; Band 3 (Kraus's Band II), centre at λ 616·6; Band 4 (Kraus's Band III) centre at λ 578; Band 5 (Kraus's Band V) = λ 514·9–460·9; Band 6 (Kraus's Band VI) = λ 452–440·75.

Sulphur in Plants.†—MM. Berthelot and G. André have investigated the quantities of sulphur present—whether as sulphates, organic sulphur, or volatile sulphur—in the seed and in the plant during germination, flowering, and fructification, in *Sinapis alba*, *Camelina sativa*, *Allium cepa*, *Lupinus albus*, *Urtica dioica*, *Tropæolum majus*, and *Avena sativa*. They find the total quantity of sulphur to increase continually from germination to flowering, but the relative quantity to decrease. The organic sulphur reaches a maximum when the plant is in flower. They believe that the sulphur is not absorbed from the soil entirely in the form of sulphates.

Calcium oxalate in the Bark of Trees.‡—Herr G. Kraus finds that a large quantity of calcium oxalate is stored up in the bast-layer of the bark of many trees and shrubs, where it plays the part of a reserve food-material, i. e. it is, to a large extent, as much as 50 per cent., taken up again on the revival of the activity of growth in the spring. Calcium oxalate is soluble in many of the organic acids that occur in the tissues of plants.

Crypto-crystalline Calcium oxalate.§—Prof. G. Arcangeli has observed that the deposit of calcium oxalate in the cells of a large number of plants has the form of a crystalline powder. In the Cinchoneæ and Solaneæ these crystals have a diameter of no more than 1–3 μ; they belong without doubt to the tetrahedral system.

* Trans. and Proc. Bot. Soc. Edinb., xviii. (1889–90) pp. 394–420 (2 pls.).
† Comptes Rendus, cxii. (1891) pp. 122–5.
‡ 'Ueb. d. Kalkoxalate d. Baumrinden,' Halle, 1891. See Biol. Centralbl., xi. (1891) p. 282.
§ Nuov. Giorn. Bot. Ital., xxiii. (1891) pp. 367–73.

(3) Structure of Tissues.

Differentiation of the Endoderm.*—M. P. Lesage notes that in many plants (the bean, radish, &c.), the endoderm, especially of the root and of the hypocotyl, may possess a different structure, even in different spots of the same transverse section; in one spot it may be suberized, in another spot amyliferous. As a general rule the cell-walls of the endoderm become more and more differentiated the greater the distance from the summit of the root; and in the same plant this differentiation may be manifested at very different distances from the summit, according to the mode of development of the root.

Folded Tissue.†—M. P. Van Tieghem states that the endoderm of the root, and often of the stem and leaf, shows a more or less decided suberification or lignification of its membranes, strictly limited to one band on the lateral and transverse faces of its cells, and unaccompanied by any thickening. This has been termed by the author *tissu plissé*, and may occur in other regions besides the endoderm. Thus in the Coniferæ and Cycadeæ the piliferous layer of the root, which is of epidermal origin, is formed by this variety of lignified parenchyme. This is the first time that this tissue has been met with at the periphery.

Secretory System of Papilionaceæ.‡—Sig. P. Baccarini states that the secreting elements in the Leguminosæ—which mostly contain tannin—form two principal systems in the branches and leaves, one of them consisting of tubular elements of greater or lesser length which accompany the xylem and the phloem of the vascular bundles in their course, the other consisting of idioblasts scattered among the cells of the cortex and of the parenchyme of the leaf. The xylem-tubes are always situated on the periphery of the pith; those of the phloem occupy various positions, being often dispersed among the sieve-tubes. The greater number of Leguminosæ are furnished with these tubes in both the xylem and phloem, though others have them in one or other only of these portions of the vascular bundles. Idioblasts occur in the cortex in most species examined. Those found in the parenchyme of the leaves either form a special layer in the spongy parenchyme, or are in immediate contact with the epiderm of both surfaces, forming a kind of sheath which incloses the mesophyll, or less often they are dispersed among the palisade-cells. A considerable number of Leguminosæ are destitute of these secretory idioblasts.

M. P. Vuillemin § criticizes several points in Sig. Baccarini's paper. Tanniferous cells or tannocysts are but feebly developed, or are entirely wanting, throughout the tribes Genisteæ, Vicieæ, and Trifolieæ; the inconstancy of the characters of other tribes in this respect is often due to errors of classification; or sometimes to the substitution of the tanniferous by some other secretory system, as, for example, by oxaliferous cells. The special structure of the tannin-cells is described in a large number of cases.

* Comptes Rendus, cxii. (1891) pp. 1522–3.
† Journ. de Bot. (Morot), v. (1891) pp. 165–9.
‡ Malpighia, iv. (1891) pp. 431–5; and Nuov. Giorn. Bot. Ital., xxiii. (1891) pp. 297–301.
§ Bull. Soc. Bot. France, xxviii. (1891) pp. 193–200.

Alkaloid-receptacles of the Fumariaceæ.*—Herr W. Zopf has investigated the chemical nature of the contents of the special receptacles of the Fumariaceæ. He found the underground organs of *Corydalis cava* to contain six different substances, viz.:—(1) a resin-acid soluble in benzol, (2) a resin-acid insoluble in benzol, (3) a yellow acid pigment soluble in water, (4) a yellow-green oil, (5) a special alkaloid, corydalin, (6) sugar. Of these substances, the one which is especially found in the idioblasts of the aerial organs is the alkaloid corydalin, which is replaced in *Fumaria* by fumariin, and in *Dicentra*, *Adlumia*, &c., by other special alkaloids. The alkaloids have their origin partly in the primary, partly in the secondary meristem.

Latex-receptacles.†—According to Herr M. Dehmel, latex-tubes are organs for the conduction of nutrient material, and are therefore nearly related to sieve-tubes. In the species of Compositæ examined, all the Liguliferæ contained latex, but none of the Tubulifloræ.

M. Thouvenin ‡ describes the laticiferous system in *Cardiopteris lobata*, belonging to the Olacaceæ. In the stem the latex-tubes occur in the middle region of the cortex, in the liber, and in the periphery of the pith; they are also found in the petiole and in the veins of the leaf.

Sieve-fascicles in the Secondary Xylem of Belladonna.§—Dr. G. Beauvisage states that the details of the anatomical structure of the roots of *Atropa Belladonna* have hitherto been only inadequately described. In the secondary tissues there is a somewhat abnormal structure analogous to that described in the stems of *Strychnos*, which consists in the presence of numerous sieve-fascicles in the secondary xylem. In the case of *Strychnos* two modes of formation have been suggested, the one by De Bary, the other by M. Hérail. After careful research the author finds that proposed by De Bary to be applicable to *Atropa Belladonna*. It is that the cambial zone, instead of giving rise, as is usual, to sieve-tubes without and vessels within, produces both on its internal face.

Extra-phloem Sieve-tubes and Extra-xylem Vessels.‖—M. P. Van Tieghem states that sieve-tubes can be formed outside the phloem, in the root, stem, and leaf. A lateral root of *Strychnos nux-vomica* has six phloem-bundles, and as many primary alternate xylem-bundles outside the pith. At the periphery of the pith small bundles may be seen, which are composed of narrow sieve-tubes and parenchymatous cells; these circummedullary sieve-bundles are formed at first in correspondence with the primary xylem-bundles. Sieve-tubes are occasionally found in the cortex of the stem, for example in Cucurbitaceæ and certain Melastomaceæ. The stem of Cucurbitaceæ also has sieve-tubes in the pericycle. Vessels may be found outside the primary xylem also, in the root, stem, and leaf. Many Monocotyledons produce vessels in the pith of their roots larger than those which form the xylem-bundles.

* Ber. Deutsch. Bot. Gesell., ix. (1891) pp. 107–17. Cf. this Journal, 1887, p. 427.

† 'Beitr z. Kenntniss d. Milchsaftbehälter d. Pflanzen,' Liegnitz, 1889, 46 pp. See Bot. Centralbl., xlvi. (1891) p. 385.

‡ Bull. Soc. Bot. France, xxxviii. (1891) pp. 129–30.

§ Journ. de Bot. (Morot), v. (1891) pp. 161–3.

‖ Tom. cit., pp. 117–28.

Vessels may also be found in the rays which separate the xylem-bundles and in the pericycle of the roots, as in *Taxus* and *Torreya*. The stem can produce primary extra-xylem vessels in the cortex, in the pericycle, and in the pith.

Extra-phloem Sieve-tubes in the Root of the Œnothereæ.*—Mdlle. A. Fremont finds that sieve-tubes may occur in the Œnothereæ either in the pith of the root, in the secondary xylem, or in the "ulterior pith," by which term the authoress designates a cellular structure sometimes formed in the axis of a root after the separation of the vascular bundles which at first formed a closed central cylinder. Medullary sieve-tubes in the root have hitherto been only known in three families of Dicotyledons, viz. Cucurbitaceæ, Loganiaceæ, and Apocynaceæ. Mdlle. Fremont points out, however, that circummedullary sieve-tubes, situated at the internal edge of the primary xylem-bundles, exist in *Œnothera Fraseri* and *Œ. riparia*. Good examples of sieve-tubes produced by local differentiation of the secondary woody parenchyme are to be found in *Œ. parviflora*, *cruciata*, *macrocarpa*, *Sellowii*, and *Fraseri*; and finally it is pointed out that sieve-tubes exist in a region where they have not before been observed, viz. in the ulterior pith of the root. A good example of this occurs in *Epilobium parviflorum*.

Cystoliths of Ficus. †—Herr A. Zimmermann has examined the cystoliths in the leaves of *Ficus elastica*, and supports Kny's view that the strings which penetrate them in a radial direction at right angles to the stratification, are solid, and consist essentially of cellulose, rather than Giesenhagen's, that they are hollow cylinders filled with lime. In the Acanthaceæ, on the other hand, the radial strings are the part of the cystolith which contain the smallest amount of cellulose.

Commenting on this communication, Herr C. Giesenhagen‡ says that he thinks that Zimmermann has been led into error by examining only cystoliths from which the lime has been removed.

Herr Zimmermann, in reply,§ states that a fresh series of observations has confirmed his previous conclusions.

Supporting-elements in the Leaf.‖—M. E. Pée-Laby describes special organs of support which he finds in the leaves of Dicotyledons. These may either have the form of fibres in the woody pericycle (*Hakea*, *Burchellia*), or may consist of isolated cells. These, again, are either simple cells, as in *Osmanthus aquifolius*, *Olea europea*, and *Phillyræa*, or they are branched (spicular cells), as in *Limnanthemum nymphæoides*, *Begonia sanguinea*, *Ternstrœmia japonica*, &c. In all cases these organs make their appearance only when the leaf is assuming its final form.

Anatomy of Conifers.¶—Herr F. Berger argues against the correctness of the distinction drawn by Caspary between two different kinds of tracheid in Coniferæ, viz. the conducting cells in the medullary sheath

* Journ. de Bot. (Morot), v. (1891) pp. 194–6.
† Ber. Deutsch. Bot. Gesell., ix. (1891) pp. 17–22 (1 fig.).
‡ Tom. cit., pp. 74–7.
§ Tom. cit., pp. 126–8.
‖ Comptes Rendus, cxii. (1891) pp. 1276–9.
¶ 'Beitr. z. Anat. d. Coniferen,' Halle, 1889, 8vo, 33 pp. See Bot. Centralbl., xlvi. (1891) p. 363.

and the fusiform cells in the wood. The distinction is, he states, supported neither by the history of their development nor by any difference in their structure.

The resin-passages (in *Pinus Strobus*) may be divided into two kinds —the large passages situated in the inner layers of the cortex, and the smaller passages situated nearer the periphery. The former kind traverse the branch from its base to its apex, and are in uninterrupted communication with those of the previous year.

Anatomy of Ipomæa versicolor.*—Dr. D. H. Scott finds the following peculiarities of structure in the twining stem of this plant, belonging to the Convolvulaceæ:—It possesses the bicollateral structure of the vascular bundles, which is very characteristic of the order; but, while the structure of the greater part of both stem and root is normal, the transitional region between the two presents singular abnormalities. The internal phloem extends downwards into the hypocotyl, and passes out between the converging protoxylem-groups of each cotyledonary pair of bundles, thus joining the external phloem of the root. The hypocotyl and adjacent parts of the stem and root have a complex secondary wood containing numerous strands of interxylary phloem (phloem-islands) imbedded in parenchyme, and produced centrifugally by the cambium.

(4) Structure of Organs.

Changes in the Form of Plants produced by Moisture and Etiolation.†—Herr J. Wiesner has investigated the changes produced in those plants which bear a rosette of ground-leaves, but no stem-leaves, by growing either in an atmosphere saturated with moisture or in darkness, and finds that they can be arranged in the four following categories:—(1) Those which, both in a saturated atmosphere and in the dark, lose their radical rosette and form well-developed internodes in the stem (*Sempervivum tectorum*); (2) Those which undergo no change under either of these conditions (*Oxalis floribunda*, *Plantago media*); (3) Those which form well-developed internodes under the influence of darkness, but not under that of saturation (*Taraxacum officinale*); (4) Those which form well-developed internodes under the influence of moisture, but not under that of darkness (*Capsella bursa-pastoris*).

Mangrove-vegetation.‡—Herr G. Karsten enters into further details respecting the structure of the Rhizophoreæ and other trees which compose the mangrove-vegetation of the swamps of the Malayan Archipelago. In his observations on the structure of the embryo-sac and the development of the embryo, he agrees, in all essential points, with Treub.§ In all cases, except *Lumnitzera* and *Sonneratia*, the embryo-sac breaks through the nucellus, usually consumes it, and hence lies free in the integument. Typical formation of endosperm occurs in *Scyphiphora* and *Nipa*. In sheltered situations many mangrove-trees are "vivi-

* Ann. of Bot., v. (1891) pp. 173–9 (2 pls.).

† Ber. Deutsch. Bot. Gesell., ix. (1891) pp. 46–53.

‡ Biblioth. Bot. (Luerssen u. Haenlein), Heft 22, 1891 (71 pp. and 11 pls.). Cf. this Journal, *ante*, p. 365.

§ Cf. this Journal, 1885, p. 271.

parous," i. e. the seeds germinate while still attached to the parent-tree. That the aerial roots in *Bruguiera eriopetala* and other species are organs of respiration, is unquestionable. In *Rhizophora Mangle* their chief function is a supporting one; but they also possess large intercellular spaces which serve to assist respiration. Similar aerial roots or "pneumatophores" occur also in many other plants. All mangrove-trees contain large quantities of tannin, which is probably serviceable in preventing rotting.

Stigmatic Disc of Vinca.*—Sig. M. Pitzorno has studied the structure of the viscid discoidal expansion which lies beneath the tuft of hairs on the stigma of *Vinca major*, and which plays an important part in the process of pollination. He finds that the viscid substance which is exuded, during the time of flowering, from the periphery of the stigmatic disc, is a product of the secretion of special glandular hairs which clothe its margin. The exudation takes place by simple diffusion through the membrane of these hairs. The viscid substance appears to be the result of a chemical transformation of starch-grains which are present in abundance in the subjacent parenchyme; the transformation takes place within the glandular hairs.

Pollen of Strelitzia.†—Herr E. Palla describes the structure of the threads which are found among the pollen-grains of *Strelitzia reginæ*, and which have been mistaken by some writers for pollen-tubes. Each thread usually consists of two or three, less often of four cells, the length of which varies between 200 and 550 μ; the end of the thread is frequently closely attached to a pollen-grain. As to their origin, each thread was originally a row of cells belonging to the epidermal portion of one of the two pollen-sacs, which had become detached from the rest of the tissue shortly before the bursting of the anther. The threads appear to continue to grow in length among the pollen-grains after their separation. Their object appears to be to assist in the dissemination of the pollen, which is chiefly brought about by the agency of birds.

Stomates in the Calyx.‡—Herr W. Korella found that, out of 288 species of plants examined, belonging to 192 genera and 58 families, stomates were entirely wanting in the calyx in only five species; in by far the greater number they were present on both surfaces. Their size and their distribution over the surface of the sepals vary greatly.

Fruit and Seed of the Juglandeæ.§—Sir John Lubbock describes the structure and development of the fruit and seed of *Pterocarya*, and compares them with those of the walnut. The fruit of the former is winged, while that of the latter is not. While the cotyledons of *Pterocarya* are leaf-like and aerial in germination, those of the walnut never emerge from the seed, but are curiously folded by the efforts made to occupy the interior of the nut. The seeds of the walnut are large and contain a supply of nutriment, which causes them to be dispersed by

* Nuov. Giorn. Bot. Ital., xxxviii. (1891) pp. 280–2.

† Ber. Deutsch. Bot. Gesell., ix. (1891) pp. 85–91 (1 pl.).

‡ 'Ueb. d. Vorkommen u. d. Vertheilung d. Spaltöffnungen auf d. Kelchblättern,' Königsberg, 1889, 68 pp. and 1 pl. See Bot. Centralbl., xlvi. (1891) p. 385.

§ Journ. Linn. Soc. (Bot.), xxviii. (1891) pp. 247–54 (6 figs.).

squirrels and other animals, while in the case of *Pterocarya* the dissemination is aided by the wings of the fruit.

Leaves of Viburnum.*—Sir John Lubbock points out and attempts to explain the remarkable difference between the leaves of our two native species of *Viburnum*,—*V. Opulus* and *V. Lantana*. The former have stipulæform appendages, while the latter are entirely exstipulate; the former have honey-glands at the base of the lamina, the latter have not. The former of these two differences he attributes to the different way in which the leaves are folded in the bud, in consequence of those of *V. Opulus* being three-lobed, those of *V. Lantana* not lobed. The honey-glands probably serve to protect the young and tender leaves of *V. Opulus*, which are quite smooth, from the attacks of caterpillars and other insects, while the leaves of *V. Lantana* are otherwise protected by a felt of hairs.

Form and Function of Stipules.†—Sir John Lubbock adduces a number of examples where, within the same natural order, some species have stipulate, others exstipulate leaves, and endeavours to arrive at a general law governing the presence or absence of stipules. He believes that, as a general rule, the difference has reference to the mode of protection of the bud. This protection may be effected in various ways,—by the stipules, by the base of the leaves, by the more or less expanded base of the petiole, by the pedestal of the petiole, by scales, by hairs, by gummy secretions, &c. Sometimes, also, the stipules assume the function of the leaves themselves, or they become spiny and serve as a general protection to the plant, or they are glandular, &c.

Pearl-like Glands of the Vine.‡—According to Herr H. Müller-Thurgau, the small pearl-like structures which occur on the young branches and leaves of most, though not of all, varieties of the grape-vine, are of a trichomic nature. They are usually spherical, and are elevated on a short pedicel; from ten to twenty large cells are covered by a small-celled epiderm, usually provided with one stomate to each gland. Their formation is independent of the vigour of the plant or of the moisture of the air. Their purpose appears to be to serve as protecting organs against the attacks of small animals.

Roots springing from Lenticels.§—Herr H. Klebahn describes the roots which spring from beneath the lenticels in the stem of *Solanum Dulcamara*, often even at a considerable distance from the soil. These roots possess a well-marked root-cap, dermatogen, periblem, and plerome.

Somewhat similar structures are found in *Herminiera Elaphroxylon*, a floating plant belonging to the Papilionaceæ from the Nile region; and here also are remarkable tubercles on the roots, the tissue of which is partly of an aerenchymatous character. They contain also, beneath the cortical layer, a bacteroid tissue of the same nature as that in the tubercles of many other Papilionaceæ.

* Journ. Linn. Soc. (Bot.), xxviii. (1891) pp. 244–7 (1 fig.).
† Tom. cit., pp. 217–43 (11 figs.).
‡ Weinbau u. Weinhandel, viii. (1890) pp. 178–9 (1 fig.). See Bot. Centralbl., xlvi. (1891) p. 362.
§ Flora, lxxiv. (1891) pp. 125–39 (1 pl.).

Root-nodules of the Pea.*—Herr A. Prazmowski gives a *résumé* of the numerous observations on this subject by different observers, and details of fresh experiments of his own. He regards the structures as truly symbiotic, since it is only plants provided with these nodules that can acquire nitrogen from the free nitrogen of the atmosphere, by the intervention of the nodule-bacteria. The plant can derive benefit from the symbiosis only after it has overpowered the bacteria, the resorption of the products of the bacteria being the main cause of the increased vigour of the plant from that time. Starch is present in the nodules in considerable quantity, and is directly taken up by the bacteria.

Structure of swollen Roots in certain Umbelliferæ.†—According to M. G. de Lamarlière, the adventitious swollen roots of *Œnanthe* present a somewhat abnormal structure. The author has studied these, together with the swollen roots of species of *Carum*, *Cicuta*, and *Sium*, and found a series of transitions between the abnormal *Œnanthe* and the normal lateral roots of other species of the same family, and concludes by stating that the abnormality of *Œnanthe* and *Carum* is rather apparent than real.

β. Physiology.

Hansen's Vegetable Physiology.‡—Dr. A. Hansen publishes a complete text-book of vegetable physiology, intended especially for the instruction of non-scientific readers. The subject of metabolism is treated in especial detail. With regard to the conduction of water, the author declares himself an adherent of Sachs's theory of imbibition.

(1) Reproduction and Germination.

Sexual Nuclei in Plants.§—M. L. Guignard points out that the number of chromatic segments in the nuclei of the embryo is exactly that in either the male or female nuclei respectively. There must, therefore, at some period in the course of development, be a reduction of one-half in the number of chromatic segments; and he sets himself to discover at what period this reduction takes place. From observations made on *Lilium Martagon*, with which those on other plants also agree, M. Guignard finds that the reduction takes place suddenly, and always at the same stage, in both male and female organs, viz. at the moment of the first binary division of the pollen-mother-cell and of the embryo-sac. A similar phenomenon is stated by Hertwig to occur in the animal kingdom, in the course of development of the spermatozoa of *Ascaris megalocephala*.

Formation of Endosperm in the Embryo-sac of Gymnosperms.‖—Mdlle. C. Sokolowa describes in detail the mode of formation of the endosperm within the embryo-sac of some Gymnosperms, especially *Pinus*, *Juniperus*, and *Ephedra*. Her observations agree, in general, with

* Landw. Versuchs-Stat., xxxvii. pp. 161–238, and xxxviii. pp. 5–62. See Journ. Chem. Soc., 1891, Abstr. p. 607. Cf. this Journal, 1890, p. 59.

† Comptes Rendus, cxii. (1891) pp. 1020–1.

‡ 'Pflanzen-Physiologie,' Stuttgart, 1890, 8vo, 314 pp. See Bot. Centralbl., xlvi. (1891) p. 196.

§ Comptes Rendus, cxii. (1891) pp. 1074–6. Cf. this Journal, 1890, p. 358.

‖ Bull. Soc. Imp. Nat. Moscou, 1890 (1891) pp. 446–97 (3 pls. and 10 figs.).

those of Strasburger. At an early stage the parietal protoplasmic layer of the embryo-sac contains a single layer of lenticular nuclei which are connected together by a number of radiating strands of protoplasm. Between the nuclei, and in the midst of the radiating strands, are the cell-plates, i. e. plates composed of isolated granules of protoplasm. When the formation of endosperm begins these cell-plates are transformed directly into the cellulose-membranes which eventually divide the parietal layer of nuclei into a number of polygonal cells. The process is somewhat intermediate between that of ordinary cell-division and that known as free-cell-formation. While this process is taking place the embryo-sac of Gymnosperms is a free cell with rounded outline, sufficiently large to be visible to the naked eye. By the gradual increase of the parietal layer, the embryo-sac eventually becomes completely filled up by a compact tissue of remarkable regularity, the cells of which are mostly elongated greatly in the radial direction. In smaller details four different types are described, represented by *Cephalotaxus*, the *Cupressineæ*, *Taxus*, and *Ephedra*.

The appearance of the cell-plates above described coincides with the fragmentation of the large and dense elements of the chromatin into fine granules. The authoress agrees with Frommann and Heuser, but differs in this respect from Strasburger, in asserting that the filaments of the nuclei in the parietal layer are intimately united with those of the surrounding protoplasm, forming, with them, a continuous net-work. The substance of which the cell-plates are composed consists of granules, the denser and larger of which are coloured by methyl-green with the same intensity as the nucleoles and other denser elements of the nucleus. The number of primary cells of the endosperm usually corresponds to that of the original parietal nuclei of the embryo-sac, and it appears certain that these are the essential factors in the cell-formation which takes place within the sac.

It is a group of short cells belonging to the parietal layer which ultimately develope into the corpuscles or secondary embryo-sacs; and, in the tendency, in *Pinus* and *Cephalotaxus*, towards the early differentiation of these cells, the authoress sees the foreshadowing of the process which is universal in Angiosperms, the formation of the embryonic vesicles before that of the endosperm. *Ephedra* exhibits a still closer approximation in this respect to Angiosperms.

Relations between Insects and Flowers.*—Mr. T. Meehan epitomizes his arguments in favour of the view that too much stress is laid by botanists of the Darwinian school on the part played by insects in the pollination of flowers. He affirms that flowers do not abhor "own-pollen," and that no flowers are so truly fertile as the cleistogamous, while those which fertilize before the corolla expands are also certainly fertile. Plants wholly dependent on insects for fertilization are all perennials; and an innumerable number of the flowers of these plants fall unfertilized. All annuals, on the other hand, though in some cases so arranged that cross-fertilization may occur, can self-fertilize when cross-fertilization fails; and in almost all cases annuals have every flower fertile.

* Bot. Gazette, xvi. (1891) pp. 176–7.

Fertilization of Papilionaceæ.*—Herr E. Loew describes the mode of pollination in two species of Papilionaceæ that are cross-pollinated by the agency of Lepidoptera.

In *Oxytropis pilosa* the process is aided by the union of the alæ and carina into a cone-like body; the visiting insects are chiefly *Eucera longicornis* and *Osmia aurulenta*.

In *Apios tuberosa* from North America, the structure is different, and does not favour the usual process in Papilionaceæ,—the pollination of the under side of the body of the visiting insect by the pressing of both stigma and anthers out of the trough formed by the carina. Self-pollination is in this instance prevented by the remote position of the anthers and stigma from one another caused by the remarkable coiling of the style.

Lepidopterophilous Flowers.†—Herr A. G. Kellgren enumerates thirty-three species of flowers growing on the Omberg, an isolated mountainous region in Germany chiefly covered with pine-woods, which are pollinated by the agency of lepidoptera. They all belong to the order Leguminosæ.

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

Physiological Function of Phosphoric Acid.‡—Dr. O. Loew attributes an important function to phosphoric acid in promoting the nutriment of the nucleus and the consequent faculty of growth and division of the cell. Although cells can live and form starch and protoplasm without the presence of phosphoric acid, their power of growth and multiplication is greatly dependent on it. The author regards nuclein, of which the cell-nucleus is composed, as a compound of an albuminoid with phosphoric acid. Experiments on *Spirogyra nitida* and *Weberi* showed that the addition of 0·1 per cent. of potassium phosphate to the nutrient solution in which they were grown, resulted on an average in an increase in the cells to nearly double their normal length, while their diameter was not materially increased. There was no increase in the amount of starch formed, nor in the number of bands of chlorophyll.

Influence of Salt on the Quantity of Starch contained in the Vegetative Organs.§—M. P. Lesage gives the results of numerous experiments made on this point with *Lepidium sativum*. When this plant was watered with a liquid containing 12–15 gr. of salt per litre, starch disappeared completely, but the author also states that the diminution of starch is not proportional to the augmentation of salt.

Transpiration-current.‖—Herr T. Bokorny recommends ferric sulphate in a 0·1 per cent. solution as by far the best colouring fluid for following the course of the transpiration-current in plants. By its use he has determined that collenchymatous tissue is one of the paths through which the current passes. By precipitation with potassium

* Flora, lxxiv. (1891) pp. 84–91, 160–71 (2 pls.).
† Bot. Sekt. Naturv. Studentsällsk. Upsala, Dec. 5, 1889. See Bot. Centralbl., xlvi. (1891) pp. 317 and 343.
‡ Biol. Centralbl., xi. (1891) pp. 269–81.
§ Comptes Rendus, cxii. (1891) pp. 891–3.
‖ Ber. Deutsch. Bot. Gesell., ix. (1891) pp. 2–9.

ferrocyanide, the iron may be perceived to have ascended as much as from 20 to 50 or even 70 cm. in half an hour.

Passive Circulation of Nitrogen in Plants.*—According to M. H. Devaux, the tissues of aquatic plants are not equally permeable to different gases, carbonic acid permeating them much more easily than oxygen. The author draws the following conclusions on the circulation of nitrogen. If nitrogen is found in the internal atmosphere of plants in a larger or smaller proportion than in the external air, the difference is due to the gaseous current produced through the openings. The difference of pressure between the external and internal nitrogen causes constant diffusion, which tends to re-establish equilibrium.

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

Fermentation of Tobacco.†—Herr E. Suchsland has investigated the chemical changes which take place in tobacco after it has been gathered and packed, and which result in the formation of aromatic and other compounds. He finds them to be of the nature of fermentation, comparable to the lactic, butyric, and acetic fermentations. The cause of this fermentative process is the presence of large numbers of Schizomycetes, belonging to the bacterium-, and in smaller quantities to the micrococcus-forms. They are of two or three different kinds, but their special characteristics are not described.

Nitrification by a Schizomycete.‡—Dr. O. Loew suggests that the oxidization of ammonia caused by the nitrifying Schizomycete *Nitromonas*, is partly complete, as expressed by the equation $2NH_3 + 3O_2 = 2NO_2H + 2H_2O$, partially incomplete, $2NH_3 + 2O_2 = 2NO_2H + H_4$; and that the hydrogen thus set free immediately combines with carbon dioxide to form formic aldehyde, according to the equation $CO_2 + H_4 = CH_2O + H_2O$.

γ. General.

African Myrmecophilous Plants.§—Herr K. Schumann describes the species of the African genus *Cuviera* (Rubiaceæ) which furnish abodes for ants, viz.:—*C. physinodes* sp. n., *angolensis*, and *longiflora;* also *Canthium glabriflorum*, belonging to the same natural order, and *Barteria Nigritiana* and *fistulosa*, belonging to the Passifloraceæ. *Cola marsupium* sp. n. (Melastomaceæ) possesses bladders on the leaves similar to those of other myrmecophilous species of the same order; but it can only be placed provisionally in this category, as the author has not been able to detect that the bladders are inhabited by ants.

Atavism of Plants.‖—Baron d'Ettingshausen and Prof. Krasan again call attention to the phenomena of polymorphism, and especially of heterophylly in the Cupuliferæ, as an example of atavism. A polymorphic species, such as frequently occurs in that order, is a collection of forms, some of which are successive, others contemporaneous.

* Journ. de Bot. (Morot), v. (1891) pp. 130–2.
† Ber. Deutsch. Bot. Gesell., ix. (1891) pp. 79–81.
‡ Bot. Ver. München, April 20, 1891. See Bot. Centralbl., xlvi. (1891) p. 222.
§ Ber. Deutsch. Bot. Gesell., ix. (1891) pp. 54–72. Cf. this Journal, *ante*, p. 73.
‖ Arch. Sci. Phys. et Nat., xxv. (1891) pp. 257–74. Cf. this Journal, 1890, p. 635.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Phylogeny of Ferns.*—Returning to the subject of the relative antiquity of the leptosporangiate and eusporangiate ferns, Prof. F. O. Bower now abandons his previous view, and adopts rather that of Campbell.† He discusses the points which have been relied on as showing an affinity between the Hymenophyllaceæ and Mosses, viz.:—The filmy character of the leaf, the filamentous prothallium, the projecting sexual organs, the presence of a single well-defined apical cell, and the reputed absence of roots in some filmy ferns; and shows that none of them can be regarded as trustworthy evidence of genetic affinity. On the other hand, the fact that the leptosporangiate ferns are the only known leptosporangiate Vascular Cryptogams is some indication of their later origin, a view strongly supported by the facts of palæophytology; the Marattiaceæ attained a great preponderance in the Carboniferous period compared to their frequency at the present time.

Prof. Bower is disposed to trace an affinity between the eusporangiate ferns and the Hepaticæ, the sporophyte of the fern corresponding to the sporogone of the liverwort, and the isolated archesporial cells of the former to the united archespore of the latter. The Cycadeæ have probably sprung from some forms allied to our modern Marattiaceæ and Ophioglossaceæ, the Coniferæ from some forms allied to Lycopodiaceæ.

Apical Growth of the Prothallium of Ferns.‡—Prof. D. H. Campbell describes the mode of growth of the prothallium of *Onoclea sensibilis*, *O. Struthiopteris*, *Osmunda cinnamomea*, and some Polypodiaceæ, and points out its identity, in all essential features, with that of the Hepaticæ, especially in *Metzgeria*, *Aneura*, and the Anthoceroteæ, as well as in the Marchantiaceæ and Ricciaceæ. This consists essentially in growth from a single two-sided apical cell, from the sides of which two rows of segments are cut off by parallel walls. From these facts he argues the genetic derivation of Filices from Hepaticæ, the Osmundaceæ and Marattiaceæ being probably the primitive forms of the former.

Muscineæ.

British Mosses.§—Rev. H. G. Jameson publishes a complete key for determining British mosses; the first part giving the distinguishing characters of the genera, the second part the distinguishing characters of the species in all those genera which include more than a single British species.

Apical Growth of Hepaticæ.||—From observations on several species of thalloid Hepaticæ, especially *Marchantia polymorpha*, Mr. D. M. Mottier has come to the conclusion that the apical growth takes place not, as usually supposed, from several, but originally from a single apical cell.

* Ann. of Bot., v. (1891) pp. 109–34 (1 pl.). Cf. this Journal, 1890, p. 66.
† Cf. this Journal, 1890, p. 637.
‡ Bull. Torrey Bot. Club, xviii. (1891) pp. 73–80 (1 pl.).
§ Journ. of Bot., xxix. (1891) pp. 33–45, 132–42, 196–206 (1 pl.).
|| Bot. Gazette, xvi. (1891) pp. 141–3 (1 pl.). Cf. *supra*, Prof. Campbell.

Algæ.

Continuity of Protoplasm in Algæ.*—Herr F. G. Kohl has detected continuity of the protoplasm from cell to cell in *Spirogyra*. The connection is of two kinds, one of which is transitory, the other permanent. The pores in the septa through which the threads of protoplasm pass exist from the time when the membrane is first formed. The staining reagent with which the best results were obtained was tannin-anilin.

Mr. B. M. Davis † describes the same phenomenon in the cells of the filament of the *Chantransia*-form of a species of *Batrachospermum*. The best staining reagent is, according to him, an alcoholic solution of eosin, after the application of which the filament is first washed with water, and the cell-contents then shrunk by dilute glycerin.

Histology of Polysiphonia fastigiata.‡—Mr. R. J. Harvey-Gibson describes several features in the structure of this sea-weed, epiphytic on *Ascophyllum nodosum*. The protoplasm both of the central and of the pericentral cells are in complete communication when in a young condition; but the author believes that this is not maintained in older conditions. The tetraspores appear to be formed by a process of ordinary but incomplete division of the contents of an apical cell. They have special cell-walls while still within the mother-cell. Between the central and the pericentral cells well-marked intercellular spaces occur, which have a distinct lining of their own. The attachment of the epiphyte to its host is very intimate. Root-filaments given off from the base of the frond penetrate deeply into the tissue of the host, and wander amongst the cortical cells and medullary hyphæ; these filaments have very thick cell-walls.

Sporange of Rhodocorton.§—Mr. R. J. Harvey-Gibson describes the tetrasporanges of *Rhodocorton Rothii* and *floridulum*, the tetraspores being formed in them as quadrants, not as tetrahedra. After the formation of the first sporange a series of fresh ones are sometimes produced by a method of innovation, which is simply an extension of the mode of renewed growth of the vegetative filaments.

Caloglossa Leprieurii.‖—Prof. C. Cramer describes the vegetative structure and the reproductive organs of this sea-weed. The tetraspores are formed in mother-cells, which are metamorphosed superficial cells, and escape through oval or fissure-like openings. These mother-cells are situated on each side of the row of cells which subsequently becomes the mid-rib of the leaf, and are distinguished from the first by a special mode of growth and of division, in consequence of which they become much larger than the sterile marginal cells. Antherids appear to be of very rare occurrence; they are situated, like the tetraspores, in a double row on each side of the mid-rib of the leaf.

Antherids of Lomentaria.¶—Mr. H. J. Webber describes the antherids of *Lomentaria uncinata*, which are usually found at the ends

* Ber. Deutsch. Bot. Gesell., ix. (1891) pp. 9–17 (1 pl.).
† Bot. Gazette, xvi. (1891) p. 149 (1 fig.).
‡ Journ. of Bot., xxix. (1891) pp. 129–32 (1 pl.).
§ Journ. Linn. Soc. (Bot.), xxviii. (1891) pp. 201–5 (1 pl.).
‖ 'Ueb. Caloglossa Leprieurii,' Zurich, 1891, fol., 18 pp. and 3 pls.
¶ Ann. of Bot., v. (1891) pp. 226–7 (2 figs.).

of the branches of the frond, forming little spherical heads. The male plant does not differ, in general appearance or manner of growth, from the tetrasporic or sterile plant; and in one instance, antherids and tetraspores were found on the same plant.

Cystocarp of Callophyllis.*—From observations made on *Callophyllis laciniata*, Miss A. L. Smith concludes that the cystocarp is a compound body, and includes the products of a number of procarps. The carpogone, with its trichogyne, is borne upon one of the smaller cells of the medullary tissue, which lies alongside a larger auxiliary cell. After the trichogyne has forced its way between the cortical cells, and fertilized the carpogone, fusion takes place between the carpogone and the auxiliary cells. The procarps in each cystocarp are sometimes separated from each other by a mass of tissue, sometimes crowded together in immediate contact.

New Freshwater Floridea.†—Herr G. Karsten describes a freshwater alga from Amboyna belonging to the Florideæ, and to the hitherto entirely marine genus *Delesseria*. The frond is of a reddish-brown colour, only a single layer of cells thick except at the mid-rib, 2–3 mm. broad, and constricted at intervals of 8–10 mm. into narrowly elliptical segments; at these points of constriction numerous rhizoids grow which fix the alga to various substrata. The growing point is always recurved, and growth takes place by means of a single apical cell, from which successive segments are cut off by transverse septa. No organs of reproduction were observed. It is named *D. amboinensis*.

Chantransia, Lemanea, and Batrachospermum.‡—Mr. G. Murray and Miss E. S. Barton describe, under the name *Chantransia Boweri*, a new species found growing on *Lemanea fluviatilis* in Scotland. Not only were monospores found, but also antherids, trichogynes, and cystocarps. The cystocarps form corymbose stalked clusters of carpospores, and resemble those of *C. corymbifera*.

The authors dispute the conclusion of Atkinson § that *Lemanea* has itself a *Chantransia*-form, the form so described being, they believe, a protonemal form bearing a close resemblance to *Chantransia;* and they also throw very considerable doubt on Sirodot's well-known view that the freshwater species of the so-called genus *Chantransia* are but a special form of *Batrachospermum*. They claim to have established a freshwater group of species of *Chantransia*, consisting of *C. Boweri* and *investiens*, and corresponding to the suppressed genus *Balbiania*, which, in all generic points, resembles the marine species *C. corymbifera*.

Classification of Fucoideæ.‖—Dr. J. B. De Toni proposes an arrangement of the genera of Fucoideæ (comprising the Cyclosporinæ or Fucaceæ, the Tetrasporinæ or Dictyotaceæ, and the Phæozoosporinæ or Phæosporeæ) into families. The Cyclosporinæ are divided into the Durvillæaceæ, Himanthaliaceæ, Fucaceæ, Cystosciraceæ, and Sargassaceæ.

* Journ. Linn. Soc. (Bot.), xxviii. (1891) pp. 205–8 (1 pl.).
† Bot. Ztg., xli. (1891) pp. 265–71 (1 pl.).
‡ Journ. Linn. Soc. (Bot.), xxviii. (1891) pp. 209–16 (2 pls.).
§ Cf. this Journal, 1890, p. 641.
‖ Flora, lxxiv. (1891) pp. 171–82; and Ber. Deutsch. Bot. Gesell., ix. (1891) pp. 129–30.

The Tetrasporinæ comprise the Dictyotaceæ only. The very numerous genera of Phæozoosporinæ are distributed among the following families:—Cutleriaceæ, Lithodermataceæ, Ralfsiaceæ, Sporochnaceæ, Arthrocladiaceæ, Laminariaceæ, Spermatochnaceæ, Stilophoraceæ, Chordariaceæ, Elachistaceæ, Desmarestiaceæ, Myriotrichiaceæ, Dictyosiphonaceæ, Striariaceæ, Encœliaceæ, Sphacelariaceæ, Ectocarpaceæ, Phæothamniaceæ, Phæocapsaceæ, and Tilopteridaceæ. The genera *Nodaria* and *Thorea* are not placed; and *Actinema* is excluded.

Phæosporeæ.*—Prof. T. Johnson makes the following observations on various species of Phæosporeæ:—In *Carpomitra Cabreræ* and *Sporochnus pedunculatus*, the mode of growth of the thallus is trichothallic, the apices of the branches being occupied by tufts of innumerable hairs with basal growth. The sporanges are unilocular and multisporous. The receptacle is the modified apex of a branch of the thallus. The zoospores of *S. pedunculatus* are sensitive to light. In *Asperococcus* plantlets arise on the thallus by trichothallic growth, from hairs with basal growth, in a mode which shows an affinity with *Punctaria* rather than with the Sporochnaceæ. In *Arthrocladia villosa* the sporanges are unilocular and multisporous, and form stalked chain-like sori. *Desmarestia ligulata* has unilocular sporanges containing from 1 to 4 spores, and morphologically equivalent to any cell of the thallus. In the mode of growth of the thallus, and in the contents of the sporanges, *Desmarestia* shows a close affinity to the Tilopterideæ.

Dictyotaceæ.†—From observations made chiefly on *Dictyopteris polypodioides*, Prof. T. Johnson regards the Dictyotaceæ as forming a family of the Phæophyceæ. In the possession of tetrasporanges it does not differ essentially from the Tilopterideæ, where the non-sexual non-motile spores are quadrinucleate. The contents of the antherids have hitherto been described as non-motile pollinoids, but the author thinks they are probably ciliated antherozoids resembling those of the Cutleriaceæ and Fucaceæ. In the brown pigment and in the presence of isolated scattered oogones in *Dictyopteris* and *Spatoglossum*, the Dictyotaceæ also present characters which belong to the Phæophyceæ rather than to the Florideæ. The family to which they are probably most nearly allied is the Tilopterideæ.

Spirogyra.‡—Mr. G. Mann finds that when *Spirogyra nitida* and *jugalis* grow at a great depth, the filaments present some differences from those growing in shallow water. The filaments are from 2·5 to 3 feet long, and are divided into an apical, a shaft, and a foot-portion, the cells of which present certain differences. Crystals are of common occurrence in the filaments, composed probably of calcium oxalate.

Ctenocladus.§—Reviewing his description of this genus, Prof. A. Borzì removes it from the Chætophoraceæ to another section of the Ulotrichiaceæ, mainly on account of the structure of the cells, which are cylindrical and arranged in filaments branching in one direction only, the single chromatophore being in the form of a parietal plate placed

* Ann. of Bot., v. (1891) pp. 135–44 (1 pl.).
† Journ. Linn. Soc. (Bot.), xxvii. (1891) pp. 463–70 (1 pl.).
‡ Trans. and Proc. Bot. Soc. Edinb., xviii. (1889–90) pp. 421–31 (8 figs.).
§ La Nuova Notarisia, 1891, pp. 385–7. Cf. this Journal, 1884, p. 103.

longitudinally on one side of the cell with a central pyrenoid surrounded by an amyliferous envelope. He divides the Ulotrichiaceæ into three sub-families, viz.:—(1) Chætophoreæ, filaments branching, branches ending in a hyaline hair (*Stigeoclonium*, *Draparnaldia*, *Chætophora*, &c.); (2) Ctenoclad[i]eæ, filaments branching, not piliferous (*Ctenocladus*, *Chlorotylium*, *Chloroconium*, g. n.); (3) Ulotrichieæ, filaments not branching nor piliferous, rarely acuminate (*Hormiscia*, *Ulothrix*, *Uronema*). The new genus *Chloroconium* is thus characterized,—Ramuli alterni, omnes aut saltem fructiferi repentes, ad apicem fructiferi; zoosporæ ciliis binis. It includes *Chlorotylium coriaceum* Borz., *Cladophora compacta* A. Br., and three new species.

Leptosira and Microthamnion.* — On similar grounds to those mentioned in the preceding paragraph, Prof. A. Borzì now considers the genus *Leptosira* as belonging to the Chroolepidaceæ rather than to the Ulotrichiaceæ. The cells are of a very light green colour, with a single broad parietal chromatophore, which often clothes the cavity on all sides. In the possession of a single chromatophore and in other characters it agrees closely with *Microthamnion*, and the author proposes to classify the genera of Chroolepidaceæ in three subfamilies as follows:—(1) Chroolepideæ, branches entirely free, each cell containing several chromatophores (*Trentepohlia*, *Trichophilus*, *Gongrosira*, *Acroblaste*; (2) Phycopelteæ, branches, or at least the fructiferous ones, frequently coalescing laterally, and forming a broad disc-like thallus attached to the substratum, each cell with several chromatophores (*Phycopeltis*, *Hansgirgia*); (3) Microthamnieæ, branches erect, free, each cell with a single chromatophore (*Microthamnion*, *Leptosira*).

Cell-sap of Valonia.†—Herr A. Meyer has examined the chemical composition of the cell-sap of *Valonia utricularis*. He finds the residue on evaporation to amount to 3·244 per cent., or somewhat less than that of sea-water. Of this, about 0·238 is organic. In the relative proportion of the inorganic salts, the most noticeable differences from the composition of sea-water are the much larger proportion of potassium chloride, the much smaller proportion of sodium chloride, and the entire absence of calcium salts and of bromides.

Structure and Reproduction of Chlamydomonas.‡—Prof. Goroschankin has confirmed his observations published many years since (in Russian) on the mode of reproduction of *Chlamydomonas Braunii* Gor. (*C. pulvisculus* Dang. non Ehrb.).

This species multiplies rapidly, under favourable circumstances, in the ordinary non-sexual manner. The non-sexual individuals are provided with a perceptible membrane, and always with two flagella of about equal length with the body; the chromatophore has the form of a cup, at one end of which lies the massive pyrenoid; the "eye-spot" has the form of a long slender rod; and non-sexual propagation takes place in quite the ordinary way; but the sexual mode of reproduction is of a very unusual character, owing to the conjugating individuals being furnished with a membrane. The larger female individuals containing

* La Nuova Notarisia, 1891, pp. 387–91.
† Ber. Deutsch. Bot. Gesell., ix. (1891) pp. 77–9.
‡ Bull. Soc. Imp. Nat. Moscou, 1890 (1891) pp. 498–520 (2 pls.).

the oosphere may be termed *megagametes* (macrogametes), the much smaller male individuals *microgametes.* Both kinds arise, after many non-sexual generations, the former by division of the non-sexual cells into two or four, the latter by division into four or eight. The former vary between 20 and 29 μ, the latter between 9 and 15 μ in size; both closely resemble the non-sexual individuals, but are somewhat more elliptical, and possess a distinct double membrane. Conjugation was never observed between gametes of the same kind. A mega- and micro-gamete unite by their narrower ends, and continue in motion for a considerable time, often more than an hour; they then lose their flagella and come to rest. While still in motion, the contents of the male cell begin to move towards its anterior portion, and gradually pass over entirely into the anterior portion of the female cell through a canal which connects the two with one another. The protoplasts and the two nuclei unite completely, but not the pyrenoids and chromatophores. The product of conjugation becomes rounded off and excretes a coat of cellulose. The author compares this process of conjugation to that which takes place in the Zygnemaceæ. The gradual coalescence of the two nuclei can be easily followed in a hanging drop, even without the use of staining-reagents. A cellulose-reaction was in a few cases observed in the membrane of the gametes. The zygotes are usually enveloped in a brownish granular mucilaginous substance. Their contents break up into two, and eventually into four or eight, non-sexual flagellated individuals.

Chlamydomonas Braunii has also a palmella-condition, which can be readily cultivated in a moist chamber, and is then indistinguishable from colonies of *Pleurococcus* or *Glœocystis;* from these the non-sexual flagellated individuals are again developed.

Hariotina.*—Prof. A. Borzì identifies Dangeard's *Hariotina reticulata* with *Cœlastrum verrucosum* (Reinsch) De Toni. It consists of colonies of four, eight, or sixteen spherical cells; each cell has a chromatophore in the form of a parietal plate inclosing a pyrenoid. It is propagated by zoospores, from sixteen to thirty-two being formed in each cell, in the same way as those of *Hydrodictyon* and *Pediastrum.*

Fungi.

Nucleus of the Oomycetes during Fecundation.†—M. P. Dangeard has investigated the appearance of the nuclei of the sexual elements in cellular Cryptogams, and particularly in Fungi. He points out that with care two cases can be distinguished, the one in which the sexual elements are uninucleated, and the other where they are plurinucleated. An example of the first is afforded by *Basidiobolus ranarum*, in which simple fusion takes place, analogous to the fecundation of the Conjugatæ and Chlamydomonadineæ, among Algæ. The second case, however, is much more common among Fungi, in which the vegetative and reproductive cells are plurinucleated. The nuclei of the oospheres can be easily observed until the time of communication with the antherids; but they then disappear, and either assist in the formation of the oosperm

* La Nuova Notarisia, 1891, pp. 382–4. Cf. this Journal, 1890, p. 489.
† Rev. Mycol., xiii. (1891) pp. 53–5.

and of the oleaginous globule, or the new character of the protoplasm hides them from the observer. A little later several nuclei are to be found in the protoplasm between the oleaginous globule and the membrane.

Hemiasci and Ascomycetes.*—From an investigation of the history of development of a very large number of Basidiomycetes and Ascomycetes, Dr. O. Brefeld has arrived at the conclusion that there is a much closer affinity between these two groups than has generally been supposed, the sole constant distinction between the two being the formation of spores within asci in the latter. The examination of 400 species of Ascomycetes has led him to the conclusion that the so-called pollinode (antherid) and carpogone, as well as the trichogyne, of lichens, are not true sexual organs, and that the so-called spermatia (pollinoids) are simply very small conids, which can be made to germinate. The only reproductive organs in the Ascomycetes are non-sexual spores, conids, chlamydospores, and ascospores. The ascus is derived from the many-spored sporange of the lower alga-like fungi, just as the basid is from a one-spored sporangiophore. There is, however, a sharp distinction to be drawn between the true Ascomycetes (Exoasci and Carpoasci) and the *Hemiasci* (*Ascoidea*, *Thelebolus*, *Protomyces*).

The author then proceeds to describe the experiments by which he succeeded in causing the "spermatia" of the true Ascomycetes to germinate. Among the Pyrenomycetes this occurred in *Ophionectria scolecospora* sp. n., *Polystigma*, and in many Trichosphæriaceæ, especially in the stromatic Sphæriaceæ, as in numerous species of *Xylaria* and *Hypoxylon*. Similar results were obtained with *Hysterium pulicare* (Hysteriaceæ) and with many Discomycetes.

The conids which are so characteristic of Fungi are regarded by Dr. Brefeld as having been acquired when the algal ancestors of the Fungi took to a terrestrial mode of life and became Fungi; they are derived from one-spored sporanges in which the formation of the endogenous spore has been suppressed. Asci and basids have a common origin in the sporanges of the lower Fungi.

The fructification of the Hemiasci approaches that of the Phycomycetes, while the vegetative condition agrees more closely with that of the typical Ascomycetes. The new genus and species *Ascoidea rubescens* is described, as is the development of *Protomyces* and *Thelebolus*.

Among true Ascomycetes, the Exoasci include only the genera *Endomyces*, *Taphrina*, and *Exoascus*, and the new genus and species *Ascocorticium albidum*. The development of *Endomyces* is described in detail. The author regards the Saccharomycetes not as Ascomycetes, but as a stage in the development of some higher form of Fungi which cannot at present be determined.

Intoxicating Rye.†—M. E. Prillieux describes the phenomena attending the eating of bread made from a certain sample of rye, in a

* 'Unters. aus d. Gesammtgebiete d. Mykologie,' Heft 9; Münster, 1891, 156 pp. and 4 pls. See Bot. Centralbl., xlvi. (1891) pp. 321 and 350. Cf. this Journal, 1890, p. 368.

† Bull. Soc. Bot. France, xxxviii. (1891) pp. 205–8; and Comptes Rendus, cxii. (1891) pp. 894–6.

country village in France, both on men and other animals. They resembled intoxication rather than the effects of ergot. M. Prillieux found these results to be caused by a fungus, the mycele of which attacks the seed of the rye; it resembles *Dendrochium*, but differs from that genus in the spores being produced in the interior of the branches. He names the fungus *Endoconidium temulentum* g. et sp. n., with the following diagnosis of the genus:—Sporodochia pulvinata albida, sporophoris hyalinis ramosis; conidia hyalina rotundata, in interiore ramulorum subinde generata et mox ex apice exsilientia.

Assimilation in Lichens.*—M. H. Jumelle distinguishes three series of lichens in relation to their powers of assimilation. The first includes those in which the thallus is well developed and green or greenish (ex. *Peltigera canina*, *Physcia ciliaris*, &c.), the assimilation being particularly active. In the second series the thallus is still well developed, but is of various tints (ex. *Umbilicaria pustulata*, *Parmelia caperata*); the process of assimilation is here still evident. Finally, we have the crustaceous lichens (ex. *Lecanora hæmatostoma*, *Lecidea superans*), in which assimilation is feeble. The conclusion is thus arrived at that all lichens are able, when the conditions are favourable, to decompose carbonic acid gas, gaining carbon thereby.

Dependence of Lichens on their Substratum.†—Herr A. Zahlbruckner points out the difference between the lichens which inhabit siliceous primary and those which inhabit calcareous rocks. As a general rule also, different species of lichens are found on the different primary rocks—granite, gneiss, quartz, basalt, serpentine, &c.; and the same is true of chalk and limestone. The first of these two groups of lichens is characterized in general by bright colour, the second by various shades of grey and yellow.

Lichens of the Mulberry.‡—According to M. G. Hallauer, the corpuscles which cause *pébrine* in the silkworm are masses of the "antherozoids" (pollinoids) of the lichens which infest the mulberry-tree. When these lichens grow on the leaves they are harmless to the tree itself; but when they cover the branches or trunk, they are exceedingly prejudicial to the next crop of leaves.

Structure of Uredineæ.§—Herr P. Dietel has investigated several points in connection with the Uredineæ, especially the structure of the spore-membrane and the nature of the colouring matter of the spores.

In many teleutospores the membrane consists, when mature, of three layers. From the history of their development, and from the behaviour of the different layers with nitric acid, the author shows that the outermost only must be regarded as exospore, both the inner layers belonging to the endospore, which arises as an excretion from the cell-contents. The germ-pores, which appear like bright spots on the membrane, perforate, in most species of *Phragmidium*, only the inner layer of the endospore; in many species of *Puccinia*, where there is

* Comptes Rendus, cxii. (1891) pp. 888-91.

† Mittheil. Sect. f. Naturkunde d. Oesterr. Touristen Club, ii., pp. 81–3. See Bot. Centralbl., xlvi. (1891) p. 229.

‡ Comptes Rendus, cxii. (1891) pp. 1280-3.

§ Flora, lxxiv. (1891) pp. 140–59 (1 pl.).

only a single germ-pore, it perforates the whole thickness of the endospore. In many species of *Puccinia* the endospore consists of only a single layer. In *Coleosporium* each spore is invested by only a single membrane, and is usually divided by septa into four cells. According to the author's view, the teleutospores of *Coleosporium* are equivalent, strictly speaking, to basids or promyceles. In *Chrysomyxa*, also, the spores have only a single membrane.

Most uredospores have also a distinctly recognizable exospore and endospore, the latter, again, often consisting of two layers. Those of *Coleosporium* and *Chrysomyxa* have, however, a very abnormal structure, and the author regards them as in no way equivalent to the uredoforms of the Uredineæ, but as representing the æcidium-generation. The elevations which frequently occur on the surface of spores belong sometimes entirely to the exospore, sometimes also partly to the endospore.

Two kinds of pigment are found in the membranes of uredospores and teleutospores—one soluble, the other insoluble in water. The latter occurs in all brown membranes of uredospores, and in the brown paraphyses of many species; the former in the membrane of teleutospores, rarely in that of uredospores. The soluble pigment is found only in those species the teleutospores of which are firmly attached to the host-plant.

Puccinia parasitic on Saxifragaceæ.*—Herr P. Dietel identifies *Puccinia Saxifragæ*, parasitic on *Saxifraga granulata* and *carpathica*, with the *fragilipes* form of *P. Chrysosplenii*, parasitic on *Chrysosplenium alternifolium* and *oppositifolium*; the *persistens* form of this species being suppressed. He also identifies *P. pallido-maculata*, parasitic on *Saxifraga punctata* in Colorado, with *P. Adoxæ*, parasitic on *Adoxa* both in that State and in Europe, and founds on this fact an argument for placing *Adoxa* among the Saxifragaceæ, rather than among the Caprifoliaceæ or Araliaceæ.

New Uredineæ.†—Herr P. Magnus describes two new species of Uredineæ:—*Diorchidium Steudneri*, parasitic on *Ormocarpum bibracteum* (Leguminosæ) from Abyssinia, and *Cæoma circumvallatum* on *Geum heterocarpum* from Armenia; the latter is characterized by the sterigmas being surrounded by a wall of paraphyses.

In another communication ‡ the same author makes *Triphragmium Acaciæ* the type of a new genus *Sphærophragmium*, characterized by the teleutospores consisting of from four to nine cells, which are not arranged in a row, as in *Phragmidium*, but form a spherical or ellipsoidal body.

Himalayan Uredineæ.§—After describing a new species of *Puccinia*, *P.* (*Cæoma*) *Smilacis*, parasitic on *Smilax aspera*, the late Dr. A. Barclay discusses the characters of the alleged genus *Cæoma*, and sees no good ground for separating it from *Æcidium*.

In another memoir the same author describes a teleutospore-, a uredo-, and an æcidio-form of *Puccinia*, all parasitic on different species

* Ber. Deutsch. Bot. Gesell., ix. (1891) pp. 35–45 (1 pl.).

† Tom. cit., pp. 91–100 (1 pl. and 1 fig.).

‡ Tom. cit., pp. 118–24 (1 pl.).

§ Scient. Mem. by Med. Officers of the Army of India, pt. vi. (1891) 5 pp. and 1 pl., and 4 pp. and 2 pls. Cf. this Journal, *ante*, p. 231.

of *Rhododendron* in the Himalayas. Whether these three forms are genetically related to one another cannot at present be decided.

Entomophytic Cladosporieæ.*—M. A. Giard classifies the entomophytic Fungi under four heads:—(1) The Laboulbeniaceæ, whose attachment to the host is simply a superficial one; (2) the Entomophthoreæ, which are entomophagous, and fatal to the infected insect; (3) the Hypocreaceæ and imperfect forms (Isarieæ), which attack living insects, but are also capable of living on their dead bodies or on artificial media; (4) the Entomophytic Cladosporieæ, which kill the insect, not by the destruction of its tissues, but by closing up the tracheæ. Of this last group M. Giard cites five examples:—*Cladosporium parasiticum*, parasitic on *Polyphylla fullo; Penomyces telarium* (*Entomophthora telaria*), infesting *Ragonycha melaneura*, or less often the hemipterous *Phygadicus Urticæ; Penomyces cantharidum* sp. n., parasitic on *Telephorus lividus* and *Ragonycha testacea; Polyrhizum Leptophyei*, parasitic on an orthopteron, *Leptophyes punctatissima;* and *Lachnidium Acridiorum* g. et sp. n. (*vide infra*), the fungus which is so destructive to the migratory locust in Algeria. It presents itself under two forms, a *Cladosporium*- and a *Fusarium*-form.

Parasite of the Cockchafer.†—MM. E. Prillieux and Delacroix have examined the parasitic fungus which has recently been very destructive to the larva of the cockchafer in certain districts of France, and find it to be a *Botrytis*, very nearly allied to the *B. bassiana* which causes the muscardine of the silkworm, and describe it as *B. tenella*. An *Isaria* was once found, probably the conidial form of *Melanospora parasitica*, but this was parasitic on the *Botrytis*, and not pathogenic to the larva. The *Botrytis* was found to be very readily cultivatable on potato and sweet juices.

M. Le Moult ‡ describes the ravages committed by the parasite on the cockchafer larva, and recommends its culture for the purpose of destroying that agricultural pest.

M. A. Giard,§ in reference to this subject, considers the forms *Botrytis* and *Isaria* as stages in the evolution of Ascomycetous Fungi, only a few of which are at present known in the ascogenous form. When the conidiferous hyphæ are united into long thick tufts, more or less regularly club-shaped, they come under the denomination of *Isaria* (or *Stilbum*); when these hyphæ form a kind of veil, covering the substratum, they constitute a *Botrytis*. Some species may occur in both forms. Thus the *Botrytis bassiana* of the silkworm, cultivated on the larva of *Gastropacha Rubi*, gives rise to an *Isaria;* while the *Isaria farinosa* of the latter larva may develope into *Cordyceps militaris*. The parasite of the cockchafer is rather an *Isaria* than a *Botrytis*.

Parasite of Acridium peregrinum.‖—M. L. Trabut describes a parasitic fungus which is extremely destructive to this locust in certain districts of N. Africa. It has the appearance of a white efflorescence, the filaments of the mycele producing great numbers of spores, and forming white spots on the rings of the abdomen. The author regards

* Comptes Rendus, cxii. (1891) pp. 1518–21.
† Tom. cit., pp. 1079–81.
‡ Tom. cit., pp. 1081–3.
§ Tom. cit., pp. 1270–3.
‖ Tom. cit., pp. 1383–4.

it as a *Botrytis*, and describes it as a new species under the name *Botrytis Acridiorum.*

M. C. Brongniart * has further examined the parasite, and finds that it produces spores of two kinds. He has cultivated the fungus successfully, and believes that it may be found a very useful check on the spread of the grasshopper.

Hypogæi of Germany.†—Dr. R. Hesse publishes a monograph of the German species of Hymenogastreæ, Elaphomycetes, and Tuberaceæ, numbering about forty species, of which about thirty are not at present known elsewhere. They are found most abundantly on ground covered with trees, some species being parasitic on their roots.

Basidiomycete parasitic on Grapes.‡—MM. P. Viala and G. Boyer describe a basidiomycete parasitical on the grape, belonging to the group Hypochneæ; and the authors create for it a new genus *Aureobasidium*, the characters being founded on the filamentous hymenium, the arrangement of the basids, and the form, coloration, and variation in the number of the spores. The malady developes during wet years, especially in the months of September and October, when the grapes are nearly ripe, and the first appearance of *A. Vitis* is in the form of small dull spots.

Protophyta.

α. Schizophyceæ.

Dictyosphærium, Botryococcus, and Porphyridium. § — Prof. A. Borzì publishes a contribution to our knowledge of the structure of *Dictyosphærium Ehrenbergianum.* The characteristic gelatinous colonies originate from special spherical cells, which, inclosed in thin amorphous gelatin, form small colonies of the type of *Palmella.* These colonies become rapidly disintegrated, and the cells, when isolated, undergo a process of rapid vegetative multiplication, the division taking place in two directions only. In this way the reniform cells which bear a close resemblance to *Nephrocytium* are formed. The colonies subsequently become spheroidal by division in three directions. Each of these then divides by two successive bipartitions into four portions, connected together by a slight basal attachment. This attachment subsequently divides into four pieces, each of which becomes a kind of stalk to one of the four young colonies. The chromatophore of the cell of *Dictyosphærium* is not parietal, but central, and contains a polygonal pyrenoid. The author regards the above details as showing an affinity between *Dictyosphærium*, *Schizochlamys*, and *Tetraspora*, which constitutes the family Prasiolaceæ.‖

Botryococcus Braunii the author regards as probably a stage of development of *Mischococcus confervicola* while *B. terricola* Klebs appears to belong to an entirely distinct genus.

Experiments on the cultivation of *Porphyridium cruentum* were not

* Comptes Rendus, cxii. (1891) pp. 1494–6.

† 'Die Hypogæen Deutschlands,' Lief. i. and ii., 4to, 32 pp. and 4 pls. See Bot. Centralbl., xlvi. (1891) p. 228. Cf. this Journal, *ante*, p. 230.

‡ Comptes Rendus, cxii. (1891) pp. 1148–50.

§ La Nuova Notarisia, ii. (1891) pp. 367–82. ‖ Cf. this Journal, 1889, p. 793.

decisive on the question of the genetic connection of this organism with *Pleurococcus vulgaris.*

Dictyosphærium.*—Mr. G. Massee has followed out the life-history of *Dictyosphærium Ehrenbergianum.* In its earliest stage it cannot be distinguished from a small specimen of *Pleurococcus vulgaris.* After considerably increasing in size the spherical cell divides simultaneously into four equal parts. The mucilaginous portion of the mother-cell-wall does not divide along with the chlorophyllous portion, but continues to increase in quantity, and envelopes the segments in a continuous hyaline stratum. The segments of the mother-cell eventually become spherical, and still remain attached by their central stalk-like portions, which are hollow, the contents of the minute cavity being sometimes coloured green; the cavity subsequently becomes completely obliterated. Each of the four segments again divides into four by a double bipartition; and this process may again be repeated once or twice. The contents of each final division escape as a zoospore, provided with two very long and slender cilia.

Movements of Diatoms.—Mr. C. Onderdonk † finds that several species of *Pinnularia* and one of *Nitzschia,* when in active motion, are at once arrested by a delicate application of methyl-anilin-green; this stains blue a mantle of protoplasm, which it raises up from the surface of the frustule, and shows, by the varying depths of colour, that it is folded and wrinkled; the contents of the diatom itself are stained green. He concludes from this that the motions of diatoms are due to an excessively thin external coating of protoplasm, which is probably not more than 0·00002 in. in thickness, and in a state of perpetual pulsation as long as the cell is in a living state.

Mr. R. W. Haskins,‡ on the other hand, believes, from observations on a species of *Nitzschia,* that the motion is due to the action of very minute cilia.

β. Schizomycetes.

Classification of Bacteria.§—Sig. Al. Messea suggests that the presence or absence of cilia in Bacteria may afford a basis for classification, and gives the following scheme:—I. Gymnobacteria; II. Trichobacteria. 1, Monotricha; 2, Lophotricha; 3, Amphitricha; 4, Peritricha. The Monotricha possess a flagellum at each pole, e. g. *B. pyocyaneus.* Lophotricha are characterized by a tuft of flagella at one pole, e. g. Bacillus of blue milk. The Amphitricha have one cilium at each pole (*Spirillum volutans*). The Peritricha have flagella all round (*Bacillus proteus vulgaris, B. typhosus*).

Plasmolysis in Bacteria.‖—Plasmolysis, says Herr A. Fischer, is that phenomenon occurring in the protoplasm of vegetable cells under the influence of substances having affinity for water, such as saline

* Journ. Linn. Soc. (Bot.), xxvii. (1891) pp. 457–62 (1 pl.).

† The Microscope, x. (1890) pp. 225–30. ‡ Tom. cit., pp. 272–3.

§ Rivista d' Igiene e Sanità pubblica, i., No. 14. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 106–7.

‖ Berichte üb. d. Verhandlungen Sächs. Gesell. Wiss. zu Leipzig, i. (1891) pp. 52–74 (1 pl.).

solutions, &c. Under these circumstances, the protoplasm which has hitherto been spread throughout the cell and lined quite completely the cell-wall, becomes contracted, assuming various shapes and positions.

Several examples of this inspissated condition of cell-plasma are depicted in his illustrations; such are the appearance of the cholera nostras bacillus, typhoid bacillus, *Bacterium termo*, *Clostridium butyricum*, *Bacillus neapolitanus*, *Leptothrix buccalis*, and *Spirogyra*. In the bacilli, the plasma, acted on by salt-solution, is gathered up as polar bodies at one or both ends of the cell; if at both, then the polar bodies may be joined by a narrow filament of inspissated plasma.

Quite similar effects, but with different arrangement of the plasmolysed cell-contents, are easily seen in *Spirogyra*. The plasmolytic condition is easily induced by any substance which will withdraw water from the cell-protoplasm, but the most convenient medium appears to be sodium chloride in solutions of 1/2 to 10 per cent., 1/2 to 2 per cent. being the strength most usually adopted.

Plasmolysis also occurs in disease conditions, and in cultivations; examples of the former case are *Streptothrix* disease of rabbits, and actinomycosis.

The condition of plasmolysis artificially induced by means of reagents is not without its practical value, for it enables the observer to determine whether the cells be still alive, viable indeed, since only living protoplasm is susceptible of this change.

The author concludes by discussing the views of Ernst and Bütschli on the nature of protoplasm and the nucleus of cells in particular.

Symbiosis of Rhizobium and Leguminosæ.*—In an exhaustive treatise, Herr B. Frank sums up the present state of our knowledge of this subject, and adds some new observations.

The symbiotic organism he regards as a Schizomycete, *Rhizobium Leguminosarum*, common to all the Leguminosæ. He has isolated and cultivated it in hanging drops. In a period varying from 1 to 5 days there appear in the drop actively motile swarmers which originate from the bacteroids in the tubercle. The coccus-like contents of these bacteroids develope into the swarmers which become free and motile after the absorption of the bacteroids. They are of roundish form, from $0 \cdot 9$ to $1 \cdot 3\ \mu$ in diameter, while the bacteroids are from 3 to $5 \cdot 5\ \mu$ long, the microbes lying in the latter usually in one row. Non-motile bacteria also occur. No cilia could be detected. A zooglœa-form was also observed. The bacteroids are therefore neither purely protoplasmic structures (Brunchorst) nor pure bacteria (Prazmowski), but a combination of the two, a *mycoplasm*. The author regards the microbe to be a parasite in *Phaseolus*, and the formation of tubercles to be of no use to the host. In most other Leguminosæ, on the contrary, the relationship of the microbe to the host is a symbiotic one, enabling the latter to obtain normal development under unfavourable conditions of growth, in soil containing but little humus. He finds the *Rhizobium* not only in the root-tubercles, but also in the aerial organs of the infected plants.

* Landwirthsch. Jahrb., xix. pp. 523 *et seq.* (12 pls.). See Bot. Centralbl., xlv. (1891) p. 242. Cf. this Journal, 1890, p. 372.

Microbe of the Tubercles of Leguminosæ.*—According to M. E. Laurent the bacteroids of the tubercles of Leguminosæ are not endowed with any power of motion except a brownian movement. They differ from true bacteria in multiplying, not by transverse division but by a kind of dichotomous budding which produces structures of the characteristic T or Y shape. This resembles the mode of multiplication described by Metschnikoff in *Pasteuria ramosa*, a parasite on *Daphnis;* and M. Laurent proposes to unite these into a new group PASTEURIACEÆ, intermediate between true bacteria and the lower filamentous fungi.

Colouring-matter of certain Schizomycetes.†—Following up his observations on the occurrence of a true lipochrome in certain Bacteriaceæ—*Micrococcus rhodochrous*, *M. Erythromyxa*, and *Bacterium Chrysogloia*—Herr W. Zopf states that the oily colouring-matter is excreted by the organism when in a living condition. There is, however, a notable distinction between the red pigment of the first two, and the yellow pigment of the last; while the former forms well-defined crystals, the crystalline character of the latter is very obscure. Herr Zopf proposes to remove *Micrococcus rhodochrous* and *Erythromyxa* from the subgenus *Staphylococcus*, and to found on them a new subgenus of *Micrococcus*, which he proposes to call *Rhodococcus*.

A Red-Pigment-forming Organism.‡—Mr. C. Slater gives with a query the name of *B. corallinus* to a red-pigment-forming organism which differs from any of those already known. It occurred as a coral-red, slow-growing, circular, non-liquefactive colony on a gelatin plate, and was probably due to an air-contamination. The colony consisted of short, thick bacilli, with very rounded ends; their breadth was almost constantly 1 μ, and the average length from 2 to 3 μ. The organism has a rolling, recurving motion, with, generally, but slow motion of translation. The most noticeable characteristic is the highly refringent nature of the poles of the cells; growth occurs easily on gelatin-peptone; the organism is distinctly aerobic. The optimum temperature for growth is between 20° and 23°. The pigment is largely contained in the cells and is not an excretion; it cannot be extracted till first liberated by the disruption of the cells by boiling; it then dissolves easily in alcohol and chloroform, though not in ether. No absorption-bands were detected. Pigment is produced in darkness as well as in diffused light. Growth by fission was observed. A comparative table is given to show the differences exhibited by six pigment-producing bacteria.

Phosphorescent Bacteria.§—Dr. O. Katz communicates at considerable length an account of the six species of light-developing bacteria previously described by him in the Transactions of the Linnæan Society N.S.W.‖ Except to remark that the micro-organisms referred to are now discussed in greater detail the present paper does not demand further notice.

* Comptes Rendus, cxi. (1890) pp. 754-6. Cf. this Journal, 1890, p. 372.
† Ber. Deutsch. Bot. Gesell., ix. (1891) pp. 22-8 (1 fig.). Cf. this Journal, 1889, p. 560.
‡ Quart. Journ. Micr. Sci., xxxii. (1891) pp. 409-16 (1 pl.).
§ Centralbl. f. Bakteriol, u. Parasitenk., ix. (1891) Nos. 5-10.
‖ See this Journal, 1888, p. 101.

Eubacillus, a new Genus of Bacteriaceæ.*—M. P. A. Dangeard describes a fresh-water Alga which, though green, forms endogenous spores like the Bacteriaceæ. The alga, which is designated *Eubacillus*, consists of long slender filaments matted together; these do not present septa or ramifications, and their hyaline contents have a greenish tinge. The formation of spores imparts to this alga its specific characters. These spores are from six to eight μ long and about three μ broad.

The mode of sporulation is similar to that observed by L. Klein in five species which are referred by this latter to the genus *Bacillus*. Herein the spores are formed by a condensation, so to speak, of the protoplasm, this by its contraction separates from the wall of the filament, and after becoming more and more refracting, finally surrounds itself with a membrane.

Phragmidiothrix and Leptothrix.†—Dr. A. Hansgirg identifies the following species of Schizomycetes:—*Beggiatoa multiseptata* Eng., *Phragmidiothrix multiseptata* Eng., *Crenothrix marina* Hansg., and *Beggiatoa fœtida* Fior.-Mazz., and all these probably with *Leucothrix Mucor* Oerst., in which case the name to be retained will be *Crenothrix Mucor* (Oerst.) Hansg. He divides the genus *Crenothrix* into two sections,—*Phragmidiothrix*, which includes the single species above named, which is marine, and *Eucrenothrix*, which is freshwater, and comprises the single species *C. Kuhniana* (Rbh.) Giard, including *C. polyspora* Cohn with its synonyms.

Bacteria in the Colonies of Puccinia Hieracii.‡—Sig. G. Caboni has observed that the spots on the leaves of *Leontodon hastilis* caused by the attacks of this fungus are infested with enormous quantities of bacteria which move about actively within the stalks of both the teleutospores and the uredospores. They were detected only when the spots had shown themselves for some time.

Bacillus malariæ.§—Dr. B. Schiavuzzi confirms the results of the investigation on malaria by Klebs and Tommasi-Crudeli, who detected the presence of a bacillus in malarious districts. The author, however, not only identifies the micro-organism with which he has been working as that described by Klebs and Tommasi-Crudeli, but he has been able to make cultivations thereof, and so carry out some satisfactory infection experiments with animals.

From his experiments the author concludes that the principal habitat of the bacillus of malaria is the air; that it is rarely found in water, especially if it have a good fall; that the districts it thrives best in are those where the soil is damp, but not covered with water; and that as the temperature of the air and soil increase, so do its germs multiply.

Practically, of course, the author's paper is an attempt to prove that the Plasmodium malariæ is not the cause of malaria.

Bacteria of Influenza.‖—Dr. F. Fischel records the isolation of two micro-organisms from the blood of persons suffering from influenza.

* Comptes Rendus, cxii. (1891) pp. 251–3. † Bot. Ztg., xli. (1891) pp. 313–5.
‡ Nuov. Giorn. Bot. Ital., xxxviii. (1891) p. 296.
§ Beitr. z. Biol. der Pflanzen (Cohn), v. (1890) pp. 245–88 (1 pl.).
‖ Zeitschr. f. Heilkunde, xii., 1891. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 611–15.

The blood was taken from the forearm with the usual precautions, and cultivated in the media commonly in use. Micro-organism i. consists of cocci ·75–·5 μ in diameter; these are frequently paired, but also are found singly or in chains. They were not decolorized by Gram's method. Inoculation experiments on animals (rabbits, dogs, horses, fowls) failed to show any pathogenic property, the absence of which is ascribed by the author to loss of vitality, during the residence of the microbe in the animal body.

Micro-organism ii. is also a coccus, of 1–1·25 μ in diameter. Injection into animals was followed by rise of temperature and catarrhal conjunctivitis. In some dogs balanitis was observed.

One horse died after injection of 40 ccm. of a bouillon cultivation, the most prominent features being jaundice, fever, and conjunctivitis; the most important post-mortem appearance, lobular consolidations of the lung. From this lung, cultivations of a coccus resembling micro-organism ii. were obtained. In another horse injected with 100 ccm. of bouillon, the symptoms were fever, conjunctivitis, exudation into anterior chamber of eye, marked weakness of posterior extremities, and hebetude. The symptoms passed away in about a week.

From a comparison of the results of these experiments on animals with the clinical picture of "Hundestaupe" the author concludes that the morbid appearances produced by intravenous injection of micro-organism ii. are comparable to those of the catarrhal form of "Staupe" and that this view receives further confirmation from the occasional participation of the intestinal, preputial, and nasal mucosas.

The author is inclined to think that these two diseases may be identical, and it is pointed out that this view receives further support from the fact that *Bacillus pneumoniæ* Friedlaender and *Streptococcus pyogenes* thrive better in bouillon which has been used for cultivating micro-organism ii. than in fresh bouillon.

Bacteria of Swine Diseases.*—Dr. G. Caneva, after an examination of the bacteria found in certain diseases affecting pigs and other animals, classifies these micro-organisms under three principal categories. The micro-organisms dealt with are the bacteria of hæmorrhagic septicæmia (Hueppe), hog-cholera (Salmon), swine-plague (Billings), swine-pest (Selander), American cattle-plague (Billings), Büffelseuche (Oreste-Armanni), Marseilles Schweinseuche (Jobert, Rietsche), Frettchenseuche (Eberth). All the organisms have some few characteristics in common; they do not liquefy gelatin, do not form endospores, are not stained by Gram's method, but when aqueous methylen-blue solution is used the pigment accumulates in greater or less quantity at both poles. On the other hand, these microbes present, in addition to obvious morphological differences, special characteristics which permit their division into three distinct classes.

The first group comprises bacteria producing symptoms of hæmorrhagic septicæmia. These are non-mobile, do not thrive luxuriantly on gelatin; do not grow at all on potato; do not produce any special changes in milk, are found both in the blood-vessels and scattered diffusely throughout the tissues.

In the second group, which includes Marseilles pig-disease, swine-

* Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 557–61.

plague, American cattle-plague, and "Frettchenseuche," these are fairly mobile, grow on gelatin like typhoid bacillus, thrive luxuriantly on gelatin, coagulate milk with formation of acid, form capillary emboli, but are not scattered about in the tissues.

In the third group are included hog-cholera and swine-plague. The characteristics of these are lively movements; luxuriant growth on gelatin, but not resembling that of typhoid bacillus; growth on potato luxuriant, and resembles that of typhoid; peptonizes milk, without previous coagulation; small capillary emboli only; not scattered throughout the tissues.

Diplococcus resembling Gonococcus.*—Sig. F. Vincentini narrates a case of cancer of the bladder, in which he found a microbe resembling in all respects the micrococcus of gonorrhœa. The coccus described by the author is identical in form, size, and appearance with the micrococcus of blennorrhagia described by Cornil, Babes, and others. The record is interesting, since a very similar case has been recorded by Bockhart, and it helps to throw doubt on the specific value of the gonococcus.

Micro-organisms found on ripe Grapes and their Development during Fermentation.†—M. V. Martinand and M. M. Rietsch record the results of their examination as to the nature and number of the micro-organisms found on grapes grown in different parts of France. Their method was to place a grape in a test-tube containing a sterilized sugary liquid. Some of the fermented fluid was afterwards tested by means of plate cultivations. In the result it was found that the microbes capable of developing in acid media (and these are the only ones which are interesting in regard to wine-making) are present on the surface of grapes in very variable numbers. The moulds and *S. apiculatus* are much more frequent than *S. ellipsoideus*. Acid-making bacilli and Mycoderms are not rare. The spontaneous fermentation of grapes is usually brought about in the first twenty-four hours by *S. apiculatus* and this subsequently gives way to *S. ellipsoideus* but without disappearing altogether.

Bacteria and Mycoderms are met with not only at the outset of fermentation, but even in the lees, a fact which indicates that it is quite possible that the cause of the deterioration of wine is to be sought for in the skin of the grape rather than in some after-contamination by the air or vessels.

Races of Bacillus pyocyaneus.‡ — M. Gessard who had already found that the production of pigment by *Bacillus pyocyaneus* depends directly on the quality of the medium, has now shown that this production depends on certain attributes in the microbe.

By thirty-four sub-cultivations which took more than a year, a variety was obtained, which formed pyocyanin in bouillon. Another variety was developed by heating a normal cultivation for five minutes to 57°. This one only produced green fluorescing pigment in bouillon. By heating the first mentioned variety a third race was produced, which had lost all power of producing pigment. All these races could be reconverted into the original stock by cultivating in pepton-glycerin-agar.

* Atti d. Accad. Med. Chi. di Napoli, xliii. (1889) 29 pp.
† Comptes Rendus, cxii. (1891) pp. 736–8.
‡ Annales de l'Institut Pasteur, 1891, p. 65. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 541–2.

Similar varieties with partial or complete loss of their chromogenic function, could be obtained by passage through the animal body.

The conclusion, which is obvious, arrived at by the author from his experiments, is that the results of a species of microbe depend on the nutrient medium, and if the medium remain the same, on the races which that species is in condition of forming.

New Micrococcus of Bitter Milk.*—Mr. H. W. Conn describes a coccus which he has isolated from bitter milk. Its most prominent characteristics are the following. Grown on gelatin, it betrays little or no tendency to chain formation, although on agar chains consisting of four or more individuals are quite common. The organism is of pretty fair size, non-mobile, aerobic, and liquefies gelatin with the formation of gas. It grows well on agar, potato, bouillon, and in milk. The latter medium is rendered bitter, and at a temperature of 35° C. is coagulated. The coagulation is probably due to a soluble enzyme, but the author failed to isolate the ferment.

The most remarkable effect of this micro-organism is the viscidity and ropiness it induces in gelatin and bouillon when cultivated therein. Strings 3 m. long and not thicker than a silk thread may be drawn out from these culture media, but it is noteworthy that this phenomenon is not observed when the coccus is cultivated in milk.

From the organism described by Weismann, which is also causative of bitter milk, the author's coccus differs in the fact that it produces butyric acid.

Germicidal Properties of Milk.†—Herr A. P. Fokker finds that if fresh goat's milk be placed in sterilized vessels and then boiled for some minutes it coagulates in 24 hours after having been inoculated with a minute quantity of *B. acidi lactici*, but if unboiled it does not do so for two to four days. By investigations with plate cultivations and counting the colonies, it was shown that, as with blood, there is at first a diminution (even to abolition) and afterwards an increase of the fungi. When heated for only a short time, the germicidal faculty was not always destroyed.

M. Ed. de Freudenreich,‡ in describing his experiments on milk, draws attention to the difficulty there is in obtaining it in perfectly sterile condition. Only sometimes, even after taking the greatest precautions, were the tubes perfectly free from germs. The most simple way is after having carefully cleansed the udder, to milk straight away into sterilized test-tubes, and this was the method most frequently adopted. But another procedure, and one which from *a priori* considerations ought to have yielded better results, was also tried. This was by means of a system of glass and caoutchouc tubes so arranged as to connect the sterilized udder with the receiving flask in such a way that there should be no contamination from the air. Some few quite sterile tubes of milk were thus procured, but on the whole we gather that the simpler method was not only less cumbersome but more successful.

The micro-organisms employed in the experiments were the cholera bacillus, the typhoid bacillus, the *Bacillus Schafferi*, and an oval micro-

* Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 653–5.
† Op. cit., vii. (1890) p. 648.
‡ Annales de Microgr., iii. (1891) pp. 415–33.

coccus often found by the author in milk. The procedure adopted was the usual one, viz. first to wait to see if the milk in the tubes was quite sterile, and then having inoculated them with different micro-organisms to incubate the tubes at 37°.

The results of the action of these microbes in cow's and goat's milk are then given in a series of tables, the first two of which deal with fresh milk drawn in sterilized tubes. The diminution was most notable in the case of the cholera vibrio and the typhoid bacillus, the other two being more resistant. If the milk were inoculated with a large quantity of the poison the germicidal action would seem to be in great measure overpowered. Again, if milk be heated, the germicidal action is diminished or lost, hence pasteurization or heating milk to kill off contaminating germs to 68°–69° for 20 minutes is detrimental to this vital phenomenon.

The bactericidal power was found to reside almost entirely in the serum or skim milk, the cream having almost no deleterious action.

The author concludes with some speculations on the nature of the bactericidal substance or essence, and gives reasons for preferring to regard it in the light of a ferment, insoluble perhaps, rather than as a something having a certain chemical reaction, and possessing properties in virtue of this alkaline or acid reaction.

Antitoxic Power of the Animal Organism.*—M. Gamaleia records the results of experiments with *Vibrio Metschnikovi*. The author had previously shown that animals naturally insensitive to the infection of the vibrio (e. g. rabbits) are also insensitive to the toxin produced by the vibrio. The present experiments were directed to ascertain if possible on what this insensibility depended. He collected the urine of rabbits which had been injected with large quantities of sterilized cultivations of the vibrio, and sought, but in vain, for some evidence of the toxin. He then supposed that perhaps the tissues of the insensitive animals possessed the property of destroying the toxin. To prove this hypothesis he rubbed the inoculation fluid with the spleen just removed from a living rabbit. This mixture was placed in an incubator at 37°, filtered and inoculated in mice and guinea-pigs. Inoculations showed that the mixture had lost its toxic action. It was also found that this antitoxic action was possessed not only by the spleen, but also, though in a less degree, by the blood-serum of rabbits. Hence it follows that the living tissues of insensitive animals are endowed with the capacity of destroying the vibrio toxin.

With sensitive animals the antitoxic action does not increase, for the author found that in guinea-pigs, after protective inoculations against *V. Metschnikovi* and cholera vibrio, their power of resistance to the soluble products of these micro-organisms does not increase, while on the other hand their power of destroying the microbes augments. From this the author concludes that there exists a certain antagonism between the antiseptic and the antitoxic properties of these animals.

Isomeric Lactic Acids as criteria diagnostic of certain species of Bacteria.†—M. Nencki after alluding to the discovery of a micro-

* La Semaine Méd., 1890, No. 56. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 452–3. † Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 304–6.

coccus (*M. acidi paralactici*) which fermented grape-sugar, but the principal product of which was not optically inactive, but turned polarized light to the right, states that from the human intestine he has isolated no less than six microbes capable of fermenting sugar, and three of these form optically active acids. Now Schardinger has isolated from water a short bacterium which decomposes cane sugar and dextrose with the formation of lactic acid, having all the chemical properties of para-lactic acid and forming salts with the same composition, e. g. the zinc salt crystallizes with two molecules of H_2O, and the calcium salt with four and a half molecules. On the other hand the acid and its salts behave differently from ordinary paralactic acid to polarized light, for while the latter turns the plane to the right and its salts to the left, Schardinger's acid turns the plane to the left and its salts to the right.

Since most of the potential and essential anaerobes which decompose carbohydrates form varying quantities of lactic acid, it becomes necessary in bacterio-chemical investigations to determine not only that lactic acid is produced, but to ascertain whether this acid be optically inactive or whether it turns the plane to the right or the left. The author relates how he isolated from the human intestine a bacterium closely resembling *B. coli commune*. But while the latter forms from glucose a dextro-lactic acid, the former (*B. Bischleri*) is optically inactive. There is no doubt that the observations of the author are extremely interesting, but we cannot follow him further into the details of the procedure pursued in his laboratory for the study of the decomposition products of the carbohydrates affected by bacteria. For this the original must be consulted.

Eisenberg's Bacteriological Diagnosis.* — The third edition of Eisenberg's Bacteriological Diagnosis has recently appeared. The whole work has been completely revised and much enlarged. Two hundred new species are described, and these are divided into three great groups:— (1) Non-pathogenic Bacteria; (2) Pathogenic Bacteria; (3) Fungi. In Group 1 are included micrococci, bacilli, and spirilla, and these are further subdivided into those which liquefy gelatin and those which do not, and also into two other classes according as they do or do not produce pigment. Still smaller groups are arranged in alphabetical order.

Of the pathogenic bacteria the author makes four great divisions:— (1) Those specifically pathogenic to man; (2) those specifically pathogenic to animals; (3) those pathogenic to animals, but which are found in man; (4) those pathogenic to animals, but which have diverse origin. This group as well as the fungi are, like Group 1, further subdivided alphabetically. The author also gives another system by classifying them according to their local origin, e.g. from water, air, skin, sputum, &c., and then again indicating that these may be further separated into pathogenic and non-pathogenic bacteria and fungi.

* Eisenberg's 'Bacteriological Diagnosis, with Appendix on Technique,' 3rd edition, Voss, Hamburg and Leipzig, 1891, p. 509. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 677–8.

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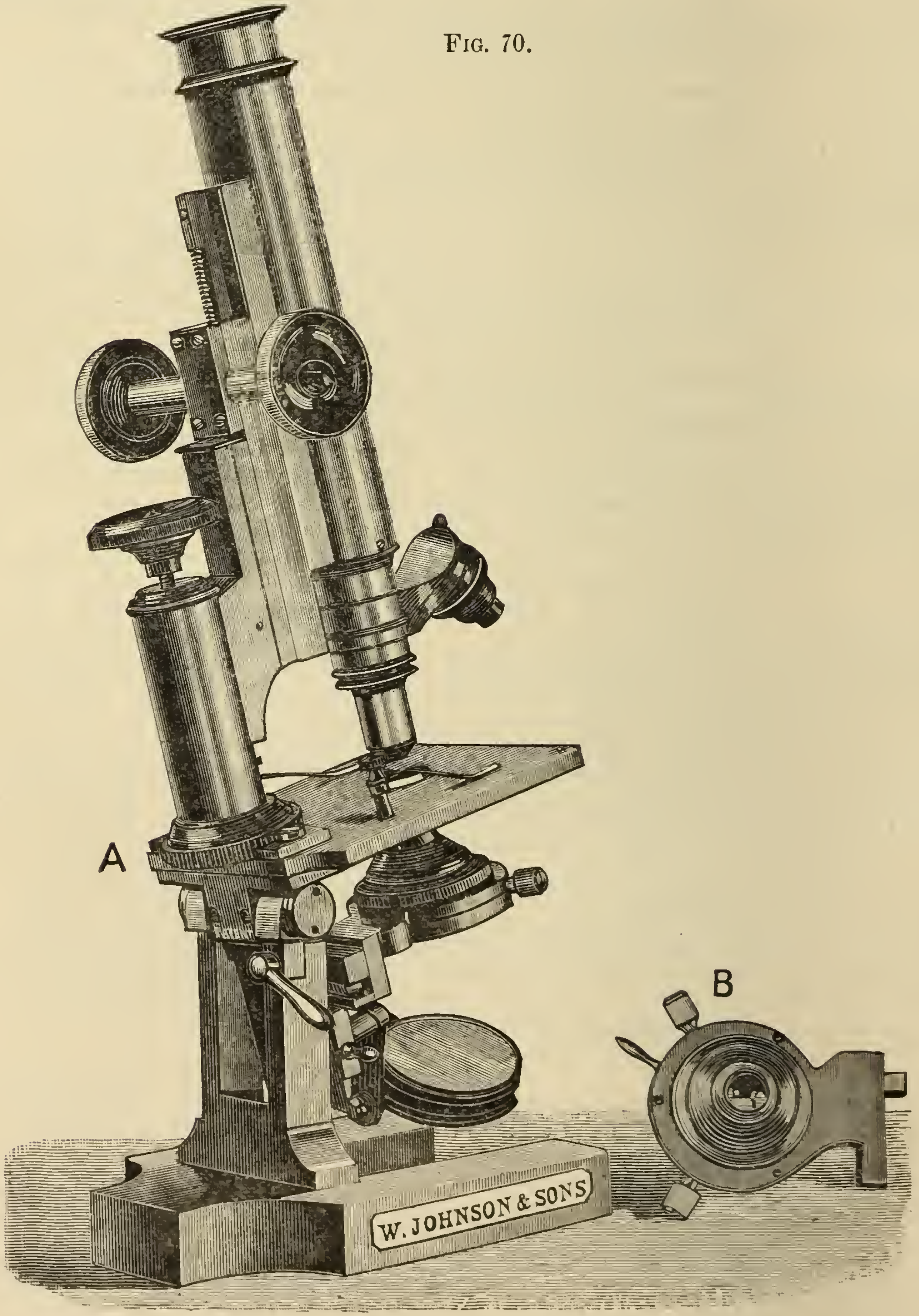
MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Johnson & Sons' Advanced Student's Microscope.—At the meeting of the Society in June last,† Mr. T. T. Johnson, of the firm of W. Johnson

Fig. 70.



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

† This Journal, *ante*, p. 556.

& Sons, exhibited and described a new student's Microscope which he had devised.

The late Mr. John Mayall, in introducing it to the President, said the special point was in the application of a screw movement for the substage adjustment. He thought it a very economical and excellent way of applying the focusing arrangement to the substage, and it appeared to him most happily chosen for convenience, and would certainly commend itself to notice. It seemed to him that Messrs. Johnson had undoubtedly "scored 1" by bringing out this screw-focusing arrangement for the substage.

This instrument has been constructed with a view to supply the student in the higher branches of research with a suitable Microscope at a moderate cost. The foot (fig. 70, A) is of the horse-shoe form, and sufficiently weighty to insure steadiness when used in a horizontal position for photomicrography.

The patented screw substage adjustment consists of a screw placed in the axis of the substage and tail-piece, which is actuated by a milled head nut, slightly projecting at A; this being readily at command gives great facility for raising or lowering the substage, and delicately focusing the condenser, &c. The substage carrying an Abbe condenser with iris diaphragm and mechanical centering arrangement is mounted on a substantial tail-piece and slides in dovetailed fittings. The substage with its fittings (when in use) is fixed to the Microscope, and is free from lateral motion; by a simple arrangement of a clamping screw it can be readily removed or replaced (see fig. 70, B) and is, as regards durability, far superior to the pivoting system. The mirror can also be removed for direct lights if required.

The fine-adjustment is on the differential screw principle insuring delicate focusing for high powers, and the coarse-adjustment on the oblique rack-and-pinion system, giving equality and smoothness of motion, the body being supplied with a draw-tube, and marked for English or Continental objectives.

A great advantage is gained by this position of the substage adjusting knob, as in addition to its being readily at command, all liability of tilting the mirror or disarranging any of the under-stage apparatus is avoided, "accidents" which often happen where it is necessary to feel for the adjustment when placed beneath the stage.

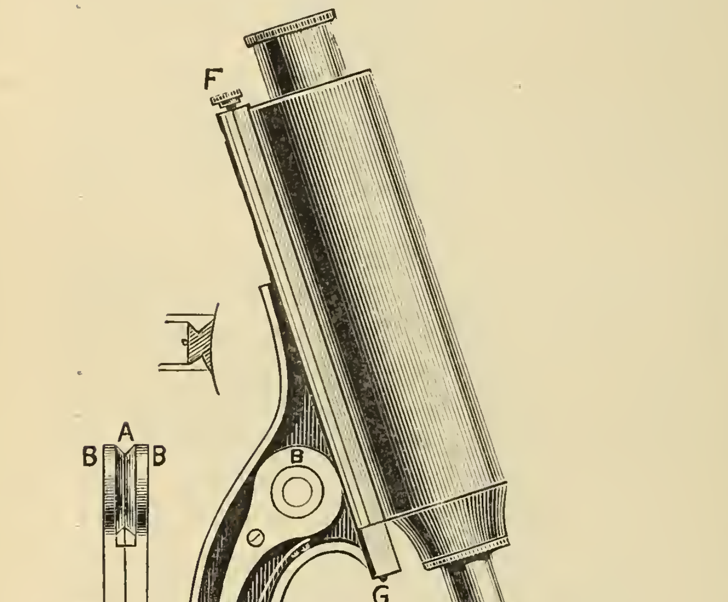
A College Microscope.*—Dr. W. H. Seaman observed:—"It may be remembered that in March 1888, *Science* published an article by me, maintaining the excellence of American Microscopes. The train of thought inspired by that article led me to make working drawings of an instrument with some novel features. These were shown to a few friends at Columbus, and were unfortunately lost from my coat-pocket at Buffalo. I did not have time to reproduce them till recently, and hoped to have the instrument itself here, but it is not quite done.

The figure (fig. 71) shows the features which are essential, in my judgment, to a good College Microscope. It will also be well adapted to the average professional man and amateur. A tripod base, rather thin,

* Proc. Amer. Soc. Micr., xii. (1891) pp. 67–8.

single foot back, wide open in front. The pillar may be single or double, but must have thumbscrew at the joint to hold it firm at any desired inclination; the mirror on swinging arm, adapted to carry a condenser if desired, and the stage just high enough to admit a short Abbe condenser; the centre of rotation of the mirror-bar just above the stage. The arm is a box-arm, Jackson model, shown with one side removed. The barrel should be of the short type and is supported on an X-shaped bar, that slides between the V's on each inside of the box-arm, as shown by detailed section. A steel tape or picture cord is fastened at each end of the X-bar, one end being the tightening screw F. This tape is wound once round the grooved wheel A, which is turned by the usual milled head and gives the coarse-adjustment to the instrument. On each side of the wheel A and on the same axis are two discs B B, that pinch the wheel A between them by a screw and act as a friction clutch. These discs are prolonged downward in the curved bar against which presses the spring E. The micrometer screw D forces the bar against this spring, and, turning the wheel A by friction, forms the fine-adjustment. Every part of the instrument is adjustable for wear. The stage is a ring, with a plate of glass dropped in it. A Zentmayer sliding holder may be used. The condenser is not shown in detail, as no special features are claimed for it. I am aware that friction fittings are not new; one was described by Mr. Wenham, vol. vii., Q. J. M.; also a chain movement was made by Pike or Grunow, of New York city, about 1850. Nevertheless, these devices do not appear to me to be as useful as that here described. The steel tape has proved successful in mechanical combinations where racks, &c., have failed, and it may succeed in the Microscope. The micrometer screw D may be replaced by a cam.

Fig. 71.

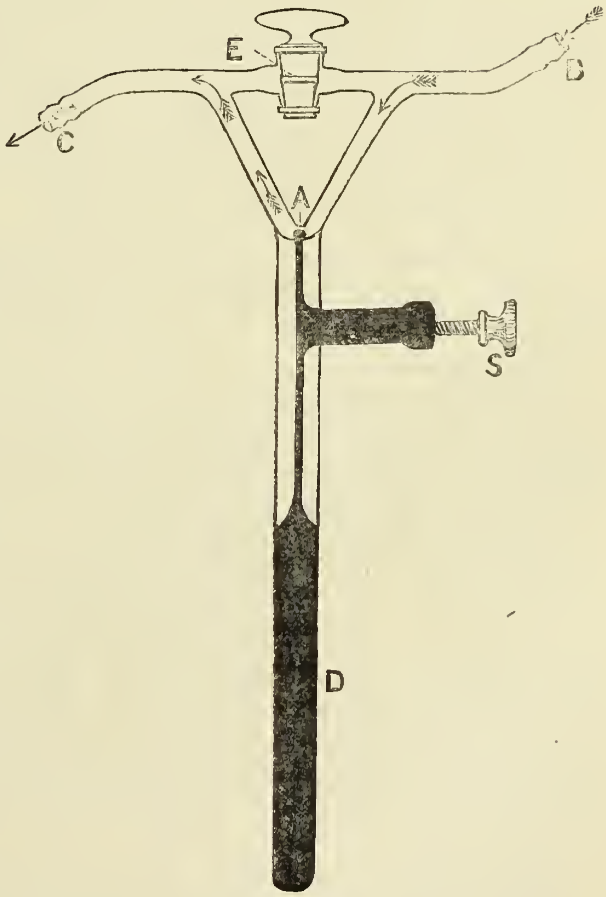


A Microscope built on the plan here outlined need not be expensive, and would be capable of all but the highest class of angular work. It may be conveniently used in its simplest form, and is at the same time adapted for the successive addition of those accessories essential to the prosecution of advanced researches with the instrument. Should it prove to answer my expectations I may refer to it again."

(3) Illuminating and other Apparatus.

Altmann's Thermoregulator.*—Herr P. Altmann has devised a very simple instrument for regulating temperatures below 100° C. The instrument works with great precision, not varying more than ± 0·05° C.

Fig. 72.



From the illustration it is seen to be made in a single piece. D is the reservoir fitted with mercury; this is narrowed above to a capillary tube, which at the side is in connection with a tube fitted with an air-tight iron screw S, which serves to regulate the apparatus for any desired temperature.

The way the instrument works is easily conceived from the illustration. When the reservoir D is heated, the mercury therein expands, and rising, cuts off, in the V tube of A, the stream of gas passing along in the direction B A C and only allows the transit of the small current along B E C. At E is a tap for regulating the supply of gas for keeping the burner just alight, and this is adjustable for any size of flame.

The instrument depends for its sensitiveness and accuracy on the large surface of the reservoir, so that the tube at A is opened or closed with great facility.

Metallic Thermoregulators.†—M. P. Miquel describes two thermoregulators, the action of which is determined by the expansion and contraction of metal bars. The bars, made of zinc, are from 25 to 50 cm. long, and are inserted in porcelain or glass tubes. The tubes are

* Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 791–2 (1 fig.).
† Annales de Microgr., iii. (1890) pp. 150–8 (2 figs.); iii. (1891) pp. 241–6 (2 figs.) and 363–74 (1 fig.).

immersed in the water-bath, and as the bar lengthens from the increased temperature, its upper end presses directly against a caoutchouc tube, through which the gas passes to the flame. Hence the flame diminishes and consequently the temperature of the thermostat. In the second model the end of the zinc bar is bevelled and its edge made to press against a lever, which is always kept opposed to the bar by means of a spring. The other arm of the lever runs between two caoutchouc tubes, one of which introduces a cooling, the other a heating medium.

The author states that having used these for some years he is able to testify that they work with great efficiency and accuracy, and gives a table recording their diurnal variations, which are certainly small. For the minute details of construction the original must be consulted.

The question of heating media is then discussed and an ingenious method for employing alcohol is described. In this case the alcohol is supplied to the flame through a tube coming from a reservoir fitted with a Marriotte's tube. The tube has an overflow pipe placed at an angle between the flame and the regulator. The regulator placed within the water-bath embraces the caoutchouc tube as it passes from the spirit reservoir to the flame, and so acts that as the bar expands it nips the tube, and thus diminishes the flow to the lamp.

Thermoregulator for large Drying-stoves and Incubators.*—M. Roux recommends the thermoregulator which has been in use at the Pasteur Institute for some years, as being very suitable for large ovens or incubators.

It is made of two metal bars welded together and bent to a U-shape. The inner bar is made of steel and the outer one of zinc. These are massive enough to prevent any springing. The length of the legs of the U are from thirty to forty cm.

The variations in temperature as recorded from the use of the large incubator at the Institute are said never to exceed 0·5°.

Capillary-siphon-dropping Bottle.†—Prof. M. W. Beyerinck says that if the V-shaped tube of a dropping-bottle be made of capillary size it will be found very useful for microscopical purposes. Thus it may be used for distributing small quantities, droplets, of any reagents from the bottle, or for capturing small animals, Infusoria, from a watch-glass, and so on.

Steam-filter.‡—The apparatus devised by Dr. P. G. Unna for filtering agar is a hollow copper sphere, the upper half of which serves as a lid.

In the bottom is a hole, through which passes the stem of an enamelled iron funnel. The top of the funnel projects above the level of the lower hemispherical segment or pan, and the distance between the edge of the funnel and the pan is about 1 cm. The pan is suspended on a tripod, from the ring of which a semicircular band passes over the pan. By means of a screw at the uppermost part of this band the lid is firmly screwed on. In the lid is also a small tap for letting off the

* Annales de l'Institut Pasteur, 1891, p. 158. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) p. 737.

† Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 589–90 (1 fig.).

‡ Tom. cit., pp. 749–52 (1 fig.).

steam. The apparatus is heated by means of a cylindrical closed pipe, projecting obliquely from the lower pan.

The agar having been cut up is boiled for half an hour on the open fire, and then having been mixed with any desired substances is placed in the funnel. In the funnel is fitted an ordinary filter-paper, filled with siliceous sinter. When the lid is screwed down, and heat applied, the pressure of the steam serves to drive the liquefied agar through the funnel into a flask placed underneath.

The chief advantages of this apparatus are its rapidity,—a litre of 2 per cent. agar can be filtered in two hours, a great economy of gas, simultaneous sterilization and clarification.

(4) Photomicrography.

The Value of using different makes of Dry Plates in Photomicrography.*—Dr. W. C. Borden remarks:—" While the variation in rapidity of different makes of plates is pretty generally understood and taken advantage of in practical work, the variations of plates in contrast and range of tones are not generally discussed in photographic literature, nor are the great benefits to be obtained by taking proper advantage of these variations understood, or generally practised. Hardly a photographic journal appears without either some new formula for a developer, or some new method of working an old one, by which it is claimed that some modification of rapidity or contrast may be produced in the plate on which they are used. Quite a large portion of photographic literature is devoted to giving these means of producing required effects in negatives, and every box of plates contains information (?) how to obtain greater or less rapidity, or contrast, as may be desired; when in fact, after a light has once struck a plate in a particular way, so changing a particular ratio, the molecular structure of the sensitizing chemicals with which it is coated, but little change in result can be produced by any developer, however much that developer may be modified. A modification, however, of the coating of the plate, giving a different chemical basis upon which the light acts, will, from the different arrangement and kind of molecules acted upon, produce a different result whatever developer may be employed. It is in this way that variations in result may be best and most surely obtained, for different makers of plates use sensitizing formulas differing in such manner that the coatings, when acted upon by light and " developed," give results differing in rapidity, contrast, and range of tones. That almost universal advice: " Get a good plate, master its peculiarities, and then use this plate exclusively," is good only so far as getting a good plate and mastering its peculiarities are concerned, for, however well the working of any one plate may be understood, results cannot be obtained from it alone, upon all kinds of objects, equal to those obtainable when different makes of plates are intelligently used, in a manner to make their peculiarities bring out, in the resulting negative, the effect sought for. For instance, if the object to be photographed has but little contrast, and a plate giving great contrast and a short range of half tones be used, a good printing negative will usually be obtained, while, if a plate having

* Amer. Mon. Micr. Journ., xii. (1891) pp. 169–72.

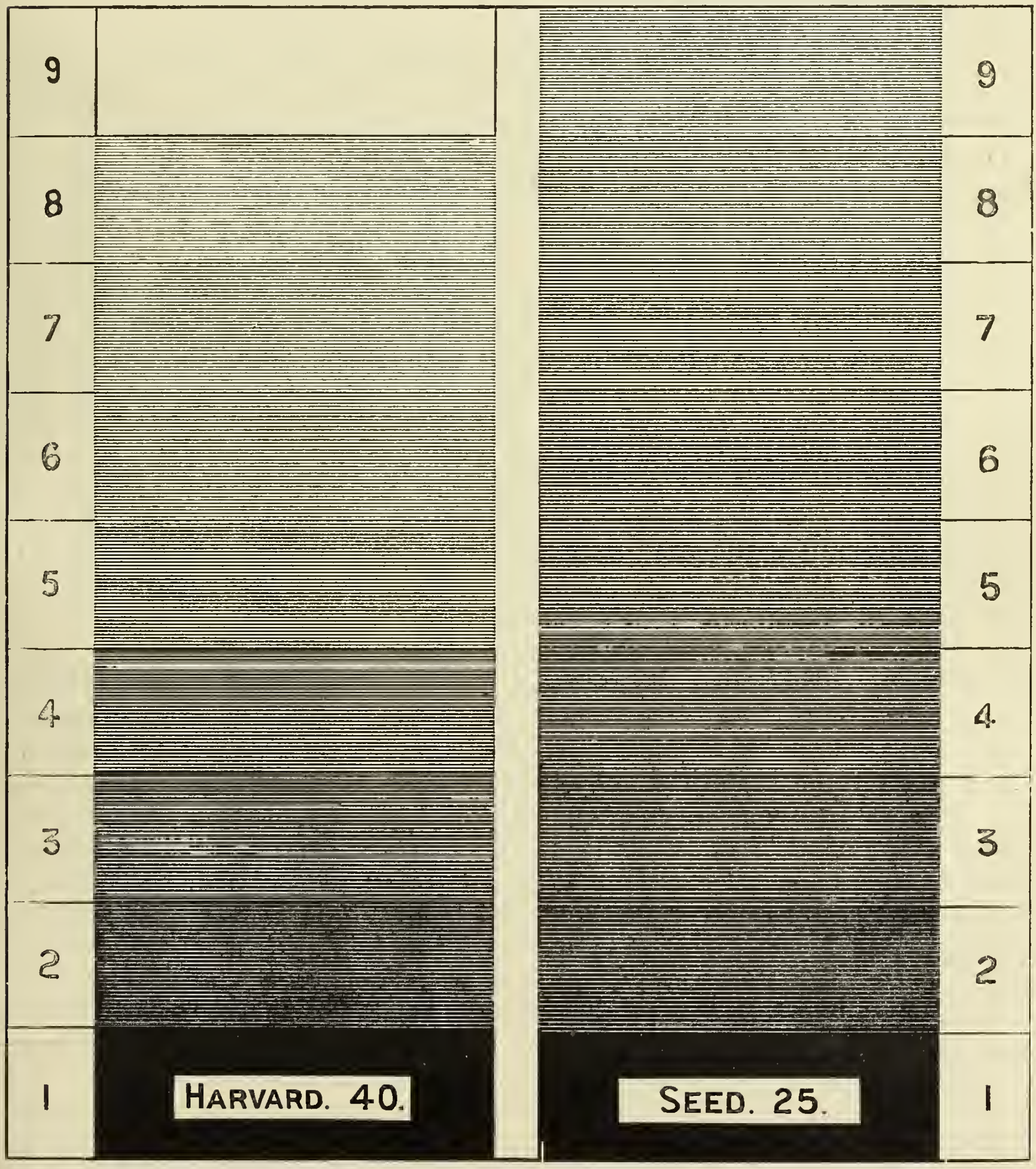
opposite qualities were used, no amount of careful exposure or development would give a negative having sufficient contrast to print properly. Similarly, with an object having great contrasts, a plate giving little contrast and long range of tones, will give a negative in which the contrasts of the object are so lessened that printable details are given in the densest parts, while were a plate having opposite qualities used, the strong contrasts of the object would be so reproduced or exaggerated that a print devoid of all detail could be obtained only. As in photomicrography, owing to the peculiar nature of the objects to be photographed, great difficulties are often encountered, the ingenuity of the operator often being taxed to the utmost, it follows that a proper selection of the plate to be used will add greatly to his resources, and will enable him to obtain results which could not be obtained were only one make of plates used, whatever legerdemain of exposure or development he might practise.

But, in order to take advantage of the different properties of different plates, it is necessary to know exactly how they differ; and this must be determined not by exposing the plates to be compared in a camera where the light may be constantly varying, and where the personal equation of the operator may enter as a disturbing factor, but in a manner by which each shall receive equal treatment. For purposes of comparison I have used a pad of thin white tissue paper (onion skin), 4 in. by $4\frac{1}{2}$ in. in size, made of superimposed pieces of paper, each sheet being 4 in. long, and 1/2 in. narrower than the next sheet underneath. This pad, when placed on a piece of clear glass in a 4 in. by 5 in. printing frame, and viewed by transmitted light, gives nine gradations of density, from clear glass up. Such a pad answers for all practical purposes, though one $7\frac{1}{2}$ in. long, placed in a 5 in. by 8 in. printing frame, and used with strips cut lengthways from 5 in. by 8 in. plates, will give a longer range of gradations. To test two or more plates, a strip about 1 in. wide and 5 in. long is cut from each, and placed side by side, film side down, on the pad in a 4 in. by 5 in. printing frame. They are then clamped in the frame, exposed for one instant to diffuse daylight, or for a few seconds to lamplight; and are then all developed together in the same developer.

It is best to develope for fully twenty minutes in a covered tray, with a developer containing a rather large quantity of sodium sulphite. If about thirty grains of the granular sulphite is used to each ounce of the developer, yellowing of the films, which might be produced by the prolonged development, will be prevented; and this without any ill effect on the resulting negatives. Development for fully twenty minutes is recommended in order that development be fully completed, i. e. that all the molecules of silver acted upon by light be reduced, for in this way only can the exact properties of all the strips be brought out, inasmuch as some plates develope more rapidly than others, and a stoppage of development before completion will produce erroneous results. The illustration is a reproduction of the result arrived at by comparing a "Harvard" plate, sensitometer 40, with a "Seed" plate, sensitometer 25, in the manner above described (fig. 73). It is a reproduction of the negatives themselves (not a print from them), so the lighter bands represent the thinner bands of the original negatives.

The great difference in the two negatives is seen at a glance. The greater rapidity of "Seed" plate is shown by band 9 in the plate, where the light had to act through but nine thicknesses of paper before acting upon the plate, being equally as dark as band 5 in the "Harvard" where the light had to act through but five thicknesses. The comparative rapidity of the Seed to the Harvard is therefore as nine to five; or for

FIG. 73.



practical purposes it may be considered as double. The greater contrast of the Harvard, and longer range of half tones of the Seed are shown by the same range being gone through in five bands in the Harvard, i. e. from band 1 to 5, that requires nine bands in the Seed, i. e. from band 1 to 9. In other words, a certain gradation of light in an object photographed, which will give with a Seed plate a certain contrast in the negative, will with a Harvard plate give practically double the contrast.

This comparison shows at once that the Harvard is the better plate to use when objects having little contrast are to be photographed, or when contrast is desired; and the Seed is the better plate when rapidity is desired, when an object having strong contrasts is to be photographed, or when strong contrasts are to be avoided and a "soft" negative desired. Also, that by the intelligent use of these plates, or others having similar qualities, results may be arrived at which could not be obtained by the exclusive use of either alone.

I have called attention to these particular plates, and have used them in illustration, because they have the opposite qualities, by taking advantage of which almost any Microscope object can be successfully photographed. Not but that there are on the market other plates having qualities in every way equal to the plates particularly mentioned. For instance, the "Eagle" plate, sensitometer 40, is an almost exact duplicate of the "Harvard," 40, in both rapidity and relative contrast; and Carbutt's "Keystone," sensitometer 16, is almost identical with the Seed, 25, in all properties except rapidity. All plates having the qualities of the Harvard and Eagle give great contrast and short range of half tones, and are therefore best adapted to objects having but slight contrasts. With such plates satisfactory negatives can be made from such little contrast, that were plates like the Seed, 25, and Keystone, 16, used, negatives having printing contrasts could not be made at all. Conversely, plates like the Seed, 25, and Keystone, 16, low contrast and long range of half tones, will satisfactorily reproduce the details of objects having great density or contrast, which details would be entirely obliterated if plates like the Harvard or Eagle were used. As plates similar in other qualities often vary in rapidity, as is the case with the Seed, 25, and Keystone, 16, this variation can be taken advantage of where the light is more or less strong, or where greater or less rapidity is desired, without in any way affecting the result, so far as the printing qualities of the negative are concerned.

I have, however, never found the most rapid plate too quick, even with low powers and sunlight, as I habitually use a light-filter of a colour complementary to that of the object photographed, For these filters, being generally either yellow, green, or yellowish-green, considerably lengthen the time of exposure; so much so, that while with a Zeiss 2 mm. h. i. apochromatic objective, a projection eye-piece, 4, and an amplification of 1500 diameters, a Seed, 25, plate will require about 35 seconds; a wet collodion plate, using a blue filter, would require but about two seconds.

As the Seed and Harvard plates have opposite qualities, which adapt them to almost every object to be photographed, before using other makes they should be comparatively tested, either with the plates named, or with some plate with the workings of which the operator is familiar, when their actual qualities will be demonstrated and their adaptability ascertained. Only by such testing can the operator know exactly what to expect, or be able to arrive at the best results, for this, like other work connected with microscopy, should never be of a haphazard sort.

The worker in photomicroscopy, who uses plates having opposite qualities as regards density, contrast, and range of tones, and who uses them intelligently, will obtain results which cannot be equalled by the one who uses one make of plates only, or who uses all kinds as may happen, without a knowledge of their properties arrived at by comparative testing."

Marktanner-Turneretscher's 'Die Mikrophotographie als Hilfsmittel Naturwissenschaftlicher Forschung.'*—The aim of this little work on photomicrography is to afford assistance to those who wish to make use of photomicrography in their investigations, so that they may attain their object with as little expenditure of time and trouble as possible. The theoretical considerations are supplemented by a number of very serviceable practical hints. After a brief sketch of the history of photomicrography and its uses, the author gives a description of a complete photomicrographic apparatus, and explains the various uses and modes of production of the different sources of light. He then deals with the properties of photomicrographic preparations and gives a concise but comprehensive account of the practical operations which are necessary for the production of a good photomicrogram. The usefulness of the book is increased by numerous bibliographical references, good illustrations, and well-executed photomicrograms.

(5) Microscopical Optics and Manipulation.

Diatom-Structure—The Interpretation of Microscopical Images.†—Dr. J. D. Cox in speaking on this subject made the following among other remarks:—

" In such a case the real question is one of interpretation of appearances seen under the Microscope, and what I have to say will bear chiefly on this point, with direct application to the study of diatoms.

All microscopists are acquainted with the position of Prof. Abbe in regard to images formed by diffraction. As commonly stated it amounts to a declaration that all microscopical images of structure with details smaller than ·0005 of an inch are diffraction images from which the true structure may be argued, but which cannot be taken as in themselves true representations of the structure. 'The resulting image produced by means of a broad illuminating beam,' says Prof. Abbe,‡ 'is always a mixture of a multitude of partial images, which are more or less different (and dissimilar to the object itself).'

This theory has been very vigorously assailed by Mr. E. M. Nelson, of London, from the practical and experimental side. In a paper read before the Quekett Club in May [1890], entitled "The Substage Condenser: its history, construction, and management; and its effects theoretically considered," Mr. Nelson asserts that the cone of light from a substage condenser 'should be of such a size as to fill 3/4 of the back of the objective with light; thus N.A. 1·0 is a suitable illuminating cone for an objective of 1·4 N.A.' He says that 'this opinion

* Biol. Centralbl., xi. (1891) p. 351.
† Journ. New York Micr. Soc., vii. (1891) pp. 76–87.
‡ R. M. S. Journal, December 1889.

is in direct opposition to that of Prof. Abbe,' and to maintain it he denies the truth of the diffraction theory as applied to microscopical images. He says of it: 'The diffraction theory rests on no mathematical proof—in the main it accepts the physical law of diffraction; but on experiment it utterly breaks down, all criticism is stopped, and everything connected with it has to be treated in a diplomatic kind of way.'* I state Mr. Nelson's position without any purpose of discussing it, and only to point out that it is this to which Mr. Smith refers in his paper when he says: 'This capacity of standing more light was pointed out from the first by Mr. E. M. Nelson, but has not received the attention it deserves, and the neglect of this point has stultified the efforts of many microscopists, both here (in England) and on the Continent, to get more out of the new glasses than the old objectives.'

Mr. Smith's investigation of diatom-structure is thus closely connected with Mr. Nelson's views and experiments upon the diffraction theory. Both will challenge the attention of practical microscopists as well as physicists. I have not gone far enough in my own investigations to warrant me in expressing a judgment on the questions involved; but I would urge every microscopist to make his ordinary work the occasion for accumulating evidence which may help to settle the very important debate. My suggestions are only such as are based upon the well-known history of diatom-study and my own experience. They are offered by way of clearing the field by pointing out the limits of the discussion and the known facts which ought to be kept firmly in mind in all such investigations.

It is no reproach to the Microscope as an instrument of investigation that there are limits to its powers and capabilities. Such limitations are common to all methods of investigation. If, trusting to my natural eyesight, I am trying to make out the meaning of appearances on a distant hillside, I find at once that all perception by the sense of sight is an interpretation of visual phenomena which are not in themselves decisive. They may lack clearness by reason of the mist in the air. They may be obscured by something intervening, like foliage, or may be partly hidden by inequalities of surface. A thousand things may prevent clear and easy interpretation of what I see. I may have to change my point of view before I can reach a conclusion, or even have to go to the object itself. If I cannot do this I may be left in abiding doubt as to what I have seen.

Microscopical examination is precisely analogous to this. If I am examining a mounted object I am tied to one point of view. I cannot approach nearer, and cannot do more than note the visual appearances and make theories to account for them in accordance with facts already learned. We try to vary the conditions as much as we can; we change our objectives; we try central light and oblique light; we examine one specimen dry and another in a dense medium; one by transmitted and another by reflected light; but when we approach the limit of minuteness of object or detail which our instruments will define, we are in the same situation as when using our natural eyes across a chasm, neither better nor worse: we have to account for what we see by a reasonable

* Quekett Club Journal, July 1890, pp. 124–5.

hypothesis which will make it take an intelligible place amongst natural objects.

Our skill as microscopists, apart from the technical dexterity in the use of our tools, consists largely in devising varied experiments and changes of condition, so as to enlarge the body of evidence from which we draw our inductive conclusions. To assist ourselves in this, we also catalogue such facts and methods, and such cautions and warnings, as our experience (or that of others) has taught us. Let us look for a moment at some examples.

We know very well that we are liable to illusions of sight, so natural and so powerful that even the intellectual certainty that they are illusions will not destroy them. If we are looking through the Abbe binocular eye-piece, using the caps with semicircular openings, we see a hemispherical object as if it were a hollow bowl, and, visually, it refuses to be anything else. But this is not peculiar to microscopical vision, for we do an analogous thing with the stereoscope, and by wrongly placing the pictures may make an equally startling pseudo-perspective.

We find that what we call transparent bodies are full of lines as dark as if made with opaque paint, and throw far-reaching shadows. But I see similar ones in the cubical glass paper-weight on the table before me, and know that by the laws of refraction the surface of a transparent body is always dark when its angle to the eye is such as to cause total reflection of the light in the opposite direction. By the same law we know that if the angle of total reflection in the same transparent cube were differently placed with regard to the eye, the now dark surface would become a mirror, reflecting the sky and distant objects as brilliantly as if silvered. Our diatom-shells give us constant experience in these phenomena. A prismatically fractured edge will scintillate so as to defy all efforts to define its outline. Reflected images look like actual details of structure in the object. Dealing, as we constantly are, with objects made of glass, we have constant use for our reasoning faculties to determine the meaning of all these refractions and reflections, which sometimes are almost as confusing as the broken images seen through the glass pendants of a chandelier.

In addition to these familiar effects of refraction and reflection, we have the class of phenomena which we call diffraction effects. These may be wave-like fringes of light and shadow following the outline of the transparent object, and reduplicating this outline; or they may be analogous fringes thrown off the subdivided parts of the object, as from the cup-like outline of alveoli, or from some projecting rib or groove like those along the diatom's median line.

We know by constant experience that when we throw light obliquely through a transparent reticulated object like a diatom-shell, the diffraction fringes from the separate alveoli run together across the shell in dark striæ, oblique or at right angles to the direction of the light. In the *Pleurosigma*, in which the rows of alveoli are oblique to the midrib, we very easily get the oblique striation by the use of oblique light; getting both series of lines at once, one only, or one strong and the other faint, as we please, and with very little trouble. We get, with a little more pains, a transverse striation, at right angles to the midrib, which is fainter because it proceeds from alveoli not so closely connected in rows. It may be called a secondary striation. With still more effort we may get a much finer and fainter striation, parallel to the midrib, by throwing light at right angles to it, or nearly so. By lamplight, and with objectives not apochromatic, and not exceeding the aperture of 1·0 N. A., these lines are usually in patches, upon spots here and there, longer (in the length of the shell) than they are wide. But with sunlight this tertiary diffraction striation may be made to cover the whole surface of *Pleurosigma angulatum* by an exquisitely fine longitudinal grating over its whole surface, as was demonstrated by Dr. Woodward in one of the most striking of his photomicrographs in what is called "the Abbe experiment." * As the improvement in our lenses, both by increasing their angle, and by the apochromatic system, tends to make visible by lamplight what before could only be seen by the sun, we should expect that something like the fibrillæ shown in Mr. Smith's photographs would be visible. Finding it would not prove that it is purely the result of known laws of diffraction; but it justifies a cautious and scientific scepticism in receiving a new explanation until we have repeated the experiment often enough, and under such varying conditions as to exclude doubt.

As we increase or reduce the obliquity of the light in examining *Pleurosigma formosum*, we know that the alveoli are distorted (or may be) in varying ways and directions. Some of these are figured in 'Carpenter on the Microscope,' but they are only a few of a numerous series. Whoever will experiment a little may satisfy himself that the permutations and transmutations of the diatom markings may be made little short of kaleidoscopic. Hexagonal markings may become square, and may have short lines running off from one angle. These lines may be lengthened, and the square or hexagon reduced to a dot, so that the appearance of the surface may be that of oblique series of parallel dashes. The direction of these lines depends on the direction of the light, making a series of gratings, of which the prevalent character may be oblique in either of two directions, transverse or longitudinal. The so-called intercostal points may be enlarged and brightened until they become the most prominent marking, and the alveoli proper may be diminished to insignificance. These appearances are so like many of those in Mr. Smith's series that we, who can only see the print and cannot get our fingers upon the fine-adjustment of the Microscope and note for ourselves the effect of a change of focus, are necessarily made cautious in accepting his interpretations; but there should be caution in rejecting as well as in accepting, and he fairly challenges us to repeat his investigations under similar circumstances, and with similar objectives.

An examination of his print No. 12 with a hand-lens will illustrate what I am saying. When looked at with the naked eye, this print shows a long patch of longitudinal striation on the lower side of the valve. Immediately below the midrib we see the coarse, oblique dotting peculiar to *Pleurosigma formosum;* but if we use the lens we see at once that, in the patch referred to, the dots are twice as numerous as the

* See Roy. Micr. Soc. Journ., ii. (1879) p. 675; also Mon. Micr. Journ., xvii. p. 82.

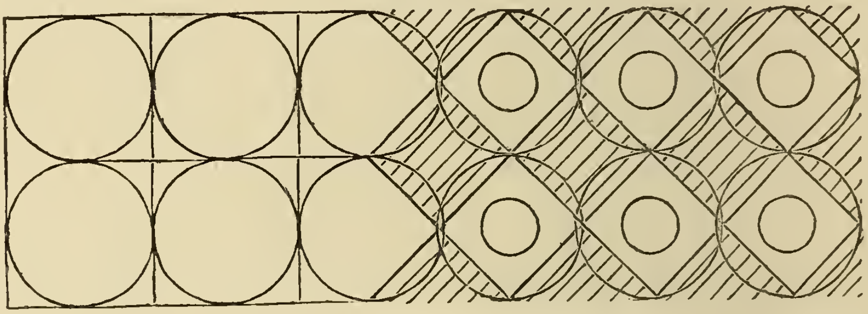
alveoli of the shell. The interpolated ones (proceeding from above downwards) are at first very small, then larger but rectangular, and twice as long as wide, making the pattern one of alternate dots and rectangles; as we pass to the right the rectangles run into each other obliquely, making a wavy white line, the dots of the alveoli proper being in the bends of the line, very much as in the longitudinal fibrils of print No. 11. This change, distortion, and multiplication of the dots is so entirely within our common experience in diatom-study, that I have no hesitation in explaining the longitudinal striated appearance in this patch as the result of the reduplicating of the dots by the intercalation of the rectangular ones, making in fact broken lines, which on so small a scale are sufficiently even to make continuous ones to the naked eye. On the other side of the midrib in the same print (No. 12) the rectangles and round dots are of nearly equal size, but they still make a faint longitudinal striation, diverging a little from the midrib as we pass from left to right.

We thus have an ocular demonstration how a striated appearance may be made out of a tessellated one, when there is no question of continuous fibrils. Yet even this does not prove that the fibrils are not there. Of course all visual appearances under the Microscope have their cause in the structure of the object, considered in relation to the laws of transmitted and reflected light. The puzzle often is to tell what to attribute to each factor. I do not think it difficult to account for the tessellated appearance of dots and squares with alternate blue and red colour. To do so may require us to refer to some elementary matters in diatom-marking.

Dr. Brebisson, at a very early day, divided the regular dotted markings of diatoms into three classes: (1) *Quadrille rectangle droit*—in squares parallel to midrib, e. g. *Pleurosigma balticum*; (2) *Quadrille rectangle oblique*—in squares oblique to midrib, e. g. *P. formosum*; (3) *Quinconce*—quincunx or lozenge of 60° smaller angle, e. g. *P. angulatum*. This classification has been a good deal neglected, but has good claims to remembrance, and will assist me in explaining the phenomena before us.

In Mr. Smith's print No. 6 is well shown what I regard as the normal scheme of areolation of *P. formosum*. It will be seen to be a reticulation with meshes as nearly square as nature gives us in growing things. If the corners of these meshes be filled up, the included circles will still keep to each other the relative position of Brebisson's oblique quadrille. The diminution of the round alveoli would not need to proceed far before the approximately rectangular mass of silex between the circles would be about as large in diameter as the circles themselves. Under the laws of optics, which we have already seen illustrated in print No. 12, the tendency of approximately rectangular details is to become more strictly so in the microscopical image. In Fig. 74 I have illustrated this by a geometric diagram, of which one half shows the square reticulation, and the other the resulting tessellation of solid squares and round alveoli when the walls are thickened and the corners filled up. It will be noticed that when the corners are so filled as to make the alveoli circular, the interspaces are approximately square, and, being solid, will be red or pink by transmitted light when the alveoli are bluish-white. On the inner side of the shell the thin circles, or "eye-spots," are usually smaller than on the outer side; the diffraction effect by transmission of light will straighten the edges of the tessellated outline; the squares will each have half the area of, and will be diagonal

FIG. 74.



to, the original squares; and with their alternate colours we shall have exactly the appearance which Mr. Smith describes, and which is very well shown in prints * Nos. 1 and 2, compared with No. 6.

The peculiarity of the quincuncial arrangement of alveoli is that when the circles crowd upon each other so as to become polygons bounded by straight lines, they form hexagons instead of squares, and even when they are circles in a continuous plate of silex the hexagonal outline is a persistent ocular illusion. We should expect, therefore, that the tessellated appearance with equal squares of red and blue would be a mark of *P. formosum* as distinguished from *P. angulatum*, under proper conditions of illumination and examination.

We are justified in concluding, therefore, that the phenomena of colour and form thus examined are not only consistent with, but strongly confirm, the generally received theory of diatom-structure, and cannot be said to indicate anything new in that direction.

Mr. Smith also expresses the opinion that only by means of a wide-angled objective, and illumination by a wide cone of light from the sub-stage condenser, can the upper and lower films of a shell like *P. angulatum* be discriminated. As he recognizes some photographs made by me, and deposited with the Royal Microscopical Society in 1884, as showing this discrimination, it is due to scientific accuracy to say that they were made with a Wales 1/15 water-immersion objective of about 1·0 N.A. aperture, and with a narrow cone of light coming from a Webster condenser under the stage having a diaphragm with a 1/4-in. opening behind it. Mr. Smith's own objects photographed could not be illuminated with a very wide cone of light, as they were mounted dry, and he tells us he used his condenser dry. There was therefore a stratum of air both above and below the slide on which the object was mounted, and the illumination could not exceed the "critical angle," 82°, in passing through the cover-glass, and must in fact have been considerably less.†

* These prints are given in an article by Mr. Smith in the journal here quoted (pp. 61–72).

† In my note-book, June 3rd, 1884, I find that I entered my observation of one of the broken shells which I photographed, as follows: "A remarkably interesting

In my own experience I have found a broad cone of illumination unsatisfactory, for the same reason that I have found oblique light in one direction unsatisfactory. It is almost impossible to centre the sub-stage condenser so accurately that a wide cone can be trusted to be central. If you centre it by examination with a low power, it is almost certain that it will not be centered for a high power, for two objectives are rarely centered alike. The field, under a magnification of 1750 which Mr. Smith has commonly used, is so small that the least decentering will illuminate it only by the oblique rays from one side of the cone, and we then immediately get diffraction effects. I am bound in candour to say that in most of Mr. Smith's prints I recognize similar effects to those which, in my own work, I attribute to oblique light. It may be that, with improved contrivances to secure exact centering of objective and condenser, we shall find advantages in the use of the wide cone. I speak now only of my own experience under existing methods. The slightest turn of the mirror on its axis will change light from central to oblique; and I suppose we are all in the habit of doing this, so as purposely to throw light through one side or segment of the condenser for the purpose of studying the effect on an object of the changing direction of illumination. So unstable a source of light prevents our knowing very exactly when the light is strictly central, and makes it hard to return to any exact condition from which we have departed even a little. These considerations have kept me (perhaps mistakenly) in the practice of using the narrow cone of light for photography, reserving my oblique light for special resolutions of striation and for the professed study of changing effects.

Similar reasons have made me distrustful of dry mounts when high powers are to be used upon any but the thinnest objects. Refraction, and attendant diffraction, are so increased with increase of index, or rather increased difference of index, that it has grown to be a maxim with me to have the mounting medium and the object as near alike in index as is consistent with the discrimination of structure. The pale images of transparent objects are those I find most truthful, for paleness is consistent with good definition and resolution, whilst the brilliant pictures are apt to be glittering deceptions. I fully admit, however, that it may well be that with improved glasses we may add to the extent of details visible upon a surface, like that of a diatom-shell, and that it is possible that mounting in most media would obliterate the finest of these details. To a certain extent we are all familiar with this. A rather coarse dry shell like *P. balticum* will have its details instantly obliterated if water from the immersion of our objective penetrates beneath the cover-glass. Mr. Smith's print No. 50 might pass as an excellent reproduction of this effect, the fluid passing along the structural lines, obliterating part and leaving part.

But when full weight has been given to all these things, and we have put aside those of Mr. Smith's long and beautiful series of photographs

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fragment of *P. angulatum*, showing partial removal of one film, and fracture through dots over a large space." In preparing this paper I have repeated the examination with the objective named, and find the distance between upper and lower film easily appreciable in focusing.

which are liable to our criticism, there still remain several which cannot be thus disposed of.

Prints Nos. 14 and 15, taken with half the magnification of most of the others (× 875), show strips of surface marking which strongly support Mr. Smith's interpretation, viz. that the outer surface of *P. formosum* is covered by a longitudinal series of fibrils separating so as to pass round the alveoli and uniting over the solid corner interspaces. The definition in these cases is not only reasonably clear and free from the ordinary marks of diffraction effects, but, most conclusive of all, there is in No. 15 a bit of this film floated off the shell and lying detached by its side. The fibrillar structure of this bit leaves little room for scepticism, and it so exactly accords with the appearance of the similar fibrils remaining on the surface of the shell that I cannot refuse to accept it as evidence of structure. Going back from these to prints Nos. 10 and 11, we now find reason to accept these also as evidences of the same structure, though distorted by obliquity of light, so that they would not have been satisfactory taken by themselves. On No. 5 also we may recognize some of the same fibrils. The single detached fibril in No. 9 is not so directly connected with any other specimen, either in the photograph or in Mr. Smith's description, as to present the evidence on which it is shown to be part of the same structure; but the measurement of its flexures so corresponds with the areolæ of the shell that its probable connection with a similar valve may be assumed.

The interpretation of this structure which seems to me most satisfactory is to regard these fibrils as superposed upon the general surface of the shell as a protection to the thin capping of the alveoli against abrasion. It would, in that case, come under the description of those appearances which I have referred to in paragraph 4 of my general summary, viz. a "thickening on the exterior of the lines bounding the areolæ . . . . which is not in contravention of, but is in addition to," the usual formation of the shell by means of two principal plates or films. All the species of *Pleurosigma* which have the alveoli arranged in Brebisson's *quadrille* seem to have strengthened ribs between the rows of "dots"—*P. balticnm, P. attenuatum*, &c., have them longitudinal and straight. Mr. Smith's observations seem to prove that *P. formosum* and its congeners have them longitudinal but wavy, which is a positive addition to our knowledge, since we should naturally have expected them to be oblique. The appearance of the finer square tessellation in either of the principal films of an obliquely marked *Pleurosigma* would seem to prove it to belong to the "quadrille" marked class, and I think the smaller forms which Mr. Smith has left unnamed may be identified as *P. obscurum* W. Smith, which is probably only a small form of *P. formosum* or *P. decorum*.

I do not find in the prints any conclusive evidence that the quincuncial marked species, as *P. angulatum*, have the same series of fibrils. No one doubts that all have a vegetable membrane in which the silex is deposited, and, under favourable circumstances, a fracture through a row of dots would leave the thicker connecting membrane looking approximately like a fibril. The argument from analogy is not as strong here as in the case of the "quadrille" marked kinds. The structure may be found in all, but the evidence does not yet seem complete. There is here a good field for further investigation.

This leads me to say that the size of the fibrils shown by Mr. Smith does not seem to me so minute that any good 1/10 or 1/15 objective should not define them. We must remember that the condition of an object may count for much in the resolution of its structure. A thickly silicified shell may not show what an imperfectly silicified one will demonstrate. The former will break into small angular bits with a mineral fracture; the latter may separate into threads or membranes. The floating off of the fibrils in print No. 15 seems to show that the shell was in a peculiar condition; a sort of dissection of an uncommon kind having taken place naturally or artificially. It would be an interesting experiment to subject various species of *Pleurosigma* to the action of hydrofluoric acid for varying periods, and then mount them for examination. To extend Prof. Bailey's old experiments in this direction would be very useful, but the danger of injury to the objective is such that it would hardly be advisable to watch the action of the acid under the Microscope.

If I seem to have reduced the new matter in Mr. Smith's observations to a minimum, I should not do justice to my sense of the real value of his work unless I add that enough remains to make it, in my judgment, a very important and interesting step in the investigation of diatom-structure. It is also full of promise that still further results may be attained by pursuing the investigation on the same line. I am confident, therefore, that the Society will join with me in expressing a sincere sense of obligation to him for communicating the results of his observations, and especially for the valuable aid in understanding them which is given by his beautiful series of lantern slides and prints."

On a new Method for the Measurement of the Focal Length of Lenses or Convergent Systems.*—Sig. G. Vanni gives the following method for measuring the focal length of lenses. If F denote the focal length, p and q the distance of the object and image from the two focal points, we have $p q = F^2$. Small displacements of the object $\Delta \Delta_1$ produce corresponding small displacements of the image $\delta \delta_1$ in such a way that always $(p + \Delta)(q - \delta) = F^2$ and $(p - \Delta_1)(q + \delta_1) = F^2$. These three equations determine p, q, and F when the displacements are known. The plane object is movable on the optical bank and the position of the image corresponding to known displacements of the object is determined by means of a Microscope.

Proof of a simple Relation between the Resolving Power of an Aplanatic Objective of the Microscope and the Diffraction of the finest Grating which the Objective can resolve.†—M. C. J. A. Leroy starts with the general theorem of Abbe that an objective in order to resolve a grating must have its aperture sufficiently large to admit at least two spectra of the grating. Abbe deduces this relation as the expression of a special function of the angular aperture of the

* See Central-Ztg. f. Optik u. Mechanik, xii. (1891) p. 152; and Atti dell' Acc. d. Nuov. Linc., 6, 90.

† Séances de la Soc. Franc. de Phys., 88. See Central-Ztg. f. Optik u. Mechanik, xii. (1891) p. 152.

objective, his "specific function of the aperture," and takes it as the starting-point of a theory of microscopic vision. To the latter the author raises objections, although he admits that the experimental data are beyond doubt, His idea is that the theorem is an immediate consequence of the diffraction on the edges of the diaphragm which limits the aperture of the objective, and that consequently the specific function of Abbe is nothing else but the diffraction produced by the edges of the aperture.

(6) Miscellaneous.

Dr. Dallinger's Address to the Quekett Club.*—The Rev. Dr. Dallinger said:—"In addressing you to-night, as President of our Club, I shall keep before me the fact that, whilst we seek as a Club to prosecute all our mutual and individual inquiries in a completely scientific spirit, many amateurs are included in and welcomed by the Club, and that we aim at promoting and aiding early efforts with our favourite instrument, quite as much as criticizing the last results of experienced research, or the latest endeavour to render more perfect the instruments with which we work.

Keeping these facts before me, I am strongly impressed with the conviction that no subject can have a more general area of interest among microscopists than the work being done regarding the nature of the animal and vegetable cell. To what extent a full and complete knowledge of animal and vegetable cellular life and history, leading to a full grasp of the comparative physiology and morphology of cells, may ultimately contribute to a completing of our knowledge of life and function in animals and man, it may not be possible to say; certain it is that what we already know has profoundly affected our insight into animal structure; but our progressive and further knowledge of the structure of the tissues that form the body, and of their physiological and even pathological action, must be concurrent with our advancement in this subject.

Upon the progressive excellence, therefore, of the Microscope as an instrument of precision on the one hand, and upon the increasing delicacy and skill with which we are enabled to prepare tissues for examination and progressive research with that instrument on the other hand, must depend our advancement.

Whatever leads to more perfect optical construction is an essentially good thing; and what is sometimes cavalierly treated as "amateur microscopy" has contributed largely to optical advancement.

It is after all "the battle of the lenses" that has led up to, and called into existence, the splendid lenses of to-day. But this was, for all practical purposes, a battle fought by amateurs and opticians. Our schools of biology in England, the Continent, and America took little, if any, part in it. Yet without question it is the students in our great biological schools who are deriving the largest benefits from the splendid improvements in quality, price, and modes of using recent Microscope objectives.

By apochromatism the study of ultimate cell-structure and cell change,

* Journ. Queck. Micr. Club, iv. (1891) pp. 304–14.

normally and pathologically, has been made a splendid possibility. The "laying" of optical "ghosts," the elision of complicated and confusing foci, by beautiful optical construction, is of incalculable value. It gives certainty and precision to all work done.

But we must be careful now not to reintroduce the ghostly element by false interpretation. I am increasingly convinced of the possible danger of employing shafts of oblique light only in one azimuth. The peril of misinterpretation is enormous.

Indeed, I have a growing conviction that all small cones of illumination may be fraught with danger, at least to the amateur.

Our German fellow-workers have only lately risen to the perception that the condenser is of value at all, but the condenser they universally employ is chromatic. Its aberration is enormous. True, their greatest microscopical optician has within the last three years seen the value of achromatism, and has made an achromatic condenser; and its value, as compared with that of the chromatic combination, is inestimable.

But surely if we are to get the purest results from apochromatized lenses, if we are to get a focal image absolutely freed from ghostly confusion, we should have an apochromatized condenser, and a condenser of the greatest possible numerical aperture.

In England those who have made microscopy a special pursuit, have long worked with fine achromatic condensers. I am glad now to know that the first apochromatic condenser yet made has been produced by the firm of Powell and Lealand, and it only needs an hour's trial in expert hands, and experienced judgment, to discover its great superiority. It has an aplanatic focus of ·9, and even if oblique beams only in one azimuth be used, their danger is reduced to its lowest. But it is by the employment of large cones of illumination, and not with small ones, that I say cautiously, but still with emphasis, the finest and truest results are to be obtained.

We may well pause before we finally pronounce on this subject, but it certainly is one that must be settled in practice, however present theory may point; and we must all feel that the remarkable paper of my friend Mr. Nelson on this subject, read to us during the past year, must be gravely considered, and made a starting point for patient research. For it is by such means that an amateur club like ours may contribute what is of permanent value to the professors and students who use the Microscope so largely in our schools of biology and medicine.

But, nevertheless, it is possible to push one phase of optical construction so far as to accomplish the object, but to leave doubtful the usefulness of the object gained.

We have all heard of the new objective produced by the firm of Zeiss, of Jena. It has a numerical aperture of 1·60. This from one point of view, is a great advantage. None would have greater reason to hail it than I, in the special work with which my life has been largely occupied.

Now, I have spent five consecutive days in the close and critical examination of one of these objectives, which, so far as I know, has been in no other hands but my own and those to whom I have shown it. I desire to take the sole responsibility of estimating its value. In my hands it is an extremely beautiful lens; it is well centered, well corrected, and shows plainly the advantage of its enormous aperture. It is a triumph of the optical firm which produced it.

But I would hasten to say (1) That I would not trust a single result produced by its means, when oblique light in one azimuth is employed, especially with the chromatic flint condenser provided by the firm of Zeiss for its illumination. It is fatal to its truth. We can absolutely get almost any desired result with it. It is a very optical witch of Endor for calling up ghosts and ghostly visions.

(2) I did not use with it the condenser provided for its illumination. This has a dense flint front lens, and an enormous amount of aberration. It breaks the delicate balance of the beautiful objective, and is to it, in critical hands, worse than the chromatic Abbe condenser used upon fine apochromatic objectives of lower aperture; and naturally

(3) I could only successfully employ the fine achromatic condenser of Powell and Lealand with the great numerical aperture of 1·4. This, of course, could not utilize all the immense aperture of the lens, but when its full cone was employed with its relatively great aplanatic aperture of 1·1, it yielded results that to a student of delicate diatomaceous images was a vision of beauty indeed.

And it could do more than this with an apochromatic or even an achromatic condenser of its own aperture.

But now comes the pragmatic question, which we are bound to ask, "What does this objective contribute to the practical work to which, for the attainment of the highest results, the Microscope must be applied?"

I say at once for the amateur and the lover of splendid images the objective may be a delight.

But I have pointed out before that even immersion objectives, though they have a great, have nevertheless a very limited, use in strict biological inquiries of a certain kind.

This is true of water; it is doubly true of oil. If we are examining minute life under a limited cover, the fluid above, between the lens and the top of the cover-glass, will ultimately, in following the travels of the living creature, be caused to mingle with the fluid between the cover and the slip, and so destroy the work.

But in spite of this, immersion and especially homogeneous objectives have an enormous value for experiments in control and comparison.

But with the new lens of this great aperture, not only have we to use flint covers, specially and expensively ground, and flint slips, but of course we have to employ a dense mounting medium absolutely fatal to all organic tissues.

Flinty and carbonaceous animal and vegetable products, however fine, may be examined by its means; but the cell as such, to say nothing of the living cell and unicellular organisms, can never at present be subject to its optical analysis.

Now it must not be supposed that this fact was not fully known to its accomplished makers when they devised and sent it out; that would be an error. But in our inquiry as to the influence it will exert upon the special work of the Microscope in unravelling the structure and deportment of animal and human tissues it is a great factor.

In spite of the splendid result attained by it, as biologists we gain nothing. We are where we were, and studies of cells and cell life must be made with dry and immersion apochromatics of N.A. 1·4, or at most 1·5.

With this fact before us, it will be well for us to remember what we are searching for as experts, in tracking the life and behaviour of various cells, and founding, or endeavouring to found, a comparative morphology and physiology of cells and unicellular bodies.

The sphere of all research is strictly physical. Existence, not the cause of existence, succession, not the cause of succession, is our object. There can be, perhaps, but little doubt that life is a cause of phenomena, not a phenomenon in itself. As such it is impalpable to the scientific method. It cannot be the subject of experiment nor the object of a demonstration.

Certainly, in tracking the essential activities of life home to the individual cell amidst its class, or group of cells, or to the unicellular organism, we are coming into closer quarters with the mysterious cause of the phenomena of vitality. But its nature eludes us as much as before. We are, of course, no nearer to the solution of the problem of what life—the cause of all the phenomena of living things—is, than we were before.

We track its phenomena to almost their last scene of phenomenal action, but it is still only phenomena we are studying.

I do not assume that life is not a physical cause. We have no justification for doing so. But if we would go further back than the finally accessible phenomena of cell morphology and cell function it would appear that we must penetrate the mystery of atomic properties as they are found in living things, for it is, so far as our present knowledge can carry us, to the unaccountable combination of thoroughly known chemical elements that life and its properties are due. The at present unanswerable question is how not-living substances, such as C, H, O, N, with whose properties we are so familiar, should so combine, as in their combination to acquire the properties of life.

But while our inquiry will strictly confine us to phenomena, the study of the phenomena of minute cellular structure and minute unicellular organisms is essentially the highest, and, in some senses, the newest line of inquiry open to patient and enlightened study.

Its promise is enormous. But I would urge the necessity for the study of the living cell; the dead cell, dried and stained, is a poor representative of the living cell both in form and internal appearance.

The unicellular organisms, as the simplest types of cell, deserve the closest and most untiring research before broad inferences are made upon the nature and behaviour of grouped cells in tissues.

As there can be no abstract protoplasm—no protoplasm not belonging to a specific organism—and not therefore presenting itself to us as protoplasm with its own specific history and inherited qualities, so there cannot be an abstract cell. That can only exist in the imagination of the theorist. Every cell we meet with in biological realities is not only a cell, but a cell complicated with its own peculiar history and inheritance, and therefore those cells with the least complicated history should command our earliest and most thorough study; and from these we may safely advance to the more and the most complex.

Some of the cellular elements of the tissues have been noted with even simple Microscopes for over two hundred years, Dr. Hooke, in the year 1665, being among the first observers. The nucleus itself may be said to have been seen and described over one hundred years ago. It is still, however, true that the first great step leading to actual scientific advancement in this subject was made in 1831 by the distinguished botanist Robert Brown. He gave us definite knowledge of vegetable cells, and he demonstrated that the nucleus was a normal element of the cell.

What was called the nucleolus was discovered by Valentin five years later.

But even before Brown, Turpin had affirmed the physiological significance of the cell, attributing to cells distinct individualities, and affirming generally that plants were formed by their agglomeration.

But, as is now well known, the cell theory proper was founded by Schleiden, but by him it was restricted to plants. He defines the vegetable cell as "the elementary organ which constitutes the sole essential form-element of all plants, and without which a plant cannot exist; and as consisting, when fully developed, of a cell-wall composed of cellulose, lined with a semi-fluid nitrogenous coating."

To him, therefore, the cell presented itself as a vesicle with semi-fluid contents. This was in 1838. In the following year Schwann extended the cell to the animal kingdom, but to the two elements of Schleiden he added a third, that is to say, the nucleus, which he deemed essential to the existence of the cell in some period of its history. And on his authority these triple elements of the cell were universally believed to exist.

In proportion, however, as the cell theory was more and more extensively seen to characterize the animal world, it was found increasingly difficult to maintain the threefold constituents of the cell.

The conception that the cell was a "vesicle closed by a solid membrane containing a liquid in which floats a nucleus containing a nucleolus" rapidly gave way before investigation. In 1841 it was shown that cells multiplied by budding, and that the nucleus underwent fission when the cell divided; and it was contended by Goodsir that no cell could arise save from a parent cell, which was seen by Virchow to have direct application to pathology.

But it was Naegeli, a botanist, who showed first the unimportance of the cell-wall, and he was supported by Alexander Braun. But it was scarcely a universally accepted belief until Leydig, in 1857, decidedly declared it unessential, and defined a cell as "a soft substance inclosing a nucleus."

After this it was shown by Max Schultze that a cellular life might be complete even without a nucleus, as in *Amœba porrecta*; thus we come back to the cell as the ultimate morphological unit in which there is any manifestation of life.

Thus, then, by the cell theory in this form we discover that "every animal presents itself as a sum of vital unities, any one of which manifests all the characteristics of life."

I must not linger even for a recapitulation of the earlier views held regarding the living matter which constituted the cell; enough here that it was held to be a matter with an endowment of its own, possessing properties which were *sui generis*, that is to say, that not-living matter could not, by any process we are acquainted with, take on the unique properties of matter which lived. Only from the living could the living arise. This matter was called *protoplasm*, and a quarter of a century ago was defined as "a diaphanous semi-liquid viscous mass, extensible, but not elastic, homogeneous, that is to say, without structure, without visible organization, having in it numerous granules, and endowed with irritability and contractility."

A minute particle of this, either nucleated or non-nucleated, was considered a cell.

But undifferentiated protoplasm did not long universally hold the field. It was gradually shown that a distinct structure was discoverable in some cells, and subsequently it was shown that nearly all cells and all forms of protoplasm show a microscopic network of fine fibres. In short, it became plain that the reputed structurelessness of the cell was due to the inefficiency of the lenses used, and was dissipated when competent optical aids were employed.

Since this time great progress has been made, and modern objectives, finely corrected and of great optical precision, have been very widely used, and it has been shown that the nucleus, instead of being the simple body it was at one time believed to be, proves itself to be of great complexity; and, as I believe, within it are initiated all the great changes which the cell as a whole undergoes.

This could be shown in various ways, but I have been able to demonstrate it in regard to the lowliest and least of all the organisms fairly accessible to us.

The histories of the Saprophytes of this country I have been working at for over twenty years. It is only within the last six or seven that I have been able to deal with the nucleus as an optical entity to be investigated by itself.

In my earlier work we were obliged to study the organism as a whole. Our best objectives failed us when we ventured to study the nucleus. So we were obliged to treat the nucleus as participating in or sharing the life processes of the cell. It was, in fact, to us then a mere passive instrument.

But homogeneous and apochromatic lenses have changed all that. With the objectives I can now employ I am able to deal as definitely with the nuclei of such saprophytes as possess them as I was twelve years ago with the whole organism. Yet the amplification is not greater, nor so great; but that secret of all successful microscopic investigation, a numerical aperture suited to the amplification used, is at our disposal, and this with the ghosts of injurious spectra taken away.

The result is a discovery that the apparently simple nucleus of the lowliest and the least of known organic forms is complex in a high degree; that it is the spring and fountain of vitality in the cell. All modifications to which the cell is subject in its life cycle originate in it. It is, moreover, at certain periods of development of the cell endowed with striking structure, and this structure grows more or less marked as the unicellular organism enters upon or passes certain cyclic periods of change.

In brief, the nucleus of the simplest of living cells is complex in an astonishing degree; and, therefore, I would argue that by its careful study, and by the study and comparison of kindred unicellular organisms, we shall find nuclear complexity in its least complex condition, and, therefore, more capable of guiding us amongst the perils of the karyokinetic figures of the cells of tissues with vast biological histories and long biological inheritance.

Nor is this all. They may be studied in their living condition, and, I will add, only with efficiency in that condition. Stains may be to some extent used without destroying the organism, and by patience and a thorough knowledge of the nature and use of objectives and condensers, facts of immense value can be made out.

What we want to discover is, what determines the changes in so lowly and minute a nucleus, and what are the correlations between the changes in the nucleus, and the powerful changes brought about in the minute unicellular organism.

The entire organic cell, with a complete life-history definitely known, if relatively large, may be, say, the one-thousandth of an inch in breadth and thickness respectively. Cubically it occupies the four-thousand-millionth of a cubic inch.

The nucleus may be the one-tenth part of this cubically. Yet within this area all the determinate causes of vital phenomena of the whole unicellular organism are at work; and what is more, they are accessible to our perception through modern instruments—and those, when properly used, are instruments of precision.

So far as my present ability and instruments carry me, when the organism is in a fixed or static condition, whether for a shorter or a longer time, the nucleus is a glossy hyaline body with considerable refractive power and no discoverable structure.

But directly a change is about to ensue the nucleus puts on the first evidence of it. The cyclic change of these unicellular organisms is, that after growth from the germ or egg emitted from a maternal sac, and when maturity is attained, the cells go through rapid and successive fission. Their division into two or more in every case is complex, insomuch that, however complicated the flagella of the organism may be, the division is so effected as to produce for each divided part the flagella possessed by the original undivided form, and so with the nucleus.

Following upon this, after a long series of fissions extending over many hours, the final links unite with other ordinary forms, the protoplasm of each melting into the other and producing a sac in which the genetic seed arises, from which a new generation grows.

Now the added point of great moment is that I can now—previous to the first fission in a new generation—discover the initiation of this act in the nucleus. In fact a powerful change takes place. The hyaline particle becomes turbid, as I now know, with structure; this structure divides, and this initiates the division of the nucleus. Upon this follows the division of the whole organism.

This takes place in every fission.

But quite another change comes over the nucleus of the last link in a chain of fissions. Instead of becoming semi-opaque with structure, it becomes opaque by what, to our present resources, is a homogeneous milkiness, and greatly enlarges.

Once observed, there is no mistaking the nucleus in the two conditions, and always when in this last condition it seeks and effects union with another, and genetic products ensue.

I cannot but believe that we have here the act of fertilization in its simplest condition, and the act of cell-budding in its most initial state. By their study the complexities of karyokinesis may be, I believe, approached and understood. It is worthy of our best effort; and certainly is worthy of the finest endeavour of the optician and the chemist to provide us with the best possible objectives—not objectives that, though triumphs of science and art, are not adapted to our wants—but objectives that may be applied to this most difficult and most promising labour by meeting our specific and inevitable wants.

This may not be possible without the chemist's aid. It seems almost certain that mounting media of great refractive indices are indispensable; but to serve the purpose of the student of living cells they must be media applied without heat, and at least tolerant, or for some moments at least not destructive of organic tissues.

Of this I do not despair, and when I see what great mathematical and optical insight and ability have done in the past, combined with perfect lens grinding and mounting, I anticipate a nobler future for microscopic biology and microscopists of the true type."

The late Mr. John Mayall, Jr., Sec. R.M.S.—Our deceased friend, who to so many of us was the type of manly vigour no less than of great mental activity, died on the 27th of July last, from an attack of acute pneumonia; his illness was so short that many learnt of our loss only when the August number of the Journal came into their hands.

Mr. Mayall was not fifty years of age, having been born at Lingard, in Yorkshire, on January the 7th, 1842; he received his early education at the Lycée Bonaparte, where, as we may suppose, he acquired his accurate knowledge of French language and literature: on his return to England he was for a time a student at King's College, London. But, as we all recognize, a man's education depends as much, if not more, on his associates than his schoolmasters; Mayall was a friend of the great French painter Meissonier and the distinguished English mathematician Augustus de Morgan.

His acquaintance with and mastery of the theories of mathematical optics was of great service in the introduction and explanation of the views of Prof. Abbe; he translated Naegeli and Schwendener's treatise on the Microscope, and he delivered two valuable series of Cantor Lectures on his favourite instrument before the Society of Arts. He first became associated with this Society in 1867, and was a member of its Council from 1881 to the time of his death; in 1890 he was elected to succeed Mr. Crisp as one of the Secretaries of the Society. In this last office he was most energetic, undertaking the greater part of the direction of the affairs of the Society, and being a constant visitor to our rooms. He carried through the business of our removal at great trouble to himself, but none to the Society, and, even on his death-bed, he sent communications to his colleague regarding some difficult questions in which the Society's interests were involved.

The Fellows had ample opportunity of observing Mayall's acquaintance with all the details of the manufacture and manipulation of the

Microscope; he made himself personally acquainted with what was being done at Jena, and he may well be said to have been the link between English and foreign microscopists of all nations. The large collection made by Mr. Crisp was thoroughly well known to him, and he took a warm interest in everything that concerned it.

If his great knowledge of his subject had any drawback, it was one that affected him alone adversely; an inventor of a new instrument never likes to be told that much or all is old; the constructor of a faulty one objects to having his errors swiftly exposed. As Mayall was no respecter of persons, and perfectly lucid in his criticisms, he was, perhaps, a more unpopular man than he really deserved to be. To a rare knowledge he added a rare courage.

The activity of his mind showed itself in his proficiency at games of skill, and particularly of chess, but he was hardly less active of body; not only was he a good fencer, but in these days of cycling it must not be forgotten that he was the first to ride a bicycle from London to Brighton.

The thoroughness with which he put his hand to do his duty or his pleasure was equally evident when he was called upon to serve a friend or do a kindness; others beside the present writer must have been astonished at the time and trouble he would ungrudgingly devote t serve them.

The anonymous manner in which this Journal is conducted makes it impossible for any not "behind the scenes" to know how much its success has been due to his assistance; one who does know may sum it up by saying that the death of Mayall has deprived him of one of the shrewdest counsellors a man may ever hope to meet with in his earthly pilgrimage. The student of microscopy will regret that a work just commenced on the history of the Microscope will now never see the light.

We append a list of Mr. Mayall's papers and inventions:—

C. Naegeli and S. Schwendener, The Microscope in Theory and Practice. Translated from the German. 8vo, London, 1887.

Immersion Objectives and Test Objects. Monthly Micr. Journ., 1869, pp. 90–3.

The Controversy on the Aperture Question. Letters in the Monthly Micr. Journ., 1875, pp. 93–7, 150–1, 214–5, 299–301; 1876, pp. 50–1, 97–100.

Aperture Measurement of Immersion Objectives. Journ. R. Micr. Soc., 1879, pp. 842–3.

Immersion Illuminators. Journ. R. Micr. Soc., 1879, pp. 27–31.

Description of Nobert's Ruling Machine. Journ. Soc. Arts, xxxiii. (1885) pp. 707–15.

Cantor Lectures before the Society of Arts, 1886, 1888, 1889. Published in Journ. Soc. Arts, xxxiv., xxxvi., and xxxvii.

An account of his visit to Jena. Journ. R. Micr. Soc., 1887, pp. 322–5.

Various Papers on Microscopy and Microscopical subjects published in the 'English Mechanic' under his *nom de plume* of F.R.M.S.

He also devised and improved the following, of which notices were published:—

Immersion Stage Illuminator. Journ. R. Micr. Soc., 1879, pp. 837–8.

Spiral Diaphragm for Oblique Illumination. Journ. R. Micr. Soc., 1881, pp. 126–7.

Modified form of Nelson's Lamp. Journ. R. Micr. Soc., 1884, pp. 286–7.

Amplifiers for the Microscope. Journ. R. Micr. Soc., 1884, p. 607.

Stepped Diagonal Rackwork. Journ. R. Micr. Soc., 1885, pp. 958–9.

Mechanical Stage. Journ. R. Micr. Soc., 1885, p. 122.

Jewelled Fine-Adjustment. Journ. R. Micr. Soc., 1890, pp. 508–9.

Carl Wilhelm von Naegeli.*—As the son of a country physician at Kilchberg near Zurich, Naegeli was originally intended for the medical profession, and for this purpose studied at the University of Zurich. His interest in medical matters, however, soon waned, and it was not long before he turned his attention to botany, in the study of which his progress was so rapid, that in 1840 he obtained his doctor's degree at Zurich by a work on the Swiss *Cirsiæ*. After a brief sojourn in Berlin, spent in the study of Hegel's philosophy, Naegeli turned to Jena, where he became associated wtth Schleiden in editing the 'Zeitschrift für Wissenschaftliche Botanik.' In that journal he published his important discovery of the spermatozoids of Ferns as well as of the Rhizocarpeæ, first explained the importance of the apical cell, and showed by examples the astonishing regularity in the growth of the cells of plants. Journeys to Italy and England gave Naegeli opportunities for the study of marine Algæ, which resulted in the appearance in 1847 of his work 'Die neueren Algensysteme und Versuch zur Begründung eines eigenen Systemes der Algen und Florideen,' followed in 1849 by his 'Gattungen einzelliger Algen.'

Naegeli entered upon his academic career, first as Privatdocent and then as Professor at Zurich. From Zurich he soon received a "call" to Giessen, and in 1852 to Freiburg. The three years which he spent in the latter place were devoted to the work which was contained in the physiological researches published later in conjunction with Prof. Cramer: it included the exhaustive work on the starch-granules, and on the theory of intussusception. In 1855 Naegeli returned to Zurich as professor in the then recently opened Swiss Polytechnic School. In the summer of 1857 he received a call to the University of Munich, where his first work was to prepare plans for the Botanical Museum, for which purpose he made journeys to St. Petersburg and Paris.

Amongst those who received instruction from Naegeli at Munich were Schwendener, Leitgeb, Engler, Brefeld, Prantl, Peter, and Dingler. The scientific work which he next produced, including the important researches on the course of the vascular bundles, on the examination of microscopic objects in polarized light, and the classic treatment of the question of the formation of varieties and the laws of hybridization, soon led to his being regarded as the first of living botanists. It was in the winter of 1876–7 that he brought before the Aerzlicher Verein in Munich a series of papers on the lower Fungi and their connection with infectious diseases; in 1879 appeared the 'Theorie der Gärung,' and in 1882 the 'Untersuchungen über niedere Pilze.' Naegeli's contributions to bacteriology met with great opposi-

* Chiefly from a notice in the Münchener Med. Wochenschrift, by H. B.

tion, and it is true that later researches have shown that many of his theories are untenable; but the correct ideas which he was the first to enunciate have since borne fruit. For instance, he was the first to clearly explain the grounds for supposing that infectious matter could not be gaseous.

In 1884, in spite of failing health, he succeeded in completing the great work of his life on the doctrine of descent, the 'Mechanisch-physiologische Theorie der Abstammungslehre,' which will ever remain as a monument to his powers as a scientific thinker. Naegeli's principles differed widely from those of Darwin. Natural selection he was only able to recognize as a means for the removal of unsuitable forms. The production of new forms he ascribed to the principle of progression existing in the organism. To the microscopist our deceased Honorary Fellow was best known by the work on the Microscope which he published in conjunction with Prof. Schwendener, and which has passed through three editions in Germany and was translated into English. In the winter of 1889–90 Naegeli was prostrated by an attack of influenza, but recovered so far as to be able to go to the Riviera in the following winter. He died somewhat suddenly in May last.

List of all Patents for Improving the Microscope issued in the United States from 1853 to 1890.*—The following list is of interest:—

1853. H. De Riomonde: Otoscope. No. 9581.
1861. R. P. Dagron: Photo charm. No. 33,031.
1862. H. Craig: Charm. No. 34,409.
1864. J. Ellis: Seed Microscope. No. 42,843.
1865. Wales: Plain movable front to lens. No. 46,511.
1865. J. J. Bausch: No. 47,382.
1865. C. B. Richards: Friction wheels on rack motion. No. 47,860.
1866. H. L. Smith: Side reflector above objective. No. 52,901.
1866. Heath: Combined Microscope, telescope, and eye-glass. No. 54,542.
1866. R. B. Tolles: Binocular eye-piece. No. 56,125.
1866. O. N. Chase: Seed glass. No. 56,178.
1869. J. H. Logan: Dissecting Microscope. No. 93,895.
1874. J. J. Bausch: Botanical Microscope. No. 151,746.
1876. Wales' pillar fine-adjustment. No. 178,391.
1876. J. Zentmayer: Fine-adjustment carrying rack, swinging sub-stage. No. 181,120.
1876. Gundlach: Fine-adjustment. No. 182,919.
1877. Gundlach: Glass stage, sliding carrier. No. 198,607.
1878. R. B. Tolles: Sector illuminator. No. 198,782.
1878. R. B. Tolles: Swinging illumination tube. No. 198,783.
1878. J. J. Bausch: Convex base to stand. No. 199,015.
1879. Gundlach: Pillar tube. No. 211,507.
1879. Gundlach: Eye-piece of field lens and triplet. No. 212,132.
1879. H. G. Deal: Cloth-counter for bolting cloth. No. 214,283.
1879. W. H. Bulloch: Swinging substage loose from mirror. No. 215,878.

* Amer. Mon. Micr. Journ., xi. (1890) pp. 280–1.

1879. Gundlach: Triplets as one element of lens combination. No. 222,132.
1880. W. H. Bulloch: Scroll turntable. No. 226,648.
1880. Molera and Cobrian: Binocular. No. 230,320.
1880. E. Bausch: Folding Microscope. No. 230,688.
1880. J. W. Sidlo: Cog-wheel turntable. No. 235,030.
1882. Lomb and Bausch: Trichinoscope. No. 251,721.
1882. P. H. Yawman: Differential screw fine-adjustment. No. 262,634.
1883. Foster: Socket. No. 270,296.
1883. W. J. M'Causland: Magnifier for telegraph. No. 270,907.
1883. F. B. Gould: Microphotographs. No. 271,838.
1883. L. M'Intosh: Pin arm. No. 273,752.
1883. E. Bausch: Electric light and Microscope. No. 277,869.
1883. W. H. Bulloch: Bayonet-catch nose-piece. No. 287,904.
1883. D. Tetlow: Bottle seed Microscope. No. 287,978.
1884. E. Bausch: Swinging Wenham prism. No. 293,217.
1884. W. K. Kidder: Electric spark device for Microscope. No. 295,770.
1885. E. Bausch: Microtome. No. 325,722.
1885. E. Bausch: Sheet-metal flanges to tubes. No. 328,277.
1886. G. Fasoldt: Spring nose-piece. No. 334,009.
1886. G. Klippert: Turntable. No. 334,530.
1886. G. W. Palmer: Bevelled slides. No. 336,257.
1886. B. F. Allen: Stand. No. 352,639.
1886. E. H. Griffith: Turntable. No. 354,130.
1889. S. Frost: Botanical Microscope. No. 407,192.

Newspaper Science.*—" One of the latest specimens is furnished by the *Globe-Democrat*, of this city, which a few Sundays ago printed the following:—

'Charles X. Dalton, instrument-maker, says R. B. Tolles, of Boston, now dead, was the greatest maker of Microscope lenses the world has ever seen. He once made an object-glass that magnified 7500 times. It was the first and only one ever constructed, and was made as the result of a long controversy with other microscopists in regard to the possibility of resolving what was known as Nobert's nineteenth band. Nobert was a Frenchman, who, by mechanical appliances, ruled on glass parallel lines at the rate of about 100,000 to the inch. No Microscope lens then made was sufficiently powerful to count these lines. Mr. Tolles, as a result of statements made during the controversy, started to make an objective that should magnify 7500 times. This he succeeded in doing somewhere about 1874. This objective was 1/75 in. in diameter, and is about as large as the hole made in a sheet of paper by the point of a very fine needle. This lens was afterwards sold to Major Woodward, in the Government employ at Washington, but his bill was not allowed by the auditor, and the lens was taken off his hands by one Dr. Harriman. In turn he sold it to Dr. Ephraim Cutter, in whose possession it now is. Objectives that magnify 5000 times are rare, and it is a powerful Microscope that magnifies even 2500 times. These

* National Druggist (St. Louis), xix. (1891) p. 25.

are necessary in bacteriological research, and in testing blood-corpuscles to determine, for instance, whether they are of human blood or not. A local paper recently told of a Boston physician who examined the tubercle bacillus with a powerful glass that magnified 900 times. Ridiculous! You can't see the consumption bacillus with an objective that magnifies less than 1200 times. England is the great rival of this country in Microscope-making. France and Germany are behind. I suppose that sometime an objective will be made that will magnify 10,000 times, but it will be a much more difficult task than the making of a telescope glass five feet in diameter.'

"While no one will deny that Robert B. Tolles was one of the greatest lens-makers that the world ever saw, there are a great many who would hesitate to place him above his great contemporary and teacher, Charles A. Spencer, of Canastota, N.Y. Neither of them, however, ever 'made an object-glass that magnified 7500 times.' To do this would require the manufacture of an objective with a focal length of 1/750 in., which, it is needless to say, has never yet been attempted. Nobert's 'nineteenth band' contains 112,595 lines to the inch (estimating the Paris line at 0·088·813·783 in.). The Tolles 'seventy-fifth' was not '1/75 in. in diameter,' but the combination had a theoretical focal length of 1/75 in. When used with a 1-in. ocular and with a 10-in. tube-length the combination would give an amplifying power of about 7500.

'Objectives that magnify 5000 times are rare.' We should say so —and likely to remain so, since to make one would require the construction of a combination with a theoretical focal length of 1/500 in. The balance of this sentence shows that Mr. Dalton (or the reporter) confuses the Microscope (here the combination of eye-piece and objective) with the objective alone.

The statement regarding the visibility of bacillus tuberculi is not less misleading than the balance of the farrago. Bacillus tuberculi can easily be seen and recognized with a 1/5-in. objective and a 2-in. ocular, or, roughly, with an amplification of 250. With twice this amplification (i. e. 500) it becomes a very conspicuous object. In fact, the writer rarely uses amplification over 500 in making examinations for tubercle bacilli, his favourite combination being a 2-in. ocular and 1/10-in. objective."

β. Technique.*

(1) Collecting Objects, including Culture Processes.

Preparation of Nutrient Media.†—Dr. N. K. Schultz finds that really good bouillon agar and gelatin can be obtained by attending to several details which in practice are highly important. He recommends that the precipitates formed during the preparation of the medium should be removed separately, because each precipitate has its own special properties. The reaction of the medium should be determined by titration since neutralization cannot be accurately ascertained by

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes. (4) Staining and Injecting: (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

† Centralbl. f. Bakteriol. u. Parasitenk., x. (1891) pp. 52–64.

means of litmus paper. This is quite a simple process, and merely consists in adding a drop of phenolphthalein to 1 ccm. of bouillon, and then dropping in 0·4 per cent. caustic soda solution until a pale rose colour appears. Phenolphthalein is a greyish-yellow powder, and dissolved in alcohol (1 to 300) is almost colourless, but on the addition of an alkali turns dark red. This sensitiveness to alkalies renders it a convenient reagent for measuring the amount of alkalinity of nutrient media.

Bouillon should be neutralized before either agar or gelatin is added. Agar requires to be boiled for quite a long time before it is completely dissolved, while gelatin should only be boiled for a very short time.

Preserving Malaria-Plasmodia alive in Leeches.*—Dr. N. Sacharow finds that leeches (*Hirudo medicinalis*) may be used for keeping alive the plasmodia of malaria. The leeches were frozen in a piece of ice and kept in an ice-cellar for a week, the plasmodia being found at the expiration of this time quite unchanged. Their mobility was even greater than when taken directly from the blood of a patient suffering from malaria, though their form was somewhat altered and their size diminished.

Cultivating Spirillum Obermeieri in Leeches.†—Dr. Th. Pasternacki gives the result of fourteen observations made by means of leeches on *Spirillum Obermeieri*, from which it seems that this micro-organism is very resistant to low temperatures. The leeches were filled with blood from cases of relapsing fever, and a drop of blood was obtained for microscopical examination by placing some salt crystals on their tails: this caused the leech to evacuate a drop of blood on a cover-glass placed ready for the purpose.

Directly after sucking the relapsing fever blood the leeches were exposed for various lengths of time to temperatures varying from 0°–40°, and then if alive, a specimen of the blood was obtained in the manner described.

New Cultivation Medium for Bacteria.‡—Dr. P. Kaufmann states that he has obtained very favourable results from the use of jequirity as a cultivation medium. The solution is prepared in the following manner:—10 grms. of jequirity seeds are pounded in a mortar to remove the husks, and this reduces the weight to about 8 grms. The 8 grms. are then boiled in a steam sterilizer with 100 ccm. water for two hours, and when cold filtered. The fluid thus obtained is of a yellow colour, with a neutral or very slightly alkaline reaction, and after sterilizing in the usual manner, can be used without further addition or treatment as a medium for cultivating bacteria.

From their behaviour to the jequirity solution the bacteria were divisible into three classes:—(1) in which the colour remained unchanged; (2) in which it was discharged; (3) in which a green colour was produced. A further examination showed that the green cultures had an alkaline

* Wracz, 1890, pp. 644–5. See Centralbl. f. Bakteriol. u. Parasitenk., x. (1891) p. 199.

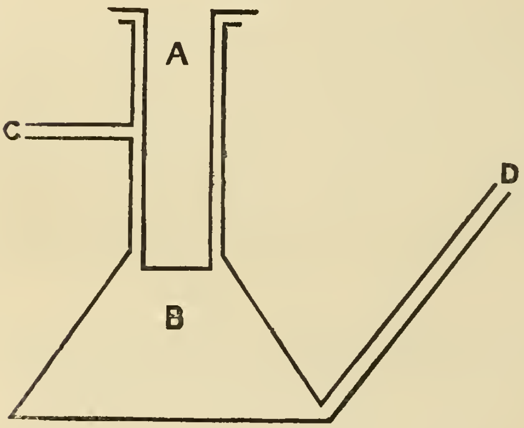
† Wracz, 1890, p. 297. See Centralbl. f. Bakteriol. u. Parasitenk., x. (1891) pp. 198–9.

‡ Centralbl. f. Bakteriol. u. Parasitenk., x. (1891) pp. 65–9.

reaction, and those in which the colour was discharged an acid one. This was confirmed by chemical experiment, for by adding an alkali the solution became green, while the addition of acids removed this colour. In this jequirity solution, therefore, there exists a means of distinguishing between bacteria which form acids and those which form alkalies.

The results of the addition of various substances, agar, gelatin, pepton, glycerin, alone or in combination and with neutral or alkaline reaction are exhibited in two tables. The most favourable results seem to have been obtained from the simple solution of jequirity with neutral reaction, and from an alkaline solution to which 2 per cent. of pepton had been added.

Fig. 75.



Reichel's Apparatus for Filtering Fluids containing Bacteria.*—Herr Reichel describes an apparatus which he has devised for filtering fluids, and which is expressly intended for bacteriological work. It consists of a glass vessel somewhat resembling an inverted funnel. The body B is intended for the receiver, while from the bottom projects upwards the tube D, and from the neck the exhaust-tube C. Into the neck fits the porcelain filter A. The tube D is intended for the evacuation of the filtrate or removal of small portions for test purposes. When in use, the air is exhausted by means of an air-pump attached at C, the orifices at A being carefully plugged with cotton-wool.

Organisms of Nitrification and their Cultivation.†—M. Winogradsky, who at one time ascribed the nitrifying faculty to a single species of bacteria called *Nitromonas*, has by later investigations satisfied himself that morphological differences exist in these organisms, and they are now classed together in a group of "Nitrobacteria," the common characteristic of which is the oxidation of the ammoniacal nitrogen. The bacteria were cultivated on the following medium, devised by Kühne,‡ and modified by the author:—Commercial silicate of soda is diluted with thrice its volume of water, and then 100 ccm. is thoroughly mixed with 50 ccm. of dilute hydrochloric acid. The mixture is dialysed for 24 hours in running water, and then for two days in distilled water frequently renewed. The dialysis is completed when the fluid remains quite clear on addition of silver nitrate. The solution may now be sterilized by boiling, and preserved in flasks closed with cotton-wool.

The second solution is composed as follows:—Ammonia sulphate, 0·4; magnesium sulphate, 0·05; potassium phosphate, 0·1; calcium chloride, trace; sodium carbonate, 0·6–0·9; distilled water, 100. The sulphates and chloride are dissolved and sterilized together, as also are

* SB. Phys.-Med. Gesellsch. zu Würzburg, 1891, pp. 44–7 (1 fig.).

† Ann. de l'Inst. Pasteur, 1891, p. 92. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 603–5.

‡ See this Journal, *ante*, p. 130.

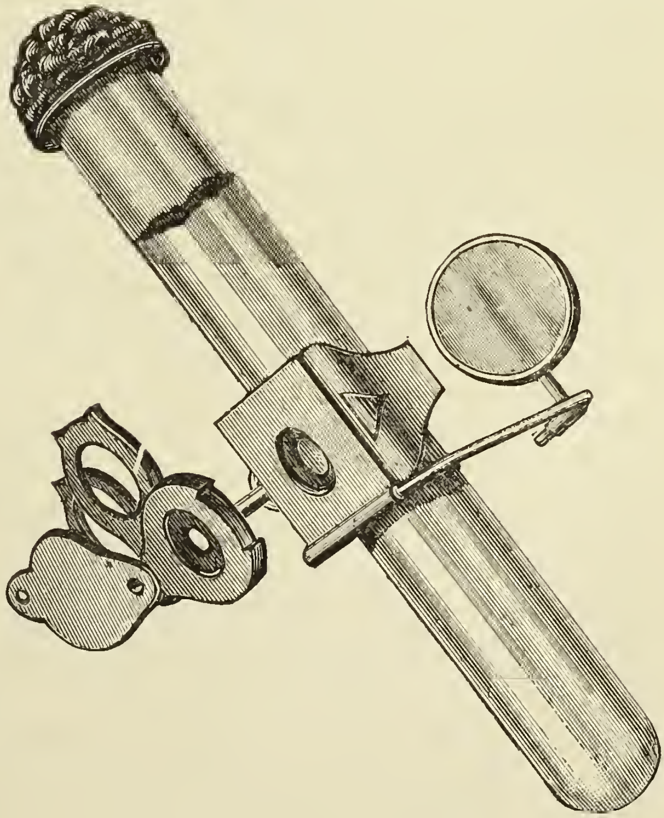
the phosphate and carbonate, and the two solutions mixed after cooling.

The next thing is to evaporate down to about one-half the silica solution in a flask until 2–3 drops set within five minutes when a drop of the salt solution is added. Ten to fifteen minutes suffice to render it firm enough to stand being scratched across. When this degree of concentration is reached the evaporation is suspended and the silica solution is pipetted into glass capsules. It is then set by adding to it one-half or one-third its volume of the salt solution, according to the degree of consistence required. The two constituents must be well mixed, and in a few minutes a slight opalescence will denote that coagulation has set in.

The material to be tested may be inoculated by mixing it with the salt solution or scratching it over the medium when solidified. For sodium carbonate magnesium carbonate may be substituted; although this impairs the transparency, it renders the colonies more evident, since this carbonate is dissolved from round about the colonies. The deep-lying colonies of the nitrobacteria are very small, while the superficial ones form a pretty thick crust along the course of the inoculation track.

Nitrobacteria may be obtained by direct inoculation of the earth, but it is better to set up nitrification in a watery saline solution by means of a bit of earth and then to transfer some of this to the solid medium. In this way are developed colonies consisting almost exclusively of nitro-bacteria, and that they do form nitrate is easily ascertainable by the nitric acid reaction with diphenylamin.

Fig. 76.



A Colony-counter.* — Mr. J. E. Line writes:—"In the study of the comparative biology of water-supplies, sewage, infusions, secretions, &c., it is necessary to fix the organisms in a nutrient medium, cultivate them to a given limit, and make a count. To do this neatly and effectively two pieces of apparatus are requisite—an Esmarch tube and a colony-counter. Glass plates and a linen-prover have been made use of, but for the more accurate results other and better means are called for. The Esmarch tube is simply a test-tube evenly coated internally with a solid sterilized nutrient medium—agar-agar, gelatin, combinations of

* The Microscope, xi. (1891) pp. 179–80.

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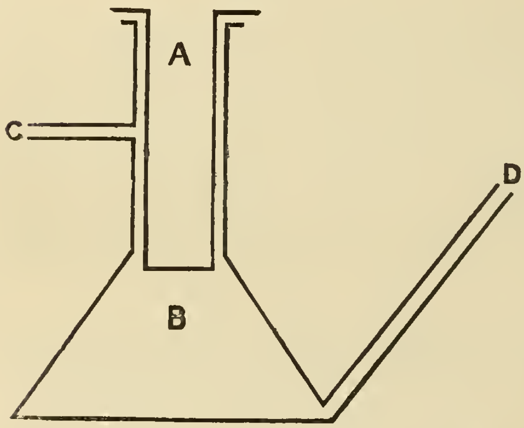

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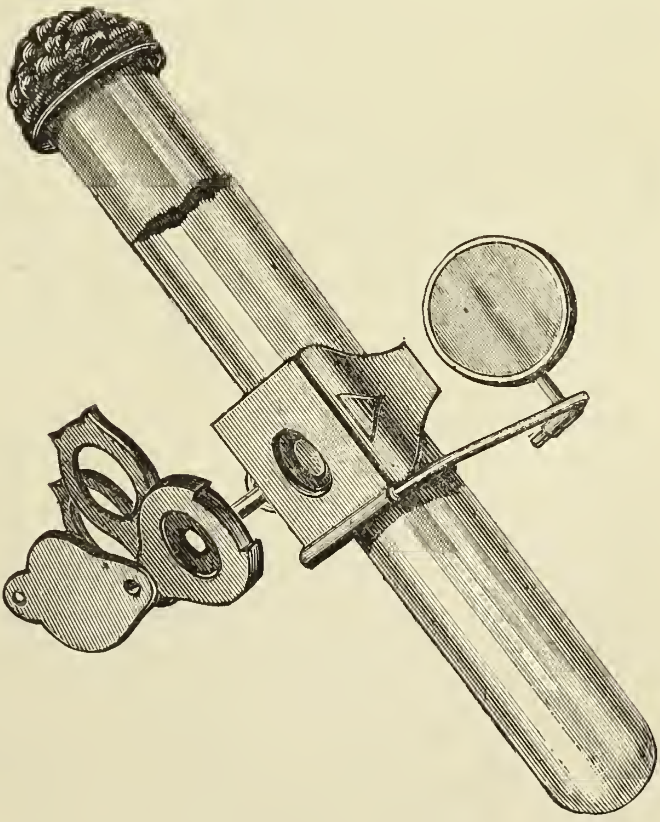

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* The Microscope, xi. (1891) pp. 179–80.

the two, &c.—and stopped with cotton. The coating is done by pouring into the tube a quantity of medium, tipping and turning the same until no part of the surface remains untouched, except, of course, that in the immediate vicinity of the cotton stopper. When the medium has thus been evenly spread, the tube is immersed to the neck in ice-water, and then stored for future use. Some roll the tubes on ice, but the medium sets and hardens unevenly, in lumps, ridges, &c.—a condition of things likely to vitiate the count. In making a comparative determination a series of tubes are taken, a given quantity of the material under examination put into each one, "swashed" about and the surplus thrown out, or by means of gentle heat (not, however, always advisable) incorporated with the medium. At the end of a given number of hours or days a count is made, the count repeated at intervals, the results recorded, and, if it is desired to experiment further, a cultivation begun.

At this stage of the examination the counter (fig. 76) comes into play. It is simply a small Microscope adapted to tube examinations, and consists of a modification of a brass knife-clamp that grasps the tube, holding it firmly to the under side of the stage, the opening in which contains a cover-glass divided into square millimetres, or, in a more recent and better form, an opening in the stage 1 × 4 mm., and the greater diameter running lengthwise with the tube. The optical part is an "Excelsior" triplet, the lenses of which can be used separately or in combination; the adjustment is frictional. The substage has universal movements, and may be readily detached if window- or lamp-light is preferred direct. The Bausch and Lomb Optical Company make the instrument."

Filtration and Sterilization of Organic Fluids by means of liquid carbonic acid.*—M. A. d'Arsonval describes a quite simple instrument for the cold-filtering and sterilizing of liquids containing colloid or albuminoid substances. A wrought-iron bottle filled with liquid carbonic acid is connected by means of a narrow tube with a steel or copper cylinder which is to receive the fluid to be filtered. The receiver of course contains a porcelain filter, and this is easily removable for the purpose of cleaning or sterilizing.

In practice the pressure used is about 45 atmospheres, and this is found to be quite as efficacious in many cases as sterilizing by heat.

The effect of this method may be increased by combining a temperature of 40° with the pressure, and, by certain modifications, cultivations may be attenuated or their development retarded.

The author noticed that the richness of the filtrate in colloid substances was in close relation to the pressure, and that in mixtures containing various ferments, for example, pancreatic fluid, the action of the fluids obtained by filtration varied with the different pressures.

D'Arsonval's Apparatus for maintaining a Fixed Temperature.†—M. A. d'Arsonval has invented a new thermostat, the temperature of which is regulated by quite a new device. The apparatus, intended chiefly for embryological and cultivation purposes, consists of a double-walled case, the interior of which is filled with water. At the middle

* Comptes Rendus, cxii. (1891) pp. 667–9 (1 fig.).

† Arch. de Physiol. Norm. et Pathol., ii. (1890) pp. 83–8. See Zeitschr. f. Wiss. Mikr., viii. (1891) pp. 102–4.

of its bottom is a folded metal plate similar to those in aneroid barometers, and under this a sort of box, into which the gas passes through a tube. From this the gas passes by two tubes, one on either side, to a couple of burners. The heat from these burners passes up through the water through two metal tubes or chimneys. When heated, the excess of water passes out through an opening in the middle of the top, and when the desired temperature is attained the aperture is closed with a caoutchouc plug, into which fits a long glass tube open at both ends. Further expansion of the water causes it to ascend in the tube, and also to press on the metal plate, and as the latter descends it presses on the central gas-pipe, and thus stops off the superfluous access of gas. In this way the temperature of the thermostat remains quite constant. An additional power of regulating the supply of gas is obtained by means of a screw fitted to the pipe, by which it is brought nearer to the flexible metal plate.

The author describes other apparatus constructed on a similar principle.

(2) Preparing Objects.

Examination of Embryonic Liver.*—In his study of the liver of the embryos of mammals Dr. O. Van der Stricht examined fresh tissue in serum and in different fluids ; teasing was effected in an aqueous solution of 1 per cent. sublimate, 1 per cent. osmic acid, or Flemming's liquid, and the elements stained with a dilute solution of safranin, methyl-green, or gentian-violet. Fixing was effected with an aqueous solution of 2 per cent. sublimate, either pure or with the addition of a little chloride of sodium, with Flemming's liquid, either pure or with an equal part of water, or with Hermann's liquid; of these Flemming's was found to be the best. The best colouring agents were safranin, gentian-violet, or Ehrlich's violet. The finest preparations were obtained by using safranin and gentian-violet simultaneously. Imbedding in celloidin was found to be preferable to the use of paraffin.

Preparation of Wing-muscles of Insects.†—Prof. E. A. Schäfer cuts open a suitable insect and places it in alcohol of about 90 per cent. for twenty-four hours or more ; it is afterwards transferred into glycerin, when the sarcostyles of the wing-muscles can be isolated and examined without difficulty. When stained, as with hæmatoxylin, the dark bands take the staining most intensely, but the various parts of the sarcostyle differ in their behaviour to staining reagents. A very valuable method is to apply the gold-formic method to the tissue when taken from the glycerin. If fresh muscle be so treated the sarcoplasm alone is stained, but if the alcohol-glycerin muscle be taken, the reduction of the metal takes place in the sarcostyles and almost exclusively in their dark bands. By these means there may be brought out, with a clearness which renders the application of the photographic method comparatively easy, points of structure which, with our present usual methods of investigation, have remained obscure.

* Arch. de Biol., xi. (1891) pp. 41–2.
† Proc. Roy. Soc. Lond., xlix. (1891) pp. 280–1.

Preparation of Nervous System of Hirudinea.*—Dr. E. Rohde investigated the nervous system of *Aulostomum* by means of teased preparations as well as of sections. The latter were generally prepared after hardening in sublimate; the living animals were forcibly extended and fixed in a small vessel containing wax; an opening was made along the dorsal middle line; the worms were covered with a one to two per cent. solution of sublimate and left for several hours. After this was removed they were gradually put into strong alcohol. Only after they had been for a day in 80 per cent. of alcohol was the nervous system taken out, stained, and imbedded in paraffin. The author strongly recommends this method. Of *Pontobdella* serial sections only were made. Mayer's alcoholic carmine solution is highly praised as a staining reagent, but Golgi's method is found to be useless for Invertebrata. The sections were generally 1/200 mm. thick, but for the recognition of the finest structural relations much more delicate sections were necessary. The sections were always put in glycerin; resinous media are to be avoided as they make the preparations too transparent for very fine work.

Mayer's picric glycerin mixture was found to be of no use, but salt solution was useful.

Mode of Investigating Sipunculus nudus.†—Mr. H. B. Ward attempted to kill his specimens in such a way as to prevent distortion and to preserve well the tissues; the thick impermeable cuticle and the wealth of muscular tissue made the operation one of some difficulty.

Specimens were allowed to remain for some time in clear sea-water so as to get rid of adhering sand; they were then brought into a shallow dish of sea-water, and 5 per cent. alcohol was allowed to flow gently over the surface; the spirit must be allowed to disseminate gradually. Narcosis varies with individuals, but supervenes in from four to eight hours. When the animals make no contractions on being gently probed with a dull instrument they may be regarded as sufficiently stupefied, and be transferred to 50 per cent. alcohol. After a short stay in this the introvert was cut off, and alone subjected to stronger alcohol. Material thus preserved may be well stained by all methods.

Development of Hydra.‡—Dr. A. Brauer, in his study of the development of *Hydra*, preserved the shell-less eggs chiefly in Flemming's solution, and those that retained their shells by treatment with hot corrosive sublimate. The yolk-granules were distinguished from the nuclei by double-staining with borax-carmine and malachite-green; and, later, as the nuclear stain was found to be too faint, shell-bearing eggs were alone so treated, and the others were put for twelve hours in Grenacher's hæmatoxylin and washed with acid alcohol. Paraffin was used as the imbedding material; for sections the older shelled ova alone gave difficulty; for these Heider's mastic-solution was used.

Study of Karyokinesis in Paramœcium.§—In the study of *Paramœcium*, Prof. R. Hertwig made use of picro-acetic acid, chromic

* Zool. Beiträge, iii. (1891) pp. 1–3 and 49–51.

† Bull. Mus. Comp. Zool., xxi. (1891) pp. 144–5.

‡ Zeitschr. f. Wiss. Zool., lii. (1891) p. 170.

§ Abhl. d. K. Bayer. Akad. d. Wiss., ii. Cl., xvii. Bd., i. Abth. (1889) pp. 4–5. See Amer. Nat., xxx. (1891) p. 87.

acid, and chrom-osmic acid, as hardening reagents. Picro-acetic acid followed by borax-carmine was the principal method. The staining process was aided by the heat of an incubator, and decoloration was effected by alcohol acidulated with hydrochloric acid. The preparation was mounted in glycerin or in clove-oil. Clove-oil is preferable to balsam, as it reveals more clearly the fibrous structure of the spindle, and allows of turning and pressing of the object at any time.

Clove-oil causes the cytoplasm to become brittle, so that the body of the infusorian may be broken up by pressure or blows on the cover-glass, and thus the nuclear spindles be set completely free. In this isolated condition they can be studied to the best advantage, as they are not obscured by overlying cytoplasm. For the study of the chromatic figures clove-oil is too strong a clarifying medium. Glycerin or water will serve better. Hertwig examined the preparation first in clove-oil, then isolated the nuclear figures, washed in alcohol, and mounted in glycerin. He was thus able to study all parts and figures under most favourable conditions.

Method of Narcotizing Hydroids, Actiniæ, &c.*—Mr. H. B. Ward writes:—"In order to kill Hydroids, Actiniæ, and similar forms in an expanded condition, a little expedient may be recommended which the writer has tried in many places and on many forms, and has uniformly found of value. The animals to be killed are left in a small quantity of the salt water in which they were brought in, until this becomes rather warm and stale, or until, in fact, they are weakened by the narcotizing effect of impure water. This manifests itself in one or two ways; some forms draw themselves completely together, while others hang half expanded and limp in the water. They are then transferred in colonies or in large groups into [a] fresh [quantity of] salt water, which is at the same time cool. The effect of a mass of cool, pure water is such as to cause the animals to expand fully and promptly. Immediately as the expansion is seen to reach its maximum, in the course usually of a few seconds, they are transferred by a quick motion into some rapid-killing reagent. After the long narcosis in poor water the polyps appear to lack energy to contract forcibly, as is usually the case. As killing reagents, alcoholic corrosive sublimate and picro-nitric acid have given the most uniformly good results. In this way the most susceptible Actiniæ may be easily preserved expanded and intact, and hydroids of all genera yield good specimens. The transfer to fresh sea-water is the only point requiring care. No time limit can be given, as the factors are too variable, but a little practice is sure to show the character and advantages of the method."

Method for Demonstrating the Formation of Acids by Micro-organisms.†—Herr M. W. Beyerinck describes a method for showing the acidity or alkalinity of the products of micro-organisms.

It consists in mixing a suitable medium, and one which will set well with very fine whiting, and then pouring the mixture into a glass capsule. The nutrient layer thus made is opaque and milky white. As coagulation media, gelatin, agar, or silicate may be employed. To

* Amer. Nat., xxv. (1891) pp. 398–9.
† Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 781–6 (1 fig.).

exemplify his method, the author gives in detail the procedure for demonstrating the presence of lactic acid bacteria and for isolating them from fermenting maize. 20 grms. gelatin (or 3/4 grm. agar) are dissolved in yeast-water made by boiling 8 grms. yeast in 100 ccm. tap water. 5–10 grms. glucose are then added, and the mixture having been boiled again, it is filtered, and a few drops of whiting and water added. It is then poured into glass capsules, so that the layer at the bottom is about 1 mm. thick.

The micro-organisms are obtained by shaking a drop of fermenting maize up in a flask of boiled water and then pouring the infected water over the chalked medium. The water is then poured off, but sufficient adheres to inoculate the medium.

As the colonies develope their immediate vicinity clears up, owing to the acid produced by the micro-organisms, and these transparent areas are visible even to the naked eye.

In addition to whiting, the medium may be mixed with carbonates of magnesium, barium, strontium, manganese, zinc. The mixture of zinc carbonate appears to be very suitable for lactic acid bacteria.

Besides indicating the production of acid, this method may be used for demonstrating the formation of alkalies. In the illustration given by the author of his apparatus, this production of alkali by an organism is shown by its power of neutralizing the acidity resulting from an acid-forming bacterium in an adjacent colony.

Demonstration of Suppuration-Cocci in the Blood as an aid to Diagnosis.*—Baron A. von Eiselsberg describes four cases in which the original diagnosis was confirmed by a bacteriological examination of the blood. In all four cases suppuration cocci were cultivated from the blood (*Streptococcus pyogenes*, *Staphylococcus pyogenes albus*, and twice *Staphylococcus pyogenes aureus*).

Examination of the blood in five cases of laparotomy where the symptoms soon after the operation were unsatisfactory, failed to show micro-organisms—a result confirmed by the subsequent satisfactory issue of all the cases. In three cases of phlegmon, one of acute osteomyelitis, and four of septic peritonitis, the cocci could only be demonstrated in three instances—a result which is explained by supposing that in certain cases of sepsis the phenomena are due to the absorption of certain chemical matters from the original inflammatory focus. Moreover, it must be remembered that as the cocci are only sparsely present in circulating blood, catching a visible germ in any given drop of blood is not a matter of certainty.

At any rate the author's recommendation that the bacteriological examination of blood should be undertaken as a supplementary aid to diagnosis is a good one, for while negative results only leave the matter in the *status quo ante*, a positive result is extremely valuable.

On a Method of Preparing Vegetable and Animal Tissues for Paraffin Imbedding, with a few Remarks as to Mounting Sections.†—Mr. Gustav Mann writes:—"*Requisites*—I. Picro-corrosive alcohol.

* Wiener Klin. Wochenschr., 1890, p. 731. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) p. 834.

† Trans. and Proc. Bot. Soc. Edinb., xviii. (1890) pp. 432–5.

Heat absolute alcohol to 50° C., saturate with picric acid, and then add bichloride of mercury to saturation. When cool decant. This solution may be made in quantity and kept. II. Absolute alcohol. III. Chloroform-alcohol—chloroform and absolute alcohol mixed in equal parts. IV. Chloroform. V. Solid paraffin, melting-point 46°–50° C. VI. Short wide-mouthed bottles. VII. Best cork stoppers, two for each bottle; the one fitted with a piece of glass tubing 1 cm. in diameter and 3 cm. long. VIII. Number of glass rods drawn out into fine points, as one must avoid bringing metal instruments in contact with the picro-corrosive fluid.

Method—A. The fixing and hardening of tissues.—Place tissue in at least fifty times its bulk of the picro-corrosive alcohol. Leave small objects (up to 1 cubic cm.) for twenty-four hours, larger objects for forty-eight hours and upwards in the fluid. Keep the bottle well corked.

B. The replacement of the picro-corrosive alcohol by pure absolute alcohol.—1. Pour off the hardening fluid till the tissue is just covered. Add absolute alcohol according to the size of the tissue in 1–10 drops every ten minutes, till the tissue is again in fifty times its bulk of fluid. After each addition move the bottle very gently to allow the added alcohol to mix with the hardening fluid. Leave tissue in this diluted mixture for twenty-four hours. In no case should this process be hurried, or strong diffusion currents will be set up, and the protoplasmic contents of the cell separate from the cell-wall. 2. Pour off the fluid till the tissue is just covered, and add absolute alcohol up to the original bulk. Move about the bottle gently every three or four hours. Most of the picro-corrosive material will thus be extracted after twenty-four hours. 3. Draw the fluid rapidly off by means of a pipette, and add absolute alcohol up to half of the original bulk. Any drying of the tissue must be carefully guarded against. Leave for twenty-four hours, and repeat the process.

C. The replacement of the alcohol by chloroform.—1. Pass, by means of a pipette, the chloroform-alcohol mixture to the bottom of the vessel, when the tissue will float on the mixture. Remove then the superfluous alcohol by a pipette, leaving only enough to cover the tissue. 2. When the tissue has sunk in the chloroform-alcohol mixture, introduce by a pipette pure chloroform, on which the tissue will float; the fluid above the tissue is removed by a pipette. After twenty-four hours the tissue may or may not have sunk in the chloroform; if not, it may be induced to do so by heating the chloroform to 20° C. (not higher); if this fail, a little sulphuric ether may be added. After the tissue has sunk, leave for twenty-four hours. 3. Place a fresh supply of chloroform at the bottom of the vessel (50 times the bulk of the tissue), and if there is a distinct line of demarcation between the newly-added and the old chloroform, the upper layer should be removed by a pipette.

D. The replacement of chloroform by paraffin.—1. Place the tissue in a warm chamber heated to 25° C.; add solid paraffin in pieces up to the size of a small pea. After each piece has dissolved, the bottle has to be moved about very gently to hasten the mixing of the paraffin, which will be in the upper layers, with the chloroform. Continue till no more paraffin dissolves. Tissue which did not sink in pure chloroform will always sink as soon as paraffin is added. 2. Place the tissue in a warm chamber heated to 30° C. for twenty-four hours. 3. Place the tissue in a warm chamber heated to the melting-point of the paraffin (46° C.), and after six hours replace the ordinary cork stopper (which up to this stage has always to be employed) by a perforated one. This method is adopted to ensure a gradual giving off of the chloroform, for I find that, if the latter be driven off rapidly, a good deal of shrinkage always results. When all the chloroform has evaporated, i. e. if after shaking the bottle gently one is unable to detect by smelling the faintest trace of chloroform, then the tissue is ready for sectioning. If the bottle be not shaken gently before smelling the solution, it is often impossible to detect chloroform, although a large quantity of the latter is still in the lower layers of the paraffin, as the upper layers part more readily with the chloroform. 4. The tissues should not be exposed longer than just necessary to the temperature of melted paraffin, but should be imbedded by means of Leuckart's type-metal box, or by two L-shaped pieces of metal running in an oblong box, the breadth of which corresponds to the short limb of the L. The metal boxes should be warmed and filled with melted paraffin. After five to twenty seconds, when the paraffin at the bottom of the box has solidified, the tissue is removed from the bottle by a copper lifter, and, without being allowed to cool, it is dropped into the imbedding box, put into any desired position by means of hot needles, and the paraffin cooled very gradually. It is best not to touch the tissue with any instrument till it is ready to be placed in the imbedding box, and also to avoid heating the copper lifter or the needles too much. Tissues thus imbedded may be kept unchanged for any length of time.

To get perfectly satisfactory results, the tissue we are treating must be living; smaller vegetable objects, as flower-buds, ovaries, growing apices, &c., must be dropped into the fluid as soon as separated from the plant, and animals like tadpoles, worms, and larvæ are placed directly into the fluid, where they are killed rapidly and in an extended position. Tissues of plants and animals must be placed in the fluid as soon as separated by dissection. Tissues of warm-blooded animals should be placed in the picro-corrosive alcohol of corresponding warmth. Treating tissues like brain, it is best to place into the bottom of the vessel a pad of cotton-wool or felt to allow the hardening fluid to penetrate readily; the pad must be removed before the chloroform-alcohol is placed below the tissue. My method was found to give very satisfactory results with plasmodia of myxomycetes, growing apices, developing endosperm, stem and leaf structures, human fœtal brain, frog's cartilage, muscle, myxomatous tissue, retina, tadpoles, wasp larvæ, caterpillars, &c. Karyokinetic figures are specially well fixed, and show the minutest details.

Now a few words as to mounting sections. Sections cut in ribbons (I use the Cambridge rocking microtome) are fixed to a slide by Schällibaum's method, thus:—An even layer of the fixing material is spread on the slide, the slide heated to 30° C. (melting-point of paraffin = 46° C.), and a piece of the ribbon gripped by a pair of forceps at one end and quickly laid down on the warm slide. In this way I get the sections to lie perfectly flat, and it is even possible to make a closely coiled-up ribbon expand with the greatest ease, without causing any further trouble. The slide is next heated above a Bunsen, just enough to melt the paraffin; it is then placed in a vessel containing resinified turpentine, which latter removes the paraffin in a few minutes; the turpentine is removed by absolute alcohol, and the sections stained by any of the current methods, then dehydrated in absolute alcohol, cleared in resinified turpentine, and, lastly, mounted in Canada balsam dissolved in turpentine, as turpentine-balsam has a low refractive index."

(3) Cutting, including Imbedding and Microtomes.

Sharpening Ribbon-Microtome Knives.*—M. J. W. Moll says that the ribbon-microtome is far superior to the sliding microtome, provided that the knife be properly sharpened.

After alluding to the shape of the knife, the form and dimensions of which are figured in his illustrations, the author says the knife is honed on a glass plate, 19 cm. long, 4·5 cm. broad, and the manner of holding the knife is depicted. The first stage consists in sharpening the knife on the dull side of the glass plate with emery and water, and then having washed it, to hone it on the smooth side of the glass, using a little "chaux de Vienne." In this way an edge quite straight and without any serrations is obtained, and a 5 μ thick section perfectly smooth, without a tear and showing no knife-marks, may be cut with certainty.

To preserve Edges of Microtome Knives.†—A writer in the 'Dental Review' says:—"To render instruments perfectly aseptic, and to preserve the cutting edges from oxidation, they should be boiled for five minutes in one per cent. solution of carbonate of sodium. They can remain in this solution indefinitely without rusting or dulling the cutting edge. When required for operation they are taken out, dried with a sterilized piece of gauze, and handed to the operator. Whenever, in course of operation, they come in contact with anything not aseptic, all that is required to resterilize them is to dip them for a few seconds into the boiling solution of sodium bicarbonate."

(4) Staining and Injecting.

Staining of Chlorophyll.‡—For staining the chlorophyll-bands of *Spirogyra*, Mr. G. Mann recommends the following process:—A glass vessel is filled with two litres of water, to which six drops are added of a 10 per cent. solution of cyanin in absolute alcohol. Then a small quantity of either *Spirogyra jugalis* or *S. nitida* is placed in the vessel, which is exposed to bright daylight. After some time, varying with the temperature of the room and the activity of the threads, from 3–24 hours, the whole of the cyanin will have been taken up by the threads. The ground-substance of the chlorophyll-bands will have changed from a green to a bluish-green colour, while the oil-globules and many of the microsomes between the bands will have turned blue, showing their fatty nature. Concentrated solution of alcanna-root, or a

* Botanisch Jaarboek, Gent, 1891, pp. 541–56 (1 pl.).
† Amer. Mon. Micr. Journ., xii. (1891) p. 124.
‡ Trans. and Proc. Bot. Soc. Edinb., xviii. (1889–90) pp. 394–6.

1 per cent. solution of osmic acid, may be used instead of the cyanin, but the results are not so good.

New Application of Safranin.*—Dr. P. Kaufmann says that he has obtained surprising results with the following solution, which stains both the tissue and the micro-organisms, though of different colours, the nuclei being red and the bacteria and fibrin blue. After the preparations have been stained for two to eighteen minutes, they are treated as in Gram's method with the iodo-potassic iodide. The solution, which does not keep very long, and should therefore be freshly made, is composed of the following:—Alcohol 98–100 per cent., 2 grms.; anilin oil, 0·5; aq. destil., 30·0; gentian-violet, 0·25; safranin, 1·25. Or the last three ingredients may be formulated thus:—25 ccm. of aqueous 5 per cent. solution of safranin, 5 ccm. of aqueous 5 per cent. solution of gentian-violet, the anilin-oil and alcohol being afterwards added.

New Syringe for Hypodermic Injection.†—M. Strauss has, by a simple modification of the plug of an ordinary Pravaz syringe rendered its cavity sterilizable by steam, dry air, or boiling. The plug is made of compressed elder-pith, and in case it should become too slack, the metal discs are screwed on to the piston rod, so that the intervening pith may be tightened up.

Colourability of Tubercle Bacilli.‡—M. G. Roux thinks that the reason why tubercle bacilli frequently fail to stain or exhibit such differences in appearance when they are stained is to be sought for in the degeneration of the anilin-oil used as mordant or in the method adopted. After obtaining a perfectly pure and recently made anilin-oil, the preparations of sputum showed numerous deeply-stained bacilli, while those stained with a solution made of old dark-coloured anilin-oil showed scarcely any at all. The author also notes that with Hermann's method the bacilli appear thicker and more numerous than when stained by the anilin-oil or carbolic acid solutions.

Phospho-Molybdic Acid Hæmatoxylin.§—Dr. F. B. Mallory recommends as a useful stain in the study of nerve-tissue a mixture of 1 part 10 per cent. solution of phospho-molybdic acid, 1 part of hæmatoxylin crystals, 6–10 parts of chloral hydrate, and water to 100. Expose to sunlight for a week and filter before using. Discharge excess of stain, which acts in from ten minutes to an hour, with 40–50 per cent. alcohol, changing twice or thrice. Dehydrate and mount as usual. If the solution does not stain deeply, add more hæmatoxylin.

Methods of Differential Nucleolar Staining.‖—Mr. Gustav Mann says:—"As far as I am able to ascertain, Guignard ¶ was the first to describe a differential nucleolar stain by a certain mixture of methyl-green and fuchsin, but he does not specify any proportion of admixture,

* Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 717–8.

† Le Bulletin Méd., 1891, p. 89. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) p. 737.

‡ La Province Méd., 1891, No. 4, p. 37. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 678–9.

§ Anat. Anzeig., vi. (1891) pp. 375–6.

‖ Trans. and Proc. Bot. Soc. Edinb., xix. (1891) pp. 46–8.

¶ Ann. Sci. Nat., sér. 6, xx. p. 318.

though he repeatedly mentions the fact of the differentiation. I am unable to follow him in his method, and, notwithstanding many trials, have failed to get his differential stain, namely, the chromatin-elements of the nucleus green and the nucleolus red by means of methyl-green and fuchsin.

While endeavouring to stain the nucleolus and endo-nucleolus differentially, my attention was drawn by Dr. Macfarlane to heliocin as a good nuclear stain for *Spirogyra.* By extending its action in combination with anilin-blue to other tissues, I have succeeded in obtaining an excellent differentiation.

Method.—Tissues, both vegetable and animal, preferably fixed by my picro-corrosive method,* are treated for ten minutes in a saturated solution of heliocin in 50 per cent. alcohol ; the sections are then transferred for from five to fifteen minutes to a saturated watery solution of anilin-blue. The superfluous stain is rapidly washed off by distilled water, and the sections placed again for one to two minutes in the heliocin-solution, dehydrated, cleared by resinified turpentine, and mounted in turpentine-balsam.

Effect.—The whole of the cell and the nucleus blue, the nucleolus red. In karyokinetic figures the cell and nuclear barrel are stained blue, the nuclear plate, monaster and diasters stained red.†

The chemical constitution of the heliocin I used I am unable to find out ; when dry it is a brick-red powder, readily soluble in water, slightly so in absolute alcohol, and in each case showing no fluorescence. A watery solution is of an orange brick-red colour. My friend Mr. Terras was kind enough to test this heliocin chemically, and found it to act thus : The dye dissolves in concentrated sulphuric acid with a red orange colour, which on boiling becomes dark brown. Water added to the dark brown fluid does not produce any precipitate. Hydrochloric acid added to the solution in water gives no precipitate, and does not change the colour. Zinc-dust added to the acid solution decolorizes it in the cold easily, and the colour does not return on exposure to the air. Strong caustic potash added to the watery solution of the dye produces no change either in the cold or when boiled. Zinc-dust added to the alkaline solution decolorizes it in the cold.

Besides the heliocin just described, another one is in the market, a dark brownish-red powder soluble in water, with a distinct fluorescence, readily soluble in alcohol, and giving the reactions of true eosins.

One should endeavour to get the heliocin first described, for it makes a beautiful contrast with the blue, and allows one to study the finer structure of nucleoli.

Should either of the two heliocins not be obtainable, any of the eosins, or erythrosins, may be substituted, when treating vegetable tissues, while for animal tissues safranin makes a tolerably good substitute.

Another differential stain is got by placing living tissues for at least a week in a saturated picric acid solution of absolute alcohol, to which

* See Trans. Bot. Soc. Edinb., xviii. (1890) p. 432, *et supra*, pp. 686 *et seq.*

† "I may state that in dividing cells of the root of *Nymphæa alba*, we may stain the whole of the cell pink, and the nuclear plate, monasters and diasters blue, by treating sections first with alcoholic eosin and then with alcoholic methylene-blue."

that variety of nigrosin known as alcohol-soluble nigrosin has been added. After-staining the sections with eosin or Kleinenberg's hæmatoxylin causes the nigrosin to be replaced by either dye, leaving only the nucleolus of a greenish-blue colour."

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

Reference Tables for Microscopical Work. III. Cements and Varnishes.*—Prof. A. B. Aubert gives the following list:—

Asphalt varnish:—Asphalt, 450 grm.; linseed oil, 225 grm.; turpentine, 1000 ccm.; or dissolve asphalt in benzol and to the solution add gold size. In the first method, dissolve by the aid of heat; dilute when necessary, with turpentine. Not very reliable as a cement.

Bell's cement:—Probably a solution of shellac, but the exact composition is not known. This in the opinion of many is an excellent cement.

Gold size:—Linseed oil, 25 oz.; red lead, 1 oz.; powdered white lead and yellow ochre, of each a sufficient quantity. Boil the oil and red lead together carefully for three hours; pour off the clear liquid, and boil with a mixture of equal parts of the white lead and yellow ochre added in small successive portions. Let it stand, and pour off the clear liquid for use.

Gram-Rutzon's cement:—Hard Canada balsam, 50 grm.; shellac, 50 grm.; absolute alcohol, 50 grm.; anhydrous ether, 100 grm. The ingredients are mixed, and when the gums are dissolved, filter if necessary, and evaporate, away from the flame, over a water-bath until of a syrupy thickness.

Gutta-percha cement (Harting):—Gutta-percha cut in pieces, 1 part; turpentine, 15 parts; shellac, 1 part. Heat the gutta-percha and turpentine together, filter, add the shellac pulverized, and heat until a drop hardens on a cold glass plate. Used to attach cells; the slide must be warm when using the cement.

Brown cement:—Pure gum rubber, 20 grains; carbon disulphide, a sufficient quantity; shellac, 2 oz.; alcohol, 8 oz. Dissolve the rubber in the smallest possible amount of carbon disulphide, add this slowly to alcohol, avoiding clots; add powdered shellac and place the bottle in boiling water until the shellac is dissolved and no more smell of carbon disulphide is given off.

Guiacum varnish:—Gum guiacum, 2 oz.; shellac, 2 oz.; alcohol, 10 oz. The powdered gum guiacum is dissolved in the alcohol and the powdered shellac added; keep the bottle in hot water until all is dissolved.

Shellac varnish:—1, shellac, 60 grm.; 2, alcohol, 60 grm.; 3, castor oil, 25 grm.; 4, alcoholic solution of anilin dye, a few drops. 1 and 2 are dissolved and heated until quite thick, then a little of 4 is added, and for every 60 grm. of the mixture add 25 grm. of castor oil, and heat for a short time.

Electrical cement:—5 parts of resin; 2 parts of hard balsam; 1 part of yellow beeswax; 1 part of red ochre. The components are melted together.

* Microscope, xi. (1891) pp. 150–2.

This is not usually employed for mounting purposes, but may be used in cementing glass and metal parts of instruments.

Zinc-white cement, German formula:—1, mastic, 10 pts.; 2, dammar, 4 pts.; 3, sandarac, 4 pts.; 4, Venetian turpentine, 1 pt.; 5, turpentine, 20 pts.; 6, benzol, 10 pts.; 7, zinc-white. 1, 2, and 3, powdered are mixed in a well-corked bottle with 4, 5, and 6; shake well occasionally; after several days filter, and triturate in a mortar with zinc-white in quantity sufficient. Dilute if necessary with benzol.

Zinc-white, English formula:—1, gum dammar, 3 pts.; 2, gum mastic, 1 pt.; 3, benzol, 6 pts. Dissolve powdered 1, 2, and 3 in a well-corked bottle; when dissolved filter, and mix carefully in water with zinc-white.

Marine glue:—India-rubber shreds, 2 oz.; shellac, 2 oz. Dissolve the rubber in mineral naphtha, add the powdered shellac, heat until liquefied, and mix well together. This gives solid marine glue, and requires heat in its application. Great care should be observed in having all fire and flame removed while there still remains naphtha in the mixture.

Lovett's cements:—Powdered white lead, 2 parts; powdered red lead, 2 parts; powdered litharge, 3 parts; gold size. The white and red lead and the litharge must be very finely powdered; for use this powder is mixed with gold size to the consistency of cream, and the cells immediately fastened to the slide. They are secure in two weeks. This stands considerable heat, and is excellent for fluids containing some alcohol. Make a little only of the mixture with gold size at a time, as it hardens quite rapidly and becomes useless.

King's cement and lacquer.—Satisfactory, and highly recommended by some.

Brown's rubber cement.—Very good for finishing slides.

Miller's caoutchouc cement.—Sold in England by opticians. It is a most excellent and quickly drying cement.

Hollis's glue.—Somewhat similar to Bell's cement.

Nearly, if not all the foregoing can be most advantageously bought of the opticians and dealers in microscopical material.

(6) Miscellaneous.

Coco-nut-water as a Culture Fluid.*—Mr. G. M. Sternberg points out that the fluid contained in unripe coco-nuts is quite transparent, with a specific gravity of 1·02285. Chemical analysis showed that it was composed of water 95 per cent., ash 0·618 per cent., glucose 3·97 per cent., fat 0·119 per cent., albumen 0·133 per cent. This fluid forms an excellent medium for numerous kinds of micro-organisms. There is no need to sterilize it, if it be removed with the necessary precautions. As its reaction is slightly acid, it must be neutralized before being used for cultivating certain kinds of pathogenic micro-organisms.

* Philad. Med. News, 1890, p. 262. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) p. 834.

PROCEEDINGS OF THE SOCIETY.

The first Conversazione of the Session was held at 20, Hanover Square, on Monday, the 1st December, 1890.

The following objects, &c., were exhibited :—

Mr. J. Badcock :—*Megalotrocha albo-flavicans.*
Pond Life.

Rev. G. Bailey :—Foraminifera from the Red Chalk.

Mr. C. Baker :—Dr. Dallinger's pattern Microscope Lamp.
E. Leitz's Microscope and Microtome.
Photomicrographic Microscope as suggested by Mr. Andrew Pringle.
Portable Limelight Projection Lantern and Slides of Micro-organisms.
C. Reichert's Apochromatic Objective 1/3 N.A. ·50.
C. Zeiss's Apochromatic Objective 1/8 N.A. ·95; Microscopes; and Abbe's Achromatic Condenser.

Mr. W. I. Chapman :—*Limnias annulatus.*
Œcistes crystallinus and *intermedius.*

Mr. H. E. Freeman :—Group of Foraminifera from Porto Seguro.
Casts of Foraminifera from Colon.

Mr. J. E. Ingpen :—Contrast in effects in objects mounted in Air, Canada balsam, Oil of Anise, Styrax, Piperine, Bisulphide of Carbon, Chloride of Tin, Bromide of Antimony, Phosphorus, Sulphide of Arsenic, and Platina deposit.

Mr. R. Macer :—*Lophopus crystallinus.*
Stephanoceros Eichornii.

Mr. C. J. Martin :—*Megalotrocha albo-flavicans.*
Pond Life.

Mr. A. D. Michael ;—Trans. Sect. of a Mite (*Gamasus terribilis*) showing the whole body filled with Nematoid worms.
Serial Sections of Acarina cut in a Swiss hotel with a common Cathcart microtome and an ordinary shaving-razor.

Mr. E. M. Nelson :—Zeiss's Apochromatic Objective 1/6 N.A. ·95.

Messrs. Powell and Lealand :—*Triceratium favus* with an Apochromatic Oil-immersion 1/12 N.A. 1·40.
Upper valve of *Pleurosigma balticum* with an Apochromatic Oil-immersion 1/8 N.A. 1·40.

Mr. B. W. Priest :—Fossil Sponge, *Cœloptychium agaricoides.*

Mr. A. Pringle :—Photomicrographic Apparatus.

Mr. C. Rousselet :—Pond Life in Winter: Collection of Rotifers obtained from under the ice.

Mr. G. J. Smith :—Chiastolite Schist, Gefrees, Fichtelgebirge.
Granulite, with Kyanite, Saxony.
Ottrelite Schist, Ottrez, Ardennes.
Pikrite, Inchcolm.

Mr. W. T. Suffolk :—Bordered Pits—Deal, 1/4 in.; with spherical Lieberkuhn.

Mr. J. J. Vezey:—Mucous membrane of Cæcum (human) injected.
Messrs. Watson & Sons:—New pattern Binocular Microscope.
Group of Diatomaceæ.
Section of Eye of Fly (*Tabanus*).
Bacillus anthracis in section of malignant pustule from the cheek of a person infected by a cow suffering from Anthrax.
Leaf of New Zealand Hemp.
Œsophagus of Dog.
Type-slide of Holothurida.

The second Conversazione of the Session was held at 20, Hanover Square, on Thursday, the 30th April, 1891.

The following objects, &c., were exhibited:—
Mr. J. Badcock:—Freshwater Polyzoa (*Lophopus crystallinus*).
Mr. C. Baker:—*Navicula rhomboides* in quinidine under Zeiss Apochromatic 1/6 N.A. ·95.
N. Lyra under Reichert's Apochromatic 1/3 N.A. ·50.
Mr. W. A. Bevington:—Head of Jumping Spider.
Mr. F. Enock:—Eggs of *Psocus fasciatus* showing parasitic fly (*Alaptus minimus*) *in situ.*
Eggs of *P. fasciatus* on leaf.
Mr. J. G. Grenfell:—A new "Diatom" with long branching pseudopodia or filaments, from the Botanical Gardens, Regent's Park.
A new Freshwater Organism.
The Symbiosis of *Micrococcus* with a new form of the Flagellata.
Mr. J. D. Hardy:—An attempt to express a frustule of *Heliopelta* in modelling clay, 9 in. diam. × 1000.
Mr. A. Howard:—Epithelioma of Human Tongue showing *Trichina spiralis.*
Mr. W. Johnson:—*Bacillus anthracis* (cultivation).
Spleen of Guinea-pig, showing *B. anthracis.*
Lung of Guinea-pig showing *B. anthracis.*
B. tuberculosis (cultivation).
Streptococci Pyogenes (cultivation).
Lung of Horse showing nodule of *B. tuberculosis.* Prepared by Mr. T. N. Davis, M.R.C.V.S.
Foot and stage of Microscope by Varley (date about 1812).
Mr. R. Macer:—*Cristatella mucedo.*
Stephanoceros.
Mr. C. Machins:—*Asplanchna Brightwellii.*
Mr. J. Mayall, Jr.:—John Marshall's Microscope (*vide* Harris's Lexicon Technicum, 1704).
Messrs. E. M. Nelson and C. L. Curties:—Projection Microscope exhibiting micro. slides with 70 mm. and AA objectives.
Mr. J. M. Offord:—*Actinocyclus Barklii.*
Messrs. Powell and Lealand:—*Rhomboides* in Balsam and *Coscinodiscus asteromphalus,* with an Apochromatic Oil-immersion 1/10 N.A. 1·50 and new dry Apochromatic Condenser.

Mr. C. F. Rousselet :—*Stephanoceros Eichornii.*

Mr. T. Ryley :—Plagioclase Felspar; Pitchstone; Gabbro; *Eozoon canadense.*

Mr. G. F. Smith :—Magma-Basalt (Limburgite), Kaiserstuhl, Baden; Basalt intrusive in carb. limestone, Carlingford; Tachylite, showing arrested development of crystal of Olivine, Schiffenberg, Giessen; Lava of Vesuvius, eruption of 1872 (Augite, Leucite, Plagioclase, &c., in vitreous base); Basalt with selvage of Tachylite, Ardtum Head, Scotland; Basalt with Nickeliferous Iron, Ovifac, Disco Island; Palatinite with twinned Augite, Martinstein, Nahe; Andesite (vitreous), Cheviots.

Mr. W. T. Suffolk :—Transverse section of Gland on Petiole of *Viburnum Opulus.*

Mr. J. J. Vezey :—Section of yolk of Egg of the Domestic Fowl.

Messrs. W. Watson & Sons :—Type-slide of Diatomaceæ from Oamaru.
Gill of Mussel with *Glochidia in situ.*
Type-slide of Sponge-spicules.
Fungus on stem of wheat (*Puccinia graminis*).
Hand of Human Fœtus showing ossification.
Bacillus tuberculosis in sputum.

THE
Royal Microscopical Society.

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

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

It consists of Ordinary, Honorary, and Ex-officio Fellows, without distinction of sex.

Ordinary Fellows are elected on a Certificate of Recommendation, signed by three Ordinary Fellows, setting forth the names, residence, and description of the Candidate, of whom the first proposer must have personal knowledge. The Certificate is read at two General Meetings, and the Candidate balloted for at the second Meeting.

The Admission Fee is £2 2*s*., and the Annual Subscription £2 2*s*., payable on election, and subsequently in advance on 1st January annually, but future payments may be compounded for at any time for £31 10*s*. Fellows elected at a meeting subsequent to that in February are only called upon for a proportionate part of the first year's subscription, and Fellows permanently residing abroad are exempt from one-fourth of the annual subscription.

Honorary Fellows (limited to 50), consisting of persons eminent in Microscopical or Biological Science, are elected on the recommendation of five Ordinary Fellows and the approval of the Council.

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The Council, in whom the management of the property and affairs of the Society is vested, is elected annually, and is composed of the President, four Vice-Presidents, Treasurer, two Secretaries, and twelve other Ordinary Fellows.

The Meetings are held on the third Wednesday in each month from October to June, at 20, Hanover Square, W. (commencing at 8 P.M.). Visitors are admitted by the introduction of Fellows.

In each Session two additional evenings are devoted to the exhibition of Instruments, Apparatus, and Objects of novelty or interest relating to the Microscope or the subjects of Microscopical Research.

The Journal, containing the Transactions and Proceedings of the Society, and a Summary of Current Researches relating to Zoology and Botany (principally Invertebrata and Cryptogamia), Microscopy, &c., is published bi-monthly, and is forwarded post-free to all Ordinary and Ex-officio Fellows residing in countries within the Postal Union.

The Library, with the Instruments, Apparatus, and Cabinet of Objects, is open for the use of Fellows daily (except Saturdays) from 10 A.M. to 5 P.M. It is closed for four weeks during August and September.

Forms of proposal for Fellowship, and any further information, may be obtained by application to the Secretaries, or Assistant-Secretary, at the Library of the Society, 20, *Hanover Square, W.*

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CONTENTS.

* In order to make the classification complete, (1) the papers printed in the 'Transactions,' (2) the abstracts of the 'Bibliography,' and (3) the notes printed in the 'Proceedings' are included here.

β. Histology.

γ. General.

B.—Invertebrata.

Mollusca.

α. Cephalopoda.

β. Pteropoda.

γ. Gastropoda.

δ. Lamellibranchiata.

Molluscoida.

α. Tunicata.

β. Bryozoa.

γ. Brachiopoda.

Arthropoda.

a. Insecta.

Vermes.

a. Annelida.

β. Nemathelminthes.

γ. Platyhelminthes.

(3) Cutting, including Imbedding and Microtomes.

(4) Staining and Injecting.

BOTANY.

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

α. Anatomy.

(1) Cell-structure and Protoplasm.

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

(3) Structure of Tissues.

(4) Structure of Organs.

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

(3) **Irritability.**

B.—Cryptogamia.

Cryptogamia Vascularia.

Muscineæ.

Characeæ.

Algæ.

Mycetozoa.

Protophyta.

α. Schizophyceæ.

β. Schizomycetes.

MICROSCOPY.

α. Instruments, Accessories, &c.

(1) Stands.

(2) Eye-pieces and Objectives.

(3) Illuminating and other Apparatus.

(4) Photomicrography.

(5) Microscopical Optics and Manipulation.

(6) Miscellaneous.

β. Technique.

(1) Collecting Objects, including Culture Processes.

(2) Preparing Objects.

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

(6) Miscellaneous.

Auct. del.

West, Newman lith.

New Fresh-water Infusoria from United States

ERRATA.

Page 727, *for* " β. Polyzoa" *read* " β. Bryozoa."
" 728, *omit* " β. Bryozoa."
" 778, lines 4 and 5, *for* " *Chreocolax* " *read* " *Chorcocolax.*"

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

DECEMBER 1891.

TRANSACTIONS OF THE SOCIETY.

X.—*Notes of New Infusoria from the Fresh Waters of the United States.*

By Dr. Alfred C. Stokes.

(*Read Nov.* 18*th*, 1891.)

Plate X.

The following diagnoses of Infusoria presumably new to science are of those forms that have been obtained from the shallow pools and the ponds near my home in Trenton, New Jersey, U.S.A., except in a few instances that are specially noted in the proper places.

Monosiga lacustris. Fig. 1.

Body elongate-obovate, twice as long as broad, widest near the centre, somewhat constricted below the point of insertion of the collar, the anterior border convexly truncate, the posterior region tapering to the pedicle; nucleus conspicuous, near the anterior border; contractile vesicles two, one near the centre of each lateral border, a large, conspicuous vacuole often developed at the posterior extremity; pedicle stout, apparently hollow, from two and a half to three times

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EXPLANATION OF PLATE X.

Fig. 1.—*Monosiga lacustris.* × 750.
„ 2.— „ *filicaulis.* × 720. A portion of the pedicle omitted.
„ 3.—*Salpingœca brunnea.*
„ 4.—*Plagiopyla Hatchi.* × 195.
„ 5.—*Strombidinopsis similis.* × 400.
„ 6.—*Chilodon labiatus.* × 375.
„ 7.—*Urostyla elongata.*
„ 8.— „ *fulva.* × 220.
„ 9.—*Trichototaxis stagnatilis.* × 260.
„ 10.—*Oxytricha setigera.* × 550.
„ 11.— „ *ludibunda.*
„ 12.—*Histrio Sphagni.* × 315.
„ 13.— „ „ Diagram of the concave margin of some forms.
„ 14.— „ *vorax.* × 150.
„ 15.—*Acineta æqualis.* × 525.
„ 16.— „ *pyriformis.* × 730.

as long as the body. Hab. pond water; attached to the rootlets of *Lemna*. Solitary.

This form most nearly approaches the *Monosiga obovata* described by the writer, but is readily distinguishable by its smaller size, the proportion borne by the length to the width, and the presence of two contractile vesicles.

Monosiga filicaulis. Fig. 2.

Body broadly ovate, the length but little greater than the width, slightly changeable in shape, elevated upon a delicately filiform pedicle from ten to twelve times as long as the zooid; contractile vesicles two, placed near the centre of the opposite lateral borders, a vacuole developed close to the posterior extremity. Length of the body, 1/1800 in. Hab. pond water; attached to the rootlets of *Lemna*. Solitary.

This is distinguishable from the *Monosiga longipes* of the author by the different form of the body, the smaller size and the much greater proportionate length of the pedicle.

Salpingœca brunnea. Fig. 3.

Lorica vasiform, the body or main portion sub-hemispherical, somewhat depressed, the neck almost as long as the height of the sub-spherical portion, the anterior margin flaring; body of the lorica usually a deep, chestnut brown in colour, while the neck-like prolongation is entirely colourless; inclosed organism not entirely filling the lorica, projecting some distance beyond the anterior aperture. Length of lorica about 1/600 in. Hab. pond water.

This beautiful form is not rare in the writer's vicinity, and it is specially noteworthy for the deep chestnut-brown colour of the body of the lorica and the colourless condition of the neck. How speedily after its formation the lorica assumes this tint is not known; I have not seen a colourless specimen.

Plagiopyla Hatchi. Fig. 4.

Body elongate-obovate, somewhat depressed, soft and flexible, less than three times as long as broad, the anterior border often obliquely rounded, the posterior extremity somewhat tapering and subacutely pointed; right-hand lateral margin frequently flattened, the left-hand side convex; oral aperture ovate, situated in the anterior body-half, near the right-hand body margin, its right-hand border bearing a narrow, undulating membrane; pharynx obscure; nucleus ovate, subcentrally placed; contractile vesicle single, spherical, near the centre of the right-hand body margin; cilia numerous, fine; trichocysts abundant, placed perpendicularly to the cuticular surface, which is minutely papillose. Length of body 1/150 to 1/200 in. Hab. ponds and standing water near Minneapolis, Minn.

The food of this interesting form seems to be chiefly vegetable, the infusorian feeding greedily upon spores and diatoms, which it engulfs apparently by suction. The body is very soft and flexible, easily forcing itself through narrow places and quickly turning on its course by a flexure or doubling of itself.

For the pleasure of studying it I am indebted to Dr. P. L. Hatch, of Minneapolis, Minn., who finds it abundantly during the summer months in grassy and shallow ponds, and observes that it thrives almost as well in standing water. He also reports that the anal aperture is postero-terminal.

Strombidinopsis similis. Fig. 5.

Body obovate, about twice as long as broad, finely striate longitudinally; frontal border truncate, slightly oblique, the body being somewhat constricted beneath it; posterior extremity obtusely rounded; a series of fine, hair-like setæ outwardly directed and projecting from the cuticular surface immediately beneath the peristome border, their length about one-half that of the body; oral depression broad, excavate, and continued as a wide, conspicuous, ciliated, pharyngeal passage extending to near the centre of one lateral border of the zooid, a tongue-like motionless projection present on one internal lateral margin of the peristome border, the oral depression appearing to be rather deeper beneath it than elsewhere; contractile vesicle single, spherical, located posteriorly; nucleus not observed. Length of body 1/400 in. Hab. standing pond water.

This form remotely resembles the author's *Strombidinopsis setigera*, and both so differ in important particulars from the typical *Strombidinopsis* that it may at some time be proper to relegate them to a new genus. The present form differs from that just referred to, in the general shape of the body, the presence of the apparently rigid, tongue-like peristomial projection, but particularly in a characteristic habit of producing from the mucous secretions of the cuticular surface a soft, shapeless, indistinct, sheath-like covering into which it retreats backward at the approach of danger. The frontal region is then somewhat contracted, the cilia and setæ being projected forward, the animal gliding backward for only a momentary and a very imperfect concealment. The mucous covering is so slight that it would commonly be unnoticeable but for the adhesion of minute floating particles and of rejected food. Its production seems to be involuntary; it is at least without definite form or describable consistence. The infusorian is in no way attached to this mucous formation, and may leave it at will. The creature at times avails itself of almost any soft collection of debris, beneath which it temporarily and imperfectly conceals itself while its ciliary currents bring to it the food morsels it needs. The peristomial cilia are capable of individual movement, the infusorian having complete control of each and all.

Chilodon labiatus. Fig. 6.

Body obovate, about twice as long as broad; posterior border usually obtusely pointed, often obliquely directed, occasionally somewhat acuminate; lip prominent, conical in outline, directed somewhat obliquely upward and outward, the anterior margin convex and continuous with the frontal border of the body, the posterior border obliquely truncate; nucleus ovate, in the posterior body-half; contractile vesicles not numerous, only two usually conspicuously developed, one on each side of the nucleus; ciliated adoral line conspicuous. Length of body 1/500–1/665 in. Hab. pond water, with decaying vegetation.

This form, as far as the lip-like prominence is concerned, somewhat resembles the *Chilodon caudatus* described by the author, conspicuously differing, however, in the absence of the dorsally developed and rigid, tail-like prolongation characteristic of the last named form, which is common and abundant in the shallow waters near the writer's home.

Urostyla elongata. Fig. 7.

Body elongated or sub-elliptical, very soft and flexible, less than four times as long as broad, both extremities rounded, the posterior often slightly the wider; anterior lip narrow, crescentic; peristomial field obovate, extending obliquely from the left-hand side of the anterior extremity toward the right for a distance about equal to one-third the length of the body, and continued internally as a narrow, tubular, non-ciliated pharyngeal passage extending to the body centre; the right and left-hand margins of the peristome ciliated, and a series of long intra-oral cilia depending from the central region; frontal styles numerous, the anterior the largest; ventral styles fine, numerous, arranged in six longitudinal series; marginal setæ longest and largest at the posterior extremity; anal styles from eight to ten, arranged in an oblique row, not projecting beyond the posterior extremity; endoplasm brown, semi-opaque; nucleus not observed; cuticular surface roughened by minute, hemispherical elevations arranged in irregular series. Length of body 1/85 in. Hab. standing pond water.

Urostyla fulva. Fig. 8.

Body sub-elliptical, soft and flexible, somewhat broader anteriorly, about three times as long as wide, the extremities rounded, the anterior lip crescentic and capacious; peristome obovate, extending to near the centre of the ventral surface, the right-hand or reflected border finely ciliate, and bearing an undulating membrane, the left hand margin also finely ciliate, and a series of long, fine intra-oral cilia depending from the roof of the peristome region and continued through the narrow, tubular pharyngeal passage which is curved toward the right-hand side; ventral cilia in six longitudinal series; frontal styles numerous, the most anterior the largest; marginal series not projecting beyond the lateral borders; anal styles five or six, fine, not projecting beyond the posterior margin, arranged in an obliquely directed series; endoplasm brown, semi-transparent. Length 1/100 in. Hab. standing pond water.

Trichototaxis * g. n.

Animal free-swimming, hypotrichous, soft and flexible, depressed; frontal styles numerous, in two curved, sub-parallel series; ventral styles forming three longitudinal rows; marginal setæ uninterrupted; anal styles well developed; inhabiting fresh-water infusions.

Trichototaxis stagnatilis. Fig. 9.

Body obovate or sub-elliptical, three times as long as broad; anterior extremity obliquely rounded, the posterior also rounded and often centrally emarginate; right-hand lateral border more or less convex, the left-hand margin flattened; frontal border exhibiting a somewhat conspicuous semicircular, ridge-like elevation, continuous with the inner or right-hand margin of the peristomial field, the latter ovate, obliquely placed at some distance from the frontal border, and extending to near the centre of the ventral surface, the posterior apex continued toward the right-hand side as a short, infundibuliform prolongation, the adoral cilia fringing the left-hand margin being directed toward the right-hand side and vibrating across the peristome field, the right-hand border bearing an undulating membrane; frontal styles numerous, in two curved series, continued posteriorly in two subcentral longitudinal rows of ventral styles, the third series of ventral setæ placed nearer the left-hand body margin: marginal setæ projecting at the posterior border only, where they are largest and most conspicuous; anal styles six or more, delicate and inconspicuous, not projecting beyond the posterior margin but arranged in an oblique row; contractile vesicle single, sub-spherical, in the anterior body-half, near the left-hand body margin and apparently discharging its contents through the dorsal surface; nucleus multiple, scattered or moniliform, the nodules sub-spherical, or broadly ovate; endoplasm finely granular, brownish; animalcule's movements seldom rapid. Length of body 1/150 in. Hab. an infusion containing decaying *Sphagnum*.

Oxytricha setigera. Fig. 10.

Body sub-elliptical, from three and one-half to four times as long as broad, soft, flexible, and contractile, the frontal border rounded, the

* Τριχωτος, hairy; ταξις, rows.

posterior tapering and obtusely pointed, the lateral margins flattened and nearly parallel; dorsal surface rounded, the ventral plane; lip narrow, inconspicuous; frontal and ventral styles five, scattered; anal styles five, all projecting beyond the posterior margin, their extremities usually fimbriated; marginal styles uninterrupted, long and conspicuous; dorsal, hispid setæ long and prominent; peristome field small, obovate, somewhat remote from the frontal margin, the inner or right-hand border apparently bearing a pendent membrane; nucleus double; contractile vesicle single, spherical, situated near the centre of the left-hand body margin, between the nuclear nodules. Length of the body 1/500 in. Hab. standing pond water.

Oxytricha ludibunda. Fig. 11.

Body ovate, depressed, soft and flexible, less than three times as long as broad, widest and rounded posteriorly, tapering toward the rounded anterior extremity, the right-hand border somewhat flattened, the left-hand margin convex; peristomial field narrow, scarcely arcuate, the right-hand or reflected border ciliate and bearing a membrane; frontal styles about eight, the three posterior smallest and most setose; ventral setæ five in number, two situated near the posterior termination of the peristome field, one subcentrally placed on the ventral surface, and two in close proximity to the five anal styles, the last often fimbriated; marginal setæ largest and most conspicuous at the posterior border; nuclei two, ovate; contractile vesicle single, spherical, near the centre of the left-hand body margin. Length of the body 1/245 in. Hab. standing pond water with decaying *Sphagnum.* Movements rapid and erratic.

Histrio Sphagni. Figs. 12 and 13.

Body obovate, depressed, about twice as long as broad; posterior extremity rounded, narrower than the anterior, the latter obliquely truncate at the left-hand side; upper lip small, crescentic; right-hand lateral border convex, the left-hand margin somewhat flattened, often sub-centrally concave or broadly emarginate; peristomial field broadly obovate, the posterior apex directed toward the right-hand side, the right-hand border finely ciliated and bearing a membrane; frontal styles nine, the three most posterior smallest and most setose; ventral styles five, two anteriorly, one sub-centrally, two posteriorly placed; anal styles large, only the first and the second on the right-hand side projecting beyond the posterior body margin, the extremities of all usually fimbriated; marginal setæ uninterrupted, those on the posterior margin largest; contractile vesicle single, spherical, on the left-hand side near the apex of the peristome field. Length of body 1/1225 in. Hab. standing water, with decaying *Sphagnum.*

Fig. 13 shows a diagram in outline of the left-hand body margin of those forms that present a concavity in the part, the appearance varying from a conspicuous sub-central hollow to a slight depression or even none, as already mentioned.

Histrio vorax. Fig. 14.

Body broadly ovate, often somewhat curved toward the left-hand side, widest posteriorly, the right-hand margin evenly convex, the left-hand side usually concave, yet sometimes almost straight; posterior margin rounded, or in mature and old forms slightly emarginate; frontal border oblique, often somewhat concave; upper lip small, crescentic; peristome extending to the centre of the ventral surface, the right-hand border ciliate and bearing a narrow membrane; frontal styles six or seven, large, uncinate, with three smaller setæ in an oblique series nearer the right-hand body margin; ventral styles five, two near the apex of the peristome field, two near the five large, broad, fimbriated anal styles, one sub-centrally placed; marginal setæ longer and more prominently projecting beyond the posterior extremity, but there comparatively few and wide apart, only the first, second and third anal styles on the right-hand side usually projecting beyond the body margin; endoplasm usually dark and semi-opaque by reason of the numerous, inclosed, small, dark granules. Length of body 1/150 in. Hab. standing pond water with decaying vegetation.

Acineta æqualis. Fig. 15.

Lorica broadly sub-triangular, much compressed, the length equal to the width of the anterior margin, the frontal border truncate, somewhat convex, apparently closed except at the slightly produced antero-lateral angles, but probably opening by a transverse slit for the escape of the embryo; gradually diminishing toward the posterior extremity, the lateral borders slightly and sub-centrally constricted, the posterior margin truncate, slightly convex; pedicle in length less than one-half the greatest width of the lorica; tentacles capitate, in two antero-lateral fascicles, one or more presenting externally a spiral aspect; endoplasm coarsely granular, entirely filling the cavity of the lorica; contractile vesicle single, spherical, located in the anterior body-half, near one lateral border; nucleus spherical, sub-centrally located near the lateral margin opposite the contractile vesicle. Length and greatest width of the lorica, 1/750 in. Hab. attached to the leaflets of *Myriophyllum* and to other aquatic plants.

In form this resembles *Acineta fœtida* Maupas, a salt-water species.

Acineta pyriformis. Fig. 16.

Lorica broadly ovate or sub-pyriform in outline, twice as long as broad, obtusely pointed at the anterior extremity, the lateral borders convex, slightly constricted near the truncate posterior extremity; pedicle short, its length less than one-half the diameter of the lorica, often somewhat curved; tentacles few, capitate, protruded from the anterior apex; contractile vesicle in the anterior body-half, apparently single; nucleus not observed; endoplasm usually coarsely granular, entirely filling the cavity of the lorica. Length of the lorica 1/1125 in. Hab. attached to aquatic plants in shallow ponds.

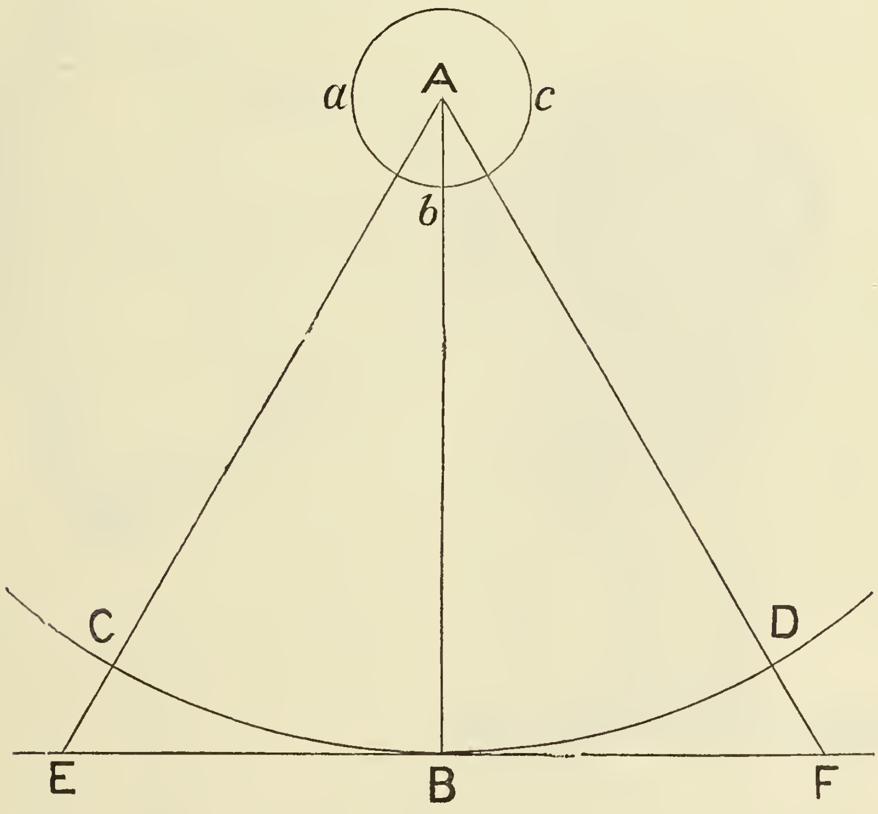
XI.—*On an Improved Method of making Microscopical Measurements with the Camera Lucida.*

By Sir Walter Sendall, K.C.M.G., M.A., F.R.M.S.

(*Read* 21*st October*, 1891.)

In fig. 77, *a b c* is a section, through the plane of the paper, of the draw-tube of the Microscope, in a horizontal position; A is the extremity of the axis of the tube, from which the line A B is drawn perpendicular to the axis, and meeting the plane of the table in the point B. If A B, the height of the Microscope from the table, be

Fig. 77.

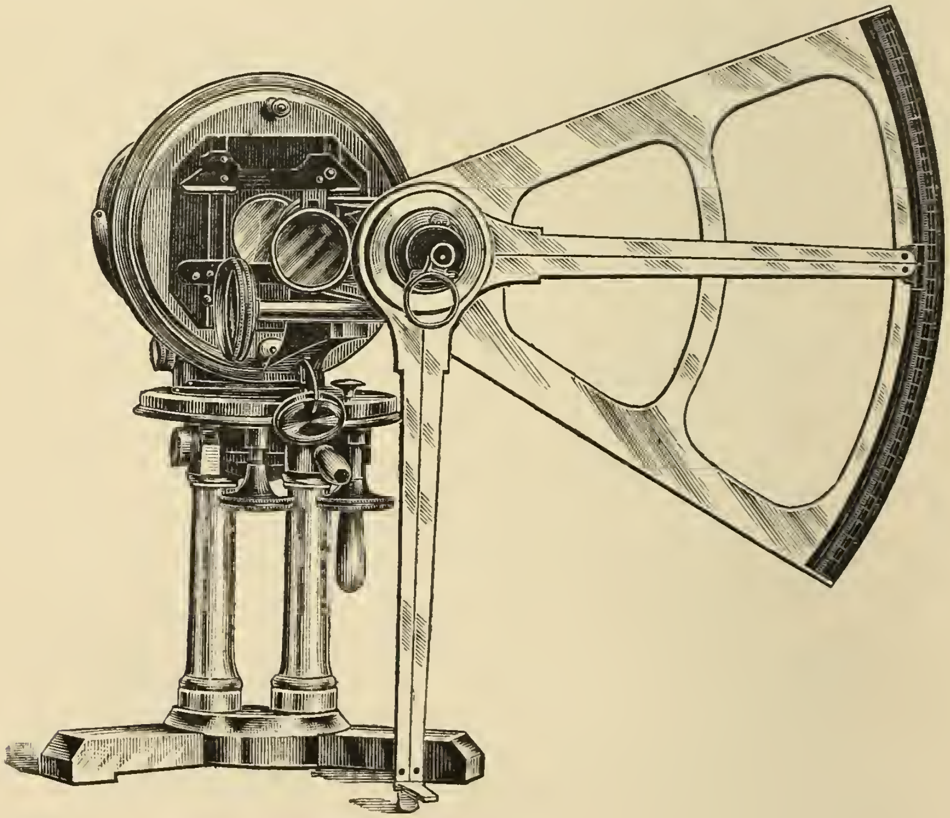


equal to ten inches, and a camera be placed at A, we shall have the arrangement commonly recommended for making drawings and measurements of the virtual image of an object, projected upon the plane surface of the table.

With centre A, and radius A B, describe C B D; take any points E, F, in the line E B F, and join A E, A F. Then, since the amount of magnification of the object, afforded by its virtual image, is dependent, at every point, upon the distance of the image from the eye placed at A, an inspection of the figure will show that it is only at the point B that we obtain a degree of magnification due to a distance of ten inches. At every other point in the surface of the table, such as E, F, we get an amplification due to a distance greater than ten inches.

A little consideration will in fact show, that if we desire to investigate the true dimensions of an object by examining its virtual image projected *upon an area of uniform magnification*, we must employ for this purpose, not the plane surface upon which such measurements are usually made, but a concave spherical surface, having the eye at A for its centre, and for its radius a length of ten inches, or whatever other distance may be convenient to the observer, or may be conventionally agreed upon, as affording a standard by which different observations may be compared with one another.

Fig. 78.



Reverting to the figure, if E F be a measurement taken across the image of an object projected upon the plane of the table, the amount of magnification deduced from such measurement will be in excess of the magnification due to a distance of ten inches, by as much as the length of the straight line E B F exceeds that of the circular arc C B D; and any conclusions drawn therefrom, either as to the magnifying power of the glasses employed, or as to the dimensions of the object under examination, will be affected with a corresponding error.

The error here involved may be corrected by a simple calculation, provided care be taken that the line to be measured is so placed (like the line E B F in the figure) as to be bisected by the central point of the field; and this can generally be effected with a fair amount of approximation to accuracy. The calculation is as follows.

The line A B, in the figure, being given equal to ten inches, and B E being known by observation, the tangent $\frac{\text{B E}}{\text{A B}}$ of the angle E A B, and hence the angle itself, becomes known; whence also the angle E A F, which is double of E A B, is known; and the linear value of the arc C B D can then be taken at once from the table of circular values, to be found in every collection of mathematical tables.

Fig. 79.

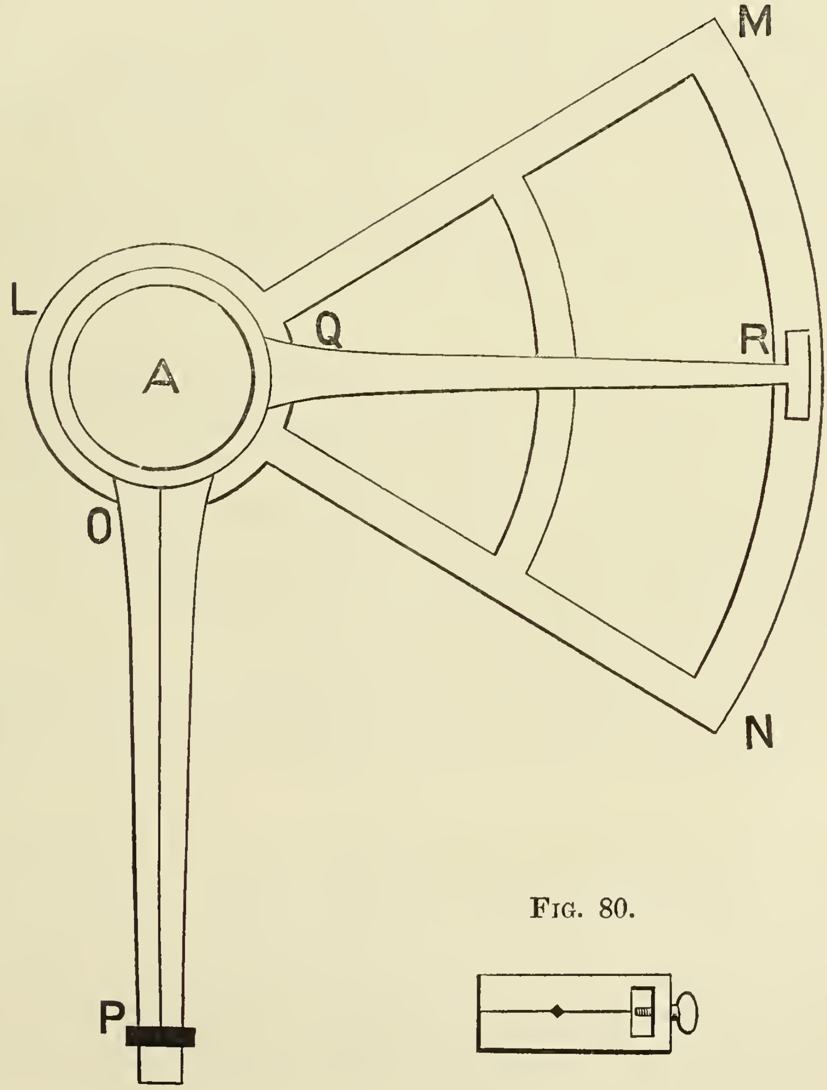


Fig. 80.

Substituting this value for the measurement E F, we obtain a quantity which accurately expresses the dimensions of the magnified image, due to a uniform distance from the eye of ten inches.

By applying a similar calculation in every case, all measurements taken with the camera upon a plane surface can approximately be reduced to their proper values; it would, however, be much simpler and more satisfactory, where accurate results are of importance, to take our measurements directly along the circular arc C B D of the figure; and this is the object of the instrument about to be described.

A mere inspection of figs. 78 and 79 will indicate the nature of the instrument, and its use.

A, being, as in fig. 77, the extremity of the axis of the Microscope, L M N is a graduated arc of 60°, fitted accurately upon the open end of the draw-tube, and secured in the position shown in the figure, by means of pins or studs which enter into notches cut upon the shoulder of the tube. It is essential that the draw-tube should not be able to turn; in a binocular body this will of course be the case, and in all others it must be specially arranged.

O P is a radial arm, which, together with A R, attached to it at right angles, swings freely about the axis of the Microscope. At P is placed a projecting piece, shown separately in fig. 80, which may be termed the speculum; this piece is slipped over the end of the radial arm O P, and kept in position at right angles to it by a binding screw. The speculum may be placed with either face uppermost; one being white with a black central line, the other black with a white line.

The arc M N is divided into degrees and parts (not shown in the figure); and at R there is a vernier, reading to the tenth of a part.

To use this instrument, a camera being placed at A, any part of the image of an object in the Microscope can readily be brought upon the face of the speculum; one edge of the image being then brought into contact with the line on the speculum, the arm O P is swung round until the same line coincides with the opposite edge, and the angle passed through is read off upon the arc M N.

This will give the dimension of the image, with perfect accuracy, measured along the circular arc C B D in fig. 77, and therefore upon an area of uniform magnification; the linear value of the measurement, to any radius, being ascertained at once from the table of circular arcs.

It is to be noted that the instrument will give accurate measurements only in one plane; that, namely, which cuts the axis of the Microscope vertically, at its point of intersection with the reflecting surface of the camera; the image should therefore be so adjusted that the required measurements may lie along the diameter in which the field is intersected by this plane; this will coincide with the horizontal diameter of the field, as presented to the observer looking through the camera.

It is also obvious that the action of the instrument is independent of the inclination of the Microscope body, or of its distance from the table; all that is requisite is that the radial arm shall have room to swing. The graduated arc may be of any dimensions, and the speculum may be adjusted to any length of radius to suit the observer's sight. In the instrument which Mr. Holtzapfel has made for the writer, the arc has a radius of ten inches, and is graduated in degrees, halves, and quarters. The least division therefore contains fifteen minutes; and by help of the vernier, readings may be taken to a minute and a half of arc; the linear value of which, to a radius of ten inches, is less than the 1/200 of an inch.

When constructed upon this scale the instrument requires a somewhat massive stand to support it; but it could easily be made smaller and lighter, though with some loss of range in the graduation.

The black face of the speculum will be found useful, in cases where the field of the Microscope is feebly illuminated; it being often easier in such cases to catch the outlines of the image upon a dark surface, than upon a light one.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

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

a. Embryology.†

Maturation of the Egg-Cell of the Fowl.‡—Prof. M. Holl, after describing young ova, and the formation of the tunica adventitia and the follicle, gives an account of the changes which occur in the nucleus during the process of maturation. In its youngest form the nucleus is circular or shortly oval, and placed in the middle of the egg. It soon becomes round if it was oval, and moves nearer to the surface of the cell. As it increases in size it returns to the centre of the cell. It shortly afterwards becomes flattened on one side, and with this again passes to the surface of the cell. During these changes in position the nucleus is always increasing in size.

The nuclear membrane has at first a distinct double contour, but this is lost as the nucleus grows; the membrane in time becomes almost or altogether lost, and the nuclear contents abut on the elements of the yolk. The nucleolus is, in the early stages of the nucleus, always visible in 2·5 μ sections; it is always placed peripherally in a space of the chromatic plexus. After increasing somewhat in size, the nucleolus begins to break up, and finally disappears altogether. The nuclear substance appears at first as an extremely fine plexiform mass, which does not stain; it fills up the narrow spaces of the nuclear plexus and extends in a thin layer between it and the nuclear membrane. This layer soon increases so that it forms an ever widening zone around the spherical plexus. In cross-section the whole of the nuclear substance appears as a disc, in the interior of which is

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

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

‡ SB. K. Akad. Wiss. Wien, xcix. (1890) pp. 311–70 (1 pl.).

the circular chromatin body; at first the disc stains only slightly, but with increasing changes of the chromatic substance it becomes darker, and has very fine darker grains scattered in it. This chromatic substance consists, at first, of a close network, which gradually becomes looser and passes into a filamentar coil; this coil increases in extent, becomes looser, and the filaments which form it begin to show cross-structure, that is, they consist of spheres set in rows and connected together by achromatin. As the cross-structure becomes more and more distinct, the particles send off from their surfaces very fine processes into the surrounding nuclear substance. The coil disappears as such, and in its place "supporting cords," which are distinctly cross-structured, traverse the nucleus; the processes, meanwhile, continue to increase in length; they, too, show cross-structure, and appear to send off processes themselves. From the ends of the ray-like processes the smallest cross-pieces are repeatedly broken up, and pass into the nuclear substance. In this way the chromatic cords become broken up, and finally disappear, while at the same time the nuclear substance becomes granular. The grains are so fine that the nuclear substance retains almost a homogeneous consistency.

The essential part in the changes of the chromatic substance of the nucleus consist in this, that what is primitively in the form of a close network increases in quantity and becomes distributed through the whole of the nuclear substance in the form of very fine granules. Finally, there are formed six chromatic rods, one end of which is placed close to the surface of the nucleus, while the other knob-like end projects into its interior; these rods have probably some relation to the formation of directive corpuscles.

When the work of others is compared with the author's results, it seems clear to him that the nuclear network of Amphibia, Birds, and Lizards passes through a regular series of changes during the maturation of the egg-cell, and there can be no doubt that similar, or very similar, changes are to be seen in the nuclei of the ova of other Vertebrates. The changes which occur in the body of the cell, in the tunica adventitia, and the zona radiata are described in detail, as are also the changes which occur in the follicle.

Development of Pronephros and Segmental Duct in Amphibia.*— Mr. H. H. Field has studied the development of these organs in *Rana*, *Bufo*, and *Amblystoma*, and he gives a very detailed account of his observations. He finds that the first trace of the excretory system is a solid proliferation of somatopleure, the pronephric thickening; the lumen of the system arises secondarily, and the pronephric tubules do not appear in consequence of the local fusion of the walls of a widely open pouch, but are differentiations at an early stage from the hitherto indifferent pronephric thickening.

Taking a wider survey of the Vertebrata generally, the author suggests that the pronephros and mesonephros are parts of one ancestral organ; that the glomeruli are strictly homodynamous with the glomus; that the entire tubular portion of the pronephros is represented in the mesonephros; that the cavity of a Malpighian capsule and the nephro-

* Bull. Mus. Comp. Zool., xxi. (1891) pp. 201–340 (8 pls.).

stomial canal connecting it with the body-cavity are detached portions of the cœlom, the equivalents of which are not so differentiated in the pronephros. This last is developed as a larval excretory organ, and it is suggested that the period at which it appears largely accounts for its peculiarities of structure.

So far as the excretory organs may throw light on the origin of the Vertebrata, Mr. Field is of opinion that the group of animals which presents nephridia most closely resembling those of Vertebrates is unquestionably that of the Chætopod Annelids, while the Vertebrate excretory system can be readily derived from that of Annelids by a series of steps which are in accord with the evidence afforded by the ontogeny of Vertebrates. At the same time he is careful to point out that none of the evidence is final, for we have no means of saying definitely what part has been played by physiologically similar needs in moulding the structure of the organs.

The author details and discusses the views of the numerous writers who have, especially in recent years, made contributions to this subject.

Breeding and Embryology of Frogs.*—Dr. J. H. Morgan states that the series of diagrams of the segmentation of the ovum ordinarily found in text-books is exceedingly diagrammatic and gives an entirely erroneous impression as to the appearance of the segmenting egg, especially during the later stages. Rauber has given excellent figures of the later stages of frog's eggs, and Dr. Morgan has in many points verified his account. Up to the eight-celled stage the segmentation is very regular, but after that no particular planes of division can be prophesied for any segment.

Newport's experiments on the orientation of the egg are the most to be relied on, and the author has been able to verify his results on a small scale.

Development of Engystoma.†—Mr. J. A. Ryder has some notes on the development of the "frog-toad," as it is called by the natives of North Carolina. The larvæ escape from the envelope three days after the deposition of the ova. Through the whole course of development there is well-marked evidence of the action of gravity in maintaining the equilibrium of the egg, the heavier or light-coloured vegetative pole remaining lowermost. There seems to be no tendency to rotate the egg through ciliary action, previous to the closure of the medullary folds. The fact that no change of position occurs for a long time in the eggs of *Engystoma* would indicate that possibly the future cephalic pole of the egg bears a constant relation to the cephalic pole of the parent, such as is known to be the case in *Batrachus tau*. As such relations between parent and offspring exist to a marked degree, if they are not universal in plants, Mr. Ryder justly remarks that it is desirable to know to what extent this rule holds for animals.

As soon as the larvæ become free they swim about actively; not, however, like a fish, for they revolve on their own long axes; after a day they take to the usual fish-like mode of progression. The adhesive organs of the mouth soon become functional; the head begins to widen

* Amer. Natural., xxv. (1891) pp. 753–60. † Tom. cit., pp. 838–40.

rapidly, the tail-fold soon becomes very thin, and the general behaviour is much more like that of the larvæ of *Rana*.

Egg and Larvæ of Teleosteans.*—Mr. E. W. L. Holt has a report on a series of observations carried on during the Royal Dublin Society's Survey of Irish Fishing-grounds. Twenty species were identified and nine not. The ova of *Lepadogaster bimaculatus* are attached to the shell by numerous interlacing fibrils which form, by the cohesion of their distal ends a structure resembling a shallow circular basket with a thickened rim, from which are given off numerous fine filaments of considerable length. In *Trachinus vipera* it was observed that the pectoral and pelvic fins were connected by a narrow lateral ridge which may, as Balfour suggested for Elasmobranchs, be regarded as a continuous lateral fin. For the first time the larva of the Dragonet (*Callionymus lyra*) has been hatched out from the egg, and the author gives a detailed description of it. With regard to a very conspicuous egg of an unknown species the author notes that it was only found in comparatively open water.

Development of Ganglia in the Fowl.†—Herr M. Goldberg finds, in sections of embryos of the second day's incubation, a strand of cells dorsal to the medullary canal, and connected with the ectoderm. This strand is derived from the ectoderm, has a secondary connection with the medullary canal, and gives origin to the ganglia of the trunk, to most of those in the head, and also to the peripheral nerve-ganglia. Goldberg confirms the observations of Onodi, Loewe, and others as to the origin of the spinal ganglia. In the head, the Gasserian, ciliary, acoustic, petrosum, jugular, and nodosum develope as the spinal ganglia do; while the genicular, the optic, and the olfactory ganglia develope directly from the brain. As to the origin of the sympathetic ganglia, Onodi's observations are confirmed.

Development of the Genital System.‡—Dr. J. Janošik has made a study of this question; he comes to the conclusion that if all the parts of the generative system were fully developed in Mammals (inclusive of Man) and the Fowl, a hermaphrodite gland would result; in this the testis would be internal, and the ovary superficial, as in lower animals where such relations have been described.

Primitively a gland is formed in which the only epithelial elements are those of the primary proliferation; if the secondary proliferation is weakened or suppressed, the gonad becomes a testis, but if it increases considerably an ovary arises. It follows that the cells from which the sperm is formed are descendants of the cells which arise from the primitive proliferation of the germinal epithelium, and are, therefore, ontogenetically older.

Phenomena of Fertilization.§—Prof. F. Vejdovsky points out that Fol is mistaken in saying that the "centrokinetic theory" was discovered by E. van Beneden and Boveri. In his memoir on *Rhynchelmis*, first published, in Bohemian, in 1887, but deposited in MS. in November

* Scientific Trans. Roy. Dublin Soc., iv. (1891) pp. 435–74 (6 pls.).
† Archiv f. Mikr. Anat., xxxvii. (1891) pp. 587–602 (1 pl.).
‡ SB. K. Akad. Wiss. Wien, xcix. (1890) pp. 260–88 (1 pl.).
§ Anat. Anzeig., vi. (1891) pp. 370–75.

1886, Vejdovsky described the periplast of the male pronucleus, its division, the appearance of daughter-periplasts, &c. The attractive spheres correspond to the periplasts, the central corpuscles to the daughter-periplasts. In contrast to Boveri, Vejdovsky regards the periplast as a structure arising independently of the sperm-cytoplasm; with daughter-periplasts appearing endogenously within it, it is continued in all subsequent divisions of the segmenting ovum. Vejdovsky does not believe in the reality of the "ovo-centrum" which Fol describes as associated with the female pro-nucleus. In the ova of *Rhynchelmis* at least there is no "marche du quadrille."

β. Histology.

Difference between the Nuclei of Male and Female Reproductive Elements.*—Prof. L. Auerbach has studied the male and female reproductive organs and elements of *Cyprinus Carpio*, *Esox lucius*, *Triton tæniatus*, *Rana temporaria*, *Lacerta agilis*, *Gallus domesticus*, &c., and after subjecting sections and preparations to the same technical treatment, finds that the sex-elements differ in nuclear characters. The head of the ripe spermatozoon consists entirely of cyanophilous substance; the tail and the intermediate portion are erythrophilous. In the ova the germinal vesicle is distinctly erythrophilous, and the nucleoli especially so. The same is true of yolk-granules, and of the cell-substance of follicular epithelium. But the substance of the ovum, and the outer layer of the vitelline membrane in the carp's ova, are more or less amphichromatic, sometimes reddish, sometimes bluish. As the head of the spermatozoon and the germinal vesicle of the ovum are the most important parts of the reproductive cells, it may be said that the male fertilizing-stuff is cyanophilous, while the complementary female-stuff is erythrophilous. And as the yolk-corpuscles are also erythrophilous, this characteristic is preponderant in the female germinal substance. Thus there is a qualitative nuclear difference between the male and the female reproductive elements.

Structure and Division of the Cell.†—Prof. W. Flemming has made a fresh study of epithelial, endothelial, and similar cells from larval salamanders. In division he finds traces of what seems to represent a cell-plate, such as occurs in plants and in some Invertebrates. He calls attention to a change in the cell-substance during mitosis—a peripheral thickening and the appearance of a clear loose internal stratum around the nucleus. He then gives a full account of what he has observed in regard to the attraction-spheres and central corpuscles in leucocytes and other cells, adding some observations to what was previously communicated.

The greater part of the present memoir is devoted to a discussion of cell-division and the origin of the spindle. The rudiment of the central spindle lies outside the nucleus, but Flemming cannot admit that the greater part of the spindle-fibres is due to extra-nuclear material. He is more inclined to believe that it is due to the linin-substances and membrane of the nucleus. But the spindle may well have a double origin.

* SB. K. Preuss. Akad. Wiss., 1891, pp. 713–50.
† Archiv f. Mikr. Anat., xxxvii. (1891) pp. 685–751 (3 pls.).

As to the cause of the initial longitudinal splitting of the chromosomata, this cannot be referred to a mechanical pull exercised by the spindle-fibres. It may be, as Boveri thinks, an independent vital process, a reproduction of chromatin elements; or it may have some relation to the formation of the intranuclear portion of the spindle-fibres. The unravelling of linin-threads from the chromatin of the nucleus may give some stimulus to the biserial arrangement of the chromatin elements which remain.

The "Intermediate Body" in Cell-division.*—Herr B. Solger has studied the division of the connective-tissue cells in the amnion of the rat, and has observed within the bridge between two almost separated cells a rod-like body which stains more darkly than the cell-substance, though less intensely than the chromatin. He refers to previous observations by Flemming and others on this minute structure.

Origin of the Karyokinetic Spindle.†—Dr. F. Hermann has studied this in the spermatocytes of *Salamandra*. The achromatin spindle certainly owes its origin to the cell-substance, to the protoplasm, but it is possible that the achromatin of the nuclear framework has some secondary share. From the dividing centrosomata to the nucleus contractile fibrils are developed, which eventually enter into a secondary connection with the achromatin fibres of the nucleus. All the fibrils which exhibit contractility belong to the cell-substance. In the central part of the completed spindle, fibrils run from polar corpuscle to polar corpuscle without entering into connection with the chromatin elements of the nucleus. But as a kind of mantle over the central spindle there extends another system of fibrils which proceed from the centrosomata to the chromatin elements. These do not run from pole to pole, but are interrupted by the chromatin elements near the equator. Around the centrosomata of the spermatocytes in *Proteus anguineus*, Hermann discovered groups of short, curved threads, which he calls archiplasmic.

Central Corpuscles and Attraction-Spheres.‡—Dr. M. Heidenhain finds attraction-spheres and centrosomata in the leucocytes of *Salamandra*, in the medullary cells of young rabbits, in the alveolar epithelium and leucocytes of the lung of a pneumonic patient, and describes the variations which these exhibit in the different cases.

Attraction-Spheres in Cœlomic Cells.§—Dr. O. Bürger finds, within the proboscis-sheath ("rhynchocœlome") of Nemerteans, resting cells, each with an attraction-sphere and a central corpuscle. The attraction-sphere lies in the long axis of the cell, often towards one end, usually by the side of the nucleus which almost always lies to one side of the cell. The centre of the attraction-sphere lies very near the nucleus, at an almost constant distance. The nucleus was often kidney-shaped, and then the centre of the sphere lay in the concavity. Only twice were double attraction-spheres observed, and the cells do not appear to divide.

* Anat. Anzeig., vi. (1891) pp. 482–3 (3 figs.).
† Archiv f. Mikr. Anat., xxxvii. (1891) pp. 569–86 (1 pl. and 2 figs.).
‡ Anat. Anzeig., vi. (1891) pp. 421–7.
§ Tom. cit., pp. 484–9 (7 figs.).

Division of Leucocytes.*—Prof. W. Flemming recognizes, as others have recognized, that free, colourless, amœboid cells, with polymorphic nuclei, in short with the characteristics of leucocytes, occur as wandering cells in the connective tissue and as inhabitants of the medullary spaces, and that they multiply abundantly by mitosis. It is certain that leucocytes divide both with and without mitosis. Like so many other cells they exhibit attraction-spheres and central corpuscles, but these do not seem to be implicated in the fragmentation or direct division of the nucleus. As to the significance of the two modes of division, Flemming comes to the following important conclusions:—The leucocytes *multiply* by mitosis, only the products of mitotic division live on and multiply; fragmentation of the nucleus, with or without division of the cell, has not to do with the production of new cells, but is a degeneration or an aberration; in some cases, where multinuclear cells are formed, it perhaps influences cellular metabolism by increasing the nuclear surface.

Structure of Striped Muscle.†—Dr. J. B. Haycraft finds that an "impression" of a muscle-fibre on a film of collodion shows in every detail the appearances characteristic of the muscle used to stamp it, in whatever state of contraction or relaxation that muscle may be. This confirms Dr. Haycraft in his previous conclusions as to the structure of striped muscle, for as the stripings are well seen on the films, they must be in part due to varicosities of the fibrils. The interfibrillar substance is of the nature of a matrix perforated by varicose tubes. There are two chief varieties of fully differentiated muscular tissue:—(*a*) There is the nucleated spindle devoid of sarcolemma and made up of fibrils cemented together, and these spindles may be striped or unstriped, the difference depending upon the rapidity of their contraction. (*b*) There is a second type consisting of cylindrical threads, sometimes invested by a sarcolemma, and with nuclei within the fibrils, under the sarcolemma, or in both of these situations, and these threads of tissue are striped or unstriped, according to the rapidity of their contraction. Striated muscle is defined as "muscular tissues, the ultimate fibrils of which have become varicose, in association with the power of quicker and more active movement." When a fibril segments into a number of much smaller portions, each one contracting and relaxing on its own account, the contractions are necessarily more rapid.

Prof. A. Rollett ‡ insists on the reality of the accessory disc (*Nebenscheiben*) or N-stripe of striated muscle-fibres. Retzius has recently maintained that this is merely due to a regular row of sarcoplasmic granules. Rollett maintains that it is due to definite anisotropic segments of the fibrils. This is shown by the appearance in polarized light, in alcoholic maceration, in stained preparations, as well as by the behaviour of the N-stripe during the contraction of the fibre.

Structure of Nerve-cells.§—Sig. G. Magini would make the following additions to the differential characters of nerve-cells. The

* Archiv f. Mikr. Anat., xxxvii. (1891) pp. 249–98 (2 pls.).
† Proc. Roy. Soc. Lond., xlix. (1891) pp. 287–303 (1 pl. and 5 figs.).
‡ Archiv f. Mikr. Anat., xxxvii. (1891) pp. 654–84 (1 pl.).
§ Atti R. Accad. Lincei—Rend., vi. (1890) pp. 19–23; vii. (1891) pp. 277–9.

nucleus has little or even no chromatin. In the motor nerve-cells of Mammals the chromatin is richly distributed in the cell-substance. There is generally a nucleolus, but this is rare in the cells of the neuroglia whose nuclei have many chromatin-granules. In motor nerve-cells the nucleolus is always excentric in position—a morphological fact perhaps of physiological interest.

Bioplasts or Plastidules.*—Drs. L. and R. Zoja have studied in various kinds of cells the bioplasts of Altmann or the plastidules of Maggi. Fuchsinophilous elements or plastidules are widely diffused in all the animals investigated. Their varied distribution in the cell is described, and particular attention is directed to their occurrence in spermatoblasts and spermatozoa. As to the probable function of the plastidules, the authors believe that they are nutritive.

γ. General.

Nature and Origin of Variations.†—Prof. C. Lloyd Morgan took the nature and origin of variations as the subject of an interesting and philosophical address to the Bristol Naturalists.

Exploration of Lakes.‡—Dr. O. E. Imhof reports on recent progress in lacustrine zoology. The littoral fauna—from the shore to a depth of 20–25 metres—is richest. Zacharias has explored forty-two lakes, Seligo sixty-four, Ssowinsky seventy-five, and so on. The fauna of the deep water in Scandinavian lakes contains some forms identical with or closely related to marine forms in the North Sea and Baltic. Numerous Alpine lakes—there are 590 in the Canton of Graubünden—have been searched. Almost all are rich in animal life, which persists even under cover of ice. Trout were found in Lej Sgrischus which lies 2640 metres above the sea-level. Most is known about the surface animals. Of these many have a very wide distribution; a few are quite local in their occurrence; some are restricted to distinct limits of vertical distribution. The list includes about 27 species of Protozoa, about 16 Rotifers, about 27 Copepods, about 46 Cladocera. As to number of individuals, one sample contained about 66,000 forms in a cubic metre, another about 113,040; but the number varies considerably at different periods.

B. INVERTEBRATA.

Animal Chlorophyll.§—Prof. E. Ray Lankester calls attention to Dr. G. Haberlandt's researches on the structure and significance of the chlorophyll-cells of *Convoluta Roscoffensis*. They have led to the suggestion that, whilst phylogenetically the cells must be regarded as Algæ, yet at the present time they have by profound adaptation to life in and with the *Convoluta*, altogether lost their character as independent algal organisms, have become an integral histological element of the worm, and, in fact, constitute its assimilation tissue. Prof. Lankester points out that this hypothesis is in complete accord with the views several

* Mem. R. Ist. Lomb. Sci., xvi. (1891) pp. 237–70 (2 pls.).
† Proc. Bristol Natural. Soc., vi. (1891) pp. 249–73.
‡ Ver. Schweiz. Naturf. Gesell., 1890 (pub 1891) pp. 157–70.
§ Nature, xliv. (1891) pp. 465–6.

times expressed by him that there is no more reason for regarding the chlorophyll-corpuscles of *Hydra viridis* and of *Spongilla viridis* as symbiotic Algæ than there is for so regarding the chlorophyll-corpuscles of a buttercup. Whether there is sufficient reason for the latter is a different question, and one not to be hastily dismissed.

It is obviously necessary to distinguish for the present the strongly marked unicellular parasites of Radiolaria and Anthozoa—the "yellow cells"—from the green cells of *Convoluta* and the chloroplasts of various forms.

Marine Invertebrate Fauna near Dublin.*—Messrs. G. Y. and A. F. Dixon have a report of their observations on various marine animals. They find that the number of œsophageal grooves in *Metridium dianthus* is not constant, as it is not unusual to find two. In the process of reproduction by fission it would appear that the parts separated from the parent are not in any way specialized; in some cases, however, there have been appearances of the formation of a bud. In this species one tentacle sometimes becomes greatly elongated and arches over the other tentacles; it ultimately returns to its normal condition, when it is not distinguishable from the others. One large example, while roving through the tank, stumbled across a fine specimen of *Bunodes verrucosa*, over which it poured out such an enormous number of acontia that the *Bunodes* drooped more and more until it died. *M. dianthus*, like *Actinia equina*, has the power of floating on the surface of the water, base upwards. The authors have paid particular attention to the arrangement of the mesenteries in this and other species, on which they have notes. Variations in coloration are also carefully noted.

Peachia hastata appears to have no stinging cells, or weak ones only, for gobies and other small fish rest placidly on it. Its ova were seen to be small spheres, furnished with short, stiff hairs or bristles, which stick out straight from the surface, and do not move like cilia. Gosse's *P. undata* is probably an immature *P. hastata*.

The authors justly remark that Gosse's description of *Zoanthus Couchii* is very general, and includes many forms that are or might be referred to distinct species—one for example is the *Epizoanthus Wrightii* shortly to be described by Prof. Haddon.

Of Crustacea the authors speak only of *Hyas araneus*, and express their belief that its habit of clothing itself with corallines, shells, and other foreign bodies is useful to it by helping to furnish it with the means of catching its prey. If the environment of the crab is changed its dress becomes altered to suit it.

The grace of the motion of *Eledone cirrosa* as it propels itself backward by ejecting water from the funnel is thought to be due to the position in which it folds its arms, always keeping the base of one on either side sharply projecting, so as to make a pair of lateral keels.

Origin and Mode of Termination of Nerves in Ganglia of Invertebrata.†—Herr. W. Biedermann gives first an account of the results of his investigations on *Hirudo medicinalis*. Of the fibres that form the commissures two that are broad generally exhibit a very distinct fibrillar

* Proc. Roy. Irish Acad., ii. (1891) pp. 19–33.
† Jenaische Zeitschr. f. Naturwiss., lv. (1891) pp. 428–66 (1 pl.).

structure, and are thereby specially distinguished from all the rest. The intraganglionic continuations of the commissural fibres are chiefly distinguished by the fact that most of them are branched. But few traverse the internal capsule without giving off numerous branchlets to the dotted substance. It is only at two points, and they are in the plane of the origin of the nerve-roots, that a branch is given off on either side from the bundle of fibrils which passes directly into the root of its side, and with it leaves the ganglion. Along the whole of the inner edge of each half of the internal capsule there are numerous nerve-branchlets which ramify in the dotted substance; these arise from the axis-cylinders which are given off from the roots of the other half of the ganglion. The central fibrous mass, or dotted substance of Leydig, is made up of elements of various origins; it forms an extraordinarily complicated plexus or rather a network of very fine nerve-fibres inclosed in itself; this is partly formed by the branching of the processes of ganglionic cells and partly from root-fibres which branch directly, as well as by lateral branches of the commissural longitudinal fibres which traverse the ganglia.

Nereis pelagica is an animal well adapted for the investigation of the minute structure of the ganglia of the ventral cord by means of methylene-blue. In all essential points there is a resemblance to what is seen in *Hirudo*. In both the most essential morphological constituents of the dotted substance is an extraordinarily complicated plexus of fine and very fine nerve-fibres, which have three points of origin. There are longitudinal fibres which, on their course through the ganglion, give off a number of lateral branches, which branch again. Then there are fibres, which, without becoming directly connected with cells, also branch considerably in the dotted substance, and, finally, a considerable contingent is afforded by the numerous secondary branches of the nervous processes. In both cases two bundles of fibrils traverse the whole of the ganglionic chain; these, in *Hirudo*, give off a branch at each, but in *Nereis* only to the four thickest roots.

The results of a few observations on *Astacus fluviatilis* and *Oniscus* are also given; in the latter the dendritic branching within the dotted substance is richer than has been observed in Worms.

In conclusion the author examines, in a general way, the results he has arrived at, and discusses them chiefly from the physiological side.

Spermatophores as a Means of Hypodermic Impregnation.*—Prof. C. O. Whitman thinks that the following proposition will with difficulty be credited:—The spermatophores represent an injecting apparatus, by means of which the spermatic elements of one individual are forced through the body-wall of another, at any point whatsoever. Such is, however, certainly the case, and may be demonstrated as often as one pleases, on almost any species of *Clepsine*. Without affirming it as a positive certainty, the author thinks there is evidence, little short of conclusive, that this is the normal method of bringing the sexual products together. Long-continued observation under most favourable circumstances has never given him so much as a single indication that the

* Journal of Morphology, iv. (1891) pp. 361–406 (1 pl.).

genital pores are ever united in the act of copulation. On the other hand, the planting of spermatophores on the surface of the body at any point that happens to come first is a common occurrence. Prof. Whitman has followed the track of the spermatozoa from the point of penetration to the cœlomic cavity in which the ovaries lie, but he has not yet determined when or how the spermatozoa pass through the wall of the ovisac; that they do so seems to be an inference justified by all the known facts. As the ovarian walls are represented by a thin membrane which becomes enormously distended as the eggs enlarge to maturity, the difficulty of penetration cannot be great; *Peripatus* and the Turbellaria seem to show that spermatozoa are capable of effecting the passage automatically. The discovery of spermatozoa projecting through the ovarian walls of *Peripatus*, as described by Moseley and Sedgwick, ceases to be a mystery.

The author gives a catena of authorities which appears to him to indicate that the original function of the spermatophore was what it now is in the Turbellarians, Rotifers, *Dinophilus*, and *Clepsine*—the injection of spermatozoa through the body-wall. This mode of impregnation is an important advance on the more primitive mode of setting the seminal elements free in the water. This deposition of sperm-capsules at random is further improved upon by restricting the act to a definite region, as the clitellum of Annelids, or the region around the external openings of the oviduct in crayfishes.

Prof. Whitman very justly remarks that what he formerly regarded as positive proof, either of self-fertilization or of parthenogenesis, is now open to some doubt.

An account is given of what was seen in the case of a new species of *Clepsine* (*C. plana*); when first placed in a dish several long white bodies were observed to be attached by one end to the dorsal surface of one or two individuals; those were naturally thought to be parasites. But, when put under the Microscope, a stream of spermatozoa was seen slowly issuing from the end that had been detached. Closer observation showed the mode of deposition; one individual, coming in contact with another, fixed itself by its oral sucker to some convenient point, and then, while pressing its protruded male pore against the back of its fellow, planted a fresh sperm-case. During the operation, which lasted only a few seconds, the region of the genital pores was more or less constricted, somewhat as it is in the act of forming an egg-cocoon. The case was, very likely, filled with spermatozoa by this act. This operation was repeated by the same individual several times in a period of thirty minutes; one of the first deposited spermatophores was 8 mm. long and 1 mm. wide; some of the last only 3 mm. or even less.

In the spermatophore it is possible to distinguish (1) a short constricted basal portion with a single tubular lumen, formed in the median unpaired portion of the male organs; (2) an elongated body with a double saccular lumen, formed in the enlarged terminal portions of the common vasa deferentia; and (3) a free end, consisting of two parts with the lumen closed or reduced to a narrow line, and formed in the ends of the ejaculatory ducts. The wall of the spermatophore is composed of two well-defined layers, the outer of which is thin, transparent, and cuticula-like, while the inner is denser, thicker, and stainable.

When first placed, the spermatophore usually stands nearly perpendicular to the surface, and considerable force is required to detach it; its mouth is completely plugged up with a peculiar secretion formed of elongated elliptical or spherical corpuscles; these dissolve in water in the course of a few minutes. They seem to serve not only as a means of protecting the spermatozoa against contact with water, but also as a means of opening and clearing the way for the safer penetration of the spermatozoa, for this mass is impelled through the skin in advance of the spermatic elements. In the course of an hour the greater part of the contents of the spermatophore will be found to have escaped. What happens when a spermatophore is produced may be supposed to be somewhat of this kind:—As soon as the sperm-case is ready for the reception of its burden, the corpuscular secretion and the spermatic fluid are driven forward into it. The spermatic fluid would sweep the corpuscular mass before it, and leave it in the basal portion of the sperm-case. The author is inclined to think that the charge is measured off each time in the ejaculatory ducts, and that the contents of the vesiculæ seminales are brought forward only to replace what has been ejected.

After some interesting extracts from various memoirs in which the mode of impregnation is discussed, the author concludes with drawing attention to the sceptical attitude adopted by Dr. Hudson * towards Dr. Plate's statements regarding the injection of spermatozoa through the body-wall. As may be supposed, Prof. Whitman is inclined to accept Dr. Plate's account.

Mollusca.

Phylogenetic Affinities of Mollusca.†—The essay of Herr J. Thiele has a much wider scope than his principal title would lead us to suppose. The following is the conclusion at which he arrives:—The decentralization of the organs is the ground-plan which is exhibited in the organism of Cœlenterates and Polyclads. Each system of organs extends over the whole body. The higher Bilateria, on the other hand, show a more or less extensive centralization; the enteron ceases to be branched, the numerous germ-glands unite; motor ganglionic swellings are formed; while the newly formed blood effects a distribution of the nutrient or excretory materials through the body, there are formed instead of water-vessels the primitively more localized nephridia; the respiration of the whole surface becomes limited to special respiratory organs, and arterial blood is distributed through the body.

The swimming movement, which was effected by cilia, is given up by the Cnidaria and Porifera, as well as by the Bilateria; but cilia are retained by Sponges, Polyclads, and other Turbellaria, and by the Nemertinea; the cilia disappear from a large part of the body in Gastrotricha and Rotifers, Molluscs and Annelids, while in some groups they may disappear altogether. Their place is taken by the development of more or less strong cuticular structures, which afford the animals a better protection against unfavourable external influences, which must be of very great significance to the slow-swimming Mollusca

* This Journal, *supra*, p. 6.

† Jenaische Zeitschr. f. Naturwiss., lv. (1891) pp. 480–543.

and to fixed animals. Hermaphroditism is completely retained by Ctenophores and Polyclads, and it is only in the higher forms that the Bilateria are seen to have the sexes separate. The Solenogastres are still partially hermaphrodite, and some of the larger groups of Molluscs and Annelids which have hermaphrodite glands appear to retain the primitive relations. The gonochorism of Cnidaria and of Rotatoria is a secondary character, as, in the author's judgment, is shown by the phylogenetic affinities of these animals.

The author deals with his subject under the following heads:—

(1) General Phylogenetic Laws; (2) Development of Cœlenterata from colonies of Flagellata; (3) Relation of Ctenophora to Sponges; (4) of the same to the Cnidaria; (5) Relation of Polyclads to Mollusca; (6) Affinities of the Amphineura; (7) Derivation of the Trochophore; (8) On Substitution of organs.

Tasmanian Mollusca.*—Mr. R. M. Johnston has published an introductory paper which he calls a provisional aid to the study of Tasmanian Mollusca. Something of the kind appears to be needed, for more than seven hundred species are known to exist in this area.

γ. Gastropoda.

Development of Central Nervous System of Pulmonata.†—Dr. F. Schmidt gives an account of his observations on the development of the central nervous system in *Limax agrestis* and *Clausilia laminata.* He agrees with those of his predecessors who derive the entire central nervous system from the external epithelium; the central ganglia arise from the epithelium of the sensory plates in the form of solid proliferations; soon after their separation from them the plates give off three blunt papillæ on each side to form the foundations of the two tentacles and the oral lobes. The epithelium of three of the tentacles gives rise by proliferation to the tentacular ganglia. The two pedal ganglia appear at the same time as the central, and are derived from the epithelium of the foot-plate. The visceral ganglia do not appear till later; they arise by proliferation of the epithelium in the neighbourhood of the orifice of the two primitive kidneys.

At this stage of development the nervous system of the Pulmonata exhibits a remarkable agreement with that seen in such Lamellibranchs as *Unio* or *Cyclas.* The subsequent changes in relative position may, Dr. Schmidt thinks, be thus explained:—After the several pairs of ganglia have separated in the embryo from the epithelium of the surface of the body and have become connected together by means of commissures, they form an integral system of organs, the further development of which proceeds quite independently of the increase in size and the unequal development of different parts of the body. Ganglia increase more rapidly in size than the commissures which unite them.

Structures known as cerebral tubes arise from the sensory plates after the formation of the foundations of the central nervous system. They first arise as sac-shaped invaginations of the epithelium of the sensory

* Papers and Proc. Roy. Soc. Tasmania, 1890 (1891) pp. 57–151.

† SB. Nat. Ges. Univ. Dorpat, ix. (1891) pp. 277–82. See Ann. and Mag. Nat. Hist., viii. (1891) pp. 186–9.

plates which appear, on each side, below the eye-tentacle, and grow in deeper and deeper until they finally come into contact with the cerebral ganglion of one side or the other. The lumen of the tube subsequently closes and loses its connection with the external epithelium, till at last it is transformed into a roundish mass which becomes completely fused with the corresponding cerebral ganglion; the boundaries of the original can, however, be subsequently made out as the small constituent elements take a much deeper stain than those of the cerebral ganglia. The author agrees with the Doctors Sarasin, the original discoverers of these tubes, in regarding them as corresponding to the cephalic pits and similar organs of various worms.

Growth of Shell of Helix aspersa.*—M. Moynier de Villepoix has investigated the growth of the shell of this snail. The epidermis with which it begins is peculiarly interesting on account of the presence of hyaline spherical globules, 10–12 μ in diameter, which cover its outer surface. They are organic in nature, and persist in the oldest shells. Calcareous matter is deposited on the inner surface of the epidermis at some distance from its edge. There is a white zone which is a gland formed of lageniform cells, with very elongated necks and granular contents; this is shown to contain calcareous matter. Behind this zone the mouth is covered by a cylindrical epithelium which contains pigment or colourless granules. In front of the zone the epithelium is invaginated to form the groove in which the free extremity of the epidermis is lodged. The bottom of this groove is occupied by an irregular plexus of cells, which appear to be epithelial; they contain transparent spherules, which present all the characters of the globules of the epidermis. This tissue forms a series of pockets in the connective tissue; the spherules grow at the expense of the protoplasm of the cells, which at last contains nothing but them. When set free the spherules collect on the fine organic membrane which is secreted by the epithelium.

The calcareous glands of the collar do not take any part in the formation of the shell, which is formed solely by (1) the pallial groove, in which are found the epidermis and the glandular pouches which produce the globules and which are now described for the first time; (2) the pallial band or gland which secretes the calcareous matter; (3) the pallial epithelium behind the gland which furnishes the pigment for the shell, and completes its calcification by the deposit of organo-calcareous layers, homologous with the nacreous layer of Lamellibranchs. When the animal has attained its definite size the band and the globule-glands completely disappear. The epithelium of the mantle and of the pulmonary sac alone remains active to serve in the internal thickening of the shell and not to repair its losses. The secretory activity of the pallial epithelium is so great that the author was able, for a period of two months, to see animals, deprived of food, reproduce every day the organo-calcareous membrane which he removed every morning.

Habits of a Murex.†—Dr. Ph. François writes that he has observed a species of *Murex* ("*M. fortispinna*"), at Noumea, in which one of the

* Comptes Rendus, cxiii. (1891) pp. 317–9.
† Arch. Zool. Expér. et Gén., ix. (1891) pp. 240–2 (1 fig.).

serrations at the mouth of the shell forms a prominent tooth-like process; and that this often looks worn, when the adjoining processes are intact. He one day saw one example of this species devouring a large *Arca*, and noticed that the tooth in question held apart the valves of the Lamellibranch and prevented them closing; the *Murex* was thus able to insert its proboscis and devour the unfortunate bivalve. The *Arca* (*Anadora pilosa*) is very difficult to detect, and shuts itself up at the least alarm.

Development of Paludina.*—Herr R. v. Erlanger has studied the development of *Paludina vivipara* with special reference to the development of the pericardium, the heart, and the persistent nephridium. In the young gastrula there are no hints of primitive mesoblasts; the mesoderm has its beginning in a ventral diverticulum of the archenteron. The cœlomic sac thus formed subsequently surrounds the gut in a bilaterally symmetrical crescent-shaped fold. Finally the mesoderm breaks up into spindle-shaped cells, which cross the body-cavity irregularly, but line the ectoderm on the one hand and the gut on the other. Erlanger believes that the mesoderm of Gastropoda is typically derived from the endoderm, in enterocœlic fashion, and thinks that the ova of the primitive forms had probably little or no yolk. A posterior aggregation of mesoderm cells, usually paired to begin with, represents the incipient pericardium; the septum between its two divisions is soon ruptured and absorbed. An evaginate thickening of the right side of the pericardium represents the beginning of the permanent nephridium. The development of the secreting portion of the kidney from cœlomic epithelium justifies the homology between the nephridia of Molluscs and of Annelids. On the left side there is a diverticulum which makes no progress; it represents the rudimentary left nephridium. The heart appears as an invaginate groove on the dorsal wall of the pericardium. This groove is somewhat curved, and is at an early stage slightly constricted in the middle. It gradually becomes a tube, retaining an anterior and posterior communication with the secondary cœlom. The median constriction is the first hint of the division into auricle and ventricle. The author also describes the pair of primitive nephridia which lie to the right and left behind and below the velum. The occurrence of primitive and permanent nephridia suggests that the Molluscs have developmentally two segments.

The Genus Atopos.†—Dr. H. Simroth describes the structure of this new genus of Vaginulidæ. He has studied three (all new) species:—*Atopos Semperi*, *A. Leuckarti*, and *A. Strubelli*. The internal anatomy is very peculiar. The heart, kidney, and lung are even further forward than in *Limax*, a position so divergent from that in *Vaginula* that Semper sought to refer *Atopos* to the Limacidæ. The mouth has no jaw-plate; the radula-sheath is remarkably developed and hidden in a special sac; the sharp rapacious teeth suggest those of Testacellidæ. From the mouth a pharynx leads to a short and narrow intestine, with a single but very large mid-gut gland in which the digestion takes place. The foot-gland is free, and around its

* Morphol. Jahrb., xvii. (1891) pp. 337–79 (4 pls.).
† Zeitschr. f. Wiss. Zool., lii. (1891) pp. 593–616 (1 pl.).

aperture there is a thick white mass formed from numerous accessory tubules. A pair of large and remarkable glands with long efferent ducts opening at the sides of the mouth, are described provisionally as spinning glands. The reproductive organs are like those of *Vaginula;* the female genital aperture is beside the anus and pulmonary aperture; the vas deferens extends forwards under the epidermis; the penis has no accessory gland. The œsophageal ring is very narrow. The whole of the interior is without pigment; the external pigmentation varies even within the limits of one species. Shell and shell-sac are as completely unrepresented as in *Vaginula.* Dr. Simroth describes the minute anatomy of the organs, and then compares the three genera *Onchidium, Vaginula,* and *Atopos,* which he regards as links of one genetic chain.

Development of Liver of Nudibranchs.*—M. H. Fischer has made a study of the young of *Eolis exigua.* When the larvæ escape the digestive tube is composed of a moderately long œsophagus, an ovoid stomach, and an intestine. In the anterior region of the stomach organs lie to the right and left; that on the left is a sac of some size, the cavity of which opens into the digestive tube and is lined by large cells with very fine cilia; these cells are capable of intracellular digestion, and the sac is the active digestive organ of the larva. The organ on the right is very small, and appears to have no function. The two form respectively the right and left lobes of the liver; the larval stomach has no relation to the similarly-named part in the adult. The two lateral organs increase in size, and in time the right hepatic lobe gives off a bud which goes to the right dorsal papilla and the left one which goes to the left, while behind it are a pair of buds destined for the second pair of papillæ. The liver of the adult Dorid is composed of a principal and of an accessory mass which seem to be derived respectively from the right and left lobes of the embryo.

Integument of Chiton.†—Herr J. Blumrich describes the structure of the decalcified dorsal shells of *Chiton siculus, Ch. lævis, Ch. Polii,* and *Acanthochiton fascicularis,* the disposition, arrangement, and development of the æsthetes and their fibrous strands, the mantle margin and its spines, and finally the epithelium of the branchial groove, the smelling organ, and the foot. The ectodermic epithelium in Chitonidæ typically consists of two kinds of cells, thread-like and glandular, with a simple cuticular fringe. This type is seen in the epithelium of the sole and in the glandular epithelium of the wall of the foot and of the olfactory organ. On the mantle-wall of the branchial cavity, the epithelium consists of cubical ciliated cells and is only locally glandular. The epithelium of the mantle is most divergent, for its cells have a very strong cuticular covering. This may be chitinous as in the "cuticula" and the "tegmentum," or calcareous as in the "articulamentum" and the spines. The glandular cells on the mantle are mainly restricted to the æsthetes and to most of the spine-bearing papillæ. There is no real difference between cuticula and tegmentum, the latter being simply the cuticula continued over the articulamentum.

* Arch. f. Naturgesch., lvii. (1891) pp. 75–104 (5 pls.)
† Zeitschr. f. Wiss. Zool., lii. (1891) pp. 404–76 (8 pls. and 1 fig.).

The entire mantle may be said to be covered with a cuticular shield, which outside the region of the shell bears calcareous spines. As the articulamentum alone is comparable with the ordinary Gastropod shell, and as the cuticula covers all, it seems certain that the cuticula is phylogenetically the more primitive. Herr Blumrich sketches the possible evolution of the shells from spines, and of the æsthetes from specialized papillæ of the mantle, but we cannot enter into the detailed results of his investigations. In a preface, Prof. Hatschek discusses the general importance of this study, which has obvious bearings on the question of the relationship between the Chitonidæ and the Aplacophora. Pelseneer's conclusion is corroborated that *Chiton* is nearer the primitive type than *Chitonellus*, and that *Neomenia* and *Chætoderma* are degenerate forms.

δ. Lamellibranchiata.

The Free-swimming Larva of Dreissena.*—Prof. F. Blochmann has found this larva, which has strangely escaped earlier discovery. It swims freely and seems to be abundant in the Ober-Warnow at Rostock, where *Dreissena* has firmly established itself. The transparent ova are extruded in clumps at the bottom of the stream; only the larvæ rise in the water. Dr. E. Korschelt has also found the larvæ, and will study their development.

Circulation in Arca.†—Dr. P. François has a note on the circulatory apparatus of *Arca barbata* (?). The auricles are almost triangular with the bases widely separated, so that, superficially, they look like two hearts; the ventricle is much reduced, and forms a sort of aortic bulb; the aorta, on leaving the heart, passes forwards, and to the right; it gives rise, on its left side, to three or four secondary trunks. The blood is like that of Vertebrates, coloured with a little water. This colour is due to a large number of very flat elliptical corpuscles which are all about 21 μ across. These observations have been verified on *A. pilosà* (?).

Molluscoida.

α. Tunicata.

Tunicata.‡—Prof. W. A. Herdman has published a revised classification of the Tunicata, in which he gives definitions of the orders, sub-orders, families, sub-families, and genera, with analytical keys to the species. He now takes a more extended view of the group than he was able to take in his 'Challenger' Reports. Among the Cynthiinæ there are the new genera *Rhabdocynthia*, which is established for the reception of those species which are provided with needle-like or rodlike spicules of carbonate of lime scattered through their tissues, and *Forbesella*, for *C. tessellata* of Forbes, which is remarkable for having only four folds on each side of the branchial sac. Among the Clavelinidæ *Rhopalopsis*, *Podoclavella*, and *Stereoclavella* are new generic groups which material recently acquired by the author has led him to establish. The

* Biol. Centralbl., xi. (1891) pp. 476–8.
† Arch. Zool. Expér. et Gén., ix. (1891) pp. 229–31 (1 fig.).
‡ Journn. Linn. Soc. Lond., xxiii. (1891) pp. 558–652.

monograph is one of the kind that is of great value in the present state of zoology.

New and Primitive Type of Compound Ascidian.*—Mr. W. Garstang describes an interesting form of compound Ascidian which he dredged off Plymouth in 5 to 15 fathoms. He calls it *Archidistoma* (*A. aggregatum*) and defines it as having incrusting colonies, and consisting of a spreading basal portion from which zooids arise at irregular intervals. Zooids free and partially fused, with distinct oral and cloacal apertures. No incubatory diverticulum of the cloaca. The test is arenaceous and there are about thirty tentacles; the ova are large and contain much food-yolk.

Archidistoma is a connecting link between the true Distomidæ and the Clavelinidæ. No true Distomid is known to possess free zooids, that is, zooids not completely imbedded in a common test. This new form, therefore, combines the structural characters of the Distomidæ with a social form of colony which is only slightly removed from that of the Clavelinidæ. It is also of especial interest because it exhibits the first stage in the evolution of the cœnobitic type of colony from the social Ascidian type, in which the zooids are entirely free and irregularly placed. Though the clumps of its zooids have no common cloaca, the cloacæ of the individuals are usually situated towards the centres of the groups.

β. Polyzoa.

Freshwater Polyzoa.†—Dr. F. Braem begins his memoir with a faunistic account of the freshwater Polyzoa of Prussia, where all the species known to be native in Europe are represented. He then passes to the problems connected with the development and reproduction of the Phylactolæmata. In *Cristatella*—and the same is true for the others—all the buds of the colony are traceable to a limited complex of embryonic cells, left over from the material of the statoblast or of the ovum, and carried on from bud to bud. This relation is expressed as the "principle of the double-bud," each bud usually forming, on its oral aspect and directly from itself, two daughter-buds, which multiply in the same way. In youth more than two buds may be formed; in older stages sometimes only one. The cystids—portions of the colonial wall interpolated between the polypides—also develope from the cells of the polypoid rudiment. The varied growth of the stock is discussed in detail. Besides the budding of individuals, there is budding of the entire colony. The movement of the *Cristatella*-stock is an essential condition of its growth. Dr. Braem then describes the development of the individual, the formation of the funiculus, and the origin of the statoblasts. He is convinced that the statoblasts are derived from both layers of the budding which leads to the formation of the germinal cells in the funiculus. The formation of statoblasts is like that of the buds; all are referable to older buds, which from the first divide into material for the upbuilding of the colony and material for the continuation of the species. The author then discusses the environmental conditions—such as cold—

* Ann. and Mag. Nat. Hist., viii. (1891) pp. 265–8 (2 figs.).

† Bibliotheca Zool. (Leuckart and Chun), vi. (1890) 134 pp., 15 pls. and many figs.

which favour the development of the statoblasts, and describes the complex internal processes which then occur. The germinating statoblast is equivalent to a single bud of the stock, or to a single cystid with its associated polypide. But in the stock the cystid developes from the polypoid bud, while the reverse is true of the statoblast, in which the cystid is primary and gives rise by folding and contraction to the polypide. The statoblast is like a bud, but with an inversion of the germinal layers. The bud is an individual developing from the polypidal pole with a secondary formation of the cystid; the statoblast is an individual developing from the cystidal pole with a secondary formation of the polypide. Dr. Braem also describes the sexual reproduction, which in a general way may be thus contrasted with reproduction by statoblasts:—The statoblast is an individual formed by budding, retained within the maternal colony, destined after the death of the latter and a resting period to continue the old stem; the fertilized ovum leaves the maternal colony while that still lives and is destined to begin a new stem. The embryonic cystid of the larva is a formation *sui generis*, and not comparable with the external part of the statoblast rudiment. This important memoir, the nature of which we have merely outlined, closes with a description of *Paludicella Ehrenbergii*.

β. Bryozoa.

Free Development in Ectoproctous Bryozoa.*—M. H. Prouho calls attention to three cases of free development in this group; these are represented by *Alcyonidium albidum*, *Membranipora pilosa*, and *Hypophorella expansa;* as these three forms differ not only in important morphological characters but in habitat and habits we may conclude that the *Cyphonautes* form is the larva of all Bryozoa whose ova undergo free development.

γ. Brachiopoda.

Anatomy of Lingula.†—Dr. P. François found that *Lingula anatina* could be detected by a small cleft in the sand which closes suddenly. Having discovered this he was able to get, in less than an hour, thirty specimens, of all sizes, from ·015 m. to ·05 m. in length. This proves that the form lives for at least more than a year, and that it therein differs from its ally *Glottidia*, which, according to Morse, attains its full development in one year. *Lingula* lives upright in its burrow, the upper part of the shell being flush with the surface and projecting at those points which correspond to the three tufts of long setæ on the upper edge of the mantle. The burrow in which it lives is not a tube in the sense of the "tube" of Annelids, for the sand is merely pushed aside, while the interior is lined with mucus secreted by the *Lingula*. The peduncle is greatly elongated and its lower part is lodged in a true tube of sand agglomerated by mucus; when the creature feels the approach of danger, the peduncle is suddenly contracted on itself, and the shell brought down to the mouth of the tube; the downward movement is effected as rapidly as that of a Serpula, and it often results in the com-

* Comptes Rendus, cxii. (1891) pp. 1316–8.
† Arch. Zool. Expér. et Gén., ix. (1891) pp. 231–9.

plete closure of the small cleft which alone revealed the presence of a *Lingula*. As in all Brachiopods the vitality is very great.

On each valve there are five muscular insertions—some for the adductors and protractors of the dorsal valve, others, more posterior, for the rotators and retractors of that valve. With regard to the circulatory apparatus the author has not been able to see the contractile ampullæ described by Morse as situated in the mantle. In each of the canals of the mantle the blood is constantly directed along an outgoing and an ingoing current, and the boundary of each current is so sharp that one is tempted to believe that each series is divided into two parts by a longitudinal septum. All the vascular ramifications end in rounded culs-de-sac, at the bottom of which the current makes a half-turn on itself. The arrangement of the trunks is such that each of them and of the branches of the sinus-system fulfils by itself at one and the same time the function of an artery and of a vein. In the body-cavity the circulation of blood is aided by the lining cilia; the mesenteries contain lacunæ. The body-cavity is prolonged into the arms and stalk; in the former there are three canals—a central sinus, the canal of the cirri and a very small labial canal. The author, in distinction to most who have written on the subject, regards the mantle and not the arms as the chief organ of respiration; and he thinks that the fleshy and muscular structure of the latter, and their thick envelope suffice to show this.

The blood is opaline and of a rosy violet; it contains a large number of corpuscles. These are more or less conical in form, and are from 20 to 25 μ in diameter.

The stalk consists of several distinct layers—an outermost, delicate, chitinous cuticle; a hyaline gelatinous layer, cartilaginous in consistency, and showing in section that it is formed of concentric lamellæ; a delicate layer of transverse muscular fibres; and a layer of longitudinal muscular fibres; there is a central cavity in which the blood circulates. In life, the stalk looks like a crystalline rod with an opaque white axis. In all the living specimens the stalk was seen to end in an ampulla, which was gorged with blood, but it has a delicate wall; it secretes the hyaline matter which surrounds the stalk. If, as often happens, a stalk is broken at its insertion into the mantle, the wound cicatrizes rapidly, and a small bud is formed which begins to elongate: it soon secretes a hyaline envelope. Dr. François kept specimens for at least six weeks in perfect health; he observed that they moved the valves of the shell in the most remarkable manner, now rubbing them on one another as a man does when he hears a piece of good news, and now moving them laterally, like the jaws of a ruminant. Now and again they contract rapidly, expel the water and draw themselves down on their stalk.

Arthropoda.

α. Insecta.

Embryology of Insects.*—Prof. v. Graber describes the development of *Meloë scabriusculus* Brdt. At a certain stage the ptychoblast shows on its inner side a hint of the ento-merosomites, but there is no segmentation of the ptychoblast into macrosomites. As regards the

* Zool. Anzeig., xiv. (1891) pp. 286–91.

curvature of the germinal streak, this species of *Meloë* comes between *Lina* and certain Hymenoptera. Of the gastroptyche only the caudal part at first developes; this extends forwards in two lateral processes, so that the contour has the form of the letter M; between the two lateral lobes the ptychoblast appears; the primitive head-lobes are still uncovered, even when the caudal fold has almost reached them; the ectoptygma persists as in *Lina*. The upper lip arises from paired swellings on the anterior margin of the protocephalon. The rudiments of the antennæ are visible even when the blastopore is still recognizable. The appendages of the first abdominal segment appear almost at the same time as the buds of the thoracic appendages, with which they are evidently homologous. On the following abdominal segments the appendages, whose existence is denied by Carrière but observed by J. Nusbaum, are at a certain stage distinctly bilobed. There are eight, not seven pairs of abdominal stigmata. Three pairs of Malpighian vessels arise as evaginations of the proctodæum. The incipient brain exhibits a single patch of dotted substance, most of the ventral ganglia show two. On very young embryos of *Hydrophilus piceus*, Graber has observed the bilobed character of the most anterior abdominal appendages. In very young embryos of *Gryllotalpa vulgaris*, the earliest rudiments of the most anterior abdominal appendages show the characteristic trilobed form of the thoracic appendages. Finally, Graber dissents from Cholodkovsky's interpretation of " lateral gastrulation."

Abdominal Appendages of Insect Embryos.*—Dr. v. Graber once more returns to the problem of the morphological import of the ventral abdominal appendages of insect embryos. Wheeler and Carrière regard these structures, especially the most anterior, as glands which were functional in ancestral forms. Graber regards them as remnants of appendages. The development suggests this; so do those cases in which they persist throughout life; the incipient rudiments are sometimes segmented; they may contain, like the limbs, a mesocœlic diverticulum; such are some of the arguments which Graber uses. He gives a table showing the different ways in which the appendages are reduced. The anterior or "prosthypogastric" structures may be reduced by constriction, by invagination, or by both, or by gradual flattening off; in the latter way most of the posterior or opisthohypogastric appendages disappear.

Protective Mimicry in Insects.†—Mr. E. B. Poulton draws attention to a Homopterous Insect from British Guiana, which mimics a leaf-carrying ant carrying its leaf. He suggests that we have here to do with a palatable insect much relished by insect-eating foes, which defended itself by acquiring a protective resemblance to leaves. The green colour and compressed body were probably evolved in response to the need for concealment. As the foes increased in acuteness, and penetrated this common disguise, it became of advantage to certain hard-pressed forms to resemble something which was positively objectionable to their enemies rather than merely useless and uninteresting. In the present case the transition from protective resemblance to protective

* Morphol. Jahrb., xvii. (1891) pp. 467–82 (6 figs.).
† Proc. Zool. Soc. Lond., 1891, pp. 462–4 (1 pl.).

mimicry would be especially easy, for it would be brought about by comparatively insignificant modifications of colour and form. The mimicking insects appear to be a species of *Stegaspis*, one of the Membracidæ, and the Ant mimicked is the Cooshie Ant (*Œcodoma cephalotis*).

δ. Arachnida.

Oviposition and Cocoon-weaving of Agelena labyrinthica.* — Mr. C. Warburton remarks that no accurate account appears to have been published of the cocoon-weaving of this form, one of the largest and most abundant of British species. If placed in a box, web-spinning begins by the stretching of a number of foundation-lines across the box at the level of the future sheet; the spider then walks to and fro along these lines, strewing them with numerous threads from its long, upturned, posterior spinnerets; at last an almost opaque white sheet becomes formed. The approach of oviposition is indicated by the animal commencing to weave a hammock-like compartment from the roof of the box and above the sheet-like web, to which it is braced by lines. Oviposition takes between five and ten minutes, and the eggs are entirely enveloped in a coating of soft material of loose texture. The final process is the construction of a closed box or case with the egg-bearing sheet for its roof; this is a beautiful filmy transparent structure.

The work is very varied and perfectly regular in the sequence of its variations; the author has been able to show that the work is performed even if the eggs are removed immediately after they have been laid; this extends and confirms the remarkable experiments on bees made by Fabre.

Copulation of Water-mites.†—Herr F. Koenike describes the peculiarities of the male *Curvipes fuscatus* and its remarkable copulation. The fourth joint of the hindmost leg is much incurved and bears strong bristles; the last joint of the third leg is shortened, curved, slightly swollen, and clawed; behind the very small genital aperture a chitinous receptaculum seminis projects into the body-cavity. At the breeding season the male keeps the tips of both of the third legs in the sperm-sac. The female offers prolonged resistance, but is gradually quieted. With the third legs the male seems to stir up the sperm-sac until emission occurs. With the bent joint of the last leg the male seizes the base of each of the fore legs of the female, the bristles making the grasp secure. The modified third legs are then used to transfer the semen, which forms a viscid mass of spermatophores and minute sharp spines. The latter may help to break up the spermatophores. The seminal mass is not directly placed in the vagina, but is fixed to the body of the female.

Anatomical and Physiological Notes on Ixodidæ.‡—Prof. A. Batelli has investigated *Ixodes reduvius*, *Ixodes hexagonus*, *Phaulixodes rufus*, *Rhipicephalus sanguineus*, and *Hyalomma marginatum*. He first describes the buccal apparatus with its stylets, rostrum, buccal glands, &c. In connection with the gut, he discusses the hepatic cæca which serve two purposes—storing and digesting. The destructive changes

* Ann. and Mag. Nat. Hist., viii. (1891) pp. 113–7 (1 pl.).
† Zool. Anzeig., xiv. (1891) pp. 253–6 (1 fig.).
‡ Monitore Zool. Ital., ii. (1891) pp. 78–84, 98–104 (1 fig.).

in the hepatic cells are then described. In the food-canal the blood loses all traces of red corpuscles, and forms a homogeneous reddish-brown mass, sometimes with crystals. Batelli supplements Pagenstecher's vague description of the Malpighian tubules, and describes the tracheal system which is genetically integumentary. A stigma is morphologically derivable from a group of hairs. The Ixodidæ have no eyes, nor apparently any dermaptoptic sense, but there are various seemingly sensitive setæ on the appendages.

Post-embryonic Development of Acarida.*—Dr. P. Kramer has studied *Diplodontus filipes* Dugès and *Nesæa fuscata* C. L. Koch. He distinguishes in the developmental history of Acarida (1) a *Tarsonemus* type in which a hexapod larva—in adult form—leaves the egg; (2) a *Trombidium* type (Trombidiidæ and Hydrachnidæ) in which an octopod nymph is interpolated between the larval and the adult form; (3) a *Tyroglyphus* type (Sarcoptidæ, Tyroglyphidæ, Gamasidæ, Demodicidæ) in which two nymph stages occur, and (4) an *Oribates* type (Oribatidæ) in which there are three nymph stages.

A Hermaphrodite Spider.†—Dr. Ph. Bertkau describes a species of *Lycosa* which exhibited the epigyne of a female and the swollen palp of a male, and had degenerate reproductive organs apparently most like diseased testes. His list of casually hermaphrodite Arthropods now includes 361 forms—9 Crustaceans, 3 Arachnids, 349 Insects.

Development of Limulus longispinis.‡—Mr. K. Kishinouyo has a preliminary note on the development of this King-Crab. About nine days after fertilization a blastodermic thickening comparable to the "primary thickening" already described by the author in the Spider, may be seen on the ventral surface of the egg. Its indifferent cells separate into ectoderm and mesoderm and form the commencement of the ventral plate. About the fourteenth day the mesoderm is divided into a number of transverse metameres, and, almost simultaneously, into two lateral parts. The endoderm is represented by the yolk-cells, which remain in the interior of the egg.

The segments of the cephalic lobe and the first appendage are primitively cut off from the anterior end of the ventral plate as one segment; all the appendages are post-oral in origin. The cœlomic cavity is not produced in the segments of the second, third, or fourth appendages; the cephalic lobe and the segment of the first appendage have a common cavity which developes along the sides of the stomodæum, and extends through the yolk to the dorsal part. In each of the segments posterior to the fifth a pair of cœlomic cavities appear which extend over and envelope the yolk; they give rise to a dorsal longitudinal median lumen (the dorsal circulating vessel) and many lateral slits (ostia). The mesoderm belonging to the second, third, and fourth appendages plays no part in the formation of the dorsal vessel.

In *Limulus* there is a distinct line of demarcation between the dorsal and the ventral surfaces. The cephalothorax, as in Trilobites, is composed of five lobes—a median, and two laterals on either side. In both,

* Arch. f. Naturgesch., lvii. (1891) pp. 1–14. † Tom. cit., pp. 229–38 (1 pl.).
‡ Zool. Anzeig., xiv. (1891) pp. 264–6.

again, the eyes are always on the ventral side of the line of demarcation, and on this line there are always spines.

The nervous system arises from a paired longitudinal thickening of the ectoderm; the anterior are much broader than the posterior ends, and there are two pairs of ectodermic invaginations; these parts form the brain. The ganglia are separated gradually from the general ectoderm, and this separation is effected before that of the brain. The eyes are developed from pre-oral ectodermic invaginations, externally to the brain; they are produced at the margin of the ventral plate and retain this position; the lateral eyes migrate backwards, and it is this movement which has led many authors to suppose that they belong to a thoracic segment.

The median eyes arise from a pair of small ectodermic invaginations, which are afterwards united into a tube; this tube is subsequently reduced to a solid rod, the distal end of which is enlarged, and lies at the margin of the ventral and dorsal surfaces.

ε. Crustacea.

Compound Eyes of Crustacea.*—Mr. G. H. Parker has an elaborate memoir on this subject. The principal question which he put before himself was, "What are the means by which ommatidial types are modified, and what is the significance of the changes through which these types pass." He has himself suggested already that those ommatidia which are composed of a small number of cells more closely resemble the ancestral type than those composed of many cells.

Three retinal types are distinguished in the compound eyes of Crustacea. In one the retina is a simple thickening in the hypodermis; this type is characteristic of Isopods, Branchiopodidæ, Nebaliidæ, Stomatopods, Schizopods, and Decapods. In the second type the ectodermal thickening becomes inclosed within an optic pocket; this may remain permanently open, as in the Apusidæ and Estheriidæ, or may become closed as in the Cladocera. In the third type the retina originates from thickened hypodermis, which subsequently separates into the corneal hypodermis and the retina proper. This is seen in Amphipods and Copepods.

The author thinks that the course of development taken by each of the three types very clearly indicates their mutual relations. The first of the types is evidently primitive, and as the other two pass through it they may be supposed to have been derived from it. In each case the retina is fixed in the simpler and movable in the more differentiated types.

The author very conveniently sums up his knowledge of the cellular composition of the ommatidia in the table given on the next page, wherein the abbreviation pr. marks the presence of any kind of cell when the number of that kind is not constant for different ommatidia in the same individual. In the Estheriidæ cones with four cells are sometimes found, though five is the usual number. It is possible that in *Serolis* there may be more than two cells in the corneal hypodermis of each ommatidium. In Schizopods, Stomatopods, and Decapods, the eighth proximal retinular cell is rudimentary.

* Bull. Mus. Comp. Zool., xxi. (1891) pp. 45–140 (10 pls.).

	Cells of Corneal Hypodermis.	Cone-Cells.	Retinular Cells.			Accessory Cells.
			Undifferentiated.	Differentiated.		
				Proximal.	Distal.	
1. Amphipoda ..	pr.	2	5	..	..	pr. (ect.?)
2. Branchiopodidæ and Apusidæ	2	4	5	..	..	0
3. Estheriidæ ..	pr.	5 (4)	5	..	..	0
4. Cladocera ..	?	5	5	..	..	pr. (ect. ?)
5. Copepoda—						
Pontella ..	pr.	2	5	..	..	pr. (ect. ?)
Sapphirhina ..	?	?	3	..	..	?
Argulus ..	pr.	4	5	..	..	?
6. Isopoda—						
Idotea	2	2	6	..	..	pr. (ect. ?)
Porcellio ..	2	2	7	4	2	"
Serolis	2 (+ ?)	2	..	..	..	"
7. Nebaliæ	2	4	7	..	..	"
8. Schizopoda ..	2	2	..	7 + 1	2	+ pr. (mes.?)
9. Stomatopoda ..	2	4	..	7 + 1	2	"
10. Decapoda ..	2	4	..	7 + 1	2	"

The author thinks that the type from which the ommatidia of all living Crustacea are probably derived would exhibit the following structures, a corneal hypodermis in which the cells are not regularly arranged, and the corneal cuticula was not facetted ; a cone composed of two cells ; a retinula composed of five retinular cells, and a rhabdome consisting of five rhabdomeres. The retina of the primitive eye, a simple thickening in the superficial ectoderm, would be composed of ommatidia of this type, arranged upon the hexagonal plan. No known Crustacean has an eye of exactly this structure, but that of *Gammarus* seems to most nearly represent it.

If these conclusions are correct, the principal types of ommatidia must have been produced mainly by increasing the number of cells in the primitive type ; the most influential means of modifying the structure of the ommatidia must have been cell-division.

Dermal Sense-organs of Crustacea.* — Dr. O. vom Rath gives a preliminary account of his comparative observations on the sensory organs of various Crustacea. He has discovered sensory hairs on almost all parts of the body. The first pair of antennæ are the bearers of the most important ; some act as protecting setæ to the olfactory organs ; these are so attached to the cuticle as to be incapable of any great power of movement ; they appear to be closed by membranes so thin as to allow of delicate sensation and the passage of fluids. Unfeathered, half feathered, completely feathered, and toothed sensory hairs may all be found on the first antennæ. The organs on the second pair are far less important than those on the first, though tactile hairs are often abundant, and exhibit great variation in size and shape. The gnathites always carry a number of sensory hairs, which the author regards as tactile bristles.

* Zool. Anzeig., xiv. (1891) pp. 195–200, 205–14. See Ann. and Mag. Nat. Hist., viii. (1891) pp. 299–313.

The histology of the nerve-end apparatus is essentially the same as that which the author has already described for Myriopods and Insects; he thinks we must exercise great caution in assigning functions to the dermal sense-organs, as their structure differs essentially from that of our own sense-organs, and they may possess senses entirely unknown to us.

Motor Manifestations of Crustacea.*—Dr. J. Demoor, after a historical introduction, gives an account of his experiments on *Palæmon serratus.* He finds that the fibres of the cerebral nerves do not cross to any considerable extent; the commissural fibres which connect the two halves of the supra-œsophageal ganglion have but little importance; each cephalic nerve ends partly in an independent nerve-centre, and each sends off a bundle of fibrils into the lateral ganglion. In the ventral cord, some fibres of the afferent nerve traverse the ganglion, and pass into the median region of the symmetrical ganglion. Fibres given off from the internal surface of the ganglion, take part in the formation of part of the transverse commissure; these curve at right angles, so as to become longitudinal, and pass towards the large internal nerve-cells of the ganglion of the same side. The number of fibres increases the more anterior the section; they predominate in the superior part of the chain, and are continuous with the fibres of the circum-œsophageal commissures. The author also gives an account of some experiments on the nervous system of Crabs made by means of sections, and the injection of various drugs.

Post-embryonic Development of Gonoplacidæ.†—Dr. G. Cano describes the larval stages of *Brachynotus* and *Gonoplax.* The former genus exhibits marked affinities with some *Grapsidæ—Pachygrapsus* and *Nautilograpsus.* As Cano was unable to examine the first larval stages of *Gonoplax*, he can give no verdict as to its systematic position.

Antennary Gland of Lucifer Reynaudii.‡—Prof. C. Grobben has made a careful examination of the antennary glands of this strange Decapod. That on the right side has an elongated terminal saccule near its hinder end and on the ventral surface there arises a constricted neck-like intermediate piece which leads to the urinary canaliculus. This at first runs parallel with the terminal saccule, and then makes a bend upwards and again descends to the ventral side; it again makes an upward and a downward turn and finally passes into a narrow canal, the ureter; this last traverses the conical excretory papilla as far as the tip, where it finds its orifice. The left antennary gland has, in general, the same arrangements as the right; but the several parts of the canaliculus occupy different positions. With regard to minute structure, the author observes that the terminal saccule is formed of an epithelium, the cells of which are generally flat, but sometimes make rounded projections into the lumen of the sac. The cell-contents are granular, and the nucleus, as compared with those of the renal-canal-cells, is small. These cells are set on a basal membrane, which

* Arch. Zool. Expér. et Gén., ix. (1891) pp. 191–227.
† Atti R. Accad. Sci. Torino, xxvi. (1890–91) pp. 639–48 (1 pl. not published in this part).
‡ SB. K. Akad. Wiss. Wien., xcix. (1890) pp. 559–67 (1 pl.).

is followed by connective tissue; the latter is connected with the large blood-vascular trunk which passes into the head.

The histological structure of the renal canaliculus is altogether different from that of the terminal saccule. The epithelial cells are large and polygonal, and so flat as to be worthy of being called pavement cells. The side turned towards the lumen has a thick striated cuticle. The protoplasm is granular in the part of the cell near the lumen, but in the rest has a peculiar structure; it is arranged in plates which are disposed perpendicularly to the surface of the cells. In places, the protoplasmic plates of one cell are continuous with the plates of a neighbouring cell; these plates are of irregular thicknesses, and a wavy course may be sometimes observed. Dr. Grobben states that his earlier view that the plates are arranged parallel to the contour of the nucleus was incorrect.

In cross-section the protoplasmic plates appear as rods, and have, therefore, the same appearance as the so-called rods in which the protoplasm of the kidney-cells so often appears to be arranged. The plates may be supposed to have arisen from protoplasmic rods set in order one behind another, and fused with one another. A similar disposition has been observed by the author in the renal cells of *Sepia*, and by Rabl in the oral epithelium of the larva of the Salamander.

The ureter has the same structure as the integument, of which it is an invagination. The wall consists of small cells with a cuticular lining on the side nearest the lumen.

Arterial System of Isopods.*—M. A. Schneider points out that in Isopods there is a vascular collar anterior to the nerve-ring, which supplies the arteries of the oral appendages. In Annelids, however, as well as in Myriopods and Arachnids, the analogue of this vessel is situated behind the brain. He has made some injections of *Porcellio* and *Lygia*, which show that the condition which obtains in Isopods is not really anomalous. In them, there are, behind the nerve collar, two arteries which arise from the aorta in the immediate neighbourhood of the point of origin of the ophthalmic artery. The course which they follow shows that they form a ring in every way comparable to that of Arachnids. The author has also been able to show that in *Porcellio* and *Lygia* the ophthalmic and antennary arteries form a vertical vascular ring which recalls that of Amphipods. He has, therefore, been able to show that the previously supposed unique arrangement of Isopods is not a true morphological peculiarity, and that they do not differ from Amphipods, as has been believed.

Development of Germinal Layers of Isopoda.†—M. L. Roule has studied the early development of *Porcellio scaber*. He finds that the blastoderm proliferates in several regions, and on the internal surface; but, notwithstanding the organs to which it gives rise, it does not lose the appearance of a simple epithelial layer set around the nutrient yolk. It retains this appearance even after the mesoderm and endoderm have been formed at its expense, and have become separated from it; and it then represents the ectoderm.

* Comptes Rendus, cxiii. (1891) p. 316. † Op. cit., cxii. (1891) pp. 1460-2.

Reproduction of Isopoda.*—Dr. G. Leichmann describes residual traces of hermaphroditism in the reproductive organs of Sphæromidæ, the form studied being *Sphæroma rugicauda*. The fact is of obvious interest in relation to the typical hermaphroditism of Cymothoidæ. In discussing the oogenesis of *Asellus aquaticus*, he describes the formation of the brood-chamber from peculiar lamellar appendages developed at the base of some of the thoracic limbs. In *Porcellio scaber*, the lamellæ are formed in the gap between the hypodermis and the cuticle of the thorax, and their formation is restricted to a single moulting period. In *Asellus*, however, the lamellæ appear very early as external appendages and their complete formation extends over three moulting-periods. It seems that the spermatozoa both in *Asellus* and *Sphæroma* penetrate as far as the ovaries, and that the fertilized ova pass rapidly down the oviducts and into the brood-chamber without the occurrence of the remarkable processes which are characteristic of the egg-laying of Oniscidæ. The author describes the typical formation of two polar bodies. It has been commonly supposed that the young of Isopoda are hatched in the brood-chamber, except indeed in the parasitic Anceidæ and Cryptoniscidæ. But Leichmann finds that in Sphæromidæ the development takes place within the body of the mother in eight thin-walled sacs which lie in pairs on the skin of the thoracic segments by the side of the nerve-cord. These sacs are not in direct connection with the ovaries or oviducts, they are invaginations of the skin. The eggs pass as usual into the space beneath the lamellæ, but are transferred thence into the eight sacs which have slit-like external apertures. As the mass of yolk is insufficient to account for the size of the larva, there must be some nutritive supply from the blood of the mother. So too in the structure of the lamellæ of *Asellus aquaticus*, Leichmann finds evidence that these serve for filtering nutritive constituents from the blood into the brood-cavity—an important addition to their acknowledged protective function.

Secondary Sexual Characters in Copepods.†—Dr. W. Giesbrecht, answering Prof. Claus, notices a number of omissions in Claus's account of the secondary sexual characters in *Calanidæ*. The omissions concern the following genera:—*Calanus* (*Cetochilus*), *Paracalanus*, *Eucalanus* (*Calanella*), *Clausocalanus* (*Eucalanus* Claus, non Dana), *Euchæta*, *Euchirella* (*Undina* Claus, non Dana), *Phaënna*, and some others.

Distribution of Copepods.‡—Dr. W. Giesbrecht adds to a previous list a summary in regard to the geographical distribution of the Copepoda collected on the "Vettor Pisani" expedition.

New Copepoda.§—Dr. C. L. Edwards describes five new Copepods which he found in the body-cavity of the Holothurian *Mülleria Agassizii*. Three of them are free-living forms,—*Dactylopus bahamensis* sp. n., *Esola longicauda* g. et sp. n., both belonging to the family Harpacidæ, and *Rhapidophorus Wilsoni* g. et sp. n., referable to the family Calanidæ.

* Bibliotheca Zool. (Leuckart and Chun), x. (1891) 44 pp. (8 pls.).
† Zool. Anzeig., xiv. (1891) pp. 308–12.
‡ Atti R. Accad. Lincei—Rend., vii. (1891) pp. 63–8.
§ Comptes Rendus, cxii. (1891) pp. 1268–70.

Two were semi-parasitic,—*Diogenidium nasutum* g. et sp. n., belonging to the Lichomolgidæ, and *Abacola holothuriæ* g. et sp. n., representative of a new family Abacolidæ. Along with the above the author also found a single specimen of a remarkable Crustacean, which he calls *Leuckartella paradoxa* g. et sp. n., whose external features suggest affinities with Copepods and with Phyllopods, though the organism is not referable to either of these orders.

Copepoda as Food.*—Prof. W. A. Herdman took an opportunity of getting large hauls of these Crustaceans to try them as food. A haul of twenty minutes, with a small net, made a dishful, which was shared by eight persons; with bread or biscuit it would probably have been a nourishing meal for one person. The species eaten was the large red form *Calanus finmarchicus*.

Two new Lernæopoda.†—Prof. P. J. Van Beneden describes two new Lernæopods, one from the Azores and the other from the coasts of Senegal. The former was found on a Ray and the latter on one of the Squalidæ. The first species is called *Brachiella Chavesii*, and on the single female there was fortunately a male; the female extends over 25 mm., and is most interesting for the characters of the abdomen, which is perfectly distinct from the rest of the body, flattens as it widens, and is triangular in form; there are four cylindrical appendages set parallel to the ovisacs, and there is no caudal segment. In some points this species is allied to *Charopinus*. The second species, *Brachiella Chevreuxii*, has a long cephalothorax, a very wide and wavy abdomen, four cylindrical appendages and a caudal segment; the female is in all not more than 12 mm. long, and its anterior part is flexible like a swan's neck; one male was found with its mouth applied to the skin of the female in the region of the sexual orifices; the circular mouth is surrounded by a circle of small setæ, and the abdomen is terminated by two conical appendages.

Vermes.

α. Annelida.

Eyes of Polychæta.‡—Mr. E. A. Andrews has made a study of the eyes of members of various families of Polychæta. He comes to the conclusion that the eye is a collection of pigment-cells with clear refracting portions at the cuticular and nerve-processes at the hinder ends. In the branchial eyes of some tubicolous forms the retinal cells are isolated by intervening pigment-cells, and each bears its own refracting medium in its cuticular end. There is thus no fusion of refracting media to form a common lens. Each true "camera" eye of the higher errant forms is composed of many cells crowded into a spheroidal mass; the pigment portions of the cells form a deep optic or retinal cup, from the open pupil of which the lens mass may project towards the cuticle. The retinal cup is lined by a layer of clear rods, each a part of one retinal cell. Between these rods and part of the lens a "vitreous body" may be interposed, or the lens may occupy the whole of the central space within the layer of rods. This lens is often con-

* Nature, xliv. (1891) p. 274.
† Bull. Acad. Roy. de Belgique, lxi. (1891) pp. 23–35 (2 pls.).
‡ Zool. Anzeig., xiv. (1891) pp. 285–6.

nected with the cuticle by a slender stalk. The retina is looked upon as a single layer of epidermal cells, each of which has elongated in such a way that its nucleus has receded from the cuticle while the clear, cuticular end has fused more or less with that of the other cells to form the layer of rods, the lens, and (if present) the vitreous body.

Anatomy and Histology of Serpula dianthus.*—Mr. A. L. Treadwell has made a study of this small worm by means of serial sections; the original describer, Prof. Verrill, appears to have taken the dorsal for the ventral side and *vice versâ*. Owing to the extraordinary development of the dorsal longitudinal muscles the animal, when coiled, has its dorsal side concave rather than convex, and this may have led to the error. The operculum is sometimes on the right and sometimes on the left side; on the opposite side is a small pseudoperculum, which seems to be of a sensory nature. The external cilia found by Claparède in allied Annelids appear to be absent from this species, but in a number of characters it agrees with *Spirographis Spallanzani* as described by that well-known anatomist. The food consists largely, if not entirely, of diatoms. The nervous system is highly developed, and the cerebral ganglion has a diameter of 5 mm. in specimens whose whole body-diameter was 14 mm.; it gives off anteriorly two large branchial nerves, two smaller œsophageal, and one posterior and median. There is a large circum-œsophageal commissure and a large ventral ganglion on either side. The ventral system is composed of two long nerves, swollen out into segmentally arranged ganglia which decrease in size from before backwards. The tubular fibres are not so highly developed in *S. dianthus* as in allied forms, for they thin out and disappear in the first pair of ventral ganglia.

The posterior dorsal portion of the cerebral ganglion is prolonged into a most remarkable process, for a large lobe passes outwards and backwards, and after a short course bends suddenly downwards and passes into the first ventral ganglion. They form, in fact, a second pair of œsophageal commissures made up almost entirely of nerve-cells, and giving rise, apparently, to no nerves.

The tubiparous glands lie one on either side in the first body-segment, and open by a common duct; they are much convoluted and have an internal duct which opens into the body-cavity by an expanded elongated funnel. The ovaries are small rounded bodies, one on either side in each segment behind the middle of the body, and set close against the segmental septa; the ova lie loose in the body-cavity, and completely fill it towards the hinder end; the external openings are in the posterior part of each segment, are small and surrounded by a thin lip made up of hypoderm, muscles, and peritoneum, greatly reduced in thickness, and of a special layer of circular muscles. The arrangement is such that a contraction of the body-muscles would open and that of the circular muscles would close the orifice. No male specimens have yet been seen.

Protective Device of an Annelid.†—Mr. A. T. Watson describes a Sabellid worm in which the tube, on the retreat of the contained

* Zool. Anzeig., xiv. (1891) pp. 276–80.
† Nature, xliv. (1891) p. 507 (3 figs.).

animal within it, proceeds to coil up like a spiral spring. This is, of course, an effectual protection against the intrusion of enemies. The worm, which belongs to an undetermined species, was obtained from Jersey.

Distribution of Magelona.*—Mr. E. A. Andrews adds the coast of North America for *M. papillicornis* found off the British coast; the worm has also been taken at Wimereux and off the coast of Brazil. Its wide distribution would be remarkable, as the adult lives buried in the sand, were it not for the long duration of the pelagic larval stage which allows of transport by ocean currents.

Clepsine plana.†—Prof. C. O. Whitman gives a detailed description of this new American species. In the course of his remarks he draws attention to the hitherto overlooked fact that, among Leeches, metamerism has undergone modification in two opposite directions. Variation by centripetal reduction of the number of rings is universal; variation by multiplication of rings characterizes, as a rule, only the higher forms, such as *Hirudo* and *Nephelis*. *Clepsine* rarely exhibits the second mode of variation, but a physiological explanation can be offered of the difference in this respect between the Clepsinidæ and the Hirudinidæ. *Hirudo* swims, and for this purpose a long flexible body is required; *Clepsine* habitually creeps, and for this mode of locomotion supplementary rings have not been essential. A preliminary and not a comparative description of the new leech is, for the present, offered.

Further Researches on Segmental Organs of Hirudinea.‡—Prof. H. Bolsius gives an account of his further researches on the segmental organs of various Leeches. In all the forms examined the terminal funnel of the organ is absent, as Vejdovsky has stated for the adults of all the species which he studied. *Hæmopis vorax* differs from *Hirudo medicinalis* and *Aulostomum gulo* in having the organ less closely packed and more coiled; a single layer of glandular cells surrounds the cells which contain the collecting tube. In *Clepsine* and *Hemiclepsis* the three canals take their origin from ramifications or lacunæ: both these form three independent systems, one for each canal; they may pass from one cell to another by a special prolongation, which is distinct from that which conveys an earlier formed canal. The three canals finally unite into one collecting canal, and the union is effected at a varying distance from the inferior orifice in various species.

The protoplasm in the cells of *Clepsine* and *Hemiclepsis* is sometimes divided into areas which separately surround each canal. In most cases these areas are not limited all round, but fuse partly with the ordinary protoplasm of the body of the cell. The boundaries of the areas never have a well-marked membrane. The typical mode of union of the cells is by as many separate prolongations as there are canals in the cells.

* John Hopkins Univ. Circ., x. (1891) p. 96.
† Journal of Morphology, iv. (1891) pp. 407–18 (1 pl.).
‡ La Cellule, vii. (1891) pp. 1–77 (3 pls.).

β. Nemathelminthes.

Structure of Nemathelminthes.*—Dr. O. Hamann calls attention to the pædogenesis not only of *Echinorhynchus clavæceps* but also *Ech. agilis*. Both persist and are mature in a larval state. Like *Archigetes Sieboldi*, they have arisen by "*phylo-pædogenie*." The author would interpret many forms, even *Amphioxus*, in a similar way, as larval stages which have become sexually mature. Four species of *Echinorhynchus* which Molin described as distinct, viz. *Ech. crassatus*, *flavus*, *de Visianii*, and *solitarius*, are really one. Hamann was fortunate enough to find numerous specimens of the genus *Lecanocephalus*, of which little has hitherto been known. It has only one longitudinal vessel, situated along the right lateral line in the anterior half of the body. This vessel opens to the exterior under the nerve-ring, and communicates posteriorly with the body-cavity. Some preliminary notes on the various structures of Nematodes are communicated.

Monograph on Acanthocephala.†—Dr. O. Hamann begins his monograph with an account of the maturation and segmentation of the ova in *Echinorhynchus acus*. Among the segmenting ova in the body-cavity lie ensheathed egg-balls which result from the disruption of the ovary. While the egg-cells are still in this stage, two polar bodies are formed. The precise moment of fertilization remains unknown; the spermatozoa are sometimes found in the body-cavity of the female; it is certain that in *Ech. acus* they penetrate the membrane of the egg-ball, for within this the first two stages of division occur. The two cells which result from the first division are unequal, the larger being towards the pole which bears the polar bodies; but on the whole the segmentation is regular. The central cells are always richer in chromatin than the peripheral. There is a triple sheath round the whole mass. The epiblast is never without nuclei, though these are poor in chromatin; a few giant nuclei appear at an early stage at the posterior end; in the larva the epiblast is a syncytium. In *Ech. hæruca* no polar bodies were observed; the segmentation is at first very irregular. The stage with an epiblast of several layers all poor in chromatin, and with a hypoblast represented by an internal mass of cells whose nuclei are rich in chromatin, is regarded as a gastrula. The larval forms *Ech. proteus* and *Ech. polymorphus* are then described. Hamann regards *Ech. clavæceps* Zed. as a species which has arisen by pædogenesis, for it is sexually mature at a stage which corresponds to a comparatively early one in most other Acanthocephala.

In the second part of his monograph the author describes the histology and organogeny. The larval state of the skin—a syncytium with a few giant nuclei and direct division—persists in *Ech. clavæceps*. Tho lemnisci act like the ampullæ of starfishes, helping in the extrusion of the proboscis, serving as a reservoir for the lacunar fluid. The musculature and the proboscis, the ganglion of the proboscis sheath, and the peripheral system, the gonads and their associated ducts are all described in detail. Under the title *Ech. proteus* Westr. von Diesing

* SB. K. Preuss. Akad. d. Wiss. (1891) pp. 57–61.

† Jenaische Zeitschr. f. Nat., xxv. (1890) pp. 113–231 (10 pls. and 4 figs.).

two quite different species—*Ech. proteus* and *Ech. Linstowi* sp. n.—have been confused.

Structure and Development of Echinorhynchus.*—Herr J. Kaiser continues his account of the Acanthocephala. The sub-cuticular fibrillar feltwork is described in great detail. The constant circulation of fluid has suggested to previous investigators that the fine fibres which bound the cavities might serve to keep up the current; Kaiser has shown that the radial fibres are the sole motor elements. The zone of radial fibres and the feltwork are very closely connected, but they are quite different; the latter is secreted from the hypodermis and is truly cuticular, whereas the radial fibres are formed from the plasma of the hypodermis cells and are contractile. As to the lemnisci, it is at least certain that they are not excretory. They are homologous with the lateral vessels of Nematodes, while the tubular network in the skin is an independent nutritive system, which might be compared to a system of blood-vessels. The rest of Kaiser's memoir, so far as published, is devoted to a description of the musculature, which presents a close resemblance to that of Nematodes, and yet has very distinctive peculiarities.

Notes on Parasites.†—Dr. C. W. Stiles fails to find the tooth which some authors have described in the embryos of *Ascaris;* he has seen, however, signs of the three lips characteristic of the adult, and thinks that he has here the origin of the error. He describes a new species of *Filaria, F. Gasterostei*, from the body-cavity of *Gasterosteus aculeatus.* In Paris, in May, he observed the escape of a number of specimens of *Mermis crassa* from the larvæ of *Chironomus plumulosus.*

γ. Platyhelminthes.

Large Land Planarian.‡—Dr. B. Sharp proposes the name of *Bipalium manubriatum* for a large land planarian, found in a green-house at Lansdowne, Pa. The tail is said to be rounded, and not, as is usual, pointed. The ground colour is greyish-yellow and is traversed by five longitudinal black bands. No comparison is made with *B. Kewense*, which has been found in so many green-houses.

The Papillæ of Microstoma.§—Dr. F. v. Wagner finds that the "attaching papillæ," described by von Graff at the posterior end of *Microstoma lineare*, are not papillæ at all, but simply the projecting terminal portions of unicellular glands.

The Genus Apoblema.‖—Dr. F. S. Monticelli describes *Apoblema* (*Distoma*) *appendiculatum*, *A. ocreatum*, and *A. Stossichii* sp. n. He accepts and corroborates Juel's reasons for considering these and related tailed Trematodes as in a distinct genus of the subfamily Distomidæ, a genus for which the title *Apoblema* proposed by Dujardin is adopted. He reduces the species to nine and gives a diagnostic table of these.

* Bibliotheca Zool. (Leuckart and Chun), vii. (1891) pp. 41–72 (2 pls.). Cf. this Journal, *ante*, p. 196.

† Bull. Soc. Zool. France, xvi. (1891) pp. 162-5.

‡ Proc. Acad, Nat. Sci. Philad., 1891, pp. 120-2.

§ Zool. Anzeig., xiv. pp. 327–31 (1 fig.).

‖ Atti R. Accad. Sci. Torino, xxvi. (1890–1) pp. 496-524 (1 pl. not published in this part).

Free-swimming Sporocysts.*—Dr. M. Braun has found a number of examples of a free-swimming sporocyst, of which only one had as yet been seen, in an aquarium in which various freshwater Gastropods had been recently placed. But, whereas the unique American specimen was only 1 mm. long, his were 6 mm. in length, and they were not quite transparent. Their bodies have a T form, the azygos limb being band-like in cross-section and thickened to a knob at the free end. In this last there was a yellow opaque corpuscle which was seen to be a coiled up *Distomum*; the paired limbs form lamellar, movable appendages.

These sporocysts came, it was ascertained, from *Limnæus palustris* var. *corvus*; they were discovered to be enormously developed *Cercariæ*, and only differ from *Cercaria macrocerca* and *C. cystophora* in having a furcocercal form. The only fish seen to swallow them were goldfish, but in these no Distomata were found. For the present this interesting form may be known as *C. mirabilis*.

Structure and Development of Tænia longicollis.†—Dr. v. Linstow's present memoir is a contribution to our knowledge of the Tæniæ of Fishes. All these combine to form a small and distinct group, which are distinguished by the absence of a rostellum with hooks at the apex of the scolex. Very little is as yet known as to their minute structure, so that the author takes the opportunity of giving an account of *T. longicollis* from *Osmerus eperlanus*.

Although Dr. v. Linstow has found various Fish-Tæniæ, this is the first case in which he has found one with sexually mature proglottids; it is probable that the proglottids only mature in the summer. The Fish-Tæniæ form an intermediate stage between the Tæniæ of warm-blooded animals and that family of Cestodes which Diesing called the Paramecotyleæ. The cuticle is very fine and appears to be homogeneous; the cutis is ·0026 mm. thick and is unstained by colouring matters; it exhibits a fine radial striation, but does not deserve the name of epidermis, as it does not consist of cells. Behind it there is a circular and then a longitudinal layer of muscles, while the parenchym is traversed by separate and feebly developed dorso-ventral muscles. The hypodermis or subcutaneous layer is remarkably well developed, and consists of closely pressed, large, vesicular cells with one or more rounded nuclei. The parenchym consists of cells with a very remarkable flask-like structure; from the nuclei septa pass to the outer membrane of the cell. In *T. longicollis* there are no calcareous corpuscles, though these bodies have been observed in other Fish-Tæniæ. The suckers on the scolex are circular, and in addition to the ordinary four, there is a fifth of half their size; they consist of cuticle, equatorial, meridian, strong radial, again meridian, and again equatorial muscles. The ganglonic cells of the brain are unipolar; two primary nerve-cords arise from the brain and pass down the sides within the inner longitudinal layer of muscles; they are semi-ovate in cross section, ·026 mm. broad and ·011 mm. thick.

The vascular system is formed of two larger longitudinal trunks

* Zool. Anzeig., xiv. (1891) pp. 368–9.
† Jenaische Zeitschr. f. Naturwiss., lv. (1891) pp. 565–76 (1 pl.).

and six smaller vessels which are much looped and anastomose considerably; it may be made out without the aid of sections by simply compressing an uninjured specimen.

The generative orifices lie at the sides and are (irregularly) alternately right and left. The testes are large multicellular organs which lie to the inside of the vitellaria; there are about twenty-five in each proglottid; the seminal vesicle is a large organ which is formed by a looped and coiled continuation of the greatly widened trunk of the vas deferens. The cirrus-sheath is spindle-shaped and its wall is formed by a layer of longitudinal and one of circular muscles; when the cirrus is protruded the space between it and the sheath is filled by loose connective tissue.

The two ovaries lie at the hinder margin of the proglottid and contain germ-cells ·013 mm. in diameter; the efferent ducts lie on the inner side, opposite one another, and lead to the ootyp; the vitellaria occupy almost the whole of the outer side of the proglottids. The various efferent ducts unite at the hinder end of the vitellaria into a common yolk-duct. In the form and position of their vitellaria the Fish-Tæniæ differ considerably from those of Mammals and approach those of the Paramecotyleæ on the one side, and many Trematoda on the other. In describing these various organs the author makes comparisons with those of other Fish-Tæniæ which have been already described.

The larva, like that of *Triænophorus nodulosus*, is encysted in the liver of the fish, whose intestine harbours the adult *Tænia*; in the matter of development, therefore, there is again a marked difference from that of the Tæniæ of warm-blooded animals, and a resemblance to that of many Paramecotyleæ.

Development of some Tæniæ of Birds.*—Herr A. Mrázek has investigated the cysticerci found in various freshwater Crustacea, and limited his further studies to such as are found in their cestoid condition in the duck and goose. *Tænia fasciata* of *Anser cinereus* and *A. albifrons* passes its cysticercoid stage in *Cyclops agilis*; the long diameter of the intermediate form is from ·18 to ·22 mm., there are eight hooks from ·055 to ·068 mm. in length, and the caudal appendage is extremely long. The cysticercus of *Tænia tenuirostris*, which is remarkably small and has a crown of ten hooks, is found in *Cyclops viridis*, *C. agilis*, and *C. lucidulus*; the tapeworm hosts are *Anser albifrons*, *Anas boschas* and *A. acuta*, *Fuligula cristata* and *F. brasiliensis*. Although the cysticercus of *T. gracilis* was first described by Linstow from the intestine of the perch, it is also found in *Cypris compressa* and *C. viridis*; the adult hosts are *Anas boschas* and *A. acuta* and *Mergus merganser*. A few cysticercoids of *T. anatina* have been taken from *Cypris incongruens*, and one from *C. compressa*; the hosts of the adult are *Anas boschas* and *A. acuta*. A new Cysticercoid form, which the author calls *Cysticercus Hamanni*, was found in *Garmmarus pulex*, but the cestoid form and its host are still unknown. The body of the young parasite is from ·30 to ·40 mm. long; the greater part of the body is covered by fine cilia which are described as being immobile; the crown contains from 18 to 22 hooks.

* SB. K. Böhm. Ges. Wiss. Prag, 1891, pp. 97–131 (2 pls.).

Dr. Linstow has made the private suggestion that this cysticercus is that of *T. constricta*, but the author does not accept the suggestion.

Herr Mrázek has observed that the hooks are not developed till a comparatively late period, and he suggests that this is why the scolex is able in earlier stages to freely extend and invaginate itself; an analogous phenomenon is to be observed in *Archigetes Sieboldi*. The well-marked development of the caudal appendage in all the cysticerci observed by the author in freshwater Crustacea is due, he suggests, to the intermediate hosts being animals which are, phylogenetically, very old.

Tænia coronula.*—Mr. T. B. Rossiter has a note on this tapeworm, the cysticercus of which he was recently able to show inhabited *Cypris cinerea*.

Echinococcus multilocularis in the Cow.† — Prof. A. Guillebeau reports the tenth case of the presence of *Echinococcus multilocularis* in an old cow; it did not seem to give rise to any disturbances, but the tumour taken from the hepatic capsule was an oval 9 by 13 cm. and 5 cm. thick. No cestode heads were found. The vesicles were surrounded by a layer of giant-cells, but these were in some parts replaced by large spindle-cells.

Cysticercus of Tænia saginata in the Cow.‡—Comparatively common as *Tænia saginata* is in Man, its cysticercus is only rarely found in the Ox. Prof. A. Guillebeau takes, therefore, the opportunity of making a few observations of a case in which a large number of this cysticercus were found in the flesh of a calf three weeks old. It has the form of a yellowish-white oviform nodule, 6 mm. long by 4 mm. broad.

δ. Incertæ Sedis.

Desiccation of Rotifers.§—Dr. R. Cobelli has desiccated Rotifers for five years and five months in the powdery dust of the gutter. Thereafter they were quite dead! But after immersion in water for 3–7 days the bodies were beautifully distended, and the internal organs were distinctly seen in a state of good preservation.

Determination of Sexes of Hydatina senta.‖—M. Maupas has made some experiments on the ova of this rotifer, with the object of seeing if he can determine the sex of its developed form. He finds that at the beginning of oogenesis the egg is neutral, and that temperature is a modifying agent. If the temperature is lowered females will be produced, if it is raised males will appear.

Distyla; New Rotifers.¶—Mr. D. Bryce has some observations in support of the view already expressed in this Journal that *Distyla* and *Cathypna* are distinct genera;** he describes two new species, *D. depressa* from the River Lea and *D. muscicola* †† from among roots of *Sphagnum* in Epping Forest, and *Monostyla arcuata*, also from the Forest.

* Intern. Journal Micr. and Nat. Sci., i. (1891) pp. 291–5 (1 pl.).
† Mittheil. Naturf. Ges. Bern, 1890 (1891) pp. 7–11 (3 figs.).
‡ Tom. cit., pp. 12–15 (1 fig.).
§ Verh. K. K. Zool.-Bot. Gesell., xli. (1891) pp. 585–6.
‖ Comptes Rendus, cxiii. (1891) pp. 388–90.
¶ Sci. Gossip, 1891, pp. 204–7 (8 figs.).
** 1890, p. 726.
†† Not *musicola* as in original (*teste auct. in litt.*).

Echinodermata.

Morphology of Echinoderms.*—M. L. Cuénot finds that in the course of development of Ophiuroids the ectoderm of the walls of the body is intermingled with the mesenchyme in such a way that distinction between them is impossible: in the adult the primitive ectoderm can only be recognized at certain points, such as the tentacles and teeth. In *Cucumaria*, likewise, the wall of the body is not bounded by ectoderm, for that layer is imbedded in the subjacent mesenchyme, where it forms groups of cells, above which are the connective fibres that form the outer covering of the body. In *Elpidia glacialis* there is no distinct ectoderm at all. In all Echinoderms the calcareous matter is formed in the same way; it is deposited on a connective plexus, in which nuclei are scattered, and which may be seen after decalcification; it is secreted by mesenchymatous cells which are very abundant in all developing calcareous tissues; the holes are due to the plexiform arrangement, and not, as Hérouard thinks, to the presence of nuclei.

The small ciliated spines which invest the fascioles of Spatangoids are identical with the vibratile spinelets which the author has described in *Astropecten;* like them, they appear to facilitate the renewal of water either around the anus (circumanal fasciole) or the branchiæ (circumpetalous fasciole). The anchors of Synaptids have no muscular fibres and play a passive part in locomotion, like the hooks of Ophiurids. Such Clypeasterids as were examined were found to be all provided with small tridactyle pedicellariæ, which recall those of Spatangoids. The Cuvierian tubes of Holothurians cannot be considered as anything else than defensive organs, and can be expelled in large numbers without injuring the digestive tube.

The author has studied the invagination of the nerve-cords in *Amphiura squamata;* at first they are superficial and exactly resemble those of Asterids, but by a process which is more like epiboly than invagination, tegumentary folds are formed above the nerve-ring, the radial cords, and the basal part of the ambulacra, and inclose a smaller portion of the external medium which forms the system of epineural cavities. It is possible that in some palæozoic Ophiuroids the nervous system was superficial. In all Echinoderms the histological constitution of the central parts of the nervous system is the same—nerve-fibrils running between the base of long filiform cells, the nucleus of which is placed near the exterior. These ectodermal cells, notwithstanding their epithelial form, appear to play the part of ganglionic nerve-cells.

There are a number of vestiges of the nervous invagination; there may be an empty space above the oral ring and the radial cords, or there may be, in youth, a direct continuation between the œsophageal epithelium and the oral ring already inclosed in the tissues; as the animal grows older the communication becomes reduced, and may altogether disappear. Thirdly, the radial cords always fuse with the ectoderm at their extremities.

The central nervous system consists of an outer and more important part, formed by the ectoderm, and an inner part, less constant, much

* Arch. Zool. Expér. et Gen., ix. (1891) pp. viii.–xvi. See also Arch. de Biol., xi. (1891) pp. 313–504 (4 pls.).

more delicate and probably of mesenchymatous origin; these two layers are separated from one another by a very delicate connective layer. In all groups the ambulacra or tentacles are provided with ganglionated nerves; ganglia are massed round the spines; in *Synapta inhærens* the peripheral plexus of the skin contains a number of small ganglia, which are in relation with groups of glandular cells, which probably produce a defensive secretion. M. Cuénot is of opinion that the spheridia are certainly sensory organs, and not altered spines; like the otocysts, they are, he thinks, organs of the sense of orientation.

The organs of reserve have, in very many cases, the form of amœbocytes of the fluid of the cœlom which are filled with fat or albuminoids; thus loaded they pass into the tissues by diapedesis, and remain there till needed. The saccules of *Antedon rosacea* are probably organs of reserve; they contain a certain number of cells which are filled with yellow spherules of a proteid nature.

The cavities of an Echinoderm body are very complex, for there are (1) the cœlom, formed by the fusion of the enterocœlic vesicles and more or less subdivided in the adult by secondary septa; (2) the axial sinus of Asteroids, Ophiuroids, and Echinoids, which contain the ovoid gland, which has an enterocœlic vesicle that has remained isolated; as dependencies of this are the sinuses connected with the genital organs; (3) the ambulacral apparatus (hydrocœl), which is derived from a portion of the enterocœl; (4) the schizocœlic cavities subjacent to the nerve-ring and radial cords, which often communicate with the axial sinus and with the cœlom; (5) the various lacunar schizocœls, which are formed independently in the different groups; and (6) the supraneural sinuses which represent an invagination cavity. The author describes some of these in detail.

The three types of hermaphrodite Echinoderms have each a special form of hermaphroditism; *Asterina gibbosa* is male when young, and, later on, exclusively female. In *Synapta*, at each epoch of maturity, the animal first ejects eggs only, and, later on, becomes exclusively male. What is remarkable in this case is that all the individuals of one locality are in the same stage, whence we must conclude that the ova are not fertilized till some time after expulsion. In *Amphiura squamata* the testes and ovaries are separated, the former being radial and the latter interradial in position; cross-fertilization is most frequent probably, but self-fertilization is possible. In *Ophiactis virens* the gonads are not developed till very late, and after the animal has already reproduced itself several times by median division.

The author is unable to accept any of the published phylogenies of this great group. The simplest type he can imagine is a *Prosynapta*, from which the Synaptidæ of the present have been evolved; *Prosynapta* gave rise to a *Proholothuria*, whence the Holothurida and Elasipoda have been derived. *Proholothuria* became *Procystus*, which gave rise to Cystoids, Blastoids, and Crinoids; it was at this time that the calcareous plates found a continuous skeleton, and that the larval anus was obliterated to open again independently in spots varying with varying types. *Procystus* was the parent of *Proechinus*, ancestor of all the Echinids, and the ancestor of *Proaster*, whence diverged the Asteroids and Ophiuroids. The author recommends this theory as conciliating the two most probable phylogenetic views, those of Neumayr and the Sarasins.

Ludwig's Echinodermata.*—Prof. H. Ludwig has continued the publication of his valuable treatise. The parts before us commence with a postcript, in which some recent discoveries in Holothurians are reported, which bear on the already concluded chapter on Morphology. The history of development is next dealt with in considerable detail, and the author then passes to the systematic arrangement of the Holothurioidea, which he divides, primarily, into the two groups he has lately established, the Actinopoda and the Paractinopoda.† The various divisions as low as genera are defined; for the species the student is referred to Thiel's excellent 'Challenger' report. The parts to hand conclude with an account of the geographical distribution of the class, which is illustrated by a series of small maps.

Apical System of Echinoids.‡—MM. C. Janet and L. Cuénot have some observations on the terminology of the apical apparatus. They are of opinion that the plates ordinarily known as the oculars should be called terminals. They also call attention to some examples of multiple genital orifices, which they consider to be of a teratological nature, and not a return to the condition which obtains in the Palæechinoids. As it is merely a question of absorption of calcareous matter, this may happen at two or three adjacent points instead of at one only. In some cases the madreporic pores extend beyond the area of the madreporite, and they describe an example of *Arbacia punctulata* in which they have observed it.

Cœlenterata.

Histological Observations on Cœlenterata.§—Dr. K. C. Schneider has found that by the aid of the Hertwigs' osmium and acetic acid mixture it is possible to discover ganglionic cells on the tentacles and the pneumatophore of *Apolemia uvaria* and on the polyps of *Forskalea contorta;* these do not essentially differ from the ganglionic cells found in other Cœlenterata. Sensory cells of the usual kind have been found at the anterior end of the polyps and tentacles of *Apolemia*. In the stem of this form and of *Velella spirans*, very remarkable and abnormal cells have been detected; the epithelium consists of cells of very various forms, between which intermediate stages may be made out. In *Forskalea* there are at the sides of the trunk transversely elongated cells which send a process inwards; with this, which may divide, the longitudinal muscles become connected. In a young *Halistemma*, in the trunk of which the central canal is extraordinarily wide and the septal elevations of the supporting lamella very low, their relations were particularly well seen; from which it follows that we have here to do with epithelio-muscular cells. Circular muscular fibres do not appear to be present. In *Apolemia*, however, muscular substance is inclosed in these prolongations of the cell-body, as also in the central processes which lead to the longitudinal muscle; at the same

* Bronn's Klassen u. Ordnungen des Thier-reichs. II. 3, Echinodermen, 1891, pp. 241–376 (pls. xiii.–xvii.). † See this Journal, *ante*, p. 478.
‡ Bull. Soc. Geol. France, xix. (1891) pp. 295–304 (11 figs.).
§ Zool. Anzeig., xiv. (1891) pp. 370–1; 378–81.

time, this is not true for all the cells of the epithelium. In *Apolemia* especially the development of the cells varies in a really extraordinary way; there are some which possess, in addition to the longitudinal muscle, fibres which run transversely and vertically; others have no transverse processes and end roundly on the surface. The peripherally rounded cells are, in *Forskalea*, chiefly found on the dorsal surface. Their form is very much that of the neuromuscular cells described by Korotneff; but they are not epithelial in position, and are merely special forms of epithelial cells. There are, in addition to them, other abnormal cell-forms. Sometimes, for example, the central process is completely wanting; pretty often it happens that the processes divide, and then there are what look like typical ganglionic cells. However, whatever the extent of the resemblance may be, there is always something or other in the cell which prevents our supposing that we have to do with a nervous element.

Korotneff's views as to what should be called nervous are very wide; the presence of quite irregular protoplasmic processes leads him at once to conclude that the cell is nervous. However, the giant-cells on the trunk of *Forskalea* possess processes, which in length, form, and structure leave nothing wanting to justify their being called nervous. These cells form aggregates with their long axis set transversely to the trunk; they are connected with the rest by short, thick connecting bridges, and the nerve-fibres which radiate out from them are often of extraordinary thickness, branch like ganglionic-cell-processes, and extend below the epithelium and into the muscles. The fluid which comes from the fibres may perhaps be compared with the hyaloplasm of the ganglionic cells of higher animals. The finer the processes—some are very delicate—the more difficult is it to distinguish them from processes of epithelio-muscular cells.

After some remarks on stinging-cells, the author states that he has been able to come to definite views on the formation of the spicules by a study of *Alcyonium acaule*. Indifferent ectodermal cells here and there form groups and give rise by fusion to the matrix-elements of the spicules. They take the form of the future spicule, and secrete calcareous substance, in which at first nuclei can be recognized: later on the organic groundwork becomes completely lost.

Organization of Anthozoa.*—M. P. Cerfontaine describes a new species of *Cerianthus* from the Red Sea, which he calls *C. brachysoma*. The body has the form of a cone slightly flattened transversely; the anterior extremity is marked by a strong dorsoventral costa, the presence of which causes the animal to appear to be bilaterally symmetrical. The tentacles are few but large.

The author next discusses the arrangement of the tentacles in *C. membranaceus*, as to which a number of discordant statements have been made. He finds that the number of marginal tentacles constantly varies during the existence of an individual *Cerianthus*, for fresh tentacles are always being formed, alternately to the right and left.

A few physiological observations on *Astroides calycularis* are offered; if pieces are cut off a polype we may see that individuals

* Bull. Acad. Roy. de Belgique, lxi. (1891) pp. 128–48 (1 pl.).

arise which live without any skeleton, and not only live but grow and reproduce by budding. He describes several teratological examples and points out that monstrosities are so frequent that special care ought to be taken in establishing new genera or species.

Kophobelemnon at Banyuls.*—Prof. H. de Lacaze-Duthiers calls attention to the presence at Banyuls of this rare Alcyonarian; as only one example was found, and that was still living at the time of the communication, no details are offered as to its structure. But it is pointed out that the fauna of Roussillon is very rich in rare forms, and offers much to the student.

New Alcyonarian.†—Prof. T. Studer calls attention to a new genus of Alcyonaria found in the Atlantic by the 'Hirondelle,' which he proposes to call *Chelidonisis* (*C. aurantiaca*). With some resemblances to the Isidinæ it has also some characters of the Mopseinæ, and tends to draw the hitherto isolated genus *Isis* nearer to that subfamily.

A Freshwater Medusa.‡—Dr. J. v. Kennel gives a description of a freshwater Medusa from a lagoon on the east coast of Trinidad which he calls *Halmomises lacustris*; it is one of the Thaumantiidæ. It has no marginal bulbs, cirri, or marginal vesicles; the umbrella is hemispherical, and has, it seems, sixteen to eighteen tentacles, on the outer side of each of which there is an ocellus. The velum is thin, but broad; the manubrium is well developed; the cruciform mouth has no lobes, there are four radial canals, and the gonads are frill-like. The bell has a diameter of 2–2½ mm. The colour is hyaline and faintly yellowish, while the gonads are yellowish-brown. The author was unable to find any hydroid which could be thought to be related to this Medusa.

Sensory Papillæ of Haliclystus auricula var.§—Herr G. Schlater finds that the nervous system of this Lucernarian is relatively simple, being localized in the tentacular knobs and especially in the marginal papillæ, and consisting of a system of distinct ganglion-cells connected with the sensory cells, with the cnidoblasts, and with one another. The marginal papillæ—which have received many names—are analogous with the sensory papillæ of other Acraspeda, but represent a low grade of differentiation. They have a musculature which is very slightly different from that of the tentacles.

Heliotropism of Hydra.‖—Mr. E. B. Wilson concludes that *Hydra* has an innate (automatic ?) tendency to wander, and that light and oxygen operate not so much by calling forth new movements, as by the modification of indefinite movements that tend to recur irrespectively of external stimuli. The case shows an interesting analogy to the movements of plants.

* Comptes Rendus, cxii. (1891) pp. 1294–7.
† Mittheil. Naturf. Ges. Bern, 1890 (1891) p. xvii.
‡ SB. Nat. Gesell. Univ. Dorpat, ix. (1891) pp. 282–8. See Ann. and Mag. Nat. Hist., viii. (1891) pp. 259–63.
§ Zeitschr. f. Wiss. Zool., lii. (1891) pp. 580–92 (1 pl.).
‖ Amer. Natural., xxv. (1891) pp. 413–33.

Porifera.

Classification of Sponges.*—Dr. R. v. Lendenfeld gives a compilation of our knowledge of the characters of Sponges, in which the genera are defined and a phylogenetic scheme offered. An alphabetical list is appended of the names given to the various forms of sponge-spicules, and there is also a bibliography of authors quoted.

Development of Spongilla fluviatilis.†—M. Y. Delage finds that, in the development of the fresh-water Sponge the ectoderm is formed at the expense of cells which were primitively internal; the ciliated cells take no part in its formation, for they pass into the interior of the body, where they are seized on by the amœboid mesodermic cells, and later on take part in forming the chambers and canals. This capture of the ciliated cells is, fundamentally, only a phenomenon of phagocytosis, which is incomplete in that it is temporary; some of the cells do, indeed, appear to be truly digested; it is probable that at the moment when they lose their cilia they undergo a temporary diminution of vitality, and that the amœboid cells capture them, but are unable to digest them. The author remarks on the interest of a fact of this kind becoming a normal phenomenon of development; it recalls to him the histolytic processes seen in Insects, but with this great difference, that here the elements incorporated by the phagocytes are utilized in future histogenesis directly, and not as simple nutrient materials.

Protozoa.

Successive Regeneration of Peristome in Stentor.‡—Prof. E. G. Balbiani finds that in *Stentor cæruleus*, and probably also in other species of the genus, the region of the peristome near the mouth, the mouth, and the œsophagus occasionally become atrophied; but the atrophy is soon followed by the complete regeneration of these parts. The regeneration commences with the formation of a new peristome and of a mouth which appears at the sides, before occupying the normal position at the anterior pole of the body. A new peristome may be easily recognized by the changes in its system of striation; it is divided into secondary areas, each of which has its own striation, and of which the number increases with the age of the animal. When these areas are multiplied they give the peristome a mosaic appearance which is more or less regular, and the degree of complication allows of an estimate of the age of the individual.

When the newly formed peristome changes its lateral for its terminal position, movements of contraction are seen in the nucleus; the result of this is the concentration of all its joints in a common rounded mass; when the change of position is effected the nucleus regains its moniliform appearance. All the phases of the nucleus are like those which it undergoes during division, except that it returns to its primitive number of joints. These changes in the form of the nucleus correspond, either on fission or reparation, with the stages in the displacement of the new

* Abhandl. Senckenberg. Naturf. Ges., xvi. (1890) pp. 361–439 (1 pl.).
† Comptes Rendus, cxiii. (1891) pp. 267–9.
‡ Zool. Anzeig., xiv. (1891) pp. 312–6, 323–7 (6 figs.).

peristome; we may, therefore, conclude that the nucleus has a direct action on the movements of the protoplasm. The regeneration of the oral apparatus in *Stentor* has probably the object of repairing the waste caused by a prolonged exercise of its functions, while in other Ciliata the regeneration appears to be connected with the process of conjugation.

Two new Infusoria.*—M. A. Certes describes two new Infusoria from the neighbourhood of Paris, which he calls *Conchophtyrius Metchnikoffi* and *Odontochlamys Gouraudi.* The former is 90–140 μ long and 60–100 μ wide; the latter was much smaller, being only 20–40 μ long and 18–35 μ wide; it is allied to *Chilodon* and *Chlamydodon*, but it is necessary to make a new genus to receive it.

Rhizopoda of the Lake of Geneva.†—In a short paper on this subject, Dr. E. Pénard describes a few new species. *Hyalosphenia punctata* differs in having the membrane not smooth, but distinctly covered with very small round scales, and in its smaller size, from any member of the genus yet described. *Quadrula globulosa* is the first of its genus in which the test is almost spherical instead of being elongated and flattened. *Campascus triqueter*, which is abundant near Geneva, is very closely allied to *C. cornutus*, but is distinguished by having no horns. *Acanthocystis Lemani* is a fine species, the ectosarc of which is almost always filled with yellowish-green granules, which were first thought to be parasitic Algæ; it was, however, recognized that they were small *Dinobrya* which had been captured by this Heliozoon. The spicules exhibit remarkable variations, some being much larger than the rest, and expanding suddenly at one end; others enlarge more gradually. All, whether typical or not, are constructed on the type of a funnel. The spicules are further remarkable for being two or three times as long as the diameter of the body.

Origin and Growth of the Shell in Freshwater Rhizopods.‡—Dr. L. Rhumbler does not agree with Verworn's conclusion that the shells of freshwater Rhizopods do not grow or change after they have been once formed, that is, after the division has been effected. There are three ways in which the cases of these Rhizopods arise:—(1) By the constriction of the parent shell, as in *Lieberkühnia*, *Diplophrys*, and *Lecythium;* (2) by the formation of a new and independent shell, as in *Microgromia;* (3) from materials which the parent Protozoon furnishes, as in *Euglypha* and *Difflugia.* But it may be frequently observed that the new shells contain fragments which, on account of their size, could not have been included in the parent animal. The question thus arises: In what sense are these large fragments secondary accretions? In answering this, Dr. Rhumbler describes the formation of the case in *Difflugia acuminata* during division; the occurrence of regeneration in *Difflugia spiralis;* the growth of shells with protoplasmic cementing substance, as in several species of *Difflugia;* the gradual growth of *Arcella*-shells; and the growth of the chitinoid case of *Centropyxis aculeata.* The division of *Difflugia acuminata* shows that firm portions

* Mem. Soc. Zool. France, iv. (1891) 6 pp. (1 pl.).
† Arch. Sci. Phys. et Nat., xxvi. (1891) pp. 134–56 (1 pl.).
‡ Zeitschr. f. Wiss. Zool., lii. (1891) pp. 515–50 (1 pl. and 2 figs.).

of the shell, especially the "extrathalamous" materials for the daughter-shell, may become plastic. This plasticity makes secondary growth possible. The same conclusion is corroborated by all the investigations above mentioned. Therefore the opinion that these Rhizopod cases are permanently fixed when first established must be abandoned.

Freshwater Rhizopods.*—Dr. E. Penard gives a monographic account of the freshwater Rhizopods which he has collected for the most part around Wiesbaden. In a general introduction he discusses many interesting problems—the shell-making, the structure of the plasma, the use of vacuoles as natatory vesicles, the direct relation between the activity of the contractile vacuole and that of the organism as a whole, the pre-eminent importance of the nucleolus and its variability (ten phases being described in *Amœba verrucosa*), the movements, the nutrition, the reproduction, &c. His observations corroborate, but do not greatly add to those of previous workers. In the systematic part of the memoir, which is illustrated by about a thousand figures, one hundred and ten species are described. There are eight new species of *Amœba*, nine of *Difflugia*, four of *Arcella*, six of *Nebela*, and so on, the total of forty-seven making a notable addition to the list of freshwater Rhizopods.

Biomyxa vagans.†—Mr. W. J. Simmons reports the presence in Calcutta of this amœboid form described by Prof. Leidy from specimens collected in North America.

Trypanosoma Balbianii.‡—M. A. Certes finds that *Trypanosoma Balbianii* is generally abundant on the crystalline style of *Tapes decussata*, but it more or less completely disappears when the style is dissolved. He has observed a large specimen undergoing horizontal division into two. In February and March 1891 the species had completely disappeared from the green oysters of Marennes.

Freshwater Peridineæ.§—Herr A. J. Schilling has a monographic memoir on this group, in which, after a historical introduction, he commences by describing the organization of the creatures that compose it. One of the most puzzling parts are the so-called eye-spots or stigmata. They have the form of a polygonal or horseshoe-shaped disc, and are always placed in the longitudinal groove immediately beneath the surface of the body. As in the eye-spots of other Flagellata, the protoplasmic groundwork forms a fine network in which red-coloured granules or spherules are deposited. The speed with which these organisms move appears to depend on the size of the body. Reproduction appears to be always effected by vegetative multiplication by division into two. The statements that have been made as to processes of copulation and conjugation want further confirmation.

In the descriptive portion of his work the author recognizes the six genera, *Hemidinium*, *Gymnodinium*, *Amphidinium*, *Glenodinium*, *Peridinium*, and *Ceratium*. He defines in detail the species that belong to each, some of which are new.

* Mém. Soc. Phys. et d'Hist. Nat. Genev., xxxi. (1890–91) 230 pp. (11 pls.).
† Sci. Gossip, 1891, pp. 199–202 (4 figs.).
‡ Bull. Soc. Zool. France, xvi. (1891) pp. 94–5 (1 fig.).
§ Flora, lxxiv. (1891) pp. 220–99 (3 pls.).

Hæmatozoa of the Frog.*—M. A. Labré has made some observations on the Sporozoa and Flagellata which are found as parasites in the blood of the Frog. The former are divisible into two groups, the first of which is represented by the *Drepanidium* of Ray Lankester. The author has observed two specimens, either free in the serum or in the same blood-corpuscle, approach and fuse by one of their extremities. The fusion goes on until the two form a V, the branches of which are fused along a certain length. We have here to do with a true conjugation, similar to that seen in Infusoria. Encystation—though the word is inexact—is similar to that observed in the swarm-spore-cysts of Coccidia; the parasite folds itself in such a way as to bring its two extremities into contact, fusion goes on slowly, and ends in the formation of a rounded or oval protoplasmic body, in which the vacuoles soon disappear, and which exhibits amœboid movements. The most common mode of reproduction is by spores, which resemble those of the Microsporidia. The second group of the Sporozoa is represented by Hæmatamœbæ, the smallest of which are like pseudonavicellæ; the latter form spores.

The author calls attention to the presence in the blood of a true *Polymitus*, 16 μ wide, with three or four flagella, 40–50 μ long.

Presence of bodies resembling Psorosperms in Squamous Epithelioma.†—M. Vincent has found in various forms of epithelioma, bodies which he, like other writers, regards as psorosperms. The bodies in question may be as large as the cells of the Malpighian layer, and according to the age of the parasite, are invested with a thinner or thicker highly refracting membrane. The protoplasm is rarely homogeneous, usually granular, and frequently contains large pigment-granules. The nucleus may be absent, double, or of very various shapes. It is not unusual to find several of these bodies inclosed in the same membrane, their form being roundish or altered by compression.

The cysts lie in the epithelial cells, the nucleus of which seems pushed on one side; they may be found in the centre of the cancerous masses alone or in accumulations. These bodies are stained with great difficulty, but the following was the most successful procedure. Very thin sections were treated for a moment with ammonia, washed in water, and then immersed for five minutes in a saturated watery solution of safranin. Some of the colour was then removed with 1 per cent. acetic acid, and then having been washed with water, they were decolorized in alcohol until they assumed a rose colour. Then oil of cloves and balsam. The psorosperms are stained red, the surrounding cells yellow or violet. The author does not appear to have noticed any spore formation in his psorosperms. Cultivation experiments were failures.

Polymitus malariæ.‡—*Polymitus* is found, says Prof. B. Danilewsky, in the blood of birds and men affected with malaria, as a spheroidal protoplasmic parasite possessed of several very mobile flagella. On the surface are usually observable some dark melanin granules. A few

* Comptes Rendus, cxiii. (1891) pp. 479–81.

† Annales de Micrographie, ii. (1890) Nos. 10–11. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 383–4.

‡ Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 397–403 (6 figs.).

minutes after the preparation of the specimen these flagella may be observed to set themselves free, while within the body of the parasite certain changes are observable.

Doubts having been expressed as to the nature of the flagella, the author considers it desirable that these should be allayed. He is quite convinced that the flagellum is a normal organic constituent of *Polymitus*, while the most common objection is that they are moribund or post-mortem phenomena. Against the objections the author brings various arguments, the most powerful being that these flagella are remarkable for the unusual rapidity, duration, and energy of their movements (half to one hour or longer).

The appearance of the parasite and its relation to the corpuscle are depicted in six illustrations, which show the outline of the corpuscle distended by one to four spheroidal bodies, some of them flagellated, pushing the nucleus to one side.

The author's remarks and descriptions are based on observations made from the avian parasite, but the views expressed are considered to hold good for the human parasite also, since from a morphological and biological standpoint no real differences can be detected between the two varieties.

The author considers that he has surmounted the difficulties of his case by affirming that "the parasite is in a certain sense a polymorphic organism which easily adapts itself to external conditions."

Biological Cycle of Hæmatozoon falciforme.*—Sigg. Antolisei and Angelini confirm the observation of Canalis, Celli, and Marchiafava on the *Hæmatozoon falciforme:* this was to the effect that in the irregularly intermittent fevers prevalent in summer and autumn a special variety of the malaria parasite is to be found, and that this differs from that found in tertian and quartan ague. This variety sometimes passes through its developmental cycle very quickly, passing from the phase of the non-pigmented amœba to that of the round form with a single pigment mass and to the sporulation phase, or the last condition may supervene without the parasite showing a trace of pigment; but at times development is more slow and the parasite attains to the spiral or crescent form ere it reproduces itself. The latter forms are better found in the blood extracted from the spleen than in that of the general circulation. In the blood from the spleen more phases of development are met with than in the fingers, and as a rule the most advanced (non-pigmented) stages of development- and sporulation-forms there appear.

Malaria-Parasites in Birds.†—In a series of short notes Prof. B. Grassi and Prof. R. Feletti make some preliminary observations on malaria-parasites found in birds. They find that in birds two kinds of parasites exist—the one kind belonging to the genus *Hæmamœba* and the other to the genus *Laverania*. That these are real existences, and not alterations of the red corpuscles, is shown by the fact that the malaria-parasites of birds are possessed of a nucleus.

Of the *Hæmamœba* there are three species—*H. præcox*, cause of

* Riforma Medica, 1890, Nos 54–6. See Centralbl. f. Bakteriol. u. Parisitenk., ix. (1891) pp. 410–11.

† Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 403–9, 429–33, 461–7.

quotidian; *H. vivax*, cause of tertian; and *H. malariæ*, cause of quartan ague. The *Laverania* are said to be the cause of fever of irregular type.

After much discussion the malaria-parasites are finally assigned to the Amœbæ. It is to be hoped that when the final publication appears it will be illustrated so that an approximate idea may be obtained of the parasites in their different stages and varieties.

Researches on Low Organisms.*—M. J. Massart has investigated the sensibility of marine unicellular organisms to concentration. He finds that organisms which have become accustomed to live in a medium of constant concentration generally avoid solutions which are more or less strongly concentrated. These results are in accordance with those obtained by the author with the human conjunctiva, for he finds that it is sensitive to more or less strongly concentrated tears.

With regard to the effects of gravity, M. Massart finds that not only Flagellata, but also Bacteria and Ciliata are mobile organisms that are sensitive to weight. Two closely allied species of *Spirillum* gave totally different geotaxic reactions; the geotaxy of *Chromulina Woroniniana* changes its sign according to the temperature. Contrary to the opinion of Verworn, the author thinks that the accumulation of unicellular organisms in the superficial strata of liquids is due to irritability.

Zoochlorellæ.†—Dr. W. Schewiakoff remarks that Prof. A. Famintzin,‡ in discussing the zoochlorellæ found in Infusorians, has ignored the observations which he (Schewiakoff) made in 1887, showing that the isolated *Zoochlorella conductrix* of *Frontonia leucas* could survive and multiply, and could be introduced into colourless varieties of *Frontonia*.

* Bull. Acad. Roy. de Belgique, lxi. (1891) pp. 148–67.
† Biolog. Centralbl., xi. (1891) pp. 475–6.
‡ Mém. Acad. Imp. Sci. St. Petersb., xxxviii.

BOTANY.

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

a. Anatomy.

(1) Cell-structure and Protoplasm.

Structure of Living Protoplasm.*—Injections of vegetable and animal tissues with mercury have led M. V. Fayod to the conclusion that protoplasm is not an emulsion, but a reticulate tissue composed of canaliculate and spiral fibrils, with hyaline walls capable of excessive swelling. The canaliculate fibrils, which have about the dimensions of *Spirillum tenue*, he terms *spirofibrils;* they are probably themselves composed of still finer spiral fibrils, the *spirosparts*, and these are all twisted round a canaliculate axis; they together constitute the hyaloplasm of Hofmeister. The visible granular portion of the protoplasm, the only part which takes up staining under ordinary circumstances, is simply the contents of these canals; it is the chromatin of Flemming, and is capable of motion within the canals. The very delicate membrane of the spirals he terms *fibrolem*.

The primitive spirofibril probably increases in size and becomes canaliculate simply in consequence of the growth of the spirals which arise in its interior; and in this way it becomes transformed into a spiral composed of spirosparts with an axial canal. The fibrous network which constitutes the greater part of the protoplasm resists the action of staining reagents, but there are various ways in which its existence can be shown.

The nucleus, which is probably nothing but a knot of the last extracellular net, is formed by the junction of several bands of spirosparts which traverse it in different directions. The granular portion of the protoplasm disappears under the action of active oxygen, and this disappearance is accompanied by an excessive swelling of the protoplasm, of which only the hyaline substance remains. This hyaline substance appears to be an organic body very rich in oxygen, and its formation to be due to the oxidation which accompanies respiration. The cell-wall of plants possesses precisely the same structure as protoplasm; it is simply protoplasm impregnated by cellulose.

The above description applies especially to vegetable protoplasm; but that of animals possesses essentially the same structure.

Structure and Growth of the Cell.†—Dr. C. Acqua has come to the following conclusions on this subject, derived largely from observing the growth of pollen-grains. Those tubes which increase directly and without interruption present a homogeneous wall with no visible lacerations; the cellulose probably becomes rapidly stretched, as soon as it is formed, the constitution of the wall being very soft at the moment of its formation and for a short time afterwards. But when a period of activity is followed by one of rest, during which the wall is becoming gradually thickened, then, as soon as growth recommences, the old layer

* Rev. Gén. de Bot. (Bonnier) iii. (1891) pp. 193–228 (1 pl.).
† Malpighia, v. (1891) pp. 3–39 (2 pls.). Cf. this Journal, 1890, p. 734.

becomes lacerated and the protoplasm becomes covered by a new one. When the wall consists of several layers, these are stretched and lacerated in succession from without inwards. These facts support the hypothesis of apposition.

Influence of Temperature on Caryokinesis.*—M. E. de Wildeman has experimentally investigated this subject, the objects of his experiments being the hairs on the filaments of *Tradescantia virginica*, *Spirogyra*, *Cosmarium* and *Closterium*. He finds that below a certain temperature caryokinesis does not take place, at least in its entirety, while too high a temperature impedes this process and that of cell-division, and between the two there is an optimum temperature. For *Tradescantia* this optimum was found to be about 45°–46° C., for *Spirogyra* 12°, and for *Cosmarium* 24°. There are, however, also individual variations. Light has no direct influence on this phenomenon; the length of time required for nuclear and cellular division varies with the species and with the temperature. With *Spirogyra* and *Cosmarium* these processes are exceedingly slow at low temperatures; with *Tradescantia* they can, of course, only be followed out through the summer months.

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

Chlorophyll.†—M. N. Monteverde has made a fresh series of experiments with the view of determining the number of distinct pigments present in an alcoholic extract of chlorophyll.

If an alcoholic extract of leaves is treated with baryta water, and the precipitate extracted with alcohol, the solution has a yellow colour; if this is again shaken with petroleum-ether after addition of a few drops of water, a separation takes place of the yellow pigments; the petroleum-ether containing carotin, identical with the carotin of the carrot, together with the green pigment; the alcohol containing xanthophyll. The pigments contained in the petroleum-ether are termed by the author "upper pigments," those contained in the alcohol "lower pigments." By careful treatment the whole of the upper green pigment can be removed by alcohol from the petroleum-extract, leaving behind a golden yellow solution of carotin; this green pigment does not crystallize. The alcoholic solution contains, in addition to xanthophyll, a "a lower green pigment," which crystallizes in tetrahedra, hexagons, or stars, but usually in irregular forms. The author believes that living leaves contain only the "lower green pigment," the upper one being a transformation-product resulting from the action of boiling water or of alcohol.

Green and Etiolated Leaves.‡—Herr W. Palladin has undertaken a series of observations with the view of determining the amount of albuminoids in green and etiolated leaves of wheat and of *Vicia Faba* (without leaf-stalk). He finds the results point to the general conclusion that etiolated leaves may be divided into two groups according to the amount of albuminoids contained in them. In the case of stemless plants,

* Ann. Soc. Belge Microscopie, xv. (1891) pp. 5–58 (4 pls.).

† VIII. Congress Russ. Naturf. u. Aerzte (Bot.) 1890, pp. 32–7. See Bot. Centralbl., xlvii. (1891) p. 132.

‡ Ber. Deutsch. Bot. Gesell., ix. (1891) pp. 194–8.

etiolated leaves contain a smaller proportion than those that are green; while the reverse is the case with plants having a stem. The stems of etiolated plants contain a very small quantity of albuminoids.

In a further series of experiments on the same plants * the author finds no soluble carbohydrates present in etiolated leaves of *Vicia Faba;* and concludes that chlorophyll cannot be formed without the presence of sugar. The first chlorophyll in the leaves of germinating plants is formed at the expense of the sugar which is carried from the seed by the transpiration-current. Iron is also necessary to its formation.

Quantity of Starch contained in the Radish.†—M. P. Lesage finds that although, under normal conditions, the radish contains no, or but very little, starch, yet if the seedlings are watered with water containing sodium chloride in solution, a very considerable quantity of starch is formed. The optimum proportion of salt in the water was found to be 4 gr. per 1000; a second lower maximum occurred with 10 gr. per 1000.

Tannoids.‡—M. L. Braemer gives an account of the present state of our knowledge, chemical and physiological, of the products of metastasis grouped under the name of tannins. He regards the group as a very heterogeneous one. None of the reactions relied on for the diagnosis of tannins are common to all substances included under that term, nor are they limited to them. Our present knowledge of these substances is, in fact, very imperfect.

Crystals of Calcium oxalate.§—Recurring to the question of the form in which calcium oxalate occurs in the tissues of plants, Prof. G. Arcangeli now states that in some cases single crystals belong to the monoclinic, and not to the dimetric system. The clusters of crystals are most often monoclinic, rarely dimetric. In the former case the crystals are frequently arranged radially round a central point, and present often a different structure in their internal to that in their external portion, the former having a more radiate, the latter a more crystalline appearance. An organic nucleus could not be detected.

(3) Structure of Tissues.

Anatomy and Physiology of the Conducting Tissues.‖—M. A. Gravis divides his treatise on this subject into three sections:—(1) Morphology of the Wood. The development of the xylem in the stem and root is followed out in detail, taking *Urtica dioica* as an example; the variations in the composition of the xylem are then described in four different type-plants, *Polypodium ramosum*, *Pinus sylvestris*, *Quercus robur*, and *Tradescantia virginica*. (2) Physiology of the Wood. The theory of the circulation advocated by Böhm is adopted, and the bordered pits are treated as

* Ber. Deutsch. Bot. Gesell., ix. (1891) pp. 229–32.

† Comptes Rendus, cxii. (1891) pp. 373–5. Cf. this Jonrnal, *ante*, p. 625.

‡ 'Les tannoïdes,' 8vo, 154 pp., Toulouse, 1890, 91. See Bot. Centralbl., xlvii. (1891) p. 274.

§ Nuov. Giorn. Bot. Ital., xxiii. (1891) pp. 489–93 (1 pl.). Cf this Journal, *ante*, p. 616.

‖ Mem. Soc. Belge Microsc., xii. (1889) pp. 87–118 (2 pls.). See Bot. Centralbl., xlvii. (1891) p. 241.

receptacles for water. (3) Relations between the Morphology and Physiology of the Wood. The xylem is regarded as serving for a reservoir and conducting path for water; the annular and spiral vessels contributing chiefly to the former, the pitted vessels to the latter purpose.

Internal Phloem in Dicotyledons.*—Dr. D. H. Scott and Mr. G. Brebner discuss the origin and function of the layer of phloem which occurs in the vascular bundles of the stem and root of many Dicotyledons on the medullary as well as the cortical side, characterizing the bundles termed "bicollateral." They regard the principal, though not the exclusive, function of the phloem-systems in the root and stem, to be the conduction of food-material, and not, as suggested by Frank and Blass,† the storing-up of food-material for the fresh formation of wood. They find that (in *Acantholimon*) an internal cambium is formed in the stem at a late stage, either just inside or just outside the protoxylem; it produces a large amount of medullary wood and phloem, with inverted orientation. In the majority of plants examined with bicollateral bundles in the stem, a normal structure of the root was found, the medullary phloem in the hypocotyl being continuous with the external phloem of the root-system. A certain number of roots among the plants of this class examined had interxylary strands of phloem, and these may be either primary, secondary, or tertiary. Intraxylary (medullary) phloem has so far been found only in the roots of *Strychnos* and *Chironia*.

Equivalence of the Vascular Bundles in Vascular Plants.‡—M. P. A. Dangeard proposes to establish the equivalence of the vascular bundle in all vascular plants. Among Dicotyledons the bundles are collateral, and are either closed or open. Among Monocotyledons, collateral bundles also occur, as well as concentric, in which the phloem is surrounded by the xylem. The difficulty, however, in understanding the vascular bundle is in those of Vascular Cryptogams and those of the root. The equivalent of the closed bundle of Dicotyledons is to be found in the single-veined leaves of *Selaginella*, *Lycopodium*, and *Tmesipteris*, and in the final ramifications of the veins in the leaves of *Salvinia*, *Marsilea*, ferns, &c. The bundles are here generally concentric; but, contrary to the structure in Monocotyledons, it is the phloem which surrounds the xylem. To find the equivalent of the open bundle of Dicotyledons and Conifers, we have to look in the stem of certain species of *Selaginella*, such as *S. Krausiana*, *Galeottei*, *Lyallii*, &c.

Structure and Growth of the Apex in Gymnosperms.§—Herr L. Koch has carefully examined the structure and mode of growth of the apex of the branch in a number of Gymnosperms. The method of observation employed was the preparation of a large series of excessively thin sections by the microtome, after imbedding in paraffin in the mode recommended by the author.‖ The species examined were *Tsuga canadensis*, *Picea excelsa* and *orientalis*, *Abies alba*, *Larix decidua*, *Cedrus*

* Ann. of Bot., v. (1891) pp. 259–300 (3 pls.).
† Cf. this Journal, 1890, p. 622. ‡ Comptes Rendus, cxii. (1891) pp. 1228–30.
§ Jahrb. f. Wiss. Bot. (Pringsheim), xxii. (1891) pp. 491–680 (5 pls.).
‖ Cf. this Journal, 1890, p. 674.

Libani and *Deodara*, *Pinus Strobus* and *sylvestris*, *Thuja occidentalis*, *Taxus baccata*, *Cephalotaxus pedunculata*, and *Ephedra altissima*.

The author finds the apex of a growing shoot or leaf of a plant several years old to be occupied, not by a true apical cell, but by one or more, often four, cells or chambers, to which neither the outer nor the inner cells stand in any definite genetic relationship. There is no distinct outer layer or dermatogen, which has been derived direct from the embryo; for periclinal divisions arise even in the outermost cells, and the apex is occupied by several cup-like layers of embryonal tissue. The first differentiated tissue which is formed from these embryonal layers is the pith, in the form of large polygonal cells, before the initials of either the cortex or the vascular bundles are to be detected. At a later period the outermost layer becomes differentiated into the young epiderm by the suppression of periclinal divisions, and the cortex and vascular system develope from the inner layers. In the formation of the latter the embryonal tissue which lies between the pith and the cortex first exhibits itself in the form of an annular zone, which breaks up into the procambial bundles and intermediate tissue; a layer of the latter still retains its embryonal character, and becomes the interfascicular cambium. The further differentiation of tissues and the development of lateral organs are described in detail.

Increase in Thickness of the Stem and Formation of Annual Rings.*—Herr L. Jost has investigated the phenomena connected with these processes, his observations having been made chiefly on *Phaseolus multiflorus*, *Pinus Laricio*, and *Alnus cordata*. If all leaves and buds are removed from a tree, there will not, in the next year, be the least trace of the formation of wood, indicating that the leaves have a direct influence on the increase in thickness of the stem. The formation of vessels is in fact usually in direct dependence on the formation of foliar organs. Between the leaf itself and the leaf-trace the author finds not only an anatomical, but also a physiological connection.

Gunnera manicata.†—Dr. W. Berckholtz describes in detail the morphology and anatomy of this species. The flowers are hermaphrodite; the ovule is pendulous and anatropous; the fruit is a drupe; the seed contains an oily endosperm. In the course of the vascular bundles in its leaf-stalk, and in the bundles being closed, *Gunnera manicata* shows a resemblance to Monocotyledons; in the relative position of the xylem and phloem in the bundle to Ferns. The secondary roots have no cambium, and the pericambium usually consists of only a single row of cells. The author regards the nearest affinity of the Gunneraceæ to be with the Halorageæ.

(4) Structure of Organs.

Comparative Anatomy of Plants.‡—M. A. Chatin gives the following *résumé* of the more important results contained in the most recently published part of his work on this subject.

* Bot. Ztg., xlix. (1891) pp. 485–95, 501–10, 525–31, 541–7, 557–63, 573–9, 589–602. 605–11, 625–30 (2 pls.).
† Biblioth. Bot. (Luerssen u. Haenlein), Heft 24, 1891, 16 pp. and 9 pls.
‡ Comptes Rendus, cxiii. (1891) pp. 337–44.

Among parasites, the Rhinantheæ are distinguished, by the structure of the stem, the anther, the pollen, &c., from the allied Antirrhineæ, and from the semi-parasitic Thesiaceæ and Orobanchaceæ. The Loranthaceæ differ from the Thesiaceæ in the nature of their vessels, and in the arrangement of their fibro-vascular system, as also from the Caprifoliaceæ, Santalaceæ, Olacineæ, Ceratophyllaceæ, and Chlorantheæ. From their anatomical structure the author separates the Misodendreæ from the true Loranthaceæ. The Cuscuteæ differ from the Cassytheæ in the habitual absence of stomates. The Cytineæ, Rafflesiaceæ, and Balanophoraceæ form a natural group from their anatomical characters. Further generic anatomical details are given.

Among aquatic plants, the author separates *Ottelia* from the Hydrocharideæ, to form, with *Stratiotes* and *Enhatus*, the type of a family characterized by its anatomy and by its anatropous ovules.

Stomates occur (among parasites) in *Clandestina*, in *Hypopitys lanuginosa*, in *Monotropa uniflora*, and in the greater number of the Loranthaceæ, Thesiaceæ, and Rhinantheæ. Medullary rays are wanting in some, but not in all parasitic Dicotyledones, as well as in many terrestrial and in most aquatic species. Details are given with regard to the presence of a general and of a partial endoderm; and the occurrence of aeriferous lacunæ similar to those of aquatic plants is noted in some parasites, as in the cortical parenchyme of *Melampyrum*, *Rhinanthus*, and *Pedicularis*, and in the woody substance of *Cassytha*.

Sudden Changes of Form.*—Herr F. Hildebrand records the following examples of sudden changes of form in plants:—(1) A seedling from an ordinary form of *Juglans regia* exhibited the form known as *laciniata*, with doubly pinnate leaves. It displayed an unusual sensitiveness to cold. (2) A plant of *Hepatica triloba* with ordinary 3-lobed leaves put up in two successive years leaves with a double lobing. (3) Two specimens of *Rhamnus Frangula* produced suddenly, but in one case not on all its branches, leaves which were deeply toothed or even lobed.

Styles of Compositæ.†—Mr. J. S. Chamberlain has made a comparative study of the structure of the style in different families of Compositæ, especially in reference to the papillæ and the collecting or brush-hairs, with a view to their usefulness for purposes of classification. He finds that, like other characters in the Compositæ, those derived from the style cannot be used in all cases singly, but only in conjunction with others, in dividing the order into tribes. These characters are more constant and uniform in some tribes than in others. Thus in the Vernonieæ, Eupatorieæ, and Asteroideæ, the structure of the style is very uniform and constant for each tribe, and can be used with great advantage. In the Helianthoideæ and Cynaroideæ the characters are still sufficiently constant to be of great aid; while in the Helenioideæ, Anthemideæ, and Senecionideæ there is less uniformity. Another difficulty is that where, as in some genera of Inuloideæ and Helianthoideæ, the flowers are diœcious, the brush-hairs are wanting on the style of the female flower.

* Ber. Deutsch. Bot. Gesell., ix. (1891) pp. 214–8.
† Bull. Torrey Bot. Club, xviii. (1891) pp. 175–86, 199–210 (4 pls.).

Embryo of Trapa, Nelumbium, and of some Guttiferæ.*—M. D. Clos has studied the germination of the seeds of *Trapa natans*, and puts a different interpretation on the morphology of the various parts from those which have hitherto been proposed. He regards the embryo as belonging to the group which he terms *macropodous*. What has hitherto been taken for the single large cotyledon is the greatly enlarged hypocotyl, which always remains inclosed, but emits from below the pericarp a straight slender prolongation, 5–8 cm. in length, which becomes horizontal and channelled for the insertion of the single cotyledon and of the contiguous buds. The embryo of *Trapa* is, therefore, monocotyledonous and rootless.

Some species of Guttiferæ and Clusiaceæ are also characterized by macropodous embryos.

In the ovule of *Nelumbium speciosum*, the best interpretation of the peculiar and difficult points of structure appears to be that the thin integument consists of the primine only, and that the large fleshy body below the embryo-sac, which becomes bipartite on germination, is formed by the complete concrescence of the secundine with the nucellus. The embryo makes its appearance between the two plates into which this body divides.

Fruits which expel their seeds with violence (Schleuderfrüchte).†—Herr E. Huth enumerates twenty-five families and forty-eight genera in which fruits of this description occur. He classifies them under three heads, viz. (1) Dry fruits; in these either the carpels roll up when ripe so as to expel the seeds (*Eschscholtzia*, *Corydalis*, *Cardamine*, *Viola*, *Euphorbia*, *Ricinus*, many Leguminosæ, &c.), or they belong to climbing plants, and are dragged for a short distance by animals by means of hooks and bristles, and then spring back suddenly and expel the seeds (*Setaria*, *Lappa*, *Martynia* (?), &c.). (2) Hygroscopic fruits; either dry (*Avena*), or furnished with elaters (*Jungermannia*, *Equisetum*). (3) Succulent fruits, in which the seeds are expelled in consequence of a sudden access of water (*Impatiens*, *Momordica*, *Elaterium*, *Dorstenia*, *Oxalis*, &c.). In the case of the last-named genus, the mechanism lies not in the pericarp, but in a fibrous layer which envelopes the seeds. The greatest distance to which the author observed that seeds could be expelled was 10 metres in the case of *Wistaria sinensis* (by night).

Fruit and Seed of Umbelliferæ.‡—Sig. E. Tanfani has continued his researches on the morphology and histology of the fruit and seeds of the Apiaceæ (Umbelliferæ). He adopts the view of the morphology of the flower supported by Celakovsky, viz. that the inferior ovary is composed of the concave receptacle, which incloses in its interior the base of the carpellary leaves, and bears on its margin the other floral whorls. The seed may be either orthospermous or campylospermous, and there are all intermediate conditions between the two. The embryo is small and straight, and is attached to the summit of the endosperm; occasionally there is only one cotyledon.

* Bull. Soc. Bot. France, xxxviii. (1891) pp. 271–6.

† Samml. Naturw. Vorträge, iii. (1890) 23 pp. and 5 figs. See Bot. Centralbl., 1891, Beih., p. 267.

‡ Nuov. Giorn. Bot. Ital., xxiii. (1891) pp. 451–69 (4 pls.).

Pericarp of Compositæ.*—Herr O. Heineck describes in detail the minute structure of the pericarp of Compositæ, and classifies the various forms under eight types, dependent on the arrangement of the "hard-bast-cells" which he finds always present in the pericarp,—elongated fusiform cells with a small cavity, and distinguished by these characters from the soft-bast-cells or cells of the bast-parenchyme.

Structure of Seed of Euonymus.†—From an examination of the structure of the seed of *Euonymus japonicus*, Sig. E. Baroni confirms the view taken by Planchon and Gasparrini, that the so-called arillode is not a true aril, inasmuch as it does not proceed from the micropyle, but, in its outer layer, is in complete continuity with the podosperm and with the raphe. The red pigment of this mantle is probably derived from the chloroplasts already existing in the unripe seed.

Structure of Cotyledons.‡—Herr F. Simek describes the structure of the cotyledons in species belonging to the Caryophyllaceæ, Geraniaceæ, and Compositæ. In the Caryophyllaceæ, where the cotyledons differ considerably in form and size from the foliage-leaves, the first two pairs of the latter always form a connecting link between the cotyledons and the normal leaves, and may be termed "primordial leaves." Generic, and in some cases specific, characters may at times be obtained from the cotyledons. In the Geraniaceæ the cotyledons always differ considerably in form from the normal leaves, but there are no primordial leaves or other connecting links. Among Compositæ, in *Tragopogon* the cotyledons have also, like the foliage-leaves, a long narrow form with entire margin.

Stem of the Cymodoceæ.§—M C. Sauvageau, having already described the specific differences of structure observable in the leaves of *Cymodocea* and *Halodule*, now points out that the *Cymodoceæ* of the section *Phycagrostis*, and particularly *C. serrulata*, are better characterized by the structure of the stem than by that of the leaf; on the contrary, however, for the determination of the species of *Phycoschænus* and *Halodule*, it is preferable to have the leaf. The nine species of Cymodoceæ are taken seriatim, and the structure of the stem carefully described in each. The structure, although comparatively simple, and showing some analogies with *Zostera*, presents certain variations between one species and another. For instance, in *C. serrulata* the cortical parenchyme is the same as that met with in *C. æquorea*, while the form and structure of the central cylinder is that of the *Cymodoceæ* of the section *Phycoschœnus*; finally the lignified cortical fibrous bands are not met with in any other species.

Swellings in the Bark of the Copper-beech.‖—Herr F. Krick has examined the structure of the so-called tubers which frequently occur in the bark of the copper-beech, and which consist of true woody tissue,

* 'Beitr. z. Kenntniss d. feineren Baues d. Fruchtschale d. Compositen,' Giessen, 1890. See Bot. Centralbl., 1891, Beih., p. 112.

† Nuov. Giorn. Bot. Ital., xxiii. (1891) pp. 513–21.

‡ JB. Deutsch. Staats-gymn. Prag, 1889. See Bot. Centralbl., 1891, Beih., p. 203.

§ Journ. de Bot. (Morot), v. (1891) pp. 205–11, 235–43 (6 figs.). Cf. this Journal, *ante*, p. 65.

‖ Biblioth. Bot. (Luerssen u. Haenlein), Heft 25, 1891 (28 pp. and 2 pls.).

cambium, and cortex. They are entirely or partially imbedded in the cortical parenchyme, outside the primary hard-bast-bundle of the stem, though they frequently project into the soft-bast. They may arise either in connection with a bud or not; in the latter case there are two principal types,—tubers with a central woody tissue, and those which have a corky structure in their centre.

Leaves of Xerophilous Liliifloreæ.*—Herr C. Schmidt has examined the structure of the leaves in a number of species belonging to the orders Xerotideæ and Hæmodoraceæ, natives of arid climates or situations. The epiderm is nearly alike on both sides of the leaf; its cells have a thin but distinct cuticle, and are adapted for the storing up of water; trichomic structures are very rare. The mechanical system is strongly developed, and is composed of typical bast-cells with greatly thickened walls. The assimilating system consists of typical palisade-cells; there is never a well-developed spongy parenchyme. The aerating system is well developed, but consists only of narrow crevices. The stomates always have their longer axis parallel to the axis of the leaf; they are alike in number and form on the two sides of the leaf; the thickening-bands in the guard-cells are remarkably strongly developed, leaving only a very narrow interval between them. The conducting elements are nearly always in close contact with the assimilating system. Dispersed through the fundamental tissue are frequently very elongated cells destitute of chlorophyll and containing bundles of raphides.

Abnormal Leaves.†—Herr J. Klein has attempted to trace the laws which govern the appearance of abnormalities in leaves, especially in relation to coalescent or double leaves. He finds that when leaves bear on one petiole two more or less separated laminæ, each with its own mid-rib,—if this is the result of the union of two leaves, there are always a larger number, usually double as many, vascular bundles in the petiole as in that of an ordinary leaf; if the result of division, only the ordinary number of bundles. A double leaf results from the coalescence of two rudiments of leaves, a divided leaf from only one.

Roots without a Root-cap.‡—Herr T. Waage has made an examination of the exceptional cases in which a true root is not provided with a root-cap, especially in the Hippocastanaceæ and Sapindaceæ. He finds all intermediate stages between these and the normal structure of a root provided with a root-cap. The purpose of the capless roots appears to be to assist in the increased absorption and storing up of water where this is required. The various degrees of non-development of the root-cap may be summed up as follows:—The cap may be greatly reduced; and either with unlimited growth, as in *Trapa natans*, or with temporarily limited growth, as in *Sapindus Saponaria*, and partially in other Sapindaceæ. The root may have at first a true cap, which may become changed into a permanent root-cap as in the Lemnaceæ, or may be completely thrown off, as in *Azolla*, *Hydrocharis*, *Pistia*, and in the Bromeliaceæ. The root may be from the first destitute of a cap; and then the growth may either be limited for a time, as in *Ungnadia*,

* Bot. Centralbl., xlvii. (1891) pp. 1–6, 33–42, 97–107, 164–70 (1 pl.).
† Ungar. Acad. Wiss., June 15, 1891. See Bot. Centralbl., xlvii. (1891) p. 262.
‡ Ber. Deutsch. Bot. Gesell., ix. (1891) pp. 132–62 (2 pls.).

Stadmannia, *Diplopeltis*, *Cupania*, *Araucaria*, and *Podocarpus*; or the growth may be permanently limited, as in the Hippocastanaceæ and in the embryonal root of *Cuscuta*.

Tubercles on the roots of Ceanothus.*—Prof. G. F. Atkinson finds that the tubercles on the roots of *Ceanothus* are caused by a parasitic fungus allied to *Schinzia* (*Frankia*) *Alni* found upon the roots of *Alnus* and *Elæagnus*.

β. Physiology.

(1) Reproduction and Germination.

Weismann's Theory of Heredity.†—Herr W. Burck adduces arguments, from observations made in the East Indies and elsewhere, against the theory of Weismann that the cause of hereditary variability is sexual reproduction between different individuals. He finds that hereditary modifications often spring up without cross-fertilization. Thus in Java there are plants, of which *Myrmecodia tuberosa* is an example, which produce none but cleistogamic flowers; and these flowers present special adaptations for self-fertilization combined with properties which in other plants serve for the attraction of insects,—a white colour, abundant nectar, and proterogyny. The same is the case with various species of *Anona* and other Anonaceæ. The structure of the flowers of *Ophrys apifera* he regards as originally adapted for cross-fertilization, but afterwards modified for self-fertilization. In the case of many flowers, such as *Aristolochia* and *Coffea bengalensis*, which have been relied on as presenting striking illustrations of the necessity of cross-fertilization, the author asserts that the indications are quite as strong in favour of self-fertilization by insect-agency; dichogamous flowers are, he maintains, as a rule, pollinated from flowers of the same stock. Another argument in the same direction is furnished by European fruit-trees in Juan Fernandez, which are self-fertilized and abundantly fruitful.

Function of the Antipodals.‡—From an examination of the antipodals in the embryo-sac, especially in Ranunculaceæ and Gramineæ, Herr M. Westermaier attributes to them a more important function than has hitherto been assigned them; he does not regard them as merely useless survivals, but as serving an important purpose in the nutrition of the embryo. He arrives at this conclusion from the following considerations:—Their specific position in the embryo-sac, and the nature of their contents; their anatomical surroundings, and the cuticularizing of certain membranes in the ovule; the mode of distribution of the starch within the ovule; there being apparently special contrivances for the conduction of starch to the antipodals. In other cases they appear to be connected with the formation of the endosperm.

Reproductive Organs of Phanerogams.§—M. J. Hérail gives a summary of the present state of our knowledge of the formation of the

* Bot. Gazette, xvi. (1891) p. 262.

† Naturk. Tijdschr. Nederl.-Ind., xlix. pp. 501–46 (1 pl.). See Bot. Centralbl., 1891, Beih., p. 263.

‡ Nova Acta K. Leop.-Carol. Deutsch. Akad. Naturf., lvii. See Bot. Centralbl., 1891, Beih., p. 111.

§ 'Organes reprod. et formation de l'œuf chez les Phan.,' 143 pp. and 1 fig., Paris, 1889. See Bot. Centralbl., 1891, Beih., p. 272.

male and female organs in flowering plants, and of the details of the act of impregnation. The power of germination of pollen-grains was found to endure from one day in *Oxalis Acetosella* to eighty days in *Narcissus pseudo-Narcissus*. Light has a very prejudicial influence on the growth of the pollen-tube.

The origin of the embryo-sac in different plants is stated as follows:—In *Tulipa* and *Lilium* it is derived directly from the hypodermal axial apical cell. In *Cornucopiæ nocturnum*, this cell divides into two unequal daughter-cells, of which the subapical again divides into two, and of these the lower becomes the embryo-sac. In *Yucca gloriosa* the division of the original apical cell is somewhat more complicated; but again the lowest segment grows into the embryo-sac. In *Clematis cirrhosa* and *Cercis siliquastrum* the embryo-sac is again developed from the lowest segment. In the Gamopetalæ the hypodermal axial apical cell divides into either three or four mother-cells, of which the lowest becomes the embryo-sac.

With regard to the actual process of impregnation, the author agrees with Guignard rather than with Strasburger, and states that an actual fusion takes place of the male and female nuclei, the nucleoles present in both of them disappearing at the same time.

Cleistogamic Flowers.*—Herr W. Burck describes several species of tropical plants which produce cleistogamic flowers, in which cross-pollination is impossible, although the flowers are coloured and scented, and produce abundance of nectar. This is the case in a number of species of Anonaceæ. In *Myrmecodia*, the explanation appears to be afforded by the hypothesis that the flowers were originally adapted for cross-pollination, but that the visits of insects have been gradually suspended in consequence of the attacks of the warlike ants which always inhabit the tubers. In *Unona* sp. nov. the corolla remains always completely closed, and yet abundance of fruit is produced.

Importance of Heterogamy in the formation and maintenance of species.†—Commenting on Herr Burck's paper, Herr F. Rosen argues, from the phenomena connected with cleistogamic flowers, and others in the vegetable kingdom, that cross fertilization does not play so important a part in the maintenance of species as has been supposed by most recent writers. Even with many anemophilous plants, such as *Carex* and *Festuca*, inbreeding appears to be the rule.

Fertilization of Lilium Martagon.‡—Dr. E. Overton finds this plant a very favourable one for following out the development and coalescence of the sexual elements. The sculpturing of the mature pollen-grain is caused by short crowded rods; these are wanting in a narrow longitudinal band which is but slightly cuticularized, and through which the pollen-tubes penetrate. The number of threads in the nucleus of the pollen-grain is twelve in the great majority of cases, though in a few instances the number was undoubtedly less. The pollen-tubes are directed to the canal of the style by means of the bicellular stigmatic

* Ann. Jard. Bot. Buitenzorg, viii. (1890) pp. 122–64 (4 pls.).
† Bot. Ztg., xlix. (1891) pp. 201–11, 217–26.
‡ 'Beitr. z. Kenntniss d. Entwickelung u. Vereinigung d. Geschlechtsproducte b. *Lilium Martagon*,' Zürich, 1891, 11 pp. and 1 pl.

papillæ; after reaching the ovary they advance along a furrow, which is overspanned by threads of mucilage. The micropyle does not open of itself, but its cells are pressed apart by the pollen-tubes. The embryo-sac is, in this plant, developed directly from a hypodermal cell. A few cases of polyembryony were observed, in which the second embryo was undoubtedly the result of the impregnation of one of the synergidæ. The author is unable to confirm Westermaier's view* that the antipodals assist in the nutrition of the embryo; in *Lilium Martagon* they are undoubtedly without any such function.

Fertilization of Iris sibirica.†—Prof. A. Dodel has followed out the process of the impregnation of the oosphere in this plant. As long as the pollen-tubes are penetrating the stigma and style they are extremely slender, but increase rapidly in thickness when they have entered the ovary. A very large number of pollen-tubes enter the ovary, and it is not uncommon for more than one to enter a micropyle. In that case one or both of the synergidæ may be impregnated and develope into embryos. The following differences are presented between the oosphere and the synergidæ; the nucleus of the former contains a distinct spherical nucleole; those of the latter do not contain distinct nucleoles at the time of impregnation. The nucleus of the oosphere lies in its upper part, those of the synergidæ in their basal portion. A similar difference is exhibited in the distribution of the greater part of the cytoplasm; that of the oosphere is full of vacuoles, while that of the synergidæ contains scarcely any. These facts have led the author to the belief that the synergidæ must be regarded as partially aborted oospheres. It sometimes happens also that two of the sperm-nuclei (pollen-nuclei) enter the oosphere, and both coalesce with its nucleus.

Contrivances for Pollination.‡—Herr E. Loew has examined the structure of the flower, especially in relation to the facilities for insect-pollination, in a number of species belonging to the following natural orders:—Berberideæ, Papaveraceæ, Ribesiaceæ, Rosaceæ, Primulaceæ, Hydrophyllaceæ, Scrophulariaceæ, Solanaceæ, Borraginaceæ, Labiatæ, Caprifoliaceæ, Liliaceæ, Amaryllidaceæ, Iridaceæ. With regard to the fifth barren stamen or staminode in *Pentstemon*, the author thinks that it may serve a variety of purposes;—the two rows of hairs with which it is frequently provided serving to detain the pollen which falls upon it, and also to protect the nectaries against the incursion of creeping insects. In the genus *Narcissus* there are, from this point of view, five different types of flowers, according as its structure is adapted for pollination by humble-bees or by Lepidoptera, or by both classes of insects.

Mr. G. F. Scott Elliot § describes the arrangements of structure in nearly 200 S. African and Madagascan Flowering Plants, belonging to a great variety of natural orders, which favour cross-pollination by the agency of insects, giving also a list of the visiting insects.

* *Vide supra*, p. 766.

† 'Beitr. z. Kenntniss d. Befruchtungs-Erscheinungen bei *Iris sibirica*,' Zürich, 1891, 15 pp. and 3 pls.

‡ Jahrb. f. Wiss. Bot. (Pringsheim), xxii. (1891) pp. 445–90; xxiii. (1891) pp. 207–54 (4 pls.).

§ Ann. of Bot., v. (1891) pp. 335–405 (3 pls.).

Herr O. Kirchner * gives very careful details of the structure of about 120 species of plants, natives of Würtemberg, with especial reference to the adaptations of the structure of the flower for pollination by insect agency.

The last instalment of the series of papers on Flowers and Insects by Mr. C. Robertson † describes the mode of pollination of American species belonging to the Lobeliaceæ, Campanulaceæ, and Apocynaceæ.

Pollination and Hybridizing of Albuca.‡—Mr. J. H. Wilson describes the mode of pollination in several species of this genus from the Cape, belonging to the Liliaceæ. *A. corymbosa* is pollinated by humble-bees, and there is no spontaneous self-pollination. *A. fastigiata* is apparently sterile with its own pollen, either from the same or from a different flower; but is fertile when crossed with that of *A. corymbosa.* Attempts failed, on the other hand, to impregnate *A. corymbosa* with pollen of *A. fastigiata.* The hybrids obtained by impregnating *A. fastigiata* with pollen of *A. corymbosa* were intermediate in structure between the two parents; and their descendants, obtained by artificial pollination, retained these characters, and did not revert to the structure of either parent.

Pollination of Orobancheæ.§—Herr P. Knuth describes the mode of pollination in *Lathræa squamaria*, which is proterogynous and visited by humble-bees; and in *Phelipæa cærulea*, in which the flowers are blue and conspicuous, but are not visited by insects. In this species, as well as in *Orobanche elatior*, which has brown inconspicuous flowers, the structure is adapted for self-pollination.

Influence of Temperature on Germinating Barley.‖—According to Mr. T. C. Day, the most important point brought to light by his observations on this subject is, that the sugars reach their maximum, the starch suffers the greatest amount of degradation, the permanently soluble nitrogenous compounds are present in the greatest quantity, and the diastatic ferment is the most active, in malt grown throughout at a temperature of 55° F. The evidence as to the peculiar change in the composition of the malts which were grown at a temperature above 55° F. is strongly corroborated by the determination of the carbon dioxide and dry root formed. At higher temperatures, it appears that a portion at least of the carbon dioxide was produced at the expense of the sugars and other soluble carbohydrates, formed at the earlier stages of germination, rather than that the whole was furnished by the oxidation of the starch.

Vitality of Seeds.¶—Mr. W. B. Hemsley records two illustrations of the fact that the seeds of sea-shore plants will germinate after prolonged immersion in salt water. Seeds of *Thespesia populnea* and of *Ipomœa*

* Beitr. z. Biol. d. Blüthen, Stuttgart, 1890. See Bot. Centralbl., xlvii. (1891) p. 138.

† Bot. Gazette, xvi. (1891) pp. 65–71. Cf. this Journal, 1890, p. 628.

‡ Bot. Jaarboek, iii. (1891) pp. 232–59 (1 pl.). See Bot. Centralbl., xlvii. (1891) p. 68.

§ Bot. Jaarboek, iii. (1891) pp. 20–32 (1 pl.). See Bot. Centralbl., xlvii. (1891) p. 67.

‖ Journ. Chem. Soc., 1891, pp. 664–77 (2 pls. and 1 fig.).

¶ Ann. of Bot., v. (1891) pp. 406–7.

grandiflora, gathered in the Keeling Islands in 1888, germinated at Kew after having been kept dry for nearly two years, and then placed in sea-water, where they remained floating for twelve months, before being placed in conditions favourable to germination.

Longevity of Bulbils.*—M. M. Gandoger records an instance of the retention of the power of germination by bulbils of *Allium roseum* after the bulbs had been preserved for more than fifteen years.

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

Absorption and Elimination of Solid Substances by Cells.†—Herr W. Pfeffer has investigated the conditions under which the absorption of solid substances can be effected by naked (primordial) cells, the observations having been made chiefly on the Myxomycetes, especially on *Chondrioderma difforme*. The protoplasm has, apparently, very little power of selection, substances which are useless, as well as those which are nutrient, being taken up, and the power of absorption, or of diffusion through the parietal utricle, appears to depend entirely on the motion of the particles of protoplasm amongst themselves, and is not in any way dependent on irritation. If not immediately dissolved, these foreign substances remain, for a shorter or longer period, either in the protoplasm or in the vacuoles. In the elimination of those which are not available for nutrition, the protoplasm appears to have much more selective power than in their absorption ; some organic substances, such as *Navicula* and *Pandorina*, being thrown out by the plasmodes after remaining in them for about ten hours, as well as inorganic substances; while others are permanently retained. The protoplasm of cells inclosed in a cell-wall can only absorb or eliminate solid particles under exceptional conditions.

Assimilation and Transpiration.‡—M. H. Jumelle gives the details of various experiments on assimilation and transpiration, the following being the principal results obtained. The absence of carbonic acid in the atmosphere, in the light, accelerates transpiration. It is the arrest of assimilation which produces an augmentation of transpiration in the light. The presence of carbonic acid, in the light, does not affect transpiration of a plant, if this plant be deprived of chlorophyll. The fact, then, is amply proved that, in the light, the absence of carbonic acid accelerates the transpiration of plants, this acceleration being explained on the ground that the energy of the radiations absorbed by the chlorophyll, being no longer employed on the decomposition of the carbonic acid, is devoted to transpiration.

Assimilation in Umbelliferæ.§—M. G. de Lamarlière gives a table in which the assimilation of carbonic acid in three other species of Umbelliferæ is compared with that in *Angelica sylvestris*. Certain differences in the intensity of this assimilation can be explained, according to the author, by the comparative anatomy of the leaves. The following

* Bull. Soc. Bot. France, xxxviii. (1891) p. 244.

† Abhandl. Sächs. Gesell. Wiss., xvi. (1890) pp. 149–83 (1 pl.). See Bot. Ztg., xlix. (1891) p. 332.

‡ Rev. Gén. de Bot. (Bonnier), iii. (1891) pp. 241–8, 293–305. Cf. this Journal, 1889, p. 669.

§ Comptes Rendus, cxiii. (1891) pp. 230–2.

conclusions are arrived at:—(1) Species of Umbelliferæ with greatly divided leaves assimilate more, for an equal surface, than those with entire or less divided leaves. (2) This difference in the intensity of the assimilation is explained by the disposition of the palisade tissue, which, instead of being in a single layer, may consist of several superposed layers.

Assimilation of free atmospheric Nitrogen.*—Dr. R. Otto gives a *résumé* of the results of the more important investigations on this subject from the time of de Saussure at the commencement of the century to the present time.

Absorption and Metabolism of Fatty Oils.†—Herr R. M. Schmidt has carried out a series of experiments for the purpose of determining in what way the fatty oils contained in many seeds are employed in the nutrition of the young plant. The experiments made on the absorption of almond-oil by mould-fungi and by the cells of higher plants, appear to indicate that the passage of such oils through living cellulose membranes is the result of a saponification caused by the combination of a substance present in the cell-wall with the free fatty acids. It is possible also that a direct passage of the oil from cell to cell may take place, since the parietal utricle is permeable for oils; and in the germination of oily seeds, observation has not at present shown that any large quantity of free fatty acids is produced; these are apparently formed only at a comparatively late period.

(3) Irritability.

Anatomico-physical causes of Hygroscopic Movements.‡—Herr C. Steinbrinck has undertaken an investigation of the mechanical causes of the hygroscopic movements which bring about the bursting of mature capsules and pollen-sacs. The hygroscopic tension may be produced mainly by the normal shrinking either of layers or of striæ; to the former type belong the capsules of *Linaria*, *Antirrhinum*, and *Helianthemum*, and the pollen-sacs of the Cycadeæ; to the latter class the capsules of *Luzula* and of the Caryophylleæ (*Dianthus*, *Saponaria*, *Silene*, *Gypsophila*, and *Spergula*); those of *Lychnis vespertina* show an intermediate structure between the two. The details of the structure are described in the various species examined.

Irritability of the Leaves of Dionæa.§—According to Mr. J. M. Macfarlane, all parts of the lamina of the leaf of Venus's fly-trap are sensitive to surface stimulation. For mechanical stimulus of the leaf two touches are needed to cause contraction, unless the stimulus be very powerful, and they must be separated by a greater interval than one-third of a second. If less than one-third of a second elapses there is no contraction, and a third touch is then needed. In the first case no effect is produced if 35–40 seconds elapse between the stimuli. The author claims a perfect parallelism between combined nerve and muscular action in animals and contractive action in *Dionæa*.

* Bot. Centralbl., xlvi. (1891) pp. 387–91; xlvii. (1891) pp. 62–7, 123–9, 175–90.
† Flora, lxxiv. (1891) pp. 300–70. ‡ Tom. cit., pp. 193–219 (1 pl. and 1 fig.).
§ Bot. Gazette, xvi. (1891) p. 258.

Heliotropic Sundew.*—Prof. B. D. Halsted states that the giant American sundew, *Drosera filiformis*, is heliotropic; a new flower opens each day at the top of the bend of the curved inflorescence; and this flower, when it opens, invariably faces the morning sun.

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

Influence of Light on Respiration.†—M. K. Purjewicz has made an extended series of observations on this subject. His general results agree with those of Bonnier and Mangin ‡ that light has a prejudicial effect on respiration in plants. The mode of estimating the amount of carbon dioxide produced was by precipitation with baryta water. The object examined was exposed alternately to light and darkness for periods varying between $\frac{1}{2}$ and $1\frac{1}{2}$ hours.

With hymenomycetous fungi this result was obtained in 42 experiments out of 43, the reduction in the amount of CO_2 produced in a given time varying between the proportions of 0·58 : 1 and 0·90 : 1. The period of growth taken was either before the separation of the margin of the pileus from the stipe or at the maturity of the pileus; at which periods the intensity of respiration is very constant, while in the intermediate period of rapid growth it varies rapidly. Experiments with roots and rhizomes of Flowering Plants, with flowers, and with etiolated leaves, gave no uniform result, the intensity of the respiration being in some cases increased, in others decreased, by the action of light.

Formation and Decomposition of Oxalic Acid and its Function in the Metabolism of Fungi.§—From a very extended series of observations on certain fungi, belonging chiefly to the *Mucor*, *Aspergillus*, and *Penicillium* group, Herr C. Wehmer dissents from the views entertained by other authorities with regard to the importance of oxalates in the vital economy of the plant. Oxalic acid he regards as a secondary, but not always a final, product of metabolism, which may sometimes be excreted, or the formation of which may sometimes be altogether suspended. The conclusions were the result of the culture of the fungi in a great number of different nutrient solutions. The author believes that the same laws regulate the formation of oxalates in the higher plants as in fungi, and that their production is dependent entirely on the conditions in which their growth takes place; even the entire absence of oxalic acid, or of its salts, has no special significance as regards the vital economy of the plant.

As regards the conditions most favourable for the formation of oxalic acid,|| Herr Wehmer finds, in the case of *Aspergillus niger*, an optimum temperature (34°–35° C.), above which an increase of temperature is decidedly unfavourable to the formation of free oxalic acid. Light has a powerful effect in bringing about the decomposition of oxalic acid;

* Bull. Torrey Bot. Club, xviii. (1891) pp. 212–3.

† Schrift. Naturf.-Gesell. Kiew, xi. (1890) pp. 211–59. See Bot. Centralbl., xlvii. (1891) p. 130.

‡ Cf. this Journal, 1886, p. 1016.

§ Bot. Ztg., xlix. (1891) pp. 233–46, 249–57, 290–8, 321–32, 338–46, 354–63, 370–4, 385–96, 401–7, 417–27, 433–42, 449–55, 465–78, 511–18, 531–9, 547–54, 563–71, 570–84, 596–602, 611–20, 630–8.

|| Ber. Deutsch. Bot. Gesell., ix. (1891) pp. 163–83, 218–28.

while in the dark no such decomposition takes place as long as living organic material is wanting; neither dead organic substances nor such compounds as are found within the cell are active in this way.

Alcoholic Fermentation and the Conversion of Alcohol into Aldehyde by the "Champignon du Muguet."*—MM. G. Linossier and G. Roux, referring to the character of the fermentation induced by the "champignon du muguet," state that three stages may be distinguished during the fermentation, viz.:—(1) rapid growth of the organism; (2) active fermentation; (3) lessened activity due to the toxic influence of the fermentation products, aldehyde having, it would seem, the greatest effect. "Muguet" can cause the fermentation of dextrose, levulose, and maltose; saccharose is neither inverted nor fermented. In the slowness with which fermentation takes place, and in the maximum concentration of alcohol produced, and in the ratio of weight of sugar destroyed to weight of organism produced, the "champignon du muguet" exhibits marked analogies with the Mucorini, and differs considerably from the Saccharomycetes. The conclusion that the organism does not belong to the latter is borne out by the results of a careful morphological study.

Fermentation of Bread.†—M. L. Boutroux asserts that the fermentation of bread consists essentially in a normal alcoholic fermentation of the sugar which already exists in the flour. The yeast plays a double part; it produces a disengagement of gas which causes the dough to swell, and it prevents the bacteria, which are parasitic on the starch-grains, from developing, and thus making the dough sour and dissolving the gluten. M. Boutroux finds in the yeast three distinct microbes, two bacilli and a bacterium, but concludes that they play no direct part in the process of fermentation; if they are of any service at all, it is simply in the production of the fermentable substance, that is, of the sugar.

Commenting on this paper, M. Chicaudard ‡ states that, at the period when the dough is placed in the oven, he finds in it immense numbers of bacilli, but no yeast-cells. He considers, therefore, the fermentation of bread to be a fermentation of the gluten caused by *Bacillus glutinis*.

Fermentations induced by the Pneumococcus of Friedlaender.§—In the experiments carried out by Dr. P. F. Frankland, Mr. A. Stanley, and Mr. W. Frew, the pneumococcus had been cultivated for nearly three years on gelatin-peptone, and was afterwards further purified by obtaining a single colony through the intermediary of a plate cultivation. The authors recount the details of their experiments at considerable length, but it will suffice to recapitulate their results, which are summarized as follows:—

(1) The pneumococcus of Friedlaender sets up a fermentative process in suitable solutions of dextrose, cane-sugar, milk-sugar, maltose, raffinose, dextrin, and mannitol.

(2) It does not ferment solutions of dulcitol or glycerol, and has

* Bull. Soc. Chim., iv. pp. 697-706. See Journ. Chem. Soc., 1891, Abstr., p. 854.
† Comptes Rendus, cxiii. (1891) pp. 203-6. Cf. this Journal, 1889, p. 253.
‡ Comptes Rendus, cxiii. (1891) p. 612.
§ Journ. Chem. Soc., cccxli. (1891) pp. 253-70.

thus the power, like the *Bacillus ethaceticus*, of distinguishing between the isomers mannitol and dulcitol.

(3) In the fermentation of dextrose and mannitol, the principal products are ethyl-alcohol and acetic acid, with a smaller proportion of formic acid, and traces of a fixed acid, in all probability succinic acid.

(4) The gaseous products are carbonic anhydride and hydrogen.

(5) The ethyl alcohol, volatile acids, carbonic anhydride, and hydrogen, approximate to the molecular proportions $9C_2H_6O$, $4C_2H_4O_2$, $12CO_2 8H_2$.

(6) The productions of which may be most readily referred to the following equations:—$6C_6H_{14}O_6 + OH_2 = 9C_2H_6O + 4C_2H_4O_2 + 10CO_2 + 8H_2$, which is followed by $4C_2H_4O_2 + 2CaCO_3 = 2CO_2 + 2OH_2 + 2Ca(C_2H_3O_2)_2$.

Diastatic Ferment in Green Leaves.*—Prof. S. H. Vines criticizes the statement of Wortmann † that green leaves contain no diastase, or not a sufficient quantity to effect the transformation of starch into sugar which takes place in them. He gives details of experiments which appear to him to establish the fact that a diastatic ferment is present in green leaves; and, though the quantity found at any moment may be comparatively small, it is probable that the total amount secreted during a night would suffice to effect the observed conversion of starch into sugar.

γ. General.

Evolution of Parasitic Plants.‡—Mr. T. Meehan believes that the distinction between parasitic and non-parasitic plants is by no means an absolute one; but that many species usually parasitic will grow in the ordinary way in the soil, and have, as now existing, acquired parasitic habits. Many species of Santalaceæ are partial parasites. *Sarcodes sanguinea* and *Orobanche* will germinate in ordinary garden soil, and go on with their development through all its stages; and *Monotropa* will grow in soil with only the slightest modicum of vegetable matter.

Exudation of Sap by Mangifera.§—M. H. Leveille records a singular effect of the wet season on *Mangifera indica*. It produced no fruit; but from the extremity of the young shoots was exuded a yellow viscous saccharine fluid, identical with that ordinarily contained in the mango-fruit. He regards this as the elaborated sap which, not being required for the development of the fruit, is thus thrown off.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Life-history of Isoetes.‖—Prof. D. H. Campbell has carefully followed out the development of the female prothallium and embryo of *Isoetes echinospora* var. *Braunii*. His researches confirm the view of the affinity of *Isoetes* with the Filicineæ rather than with the Lycopodineæ. The development of the oophyte resembles much more nearly that of

* Ann. of Bot., v. (1891) pp. 409–12.
† Cf. this Journal, *ante*, p. 221.
‡ Bull. Torrey Bot. Club, xviii. (1891) pp. 210–2.
§ Bull. Soc. Bot. France, xxxviii. (1891) p. 286.
‖ Ann. of Bot., v. (1891) pp. 231–58 (4 pls.).

Gymnosperms, or the endosperm of Angiosperms, than it does the prothallium of any pteridophyte (except possibly *Selaginella*). In the multiciliate antherozoids, and in the absence of a suspensor, *Isoetes* resembles ferns rather than lycopods; the body of the antherozoid is derived, as stated by Guignard, from the nucleus of the mother-cell.

The microspore produces, on germination, a single prothallial cell, and an antherid composed of four peripheral and four central cells; each of the latter gives rise to a single antherozoid. The process of cell-division in the ripe megaspore is entirely similar to that in the embryo-sac of most Phanerogams. The first archegone arises from one of the first-formed cells, at the centre of the apical region. The prothallium is incapable of independent growth, and dies after the supply of food in the spore is exhausted. More than one archegone may be fertilized, but the complete development of more than one embryo has not been observed. The secondary thickening of the stem is of a different type from that in Gymnosperms and Dicotyledons, approaching more nearly that found in a few Monocotyledons. The author's results differ in some respects from those obtained by Farmer * in the case of *I. lacustris*.

Sieve-tubes of Filicineæ and Equisetineæ.†—M. G. Poirault discusses the characteristic differences between the sieve-tubes in Phanerogams and those in Cryptogams. The modification which occurs in the latter consists principally in the fact that while the punctations of the membrane are open in Phanerogams, in Vascular Cryptogams they are always closed. Janczewski has also stated that in the former we have callus, which is absent in the latter; the only exception to this rule being *Pteris aquilina*, in which we find callus, as in Phanerogams. M. Poirault does not, however, agree with Janczewski in this point, having found callus in Ferns, Marattiaceæ (?), Equisetaceæ, and Hydropterideæ, the only exception being the sieve-tubes of Ophioglossaceæ. The author does not insist on the absence of a nucleus and the presence in the tubes of numerous granules; and on this point his observations agree absolutely with those of Janczewski.

Nectaries of Pteris aquilina.‡—Herr W. Figdor describes the nectariferous organs of the common brake, which are found at the base of the pinnæ of the first or second order. When young they form triangular projections, which gradually become flatter. Their surface is distinguished from that of the rest of the axis by being quite glabrous, and is usually reddish. The cells of the nectar-gland are about the size of those of the ordinary fundamental parenchyme, and are often separated by intercellular spaces. They are furnished with stomates, some of which appear to possess the ordinary function, while others serve for the excretion of the saccharine fluid. Beneath the nectary is the end of a vascular bundle. Its cells contain a large nucleus, few chlorophyll-grains, and a number of larger or smaller strongly refringent granules; those at the margin also contain anthocyan. With increasing age the nectaries become functionless.

* Cf. this Journal, *ante*, p. 376.
† Comptes Rendus, cxiii. (1891) pp. 232-4.
‡ Oesterr. Bot. Zeitschr., xli. (1891) pp. 293-5 (2 figs.).

Peculiarity in the Root of Ceratopteris thalictroides.*—M. G. Poirault describes a peculiarity in this aquatic Fern. The roots produce two series of opposite rootlets; but sometimes the one and sometimes the other remains intracortical. After traversing the internal cortex, they reach one of the lacunæ in the internal cortex, and finding there conditions favourable to their development, they do not continue their growth towards the exterior, but descend vertically in the cortex for a considerable distance.

Structure of the Primary Fibro-vascular System in Lepidodendron selaginoides.†—M. M. Hovelacque states that in the stipe of *Lepidodendron selaginoides* two main regions can be distinguished:—(1) The fibro-vascular mass including the central primary xylem and a primary phloem-crown, between which is a zone of secondary fibro-vascular tissue. (2) The cortex, which may be divided into three zones. The foliar traces detach themselves from the primary xylem in the form of small circular ligneous masses, and traverse the secondary xylem horizontally. The primary phloem is more differentiated than that of *Lepidodendron Harcourtii*, and at the exterior consists of a pericambial zone of similar parenchymatous elements.

Muscineæ.

New Genera of Mosses, Aulacomitrium and Willia.—In his enumeration of all the species of Musci and Hepaticæ recorded from Japan, Mr. W. Mitten ‡ describes a number of new species belonging to each order of Muscineæ, and the following new genus of Musci,—*Aulacomitrium.* Theca apicalis, æqualis; folia perichætii in vaginam exsertam convoluta; calyptra mitriformis, plicata.

Among a large number of new species of Mosses from South Georgia, obtained in the German Polar Expedition, Herr C. Müller (Hal.) § describes a new genus and species *Willia grimmioides*, with the following generic characters,—Folia *Syntrichiæ*, sed stricta *Eubarbulæ*, apice hyalino-limbata, calyptra capsulam omnino obtegens, cylindrico-campanulata, basi in lobos rotundatos incisos subinflexos hookerioideo-divisa; peristomium nullum.

Characeæ.

Rabenhorst's Kryptogamen-Flora v. Deutschland (Characeæ).—Parts 5 and 6 of Dr. W. Migula's monograph of the Characeæ commence with the completion of the description of *Tolypellopsis stelligera.* A full account is then given of the genus *Lamprothamnus* and its single species *L. alopecuroides*, and of *Lychnothamnus* and its single species *L. barbatus.* There is a description of the general characters of *Chara*, and a schedule of its twenty-seven species, followed by a commencement of the description of the species in detail. The letterpress is exhaustive, and the illustrations are of remarkable excellence.

* Journ. de Bot. (Morot), v. (1891) p. 264.
† Comptes Rendus, cxiii. (1891) pp. 97–100.
‡ Trans. Linn. Soc. Lond. (Bot.), iii. (1891) pp. 153–206 (1 pl.).
§ 'Bryologia Austro-Georgiæ' (Separat-Abdr. Deutsch. Polar Exp.), 46 pp. See Bot. Centralbl., 1891, Beih., p. 175.

Algæ.

Influence of the Concentration of Sea-water on the Growth of Algæ.*—Dr. F. Oltmanns finds, from a series of experiments on various sea-weeds, especially species of *Fucus*, that an alteration in the proportion of salts contained in the water, say between 1·0 and 1·8 per cent., is prejudicial to their growth only when the alteration takes place suddenly; if it is effected slowly, the injurious influence is but slight. The cause of the injury is probably the inability of the cells of the plant to adapt themselves suddenly to changes of turgor. Since different species show different degrees of inability in this respect, alterations in the constitution of the sea-water caused by variations in the influx of fresh water have a material influence on the marine flora.

Endophytic Algæ.†—Herr M. Möbius gives a conspectus of all the endophytic algæ known, of which he enumerates ninety-two species, including the new *Bolbocoleon? endophytum*, which inhabits the cell-walls of *Cladophora fracta*. Of these some have been observed only on one host, others on several. They inhabit other Algæ—Rhodophyceæ, Phæophyceæ, and Chlorophyceæ; very rarely Fungi; Musci—especially *Sphagnum*, more often Hepaticæ; *Azolla* among Vascular Cryptogams; several orders of Gymnosperms, Monocotyledones, and Dicotyledones; among animals, sloths and a great variety of marine species. With the exception of those which inhabit the shells of molluscs or of turtles, they penetrate either the cells or only the cell-walls of both plants and animals. They may or may not be injurious to the host.

"Meteor-paper."‡—M. J. Istvánffi gives the following as the composition of several specimens of this structure gathered by him in Germany and Hungary:—(1) *Cladophora fracta* var., with specimens of *Oscillaria tenuis*, *Chlamydomonas Pulvisculus*, *Herposteiron repens*, *Œdogonium longatum*, and *Hantzschia Amphioxys;* (2) *Lyngbya turfosa*, with nine species of unicellular algæ; (3) *Œdogonium tenellum;* (4) a loose weft of the resting-form of a species of *Conferva*; (5) *Microspora floccosa*, together with specimens of *Oscillaria tenuis*, *Ulothrix subtilis*, twenty-one species of diatoms, three of desmids, and one of Pleurococcaceæ.

Reproductive Organs of Florideæ.§—Mr. T. H. Buffham describes the antherids in the following species of Florideæ, in which they had not previously been observed or figured:—*Bangia fusco-purpurea*, *Callithamnion arbuscula*, *Griffithsia barbata*, *Ptilota elegans*, *Ceramium echionotum*, *C. transcurrens*, *C. flabelligerum*, *Phyllophora membranifolia*, *Plocamium coccineum*, *Nitophyllum laceratum*, *Lomentaria kaliformis*, *Chondriopsis dasyphylla*, *Rytiphlœa pinastroides*, *Polysiphonia elongata*. Procarps and trichogynes were also observed in *Callithamnion tetragonum*, *C. roseum*, *C. byssoideum*, *C. granulatum*, *Griffithsia barbata*, and *G. corallina*; in most cases the pollinoids were detected adhering to the trichogynes. In *Griffithsia corallina* and *Ceramium flabelligerum* there are two trichogynes to each procarp. *Callithamnion byssoideum* was found bearing branching

* SB. K. Preuss. Akad. Wiss., 1891, pp. 193-203 (1 pl.).
† Notarisia, vi. (1891) pp. 1221-36, 1279-86, 1291-1304 (1 fig.).
‡ Természetrajzi Füzetek, vol. xiii. See Bot. Centralbl., xlvii. (1891) p. 51.
§ Journ. Quek. Micr. Club, iv. (1891) pp. 246-53 (2 pls.).

strings of spores in the place of the usual cystocarps. They bear a close resemblance to seirospores, and appear to be developed in the absence of fecundation.

Chreocolax.*—Mr. H. M. Richards discusses the structure and systematic position of *Chreocolax Polysiphoniæ*, parasitic on *Polysiphonia fastigiata* on the coast of New England. He succeeded in detecting not only the tetraspores, but also the trichogyne and accompanying organs, as well as the cystocarp. It is a true parasite, obtaining its nourishment from the tissue of the sea-weed on which it grows. The tetraspores develope from the terminal cells of the plant, and may be either tripartite or cruciate. The structure of the cystocarp appears to remove the genus from the Gelidiaceæ, in which it has hitherto been placed, and to transfer it to the Chætangiaceæ. The cystocarp resembles that of *Chætangium*, and still more closely that of *Galaxaura*. The frond is immersed in a great mass of gelatinous matter.

Sphacelariaceæ.†—Herr J. Reinke gives in further detail a monograph of this order of Phæosporeæ. Only one new species is described, *Sphacelaria indica* from Singapore, increasing the number of species of that genus from twelve to thirteen, while those of *Cladostephus* are reduced from three to two.

Cladothele and Stictyosiphon.‡—Mr. G. Murray has made a fresh examination of *Cladothele Decaisnei*, from the Falkland Islands, hitherto placed, though doubtfully, among the Siphoneæ. He found sporanges of the type familiar among the Phæophyceæ; and states that the alga is indistinguishable from *Stictyosiphon*, corresponding to that genus in the structure of the central axis and in the peripheral cells. The genus *Cladothele* must therefore be abolished, and its only species be united to *Stictyosiphon*, a genus of Punctariaceæ.

Cladophora.§—M. E. de Wildeman confirms Gay's observations on the production of rhizoids by *Cladophora*. When, under cultivation, a cell loses its cell-contents, it is common for an adjoining cell to put out rhizoids, which penetrate into the cavity of the dead cell, which they may traverse, and continue to grow in the surrounding fluid. Both *C. glomerata* and *C. fracta* undergo a great variety of modifications in cultivation, and it is probable that a large number of the very numerous species described are but modifications of one. The formation of bulbous or pear-shaped swellings is frequent, and the author has observed the production of rings in the cell-wall resembling those of *Œdogonium*.

Hormidium, Schizogonium, and Hormiscia.‖—Prof. A. Hansgirg recapitulates the arguments in favour of his view that the aerophytic species of these genera are all connected genetically with one another, and with *Prasiola*, and replies to the observations of Gay, who is opposed to the theory of the polymorphism of the lower Algæ.

* Proc. Amer. Acad. Arts and Sci., xxvi. (1891) pp. 46–63 (1 pl.).

† Biblioth. Bot. (Luerssen u. Haenlein) Heft 23, 1891 (40 pp. and 13 pls.). Cf. this Journal, *ante*, p. 225.

‡ Journ. of Bot., xxix. (1891) pp. 193–6 (1 pl.).

§ Bull. Soc. Belge Micr., 1891, pp. 154–9 (4 figs.). Cf. this Journal, *ante*, p. 503.

‖ Bot. Centralbl., xlvii. (1891) pp 6–9. Cf. this Journal 1888, p. 1002.

Pachytheca.*—Mr. C. A. Barber has carefully studied numerous specimens of this fossil from the Old Red Sandstone and Silurian formations, and concludes that it is a spherical alga consisting of a mass of cellular filaments. The cells of these filaments appear to resemble in general shape those of a living *Cladophora*.

Dr. W. T. Thiselton-Dyer † confirms Mr. Barber's statement of an organic connection between the cortical cells and those of the peripheral tissue.

Fungi.

Mycorhiza.‡—M. P. Vuillemin adopts Frank's view with regard to the nature of mycorhiza. He proposes the classification of the various kinds into Ascorhizæ and Basidiorhizæ, and the latter again into Hymenorhizæ and Gasterorhizæ. For the corresponding structure in *Corallorhiza* and *Epipogium* he suggests the term *mycorhizome*.

Endotrophic Mycorhiza.§—Summing up the present state of our knowledge with regard to the various instances of endotrophic mycorhiza, Herr B. Frank regards them as fungus-consuming plants, comparable to other carnivorous plants, which have the power of attracting the fungus into their protoplasm, and finally digesting it. The organs in which this digestion takes place are not true roots, but new formations of a peculiar morphological character, for which he proposes the term *mycodomatia* or fungus-chambers. The known examples of endotrophic mycorhiza may be classed under the following four heads:—

(1) Endotrophic Mycorhiza of the Orchideæ. The fungus is here, from the first moment of its development until the close of its life, completely inclosed in the active protoplasm of the root-cell. The fungus-hyphæ gradually lose their albuminous contents, and give them up entirely to the host, losing, at the same time, their power of independent growth.

(2) Endotrophic Mycorhiza of the Ericaceæ. The phenomena are here very similar to those which occur in the Orchideæ.

(3) Symbiosis of the Leguminosæ. The Schizomycete is here taken up from the soil into the cells of the root, and there digested in the root-tubers formed for the purpose. But when the bacteroid tissue has been absorbed, some germs still remain which return to the soil on the decay of the tuber.

(4) Symbiosis of the Alder. The process shows a complete analogy with those of the Leguminosæ. The formation of sporanges by *Frankia subtilis*, described by Brunchorst, appears to rest on erroneous observation.

The ectotrophic mycorhiza of the Cupuliferæ and Coniferæ does not come under either of the above headings.

Disarticulation of Conids in the Peronosporeæ.‖—According to M. L. Mangin, the septum which separates the conid from the basid or

* Ann. of Bot., iii. (1890) pp. 141-8 (1 pl.); v. (1891) pp 145-62 (1 pl.).

† Op. cit., v. (1891) pp. 223-5.

‡ Rev. Gén. Sci. pures et appliquées, i. (1890) pp. 326-35. See Bot. Centralbl., 1891, Beih., p. 192.

§ Ber. Deutsch. Bot. Gesell., ix. (1891) pp. 244-53. Cf. this Journal, *ante*, p. 504.

‖ Bull. Soc. Bot. France, xxxviii. (1891) pp. 176-84, 232-6 (1 pl.). Cf. this Journal, *ante*, p. 381.

sterigma in the Peronosporeæ, always consists originally of callose, to the entire exclusion of cellulose, which is only developed at a later period when the conid is fully formed. This callose, at first exceedingly resistant to the action both of water and of chemical reagents, is capable of undergoing modifications, the nature of which is at present unknown, by which it becomes soluble in water. On the access of water to the septum, this process of dissolution of the callose takes place at once, and the conids thus become disarticulated.

The species most carefully examined was *Cystopus candidus*. The basid is a club-shaped cell, the wall of which is very thick below, much thinner in the upper portion. When a conid is about to be produced, a ring of callose is formed in this upper part which is at first very thin and scarcely visible, but gradually becomes thinner and forms a funnel-like structure with the opening pointing downwards; this opening gradually closes, and the upper portion of the basid is now cut off as a conid, a sudden narrowing taking place at the line of the septum by the absorption of the outer cellulose-wall at that spot. The callose septum now assumes successively the form of a cup and of a cylinder; and by the repetition of this process, a string of conids may be formed attached to one another by cylinders of callose, and at length set free by the dissolution of these cylinders. This same process appears to take place uniformly throughout the Peronosporeæ; but is much more difficult to follow in the species of *Plasmopara* and *Peronospora*, and in *Bremia Lactucæ*.

Penetration of the Host by Peronospora gangliformis.*—Mr. W. H. Rush describes the mode in which the germ-tubes of this fungus penetrate the epiderm of *Lactuca sativa*—through the stomates, and not through the cell-walls as stated by De Bary. The germ-tubes will sometimes curve, apparently for the purpose of reaching a stomate.

Biology of Phycomyces nitens.†—M. A. De Wevre has made a series of experiments on the growth of this fungus on bread soaked with various nutritive substances and under varying conditions of light and moisture. The following are the general conclusions at which he has arrived:—Solid substrata give better results than soft, and especially than liquid media. *Phycomyces* is subject to modification according to the nutritive medium on which it developes, in relation to its size, colour, branching, rapidity of growth, and the production of septa and swellings. Light has a tendency to diminish its size, and moisture is very prejudicial to its growth.

Doassansia.‡—Dr. W. A. Setchell gives a monograph of this genus of Ustilagineæ, comprising twelve species, three of them new, which he arranges in three subgenera, Eudoassansia, Pseudodoassansia, and Doassansiopsis. He appends descriptions of two new nearly allied genera:—*Burrillia*, Sorus compact, not separating into its elements on being crushed; central portion composed of an irregular mass of parenchymatous tissue; spores closely resembling those of *Entyloma*, both in structure and in germination, compacted into several dense rows; cortex

* Bot. Gazette, xvi. (1891) pp. 208–9 (1 fig.).
† CR. Soc. R. Bot. Belgique, 1891, pp. 107–25.
‡ Proc. Amer. Acad. Arts and Sci., xxvi. (1891) pp. 13–9.

none, or composed only of a thin irregular layer of hardened hyphæ. *Cornuella*, Sorus hollow at maturity, the interior containing only loose hardened hyphæ; spores compacted into a firm layer on the outside, resembling those of *Entyloma*, both in structure and in germination; cortex none.

Fungus-parasites of the Sugar-cane.*—Herr W. Krüger describes the following diseases of the sugar-cane caused by the attacks of vegetable parasites which are destructive of the crop in Java.

The "dust-brand," by *Ustilago Sacchari*. The mycele penetrates almost the entire plant; the fructification makes its appearance at the apex of the stem or branches.

The "red-spots" on the leaves are caused by *Cercospora Köpkei* sp. n.; they appear first on the under, subsequently on the upper side of the leaves, and are at first yellow, afterwards red; the mycele on the under side of the leaf puts out tufts of branches bearing white multicellular spores. A similar disease is caused by *C. vaginæ* sp. n.

The "rust" caused by *Uromyces Kühnii* sp. n. Only the uredospores are at present known.

The "sclerote-disease" appears in the form of a silver-white mycele on the under side of the leaves, which developes later into yellowish-white sclerotes. Its further history is unknown.

Other diseases are probably produced by a *Pythium* and by a *Bacterium* resembling *B. Termo*.

Fungus parasitic on Balanus.†—M. C. Bommer describes a new pyrenomycetous fungus, *Pharcidia marina*, growing on the shell of *Balanus balanoides*, in Holland. It produces small peritheces, 117-207 μ, half imbedded in the calcareous substance of the shell, in a superficial layer of a unicellular alga belonging to the Chroococcaceæ, which is permeated by a network of mycelial filaments. The asci are club-shaped and shortly pedicellate; the spores oblong and uniseptate, 12–18 μ by 4–7 μ.

New Genus of Fungi (Sphæropsideæ).‡—Among a number of new species of fungi belonging to the Mucorini and Sphæropsideæ, M. E. Marchal describes the new genus *Trichocrea*, with the following diagnosis:—Perithecia superficialia, ovoidea, contextu parenchymatico, ceraceo-molliuscula, læticoloria, initio clausa, demum late aperta, fere discoidea; sporulæ numerosissimæ, cylindraceæ, 1-septatæ, hyalinæ; basidiis elongatis, filiformibus, dense fasciculatis, sursum 1–3-ramosis, suffultes. The author considers the genus to have affinities both with the Sphæropsideæ and with the Hyphomycetes; but its very regularly developed perithece of parenchymatous texture identifies it most closely with the Nectrioideæ.

New Pestalozzia.§—Under the name *Pestalozzia insidens*, Mr. J. L. Zabriskie describes a new species found in New York State on the bark of living elm-trunks, in which the conid is divided into four inner very

* Ber. Versuchsstat. Zucker-rohr in West-Java, Heft 1, 1890, pp. 50–179 (5 pls.). See Bot. Centralbl., xvii. (1891) p. 46.
† Bull. Soc. Belge Micr., 1891, pp. 151–2.
‡ CR. Soc. R. Bot. Belgique, 1891, pp. 134-46.
§ Journ. N. York Micr. Soc., vii. (1891) pp. 101–2 (1 pl.).

dark brown and two terminal hyaline cells, and each of the latter is prolonged into a stout curved acuminate hyaline bristle.

Diseases caused by Fungi.*—Prof. J. E. Humphrey gives a detailed account of the following diseases and the fungi which cause them:—

The black knot of the plum, a disease very destructive to all kinds of plums and cherries, both cultivated and wild, in the United States, but not yet known in this country. It is caused by the attacks of *Plowrightia morbosa*, belonging to the Sphæriaceæ.

The cucumber-mildew, which has recently appeared in various parts of America and in Japan, on several species of Cucurbitaceæ. It is due to *Plasmopara cubensis*, originally found in Cuba.

The brown rot of stone-fruits, very widely spread both in Europe and America, due to *Monilia fructigena.*

The actual cause of the disease known as "potato scab" the author regards as at present uncertain.

Fungus-parasites on Pines.†—MM. E. Prillieux and Delacroix describe two fungi which are parasitic on and injurious to pine-trees, —*Dothiorella Pitya*, on the spruce-fir, and especially on seedlings; and *Physalospora abietina* sp. n., belonging to the Sphæriaceæ, on *Abies excelsa.*

Fructification of Physcia pulverulenta.‡—Herr C. Mäule has closely observed the development of the fructification of this lichen, in order to determine the correctness of Lindau's hypothesis that the apothece has its origin in certain cells, found chiefly in the gonidial layer, to which he gives the term "primordia." Herr Mäule finds the earliest appearance of the apothece in a cluster of cells with reddish contents confined to the boundary-line of the gonidial and medullary layers. The "primordia," on the other hand, are distributed through the entire gonidial layer; and he regards them as cells differing from the remaining cells of the thallus in their chemical nature, but having nothing to do with the formation of the fructification. He proposes for them the term "Lindau's cells."

Germination of Spores in Saccharomyces.§—Herr E. C. Hansen, in narrating his experiments with three kinds of Saccharomyces, *S. cerevisiæ, S. Ludwigii*, and *S. anomalus*, states that the germination stages of all three were followed from one and the same spore. The germination of *S. cerevisiæ* has already been noticed in this Journal (1885, p. 849). That of *S. Ludwigii* is chiefly remarkable from the fact that the yeast-cells are not developed directly from spores, but from a promycele, and also from the fact that the new formations become fused together, giving rise to characteristic fusion-forms from which yeast-cells develope. When old spores germinate fusion-forms are not observed, but a transversely septate mycele arises. The spores of *S.*

* Eighth Ann. Rep. Massachusetts Exper. Stat., 1890, pp. 200–26 (2 pls.).

† Bull. Soc. Mycol. France, vi. (1890) pp. 98 and 113 (2 pls.). See Bot. Centralbl., xlvii. (1891) pp. 173 and 174.

‡ Ber. Deutsch. Bot. Gesell., ix. (1891) pp. 209–13.

§ CR. Travaux du Laborat. de Carlsberg, iii. (1891) part 1. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 663–4.

anomalus resemble those of *Endomyces decipiens*, but are distinguished therefrom by being smaller and by budding like *S. cerevisiæ* i.

The author's article ends by criticizing the attempts which have been made during the past thirty years to show that the Saccharomycetes are not independent species, but developmental forms of higher fungi, and he points out that the confusion has chiefly arisen from not properly distinguishing the true Saccharomycetes (yeasts with endogenous spore-formation) from the various Blastomycetes devoid of such spore-formation.

Researches on Uredineæ.*—Herr P. Dietel epitomizes the most important additions to our knowledge of this order of Fungi acquired during the last ten years.

Uromyces Cunninghamianus sp. n.†—The late Dr. A. Barclay describes, under this name, a remarkable fungus parasitic on *Jasminum grandiflorum* at Simla. Its peculiarities are mainly three, viz. the production of teleutospores within the peridia; the assumption of a distributive function by the æcidiospores; and the very peculiar germination of the æcidiospores. The second of these peculiarities renders the production of uredospores unnecessary, and accordingly there are none. When the æcidiospore germinates, the germ-tube, which is quickly emitted, soon acquires the appearance of a promycele, as in the case of *Endophyllum*, suggesting an affinity with that genus; but it does not actually assume the character of one, as it never produces sporids. It produces, on the contrary, sterigmatous branches which directly enter the tissue of the host, and there form another mycele, commencing the life-cycle over again.

Diorchidium.‡—Herr P. Magnus points out that the position of the germ-pores and of the septum in the teleutospores of *Diorchidium* presents no constant distinction from those in *Puccinia*, and that *Diorchidium leve* must, therefore be sunk in the latter genus. To the true genus *Diorchidium* he assigns all those species with two-celled teleutospores, in which the pedicel is inserted parallel to the septum, and the two cells are of similar form, with rounded poles, and with the germ-pores near to the poles. The type-species of the genus is *D. Woodii*, and to it must also be referred *Puccinia lateripes* and *P. insueta*.

Parasite of the Cockchafer.§—MM. E. Prillieux and Delacroix, recurring to this subject, point out that the two species of *Botrytis*, *B. tenella* and *bassiana*, differ in their spores, those of *B. tenella* being oval-oblong, while those of *B. bassiana* are globular, as also in certain special physiological properties. The authors conclude by giving details of the manner in which *B. tenella* can be multiplied, and also the mode in which insects can be infected with the parasite. Besides the cockchafer larva, the following insects have been infected by the authors with the spores of *B. tenella*,—*Rhizotrogus solstitialis*, *Cetonia aurata*, and the larvæ of *Liparis chrysorrhœa*.

* Bot. Centralbl., xlvii. (1891) pp. 15–9.

† Trans. Linn. Soc. Lond. (Bot.) iii. (1891) pp. 141–51 (2 pls.).

‡ Ber. Deutsch. Bot. Gesell., ix. (1891) pp. 187–93 (1 pl.).

§ Comptes Rendus, cxiii. (1891) pp. 158–60. Cf. this Journal, *ante*, p. 636.

New Genera of Hyphomycetes.*—Mr. R. Thaxter describes the following new genera of Hyphomycetes from North America:—

Helicocephalum. Sterile hyphæ of small diameter, aseptate or rarely septate, creeping over the substratum, and giving rise to highly differentiated erect simple aseptate sporiferous hyphæ, furnished with rhizoid-like attachments at the base, and spirally coiled at the apex; the apical portion becoming septate and constricted at intervals, its segments separating at maturity in the form of large dark-coloured, thick-walled spores. *H. sarcophilum* on carrion.

Gonatorrhodiella. Sterile hyphæ hyaline, creeping, septate and branched; fertile hyphæ erect, sparingly septate, swelling into a spherical terminal sporiferous head, which, after maturity, may become once or twice proliferous; spores formed directly from short processes covering the fertile head, in chains of a definite number, by successive apical budding. *G. parasitica* on *Hypocrea* and *Hypomyces*.

Desmidiospora. Spores of two kinds on the same mycele of hyaline septate hyphæ; microconids small, hyaline, subfusiform, produced at the apex of subulate lateral basids; megaconids very large, terminal, brown, flat, multilocular, several times successively more or less irregularly dichotomously lobed. *D. myrmecophila* on a large ant.

Mucilaginous Slime on Trees.†—Dr. F. Ludwig observed during last spring an extraordinarily copious flow of white or red mucilage from wounds caused by the lopping of branches from birches and hornbeams. The white slime swarmed with bacteria, but was caused chiefly by a new species of *Endomyces*, which he calls *E. vernalis*. The mycele is much slenderer and less branched than that of *E. Magnusii*. The cause of the red colour, which was comparatively rare, was the presence of filaments of a *Rhodomyces*, probably a new species, to which he gives the name *R. dendrorhous*.

New Achorion, A. Arloini.‡—Dr. G. P. Busquet describes a fungus, parasitic on a human subject, bearing a resemblance both to *Achorion Schœnleini* and to *Trichophyton tonsurans*. Experiments in growing it on various media are described in detail. On liquid nutritive substances it has two mycelial forms, a filamentous and a globular, presenting in this respect analogies both to *Aspergillus* and to *Mucor*. The exogenous non-sexual organs of reproduction are of three kinds,—mycelial spores, conidial structures, and aerial spores, the first two formed only in liquid, the last either in liquid or on solid media.

Protophyta.

α. Schizophyceæ.

Glœochæte.§—Herr L. Reinhard describes the history of development of *Glœochæte Wittrockiana*, which he transfers from the Chroococcaceæ to the Palmellaceæ, placing it near to *Tetraspora*. Each cell is provided with two long bristles, one of which is formed after each

* Bot. Gazette, xvi. (1891) pp. 201–5 (2 pls.).
† Biol. Centralbl., x. (1891) pp. 10–3. Cf. this Journal (1890) p. 368.
‡ Ann. de Micrographie, iii. (1890) pp. 9–21, 62–75, 136–49 (3 pls.).
§ VIII Congress Russ. Naturf. u. Aerzte; Bot., p. 13, 1890. See Bot. Centralbl., xlvii. (1891) p. 107.

process of cell-division. The cells contain small oval chloroplasts; multiplication takes place by means of zoospores, only one of which is formed in each mother-cell.

The Idea of Species in Diatoms.*—M. J. Deby replies to the paper by Dr. J. D. Cox, in which that authority proposes a great reduction in the number of genera and species of diatoms, and points out that the transitory forms of Cox are the same things as the species of those who accept the hypothesis of evolution.

Diatoms of France.†—Messrs. J. Tempère and H. Peragallo have issued thirty-one parts of a series of preparations of the diatoms of France, named by M. Peragallo. Each part contains twelve species.

New Genera of Diatoms.‡—M. J. Brun describes a number of new species of marine, pelagic, and fossil diatoms, from various parts of the world, together with the two following new genera:—*Cotyledon*, distinguished by the valve being more or less circular, and bearing an elevated irregularly folded crest; the position of the genus is at present uncertain. *Hydrosilicon*, characterized by a lamellar, sometimes panduriform, valve, having a pseudo-raphe with simple or double bifurcations towards the extremity of the valve; the margin is thickened and covered by a row of large pearls; the striations have for their centres of radiation axes crossing the raphe.

Under the name *Streptotheca Tamesis*, Mr. W. H. Shrubsole § describes what he regards as a new form of diatom from the estuary of the Thames, where it has appeared every autumn and winter for several years. It has the form of a flattish band, slightly twisted in the direction of its length, so as to form an open spiral. It is extremely delicate and transparent, but is rendered visible by splashes of bright colour. It is almost entirely destitute of silica.

Monograph of Pleurosigma.‖—M. H. Peragallo has published a monograph of the genus *Pleurosigma* and its allies. These latter he classes under three genera, viz. *Rhoïcosigma*, *Donkinia*, and *Toxonidea*. The genus *Pleurosigma* properly so-called is divided into eleven groups, viz. Formosi, Speciosi, Affines, Angulati, Rigidi, Attenuati, Acuminati, Strigiles, Colletonema, Fasciolati, and Staurosigma.

Auliscus.¶—M. J. Deby gives a catalogue of all the known species of *Auliscus*, including *Pseudauliscus*, about 120 in number.

β. Schizomycetes.

Phagocytosis.**—At the International Congress of Hygiene a valuable discussion was held on this subject. Dr. Roux, of the Institut Pasteur, in an introductory address, indicated the scope of the discussion. He began by saying that, in inviting a pupil of M. Pasteur to open the

* Journ. de Microgr., xv. (1891) pp. 112–4. Cf. this Journal, *ante*, p. 385.
† 'Les Diatomes de France,' Sér. I.–XXXI. Paris, 1890. See Bot. Centralbl., xlvii. (1891) p. 12.
‡ Mém. Soc. Phys. Genève, xxxi. pt. 2 (1891) (48 pp. and 12 pls.).
§ Journ. Quek. Micr. Club, iv. (1891) pp. 259–62 (1 pl.).
‖ 'Monographie du genre Pleurosigma et d. genres alliés,' Paris, 1891, 35 pp. and 10 pls.
¶ Journ. de Microgr., xv. (1891) pp. 183–9.
** Nature, xliv. (1891) pp. 419–23.

discussion on this subject, the Organizing Committee had reminded the Section that the great amount of interesting work which had recently been done on the subject had one point in common—namely, the attenuation of virus, and preventive inoculation, the two subjects with which M. Pasteur's name would for all time be honourably associated. With the single notable exception of vaccination, the only way of conferring immunity against any disease was the inoculation of the virus of the disease. To the old dangerous method of producing immunity by inoculation Pasteur had added the less dangerous one of preventive inoculation by means of an attenuated virus, to which he had applied the term vaccination. The designation "attenuated" virus ought to be reserved for virus weakened without being attenuated—for example, by artificially lowering the vitality of the organisms for producing it.

Methods of Attenuation.—Two methods of attenuation had been described by M. Pasteur—namely, the prolonged exposure of a culture to air at a suitable temperature, and the passage of the micro-organisms through the bodies of different species of animals. Other methods had also been employed—for example, the action of heat, the use of antiseptics, of compressed oxygen and light.

In all cases, whatever the method employed, it was found to be necessary that the attenuation should be effected slowly and gradually; rapid attenuation rendered a virus altogether inactive without impressing on it any hereditary weakness. In whatever way the virus was prepared, it must, in order to confer immunity, be brought into direct contact with the tissues of the animal. In the early experiments the virus employed was always living; the living microbe, itself attenuated as to its virulence, was used. Another possible method of conferring immunity was the inoculation of the chemical substances produced by the micro-organisms.

Phagocytosis.—Dr. Roux next dealt with the doctrine of phagocytosis associated with the name of Dr. Metschnikoff. This observer had proved, by the study of the amœboid movement of certain cells, that they possessed the power of including other cells and bodies in their substance. The phagocyte cells originated in the mesoderm. They possessed, further, the property of being able to digest the bodies which they had ingested. They were, in fact, the only cells which manifested in the human body any intracellular digestion. If the history of a bacterium in the interior of a phagocyte were followed, it would be seen that it underwent a peculiar series of alterations, very different from what took place when a microbe died in cultivating fluids. Whether a virulent virus was introduced into the bodies of animals which resisted inoculation, or whether attenuated microbes were injected into sensitive animals, the greater the degree of refractoriness shown by the animal, the more rapidly the microbes were consumed by the leucocytes. In a non-resistant animal the microbes remained free; no such phenomenon as phagocytosis could be observed. It seemed, therefore, that the phagocytes were charged with the defence of the human organism, and entered into conflict with the parasites which infected the human frame. It might be said that there were diseases in which the microbes were to be met with in the cells specially, and that these microbes nevertheless proved fatal to the animal. In tuberculosis and in leprosy the bacilli were to be found in the cells, and the results were of the most serious kind, in spite of the intense phagocytosis induced by the microbes of these diseases. This fact proved that the phagocytes and all the other means of defence were, under certain conditions, and at certain times, powerless to effect any good results; they had done their best to take up the microbe, but these had adapted themselves to the interior of the cells, and had conquered. It was not sufficient that the microbes should be eaten up, it was essential that they should also be digested by the phagocytes. Even in those cases where the struggle was going against the human organism, these cells still were the aggressors. It had been frequently observed in tuberculosis and leprosy that the bacilli had been killed in the interior of certain of these cells. The theory asserted that a struggle occurred between the microbes and the cells, but it did not imply that the bacilli always won the day. Phagocytosis only occurred in immune animals; in animals susceptible to the disease it was either not to be observed, or it was incomplete.

He then proceeded to discuss the question whether immunity was the consequence of this power of the cells to digest the virulent microbes. As had been said, the cells of a refractory animal took up the microbes, which, it would appear, under favourable circumstances remained inert in the interior of the cells.

Numerous facts had been alleged to show that the microbes at the time they were taken up by the phagocytes were not degenerated, but were, on the contrary, in a coudition of full activity. Thus, to take only one example, it had been found that in frogs the bacilli which had been taken up by the leucocytes remained alive within the protoplasm of the cell; this was apparent from their movements. In lymph taken from the body of a pigeon numerous bacilli were to be seen imprisoned in the leucocytes, and these bacilli could be watched growing, actually under the eye of the observer, within the interior of dead phagocytes; they could be seen to elongate, to push out the protoplasm, distort the form of the cell, and finally to make their escape. Another demonstration of the importance of the action of phagocytes was afforded by the fact that even in immune animals the microbes were found to increase when kept out of the reach of the leucocytes; thus, if a rabbit were inoculated in the anterior chamber of the eye, where there were no cells, the bacteria grew freely, and their development was only checked when the leucocytes had after a time migrated in large numbers, and began to take the microbes into their interior. It thus appeared that phagocytosis was a very general phenomenon, and one which was very efficacious in checking the advance of the organisms; when it failed, the individual succumbed to the virulence of the bacteria. The question remained, What was the mysterious force which attracted the cells towards the microbes? Why were the leucocytes, which in immune animals destroyed the microbes, incapable of seizing upon them in non-immune animals?

In 1883, Metschnikoff propounded his theory of phagocytosis. This theory rested on two assumptions; first, that the cells were attracted to the microbes in virtue of a special sensibility manifested towards all foreign bodies introduced into the tissues; the second was that this power of seizing upon the virulent microbes in immune animals originated in the habit formed during the earlier struggle with the attenuated virus with which the animal had been previously inoculated. The behaviour of the leucocytes might be more readily explained by assuming that leucocytes had the property, analogous to that possessed by the zoosperms of the myxomycetes—namely, that of being attracted by certain bodies and repelled by others. MM. Massart and Bordet had proved that the products of the microbes exerted a very marked chemical action on the phagocytes. When a virus was introduced into the body, it proliferated, and secreted a substance which attracted the leucocytes; the more active the virus, the more energetic were the poisons elaborated by it, and the cells which penetrated to the point of inoculation were paralysed in their action, and rendered incapable of taking up the microbes, which therefore proliferated without hindrance. Further, in certain diseases the virus produced a substance which was still more poisonous. In chicken cholera, for instance, the poison secreted by the microbes repelled the leucocytes from the point of inoculation; it thus came about that phagocytes were never found in this particular affection. This, however, was not the case with animals which had been rendered immune either by inoculation of the attenuated virus, or by the injection of a suitable dose of bacterial products. If the animal were given a strong virus, phagocytes were attracted to the point of inoculation, and these possessed the power of taking up the microbes before they had time to elaborate effective doses of their toxic material. It was, therefore, at the commencement of the disease that the critical struggle took place. If the leucocytes could not accomplish this at the beginning of the malady, their action at a later period would be useless, since the microbes would have produced enough poison to paralyse their activity. Every cause, therefore, that prevented the access of leucocytes to the point of inoculation facilitated infection. The theory of immunity propounded by M. Metschnikoff did not exclude the possibility of there being other means of protecting the organism, but it simply proved that phagocytosis had a wider sphere of action, and was more efficacious, than any other means of protecting the organism. It seemed to explain all the facts, and was, moreover, eminently suggestive. It was in this way that the knowledge of microbic poisons and chemical inoculation had thrown light on what would otherwise have been obscure. Far from being shaken by the theories which were opposed to it, this theory of Metschnikoff's had gained by the opposition which it had met, and that was a guarantee of its soundness.

Dr. Buchner, of Munich, criticized freely Metschnikoff's views. The main objections he brought forward were as follows:—

(1) Many observers failed to notice any destruction of bacilli by phagocytes, when naturally immune animals, such as white rats or pigeons, were inoculated with anthrax.

(2) In diseases ending fatally, such as tuberculosis, mouse-septicæmia, &c., the micro-organisms were frequently found in the interior of phagocytes.

(3) The experiments of Petruchky, Baumgarten, Pekelharing, and others seemed to show that the bacilli of anthrax perished in the living fluids of immune animals even when the bacilli were protected against the attacks of white corpuscles.

Metschnikoff, however, denied this, and proved that the living fluids of immune white rats form a most excellent cultivating medium for the bacilli of anthrax. These observations of Metschnikoff, according to Buchner, might be explained by the fact that Metschnikoff in his experiments introduced more bacilli than could be destroyed by the living fluids of white rats, as a certain quantity of serum was able to destroy only a very small quantity of micro-organisms. Speaking of the experiments made by his pupils Ibener and Roeder, he stated that, when a certain kind of micro-organisms were placed into a given quantity of serum, the micro-organisms might either be destroyed *in toto*, or reproduce themselves in large numbers according to the number of micro-organisms introduced in the first place into the serum. When, instead of placing the micro-organisms directly in contact with the serum, the micro-organisms were wrapped up in sterilized cotton-wool, it was found that the bacilli, so protected against the temporary harmful influence of serum, began to grow luxuriantly at the end of twenty-four hours. The bactericidal power of serum disappeared, therefore, shortly after death.

Massart, Bordet, and Gabritchewsky had previously proved that the emigration of leucocytes to the spot where the virus was introduced was due to the attracting influence (positive chemotaxis) of the chemical poisons secreted by micro-organisms, but he (Buchner) was of opinion that the substances dissolved in the cultures have hardly any action on leucocytes, but that this attracting influence on leucocytes was due to the protein present in bacterial cells themselves. Whereas the products of the metabolism of micro-organisms had little or no attracting influence on the leucocytes, the proteins themselves attracted the cells most powerfully.

As long as the bacterial cells were active and capable of reproducing themselves actively, the proteins were contained in the cells, and these poisons only left the cells when the latter became diseased or old. Hence these proteins were chiefly found in old cultures, the filtered and sterilized extracts of which always possessed a strong attracting influence on leucocytes. Hence it followed that, "The more a given micro-organism is harmfully influenced by the living fluids of a given species of animal, the more proteins will be excreted. This, as a natural consequence, is followed by a corresponding increase in the number of cells which emigrate to the point of inoculation." In every case the living fluids of the body exert a harmful influence on micro-organisms, and then, when in consequence of this the excretion of proteins takes place, the amœboid cells emigrate to the spot.

Turning now to the characteristics of this germicidal substance present in serum, he thought that its germicidal power gradually disappeared, so that after a few days the serum had no bactericidal power. This germicidal action was destroyed by the micro-organisms themselves, for, unless the latter were completely destroyed, they soon began to grow freely in serum. Serum maintained at 55° C. during half an hour, or at 52° C. during six hours, loses its bactericidal power completely. A moderate degree of warmth (37° C.) intensified the germicidal action of the blood or serum.

Turning now to the question as to whether this bactericidal action of the blood had any share in the production of immunity, he gave the following facts as proving that there was some connection between the immunity of a given animal against a given infectious disease, and the bactericidal action of its blood on the micro-organism producing the disease:—

(*a*) The blood and serum of animals, such as mice and guinea-pigs, which readily succumbed to anthrax, had no bactericidal power on anthrax-bacilli.

(*b*) The serum of animals which took anthrax readily never possessed such a strong bactericidal action as the serum of white rats, which were immune against anthrax.

(*c*) The blood and serum of animals rendered artificially immune possessed stronger bactericidal powers than the blood and serum of normal animals.

(*d*) The blood and serum of animals rendered artificially immune against a given micro-organism lessened the virulence of the specific micro-organism causing the disease.

(*e*) Whenever blood and serum possessed no bactericidal action on micro-organisms, this absence of bactericidal action might be due to the fact that, owing to the necessary manipulations, this bactericidal substance had been altered or even destroyed.

As further proving that the immunity of animals depended on some substance present in the serum, he mentioned the facts described by Behring, Kitasato, Ogata, and Emmerich, in which the injection of blood or serum of an animal immune against a given bacillus, cured another animal afflicted with the same disease. The curative power he attributed to the presence in the blood of immune animals of a protective substance, probably proteid in its nature, to which he gave the name of "alexine" (from ἀλεξεῖν, to protect). These alexines were not ordinary oxidation products of the tissues, as they were quite specific in their action. They were not simply enzymes, as they had no hydrolytic properties, but they were most probably proteid substances. These alexines were probably formed in the cells; but, when formed, their action was quite independent from that of cells, and they were probably always present in immune animals.

Mr. E. H. Hankin said that theoretical considerations led him to suspect that a particular ferment-like proteid, known as cell-globulin B, was a substance possessing bactericidal power. He tested its action on anthrax bacilli, and found that it had the power of destroying these microbes. He further found that similar substances were present, not only in animals that were naturally immune against anthrax, but also in those that were susceptible to this disease. To these substances he had given the name of *defensive proteids*. In his published papers on this subject he had noted various similarities in the bactericidal action of these substances, and that possessed by blood-serum, and these resemblances were such as to leave little room for doubt that the bactericidal action of blood-serum was due to the presence of these defensive proteids.

The serum of white rats contained a proteid body possessing a well-marked alkaline reaction, and a power of destroying anthrax bacilli. Further, when injected into mice along with fully virulent anthrax spores, it would prevent the development of the disease. On the other hand, defensive proteids of animals susceptible to anthrax did not exert such protective power, and consequently these experiments indicated a difference in the mode of action of defensive proteids of immune and non-immune animals respectively. Further, the amount of defensive proteid present in a rat could be diminished by the causes which were known to be capable of lowering the animal's power of resisting anthrax. For instance, Feser stated that rats become susceptible to anthrax when fed on a vegetarian diet. Mr. Hankin obtained similar results with wild rats. The ordinary white rat he found to be generally refractory to anthrax on any diet, and the defensive proteid could always be obtained from its spleen and blood-serum. This was not the case with wild rats. In one experiment eight wild rats were used; of these, four were fed on bread and meat, the others on plain bread, for about six weeks. Then one rat of each lot was inoculated with anthrax; of these, the one that had been subjected to a bread diet succumbed. The remaining rats were killed, and it was found that while the spleens of the flesh-fed rats contained abundance of the defensive proteid, only traces of this substance could be obtained from the spleens of the rats that had been fed on bread alone. A similar result was obtained in other experiments.

Very young rats were known to be susceptible to anthrax, and so far as could be judged from the litmus test (after dialysis and addition of NaCl), their serum appeared to contain less of the defensive proteid than did that of the adult rat. Further, Mr. Hankin found that a young rat could be preserved from anthrax by an injection of its parent's blood-serum.

These facts appeared to prove that the defensive proteid of the rat deserved its name, in that it preserves the animal from the attack of the anthrax microbe; in other words, that this substance was at any rate a part cause of a rat's immunity against anthrax.

Defensive proteids appeared to be ferment-like, albuminous bodies, and it was extremely unlikely that we should for a considerable time be able to classify them by any other than physiological tests. From this point of view it was possible to divide them into two classes; first, those occurring naturally in normal animals, and secondly, those occurring in animals that have artificially been made immune. For these two classes Mr. Hankin proposed the names of sozins and phylaxins. A "sozin" was a defensive proteid that occurred naturally in a normal animal. They had been found in all animals yet examined, and appear to act on numerous kinds of microbes, or on their products. A "phylaxin" was a defensive proteid which was only found in an animal that had been artificially made immune against a disease, and which (so far as is yet known) only acted on one kind of microbe or on its products.

Each of these classes of defensive proteids could obviously be further subdivided into those that acted on the microbe itself, and those that acted on the poisons it generated. These sub-classes he proposed to denote by adding the prefixes myco- and toxo- to the class name. Thus myco-sozins were defensive proteids occurring in the normal animal, which had the power of acting on various species of microbe. Toxo-sozins were defensive proteids, also occurring in the normal animal, having the power of destroying poisons produced by various microbes. Myco-phylaxins and toxo-phylaxins similarly would denote the two sub-classes of the phylaxin group.

The classification might be represented by the following scheme:—

Defensive proteids (Hankin). Alexins (Buchner).

- Sozins:— Defensive proteids present in the normal animal.
  - Myco-sozins:— Alkaline globulins from rat (Hankin), destroying anthrax bacillus.
  - Toxo-sozins:— Of rabbit, destroying the *V. Metchnikovi* poison (Gamaleia).
- Phylaxins:— Defensive proteids present in the animal after it has been made artificially immune.
  - Myco-phylaxins:— Of rabbit, destroying pig typhoid bacillus (Emmerich).
  - Toxo-phylaxins:— Of rabbit, &c., destroying diphtheria and tetanus poisons (Behring and Kitasato, antitoxin of Tizzoni and Cattani).

Prof. Emmerich read a paper on "The Artificial Production of Immunity against Croupous Pneumonia and the Cure of this Disease." He stated that his previous experiments on swine fever had proved that in immune animals the bacilli of swine fever were destroyed, not by the cells of the animal, but by a bactericidal substance present in the blood. It had been clearly proved by his experiments that the bacilli of swine fever were destroyed almost immediately after their introduction under an immune animal's skin. Applying these researches to the disease produced in rabbits by the inoculation of the *Diplococcus pneumoniæ* of Fraenkel, he showed that non-immune rabbits died within twenty-four to forty-eight hours after the introduction of the virus. But if such animals had been previously treated with the blood or serum of animals rendered artificially immune against the diplococcus of Fraenkel, such animals did not die, but recovered after the introduction of extremely virulent diplococci. Moreover, when the *Diplococcus pneumoniæ* was inoculated into an animal, it was possible to cure it by injecting shortly afterwards some of the serum of an animal rendered artificially immune. In the blood of animals rendered artificially immune against pneumonia we possessed an excellent cure for the disease. Not only would it be possible to cure men afflicted with pneumonia by these injections, but we could, by preventive inoculations applied in time, put a stop to the spread of an epidemic in a school or a prison for instance. His experiments, together with Dr. Doenissen's, had a great practical as well as a theoretical value.

Dr. Ehrlich stated that he had lately made a number of experiments with ricin which threw great light on the question of immunity. According to Kobert and Stillmark, ricin was an extremely poisonous body, for it acted fatally when such small doses as 0·03 mg. were injected into an animal's veins. When absorbed through the alimentary canal, a dose one hundred times larger could be easily tolerated. Nevertheless, even then, it was so toxic that, according to Kobert's reckoning, a dose of 0·18 gr. would prove fatal to a full-grown man. It had a harmful influence on the blood, producing coagulation of the red blood-corpuscles, and thromboses, more especially of the vessels of the alimentary canal.

In his opinion the toxicity of ricin greatly depended on the species of animals used for experiments, the animals most susceptible to its action being guinea-pigs. Thus, a guinea-pig weighing 385 grammes died eleven days after the inoculation of 0·7 ccm. of a 1 in 150,000 solution of ricin, the *post-mortem* examination showing characteristic hæmorrhages in the alimentary tract. One gramme of this substance might therefore prove fatal to 1,500,000 guinea-pigs. White mice, on the other hand, did not die after much larger doses, and this immunity of mice against this poison might be increased by subcutaneous injections of ricin. The same result might be obtained, however, far more easily and without any chances of failure, by feeding mice with ricin. It was best to begin with small harmless doses, gradually increasing the amount until the organism was accustomed to the poisonous substance. In ten days a mouse might then be inoculated with a deadly or even larger dose without suffering any evil effects. Thus, whilst doses of 1/200,000 gramme were absolutely fatal in normal animals, mice fed daily and in increasing quantities with ricin suffered no harm after the injection of 1/1000 gr. or 1/500 gr., or, occasionally, of 1/250 gr.

Whilst a 0·5 or 1 per cent. solution of ricin applied to the eye of a normal animal produced severe inflammation and panophthalmitis, the application of a 10 per cent. solution of ricin produced no effect on the eye of an animal previously fed with ricin. In other words, this was distinct proof of the existence of a local as well as of a general immunity against the poison. Strangely enough it was almost impossible to render the subcutaneous tissue immune against ricin, and even in exceedingly immune animals the subcutaneous injection of ricin produced distinct necrosis of the subcutaneous tissue.

It was a remarkable fact that this immunity appeared quite suddenly on the sixth day, and then increased slowly, so that on the twenty-first day the animal could stand a dose which was 400 times higher than that fatal to a normal animal.

This immunity against ricin appeared to be permanent, for it was still present in immune mice which had not taken ricin for a period of six months previously.

He had been able to extract from the blood of animals rendered immune against ricin a body which had the power of counteracting the toxic action of ricin, so that a powerful solution of ricin was rendered harmless by admixture with the blood of immune mice. It was also possible to render animals immune against ricin by injecting the blood of immune animals.

Dr. Kitasato, of Tokio, shortly summarized the results which he and Dr. Behring had obtained with the virus of tetanus. According to these observers, the blood of a normal rabbit has no influence on the toxines secreted by the bacillus of tetanus. But when a rabbit had been rendered artificially immune against that disease, its blood had the power of destroying the toxines secreted by the specific bacillus. Nay, more, the blood of rabbits made artificially immune against tetanus with trichloride of iodine, rendered mice not only refractory to tetanus but also cured the disease when already in progress. The blood, however, did not appear to act on the tetanus bacillus itself, but on the toxines secreted by the bacillus.

Dr. Adami thought that it was impossible to doubt that in a large number of infectious diseases the process of phagocytosis was extremely marked. He was of opinion that it was quite possible to accept both views of the question. The controversy had taken place chiefly as to the phenomena observed in the rat; in that animal phagocytosis was only to be observed with difficulty, and the serum of rat's blood undoubtedly possessed bacteria-killing properties to a high degree.

Dr. Klein stated that frogs and rats were insusceptible to anthrax, but that these animals could be made susceptible to the disease by a variety of means, indicating that their normal power of resistance was due to certain chemical conditions of the blood. If the bacillus of anthrax was introduced into the lymph-sac of a chloroformed frog, this animal always died of anthrax. Rats inoculated with anthrax and kept under the influence of an anæsthetic also died of anthrax. He had been unable to find any evidence to show that in these cases the leucocytes had lost their power of swallowing up bacteria, and therefore the susceptibility of chloroformed animals to anthrax could only be explained by some chemical changes taking place in the serum of the chloroformed rat or frog.

Dr. Metschnikoff said that, of all the objections which have been raised against the theory of phagocytes, doubtless by far the most important was that formulated by Behring and Nissen: namely, the fact that the serum of guinea-pigs vaccinated against the vibrio of Metschnikoff had bactericidal powers on the same vibrio. Whilst the serum of normal guinea-pigs allowed the free development of a large number of these microbes, the serum of vaccinated animals killed the micro-organisms at the end of a few hours. MM. Behring and Nissen were convinced that this fact formed a complete explanation of the acquired immunity of guinea-pigs against the *Vibrio Metchnikofi*, and that it might serve as a model for a theory of immunity. His own researches, however, proved the contrary. If one studied the phenomena as they occurred in the living animal, one noticed at once that the bacilli inoculated into immune guinea-pigs remained alive for a very long time. Some vibrios were taken into the interior of leucocytes at the point of inoculation, whilst others developed perfectly in the liquid exudation. To show this, one had only to take a drop of the latter, and place it in the warm chamber; the leucocytes perished when taken out of the organism, and allowed the bacilli contained in their interior to develope freely. The vibrios thus multiplied and filled the leucocytes, which swelled and eventually burst, allowing the microbes to pass freely into the liquid part of the exudation. Here the development continued, and one obtained very abundant cultures from the liquid exudation of the immune guinea-pig. If one extracted a small quantity of such a culture, and introduced it into the dead serum of an immune guinea-pig, this serum not only did not kill the bacilli, but also gave a more abundant development than the serum of a non-immune animal could do. The study of the phenomena in living animals made artificially immune against the vibrio of Metschnikoff, instead of overthrowing the theory of phagocytosis, furnished on the contrary an evident proof in its favour. The theories of the attenuation of virus in the bodies of immune animals, and of the neutralization of the toxines, could not be applied to his case, as the vibrios remained very virulent, and because the immune guinea-pigs are as sensitive to the toxine of the bacillus as the non-immune animal.

This example showed yet once more that one must not be content with studying the phenomena of immunity outside the organism. This criticism also applied to M. Buchner's experiments, which he had communicated to this meeting; he insisted on the fact that, in order to assure oneself thoroughly of the bactericidal property of the serum, it was necessary to take a small quantity of the culture, and spread it in a tube filled with serum. If, according to Dr. Buchner, one introduced a little of the culture wrapped in cotton-wool, the serum could no longer exercise its bactericidal power, and the microbe developed freely. Now, when one inoculated the bacillus under the skin of an animal, one introduced at the same time a small mass which did not spread freely in the blood or exudation, but remained localized at one spot. The experiments of M. Buchner, instead of furnishing an objection to the phagocyte theory, rather supported it.

Referring to the curative properties of the serum of white rats against anthrax, he had come to the conclusion that, whereas the living serum of white rats had no bactericidal action on anthrax, the dead serum of the same animals had marked bactericidal powers on the same micro-organism. When a mouse was inoculated with a mixture of the dead serum of a rat and anthrax bacilli, it nearly always died, although the disease lasted somewhat longer than usual. On examination of the point of inoculation it was found that the bacilli of anthrax did not grow quite so readily, and that an enormous number of leucocytes emigrated to the point of inoculation and took the bacilli into their interior and digested them. In tetanus, again, the leucocytes ate up considerable quantities of tetanus-spores and bacilli. Summing up his researches, he stated that whenever an animal recovered from an infectious disease this recovery was accompanied by a process of phagocytosis; whenever an animal died of an infectious disease the process of phagocytosis was absent or insufficient. The theory of phagocytes was strictly based on the principles of evolution as laid down by Darwin and Wallace.

Immunity to Anthrax.*—Dr. J. Sawtschenko's experiments with anthrax were made on pigeons and rats, and entirely with the view of supporting the doctrine of phagocytosis and upsetting the results of Czaplewski, who found that the immunity of pigeons to anthrax was in no way due to phagocytosis. The author's experiments and results are simply confirmatory repetitions of the experiments made by Prof. Metschnikoff and others, who place a very high value on the phagocyte for its power in producing immunity by eating up the parasites. The author, however, admits that complete immunity to anthrax scarcely exists, and that by gradually habituating the bacteria to a new medium, a virus is obtainable capable of killing animals previously immune to anthrax; and also that anthrax bacteria disappear quite independently of phagocytes. The deciding factor in the recovery of an animal is the action of the phagocyte, for that the phagocytes do possess this predominating influence is proved, says the author, from finding them inside the cells in enormous quantities, and very few, if any at all, lying free outside. Within the cells they are demonstrable by ordinary staining methods in varying conditions of degeneration. Yet other

* Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 473–7, 493–6, 528–32.

competent observers have failed to find these remains, and the explanation offered is that the tissue has been improperly hardened and imperfectly stained.

Natural Immunity to Anthrax.*—In discussing the vexed question of natural immunity to anthrax, Dr. G. Sanarelli alludes first to the historical aspect of the subject, and then shows how he obtained lymph free from germs and leucocytes. A carefully sterilized glass rod from 5–6 mm. thick was dipped 4–5 times in a 5 per cent. solution of collodion, and then the collodion having dried, the little bag thus formed was closed by putting some more collodion on the opening. With a little dexterity, a large number of these capsules, 3–4 cm. long and holding 1–2 ccm., can be made in a short time. They are transparent, impermeable, and perfectly aseptic. They are filled by introducing them into the dorsal lymph-sac of a healthy frog, and there leaving them for 3–4 days, by which time the collodion capsule becomes filled by transudation. The lymph is then pipetted into suitable glass vessels. With this fluid numerous experiments were made touching the bactericidal qualities of lymph, and the influence of temperature on the germicidal property. These experiments were conducted in the usual manner, and from the results obtained the author concludes that frog's lymph perfectly free from germs and leucocytes does attenuate anthrax, but that such attenuated virus does not acquire vaccinal properties. The germicidal action of lymph is lost if the fluid be heated, but cold appears to possess little or no detrimental influence. On anthrax bacilli frog's lymph exerts a degenerating influence, and this quite independently of any assistance from leucocytes. With regard to phagocytosis the action of the cell-element is not regarded with disfavour, but the author inclines, and rightly, to make immunity depend upon the combined influence of the plasma and cell elements of the blood, rather than on the unaided action of any separate constituent.

Immunization against the Virus of Tetanus.†—Prof. G. Tizzoni and Dr. G. Cattani divided their experiments with the tetanus bacillus into two series. In one they examined into the effect of various chemical substances on the tetanus virus. The only agents which possessed any active influence were carbolic acid, chlorine water, and trichloride of iodine. The first of these was used in 5 per cent. solution, and the iodine trichloride in 2 per cent. solution. All three agents, allowed to act on equal volumes of filtered tetanus cultivations for twenty-four hours, destroyed the toxicity of the virus altogether. But none of these substances, when injected subcutaneously either before or after the inoculation of the virus, was able to prevent the tetanus phenomena.

In the second series the authors made use of animals which they had found to be more or less refractory to the tetanus poison (pigeons and dogs). In fact, the pigeons used by the authors showed only local transitory phenomena, recovering after injection of a moderate quantity of a virulent tetanus cultivation completely in a shorter or longer time. And every succeeding injection produced less and less reaction, until the animals ceased to react altogether. In a similar way dogs may be

* Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 467–72, 497–504, 532–9.
† Tom. cit., pp. 189–92.

rendered insensitive to the virus provided the initial dose be very small. By this method they succeeded in rendering two pigeons and one dog refractory, and evolved the following facts:—The blood-serum of the dog when mixed with filtered tetanus cultivation destroyed its toxicity completely, even when the quantity of serum was very small, and the duration of contact very short. Subcutaneous injection of this serum rendered another dog immune to the tetanus virus, and similar results were obtained when white mice were injected. If, however, the dose was very large (1 ccm.), these animals died. Rabbits and guinea-pigs also succumbed under like conditions. The pigeon's blood-serum gave similar results. It is noted that injection of blood-serum after inoculation of the virus failed to prevent the appearance of tetanic symptoms.

Anthrax Vaccination.*—Mdme. O. Metschnikoff, when examining the effect of anthrax vaccines i. and ii. on sheep, found that the bacilli were almost always only at the injection spot, were surrounded by leucocytes, and in a degenerate condition; only a few bacilli being free and of normal appearance. Moreover, the aqueous humour of sheep which had undergone vaccine-fever, did not inhibit the growth of the spores of i. and ii. vaccines, or of virulent anthrax. Consequently it contains no bactericidal matter. Experiments on rabbits gave quite analogous results.

The vaccine-protection is therefore brought about by the products of the bacilli being diffused through the body, and the destruction of the bacteria is effected by phagocytosis.

Protective inoculation doubtless consists in the cellular elements becoming habituated to the toxic products of the bacteria.

Germicidal Substance of the Blood.†—Prof. M. Ogata has isolated from the blood of dogs and fowls a substance which renders immune to anthrax and mouse-septicæmia animals susceptible of those diseases, and the author regards this substance as a ferment contained in the blood of the immune animals. The ferment has the following properties. It is readily soluble in water and glycerin, but insoluble in alcohol and ether. Its efficiency is not impaired by the action of weak alkalies, but is entirely suppressed by carbolic and hydrochloric acids. In the presence of the digestive juices, and if heated up to 45° C., its action is destroyed. The ferment possesses not only immunizing but also disinfecting properties, and mixed with glycerin retains its efficiency for a long time without any notable change. It does not appear to possess the power of converting fibrin into pepton, or starch into sugar.

In addition to the foregoing characters, this substance also possesses the power of inhibiting the growth and development of the cholera and typhoid bacilli, a fact which induces the author to think that the disinfecting action of the blood may be due to this ferment.

The ferment is prepared in the following manner. To one part of blood or blood-serum are added 10–15 parts of a mixture of absolute alcohol and ether (equal parts). After filtration the precipitate is dried (on the

* Ann. de l'Institut Pasteur, 1891, p. 145. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 738–9.

† Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 597–602. Cf. this Journal, *ante*, p. 237.

filter paper) in the air. The dried mass is then powdered in a mortar, and to it is added lukewarm water, or a mixture of glycerin and water (equal parts) in half the quantity of blood. After standing 3–4 minutes, it is filtered quickly either through linen or cotton-wool. To this last filtrate are added ten times its bulk of a mixture of equal parts of alcohol and ether, and after standing for a day it is filtered, and the precipitate dried. The dried mass is then dissolved in 1/4 part (reckoning from the original bleeding) of water, filtered, then 1/4 part of glycerin added, or a 1/2 part of a mixture of glycerin and water. The latter glycerin extract is just as effective as the first one made from dog's serum and fowl's blood.

Effect of Human Blood and other Body-juices on Pathogenic Microbes.*—Herr R. Stern obtained fresh untainted blood by means of sterilized cupping instruments. The blood was then poured into stoppered glass vessels and therein defibrinated by shaking it up with gravel or glass beads. Portions of 6–8 drops were then distributed into test-tubes by means of a pipette. The blood was inoculated from agar or gelatin cultivations except in the case of anthrax, when the spleen of a mouse dead of anthrax or a microscopically spore-free bouillon cultivation was used. In each experiment a part of the specimen tests was heated before inoculation for half an hour up to 55° or for a short time to 60°. After inoculation the test-tubes were incubated at 37°, and at various intervals of time were poured on agar or gelatin plates.

Experiments were also made with the following fluids,—pleural and peritoneal exudates, and those from hydroceles and blisters.

From his experiments the author draws the following conclusions:—

(1) Human defibrinated blood has the power of killing certain pathogenic bacteria. It acts most strongly on *B. choleræ asiaticæ*, less on *B. typhi abdominalis*, and still less on Friedlaender's *Pneumobacillus*.

(2) The exudates and transudates possess the same property and to the same degree.

(3) The action of the blood and other body-juices appears, in different individuals and even in the same individual at different times, to be liable to not inconsiderable variations in intensity.

(4) The blood in acute infectious diseases (enteric, pneumonia) does not evince, as far as can be judged from experiments, any considerable deviation in germicidal action.

(5) Other pathogenic microbes (*B. anthracis*, *B. diphth.*, *St. pyog. alb.* and *aur.*, and *St. pyog.*), develope freely in the blood either immediately after their entrance or after a preliminary delay.

The germicidal action of human blood and other body-fluids was effectually removed by heating it for half an hour up to 60°.

Antiseptic Value of Anilin Pigments.†—M. Valude finds that violet and yellow pyoctanin are inhibitive of the growth of *Staphylococcus pyogenes aureus* and *Streptococcus pyogenes* in the proportion of 0·35 grm. pyoctanin to the litre.

* Zeitschr. f. Klin. Medicin, xviii., Nos. 1 and 2. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 132–3.

† Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) p. 711.

In less quantity a sediment consisting of well-stained cocci is deposited at the bottom of the cultivation medium (bouillon).

Dried on silk threads the micro-organisms were killed by a 1 per cent. solution of violet pyoctanin in from 75–90 minutes.

Yellow pyoctanin took much longer. From these and other experiments the author concludes that anilin pigments included under the designation of pyoctanin possess feeble antiseptic properties, but that they are under certain circumstances more effective, from their penetrative power, than sublimate.

Disinfecting property of Peroxide of Hydrogen.*—Herr Altehoefer recommends peroxide of hydrogen as a very suitable and effective means for disinfecting potable water from pathogenic germs. For completely destroying the non-pathogenic and pathogenic organisms found in water, the experiments of the author show that the relative concentration should be 1 to 1000, and the influence of the germicide should be allowed to be exerted for 24 hours.

The concentration proposed by the author is not only effective and quite harmless, but is extremely economical.

Attenuation of Bacillus of Tetanus.†—Dr. G. Tizzoni and Dr. G. Cattani describe the alterations in pathogenic power and biological characters which the bacillus of tetanus undergoes after being dried on silk threads, and when cultivated on different nutrient media, and when subjected to diverse environments.

The main characteristics of cultivations of virulent tetanus are that they always liquefy gelatin, always show a decidedly alkaline reaction, emit a very ill odour, and when inoculated in animals, even in small quantity, kill them in 24–36 hours with the well-known symptoms of experimental tetanus. But when much attenuated, these cultivations no longer liquefy gelatin even when left in the thermostat for quite a long time; they do not emit any odour and present a markedly acid reaction.

Such are the main differences between virulent and attenuated cultivations. Numerous other slight differences are described but they are less important than those mentioned. It may be added that the authors believe that the acidity of the attenuated cultivation is a consequence of this condition rather than the cause of the attenuation.

Action of the Constant Current on Pathogenic Micro-organisms.‡—M. R. Verhoogen divides his remarks on the action of the constant current on pathogenic microbes into two categories according as the object is electrolysable or not. If the former, then the action of the current is chemical; if the latter, this action is simply physical.

The treatment of tumours is considered under the section dealing with the chemical action of the current, and herein the statement is made that the positive pole should be chosen when electrolytic dispersion of a tumour is desired.

In the section discussing the physical action of the electric current,

* Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 129–37. See Bot. Centralbl., xlv. (1891) p. 251.

† Atti R. Accad. dei Lincei, vii. (1891) pp. 249–57.

‡ Bull. Soc. Belge Micr., xvii. (1891) pp. 168–91.

the sterilization of cultivation media, which is impracticable by means of heat, is the main topic.

Pseudomicrobes of Normal and Pathological Blood.*—Herr Kollman, in alluding to the appearances observable under normal and pathological conditions in human and animal blood, remarks that they are easily mistaken for micro-organisms, and points out that the works of numerous writers, especially those on anæmia and malaria, teem with examples of this confusion.

According to the author, the following are the chief forms the pseudomicrobes may assume:—(1) simple spherical forms measuring $0 \cdot 5\ \mu$ or less; (2) large spherical and oval; (3) small and large rodlets; (4) various combinations of the foregoing elements; (5) a peculiar form resembling a dumb-bell.

As a rule, all are mobile, often extremely so, and their movements have very often the appearance of being voluntary.

According to the author these forms are for the most part nothing else than degeneration derivatives of the red discs, while some of them originate from leucocytes, the blood-plates not being concerned in their formation.

Cultivations in fluid media give deceptive appearances, while on solid no development occurs.

Photogenic and Plastic Nutriment of Luminous Bacteria.†—That "photogenic aliment" is intended to apply to the light-giving quality of the nutrient medium is easy to understand, but without a special definition the comprehension of the term "plastic nutriment" would be difficult. When the nutriment is suitable for vegetation and reproduction, its action is not confined to producing merely luminous phenomena, but it gives rise to "auxanogrammes," or fields of increase, characterized by the numberless colonies which lie within the diffusion area of the nutrient substance and developed much more strongly than outside. When this condition exists the aliment is said by Prof. M. W. Beyerinck to be plastic.

Although the author's remarks are scattered over a large area, some of them are interesting, and the practical part may be summarized very shortly. The increase and emission of light by photogenic bacteria was found to be dependent on the association of pepton with certain nitrogenous and non-nitrogenous bodies by which the requisite nitrogen and carbon were obtained; for example, with pepton, asparagin, or glycerin alone there was darkness or no increase, but in combination both light and increase.

This group is called pepton-carbon bacteria. Another group is characterized by the faculty of peptonizing proteids by means of their proteolytic enzyme. This is the pepton group, of which *Photobacteria luminosum et indicum* are examples, while the first group includes *Photobacteria phosphorescens et Pflügeri*.

After discussing the theory of the luminous function at great length, and then its biological significance, the author passes in review the relations of photogenic bacteria and certain enzymes, not the least

* Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) p. 839.
† Archiv. Néerlandaises Sci. Exact. et Nat., xxiv. (1891) pp. 369–442.

interesting of which is trypsin—the pancreatic ferment. A great number of bacteria secrete this ferment, and of this number are the photogenic pepton-bacteria.

Bacteria found in Beer.*—Herr A. Zeidler isolated from beer which had become cloudy a bacterium having the appearance of *Bacterium termo* and the following characteristics:—In wort-gelatin and also in meat-juice-gelatin, along the inoculation-track dirty yellow granular colonies. After some days the gelatin was liquefied. On beer-wort-agar the track was more yellow; on potato there formed a dirty yellowish-brown overlay. After having been inoculated in beer-wort, on beer, in fermenting wort, and on yeast alone, it was found that it would develope provided that the amount of alcohol did not exceed 3 per cent.; but that in general it was easily overmastered by the yeast and quickly died after alcoholic fermentation was fairly set up.

Experiments were also made with two other bacteria, one of which is apparently identical with *Bacterium aceti*, while the other corresponds with no hitherto described micro-organism. The behaviour of both in cultivation was very similar although there were certain constant specific differences. Their common characteristics were that they acidified beer and set up a viscid, mucoid condition therein.

Pathogenic Bacteria obtained from the mud of the Lake of Geneva.†—M. Lortet isolated from the mud of the Lake of Geneva numerous micro-organisms amongst which were *Staphylococcus pyogenes aureus*, *Streptococcus pyogenes*, *Bacterium coli commune*, and the bacilli of tetanus and typhoid, and it is interesting in this connection to note that the water of that part of the lake from which these microbes were obtained is chemically a very pure water. Like other bodies these minute existences are subject to the law of gravity, sinking through the water to the surface-mud of the lake-bottom, and there preserving their vitality for probably lengthy periods, at a constant temperature of 4·5°.

Bacillus pygogenes fœtidus.‡—Dr. E. Burci isolated from a suppurating hydatid cyst of the liver a micro-organism which, by a series of experimental investigations, he identified as being the *Bacillus pyogenes* of Passet, and he further claims that he has shown this bacillus to be truly pyogenic. After discussing its more important morphological and biological characteristics, the pathogenic properties of this microbe are referred to in detail. In the first place it is shown that it possesses the power of causing the production, locally, of pus, and that the general effects are peritonitis, enteritis, infarction of liver, and slight swelling of the spleen.

The author then proceeds to show the effect of temperature on its virulence, the results from inoculation of the cultivation products, the acidification of the medium, and of variation of the medium.

Bacillus lactis viscosus.§—This bacillus, first discovered by the author, Prof. L. Adametz, in water, is now found to be the exciting cause

* Wochenschr. f. Brauerei, vii. (1890) No. 7. See Bot. Centralbl., xlvi. (1891) pp. 95–7. † Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 709–10.
‡ Ann. de Micrographie, iii. (1891) pp. 401–15.
§ Berliner Landwirthsch. Jahrb., 1891. See Centralbl. f. Bakteriol. u. Parasitenk, ix. (1891) pp. 698–700.

of a morbid condition of milk—a condition characterized by the fluid becoming viscid, stringy and ropy. It forms coccoid rodlets, with thick, refracting, non-staining capsule, and undergoes yeast-like involution forms, with small daughter-cells. When cultivated in milk it measures on the average 1·5 μ long and 1·25 μ broad, but is somewhat smaller when bred on pepton-gelatin or agar. Spore-formation was not observed. On plate cultivations of glycerin-pepton-gelatin and of agar, the colonies were whitish and round, growing at temperatures from 8° to 20°. No liquefaction of the medium took place.

Besides being able to convert milk into the ropy condition, this microbe seems also capable of preparing the way for the action of the bacillus of lactic acid, and of removing the casein, since this substance cannot be precipitated from old milk cultivations by acidulation and boiling.

The ropy substance is stated to be neither the product of a mucous fermentation nor a decomposition product of the bacillus itself, but to proceed from the sheath of the bacilli, and to be apparently, just as in *B. mesentericus vulgatus*, metamorphosed cellulose.

The author afterwards proceeds to review the list of organisms which are known to have the power of causing milk to become viscid or ropy.

Bacteria-protein and its relation to Inflammation and Suppuration.* —Herr H. Buchner finds that the decomposition products exert little or no influence on the behaviour of leucocytes.

Leucocytes are, however, extremely sensitive to bacteria-protein (Nencki), the subcutaneous injection of a few milligrams of the protein of *Bacillus pyocyaneus* setting up an inflammation which is free from microbes and so to say chemical, and marked by all the chemical phenomena of erysipelatous inflammation.

The pyogenic effect of the proteins of seven kinds of bacteria was examined by the author, who found that those of bacillus of typhoid, of the *Pneumococcus*, and of *Bacillus pyocyaneus* were very potent.

The proteins were obtained by cultivating the bacteria on solid media, digesting the pure cultivation in weak caustic potash (0·1 to 0·5 per cent.) and then precipitating the protein from the filtrate with acetic or hydrochloric acid.

Action of Light on Bacillus of Typhoid Fever.†—Herr Th. Janowski found from experiments made on the bacillus of typhoid that its development was inhibited or prevented by the action of light, and this effect is due to the chemically active rays of the solar spectrum.

The action of diffuse light was first examined by exposing test-tube cultivations to its action, and by controlling the results with similar cultivations kept covered up. Any doubts about increased growth being due to more favourable thermic conditions were experimentally excluded.

In a similar way the action of direct sunlight was tested and it was

* Centralbl. f. Chirurgie, 1890, No. 50. See Centralbl. f. Bakteriol. u. Parasitenk., ix. (1891) pp. 666–7.

† Centralbl. f. Bakteriol. u. Parasitenk., viii. (1890) pp. 167–72, 193–9, 230–4, 262–6.

found that the development of the micro-organisms was stopped in from 4–10 hours.

In another set of experiments screens were interposed between the cultivations and the light. These screens were composed of bichromate of potash, alum, fuchsin, gentian-violet, &c., in solution.

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Philadelphia Med. News, No. 918, 1890, p. 158.

„ „ **The Examination of Drinking-water with special reference to its relation to Typhoid Fever.**
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MICROSCOPY.

α. Instruments, Accessories, &c.*

(1) Stands.

A Universal Stand.†—Dr. A. G. Field describes this stand thus:—"Fig. 81 below represents a stand adapted to the wants of the professional or amateur who uses the Microscope and camera. It consists of base A, 14 × 14 × 15 in., to which are secured by dovetail, glue, and screws, two uprights, B B, 5 × 1 in., one 3 and the other 7 ft. in height. These are precisely perpendicular to base, to bring instruments and objects in line when centered. They are grooved on edges to receive tongues or arms, C C C C, of the secondary base D, and also on the camera-carrier H. The uprights are made firmer by additional pieces extending up 30 in. from the base. The secondary base, 14 × 14 in., is corner-braced as shown, and is adjustable as to height, being secured in desired position by set-

Fig. 81.

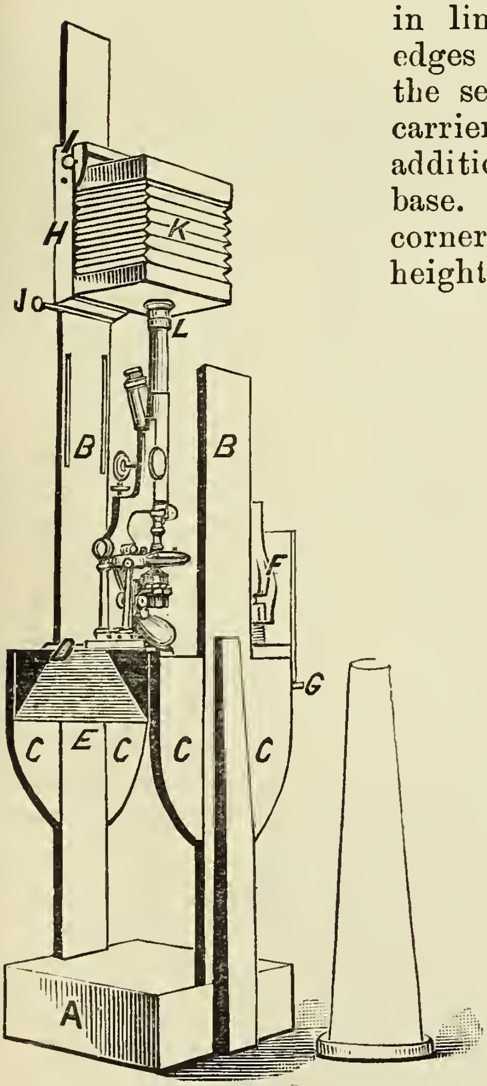
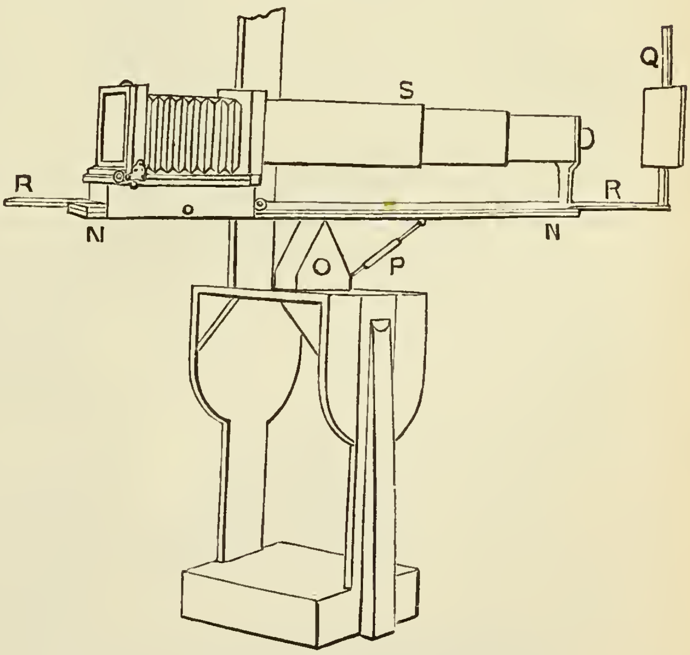


Fig. 82.



screw E. In the centre is a hole, $1\frac{1}{2}$ in. in diameter, which receives the tube of the Microscope when it is placed on the base for high amplification in photomicrography, and also the gudgeon of the support of the base-board O, when used in copying or photography. G is a

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

† Amer. Mon. Micr. Journ., xii. (1891) pp. 151–2.

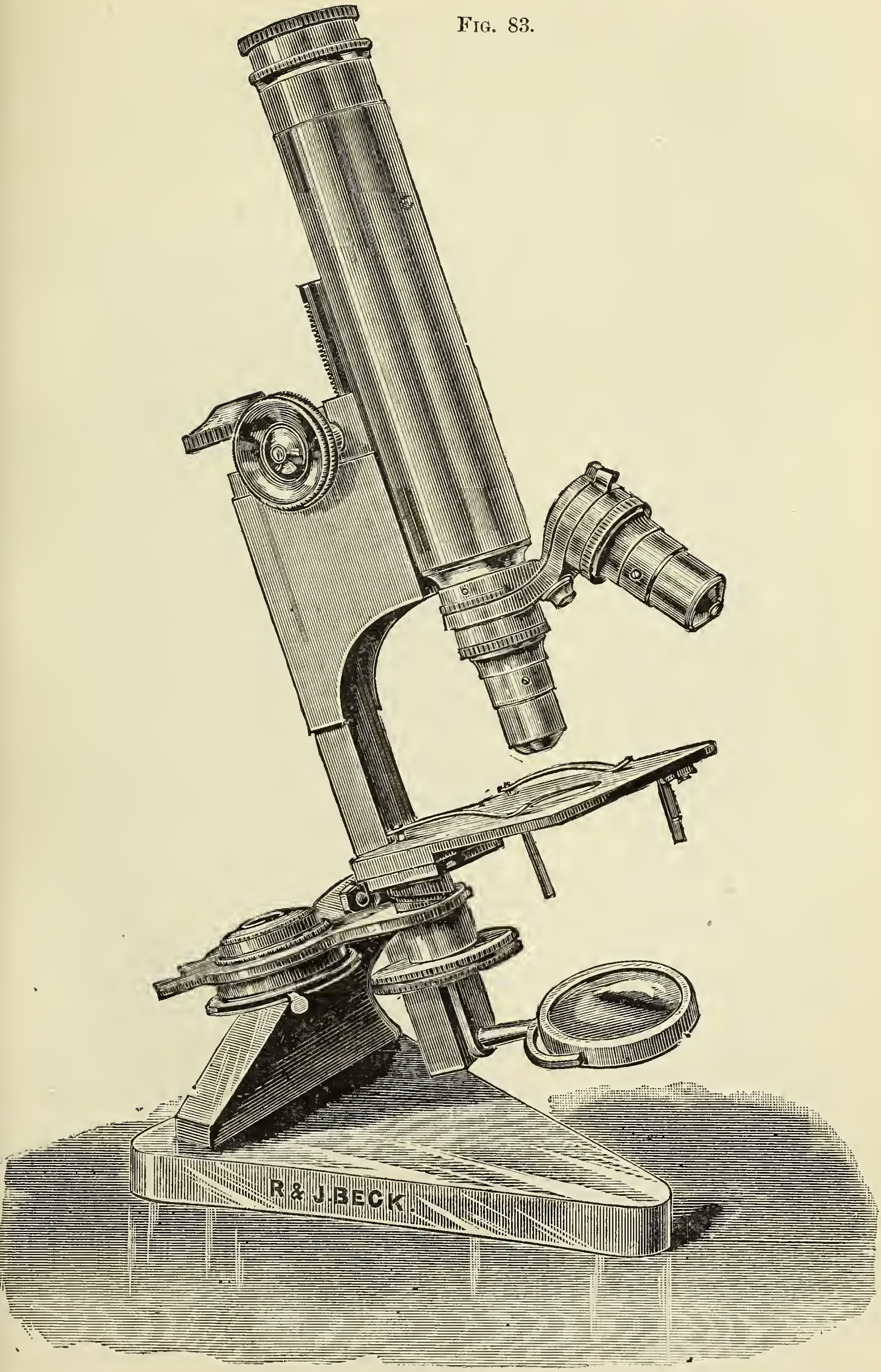
lamp-rest which slides on cleats attached to the corner braces, and has an upright for concave reflector when desired. H, sliding carrier for camera, with tongued arms of sufficient width to bring the photographic lens collar precisely over the microscopic tube when centered on either base. I, set-screw to retain it in position, and J, milled head of pinion by which it is racked down to attach camera K to eye-piece of Microscope. This light-tight connection is made with one-half of a child's rubber ball, perforated in centre to fit neck of eye-piece, and of sufficient size to fill the collar of the photographic lens. Fig. 82 illustrates use of the stand in copying enlarging, and reducing, and requires but little explanation. N, N, base-board, 5 × 1 in., 4 ft. long, grooved on edges to receive tongues on arms of camera-carrier. It is hinged to apex of wedge-shaped block O, the gudgeon of which fits snugly into the hole in centre of supplement base; S, telescopic boxes; R R, slot passing beneath the camera-carrier, with upright for carrying the picture to be copied, the distance respectively between the lens and the picture, and the lens and ground-glass, being regulated by the operator without leaving his position at the focusing screen, so that all copies may be brought to a uniform size, as for lantern slides, without regard to the size of the original. Removing the telescopic boxes and slot, we have a convenient camera stand for inside use, the lateral movements being secured by the gudgeon attachment, and the vertical by the screw brace P. If used ordinarily as a Microscope stand the instruments are always in line and position for photomicrography."

Beck's Bacteriological "Star" Microscope.—This Microscope, which was exhibited at the October meeting, is made in two forms, one with a sliding and the other with a rackwork coarse-adjustment. The fine-adjustment to both forms is that known as the micrometer screw. It is also provided with an inclining joint, a draw-tube, and a swinging double mirror. The special feature of the instrument is the movement of the substage; this is done by a milled head at the right-hand side of the instrument, by the revolution of which the substage is raised or lowered. When it has been moved to its lowest position a further turn of the milled head turns the substage out of position to the right-hand side of the instrument. The substage is fitted with an Abbe condenser and iris diaphragm.

Giant Projection Microscope.*—In the Optical Institute of Franz Poeller, in Munich, an enormous projection Microscope is now being constructed for the "World's Fair" at Chicago. Electricity plays a great rôle in this instrument. In the first place it supplies and regulates the source of light which is mounted in the focus of a parabolic aluminium reflector, and has an intensity of 11,000 candles. By means of an ingenious piece of mechanism, it also maintains the centering of the quadruple condenser and the illuminating system. It also serves to control exactly the distance of the carbon points. For this purpose the arc forms part of a shunt whose intensity is measured by a galvanometer, by the movement of the needle of which the distance of the carbon points can be read to the tenth of a millimetre. The most important innovation, however, is the arrangement for cooling the instru-

* Central-Ztg. f. Optik u. Mechanik, xii. (1891) p. 178.

Fig. 83.



Bacteriological "Star" Microscope.

ment. This is absolutely indispensable owing to the intense heat of the source of light (1·43 calories per second). It consists in pouring over the whole Microscope and polariscope a fine spray of liquid carbonic acid. So great is the cooling effect produced that an expenditure of only 0·00078 grm. per second is required. The linear magnification of the instrument is, with ordinary objectives, 11,000, and with oil-immersion lenses, as high as 16,000.

Eustachio Divini's Compound Microscope.*—Sig. P. A. Saccardo describes an ancient Microscope, bearing the inscription "Eustachio Divini in Roma, 1672," which is preserved in the Museo di Fisica, Padua, where, however, nothing further is known as to its history. A Microscope of Divini is fully described in the 'Giornale dei Letterati' i. (1668).† The present instrument is in many respects similar to the one there described. It consists of four tubes of cardboard covered with parchment coloured green and gilded. These slide with friction one within the other, and each has marked upon it in gold the points of different extension (I., II., III., IV.). The largest tube has a diameter of 8 cm. When all the tubes are closed up as much as possible, the total length from eye-piece to objective is 36·5 cm. When all are drawn out as far as the marks I., II., III., and IV., the total length is 41, 49, 54, and 56·5 cm. respectively. The lowest tube carries on its lower half a broad projecting spiral band of cardboard covered with parchment, which gears into a corresponding spiral cut into the cardboard cylinder round which is the brass band bearing the inscription. This band is supported by three divergent feet of brass 15 cm. long. The objective, consisting of a biconvex lens 8 mm. in diameter and 2 mm. thick at the centre, is fitted by means of a screw cap into a brass tube 5·5 cm. long and 2·5 cm. in external diameter. On a screw-thread round this tube moves another tube, in the lower part of which, through two side slits, passes the object-holder, which is kept firm by a spring. The object is focused by raising or lowering this tube on the screw-thread.

The eye-piece is formed of a large somewhat yellow biconvex lens 6 cm. in diameter and 5 mm. thick. It is inclosed in two wooden rings into which the first tube of the Microscope enters. Thus the special eye-piece system of Divini, which consisted of two plano-convex lenses, is wanting. In all probability these have been lost, in which case the lens just described should be regarded as the field lens.

Invention of the Compound Microscope.‡—Sig. P. A. Saccardo publishes several of the documents bearing on the claims of Janssen, Galileo, and Drebbel. Criticizing these he comes to the following conclusions:—The testimony of P. Borel in favour of Janssen has no documentary value. The documents published by Govi show that the first inventor of the compound Microscope (with concave ocular and direct vision) was Galileo in 1610. The documents published by Rezzi, which are in harmony with the testimony of Gassendi and Huygens, show that Cornelius Drebbel was the reformer of the Galilean Microscope, or was in 1620 or 1621 the inventor of the Keplerian compound

* Atti R. Istit. Veneto Sci., II. vii. (1891) pp. 817–27.
† See Dallinger's Carpenter, p. 131. ‡ Malpighia, v. (1891) pp. 40–61.

Fig. 84.

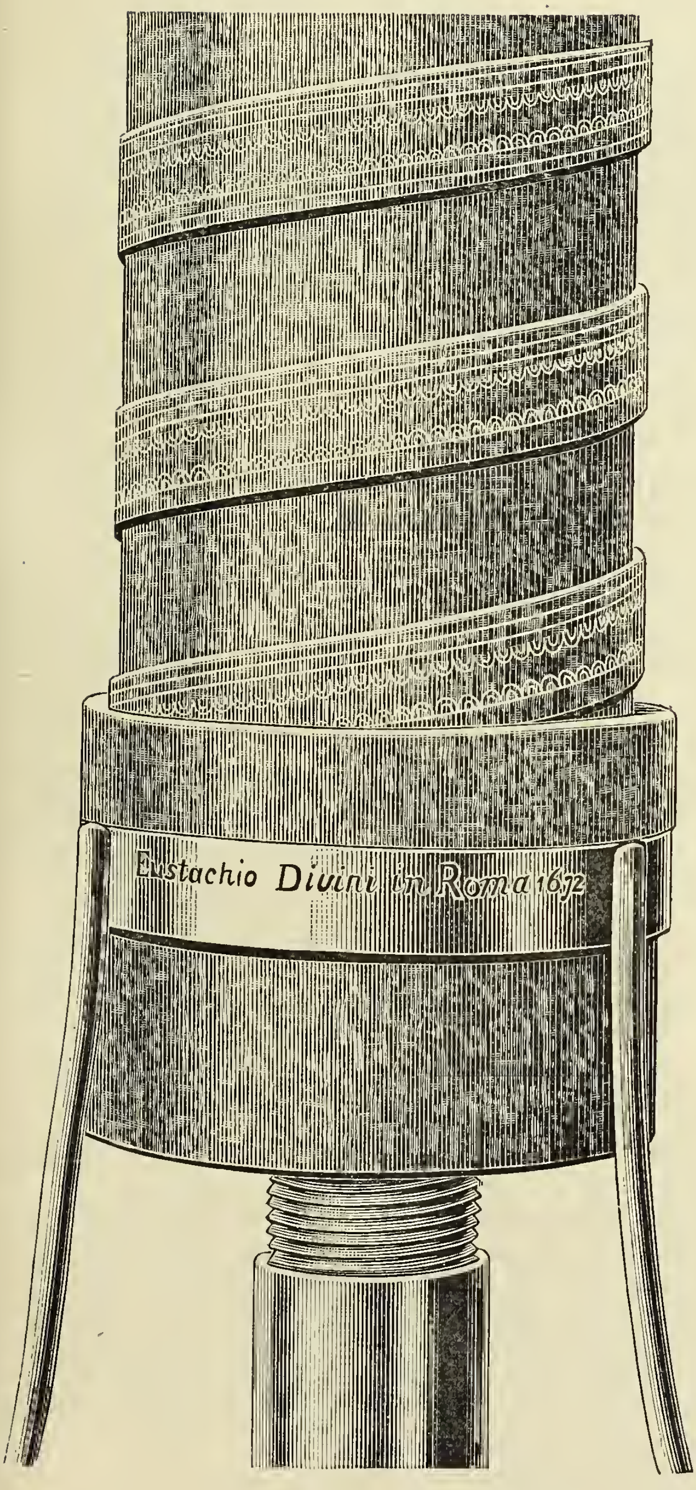
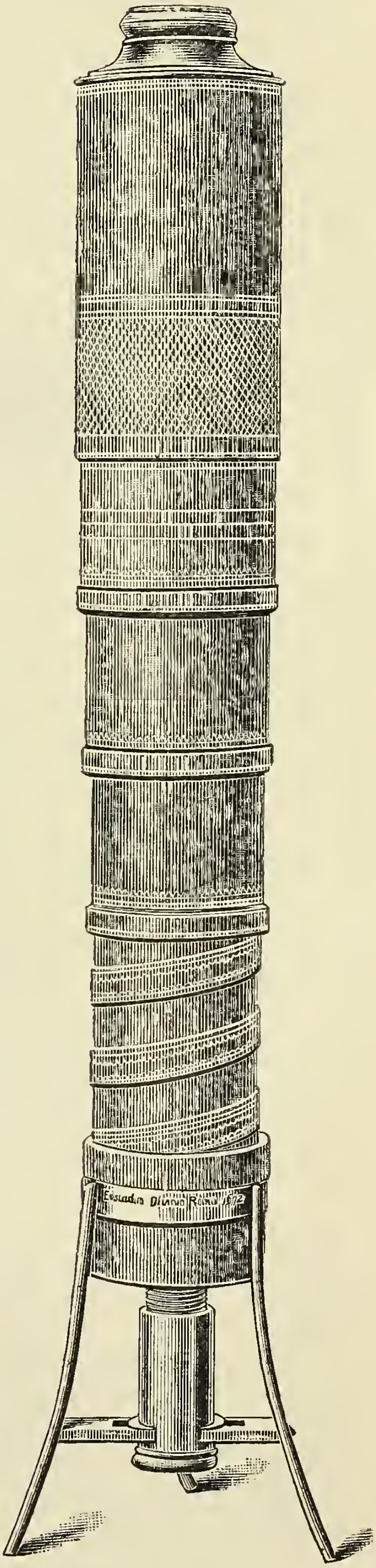


Fig. 85.



Divini's Compound Microscope.

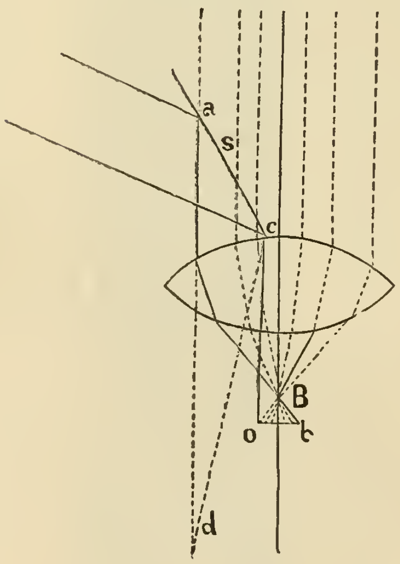
Microscope with all the lenses convex and with reversed vision. The name *microscopio* was invented in Rome in 1625 by Giovanni Faber, a physician of S. Santità.

(3) Illuminating and other Apparatus.

New Polarizer.*—Prof. S. P. Thompson read, at the British Association, a paper on "A new Form of Polarizer." He explained that owing to the great dearth of Iceland spar large Nicol prisms could not be obtained, and he therefore thought it expedient to devise some means of producing polarized light without its aid. The method proposed consists in reflecting the light from a black glass mirror, whose surface is covered with a plate of clear glass. In this way less light is lost than if black glass alone were used. The light from the lantern is reflected on the mirror by means of a total reflecting prism. After being polarized it is again turned back into its original axis by a second reflecting prism. This latter prism, however, must be very carefully annealed in order that the light may remain plane polarized.

Microscope Mirror for Illumination by Reflected Light.† — Herr Gustav Selle has devised an ingenious method of illuminating the object. Immediately above the objective system is a concave mirror, which reflects the rays incident upon it through an aperture in the side of the case of the objective in such a way that the external rays of the reflected cone *a c d* (fig. 86), by passage through the objective, are refracted through the focus B to the further edge of the object *b*, while the inner rays are refracted parallel to the axis of the Microscope to the near side *o*.

Fig. 86.



Electro-Microscope Slide for Testing the Antiseptic Power of Electricity.‡—Dr. R. L. Watkins writes:—"Fig. 87 represents an instrument that I have devised for the purpose of ascertaining whether or not electricity will destroy the life of germs. It is the result of a number of experiments to confirm a belief I have long held, that electricity is an antiseptic and disinfectant. I also learned, while experimenting, that Apostrali had made the same claim.

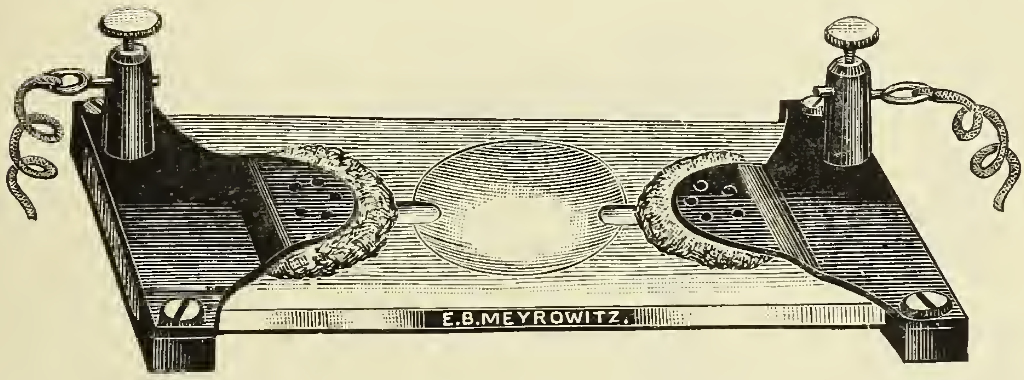
The instrument consists of a glass slide, in the centre of which is a sunk cell. Two grooves, each 3/4 in. long, run from this cell outward. Two brass pieces are fitted over the extremities of the slide in such a manner that the rounded points, the under surfaces of which are lined with platinum, will cover a portion of the grooves. These rounded points do not touch the glass, but are raised above the grooves about

* English Mechanic, liv. (1891) p. 36.
† Central-Ztg. f. Optik u. Mechanik, xii. (1891) p. 239.
‡ Amer. Mon. Micr. Journ., xii. (1891) p. 204.

1/8 in. Binding posts are riveted to the brass for connection with a battery.

In order to apply this instrument, a sufficient quantity of the fluid containing the bacteria should be used to fill the cell and grooves. A cover-glass is placed over the cell and its contents. Two small clean sponges, saturated with either the fluid or distilled water, are then placed

Fig. 87.



underneath the platinum points and in contact with the fluid in the grooves. The bacteria are now ready for observation, the electricity is turned on, and the quantity noted by the milli-ampere meter to stop all sign of germ life. They can now be cultivated on gelatin in the ordinary way should it be desired to determine whether or not their vitality has been entirely destroyed.

Other uses for the slide will readily occur to one working in this field: for example, the effect of electricity on the blood and different tissues.

I have found this instrument very satisfactory, not only as an easy, but as a quick way of finding out the amount of electricity required to destroy micro-organisms."

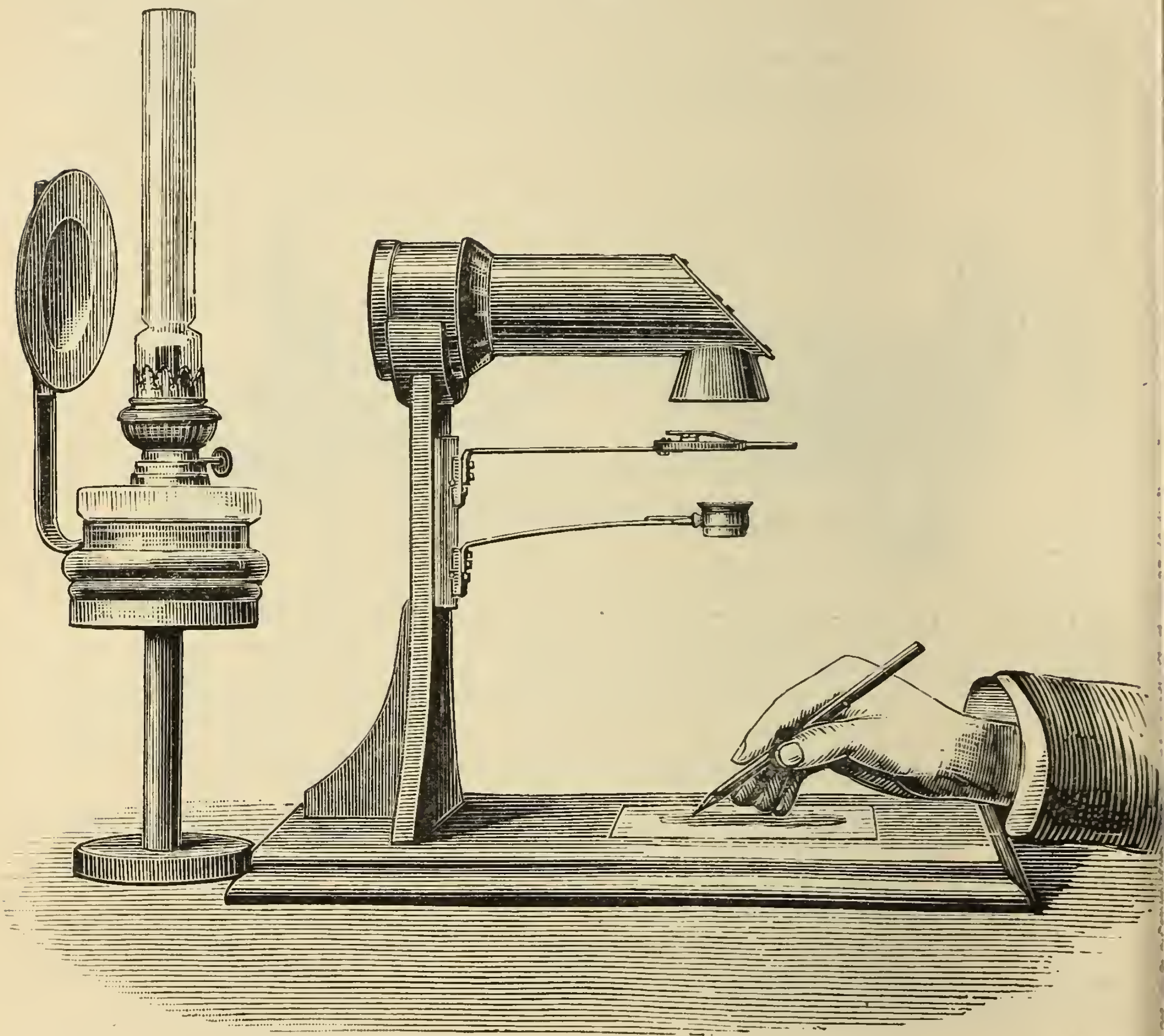
New Apparatus for drawing Low Magnifications.* — Dr. L. Edinger has devised a simple form of apparatus for drawing low magnifications (fig. 88), in which the image is projected directly upon the paper and a perfectly free movement is given to the object which lies horizontally on a stage.

The apparatus has the following construction. On a polished wooden base, which serves as drawing board, rises a wooden upright which supports a horizontal tube, closed in front by a condensing lens and behind by a mirror set at 45°. The rays of a lamp are concentrated by the lens upon the mirror. Through an opening beneath the mirror the light falls downwards upon an object-stage which is adjustable in height. Beneath the object-stage is a lens, supported in an adjustable holder, which produces on the base-plate an objective image of preparations which are placed on the object-stage. According to the adjustment of lens and drawing-board it is possible to take magnifications from 2 to 20. The apparatus, however, is supplied with three lenses,

* Zeitschr. f. Wiss. Mikr., viii. (1891) pp. 179-81.

since it is not advisable to produce all gradations of magnification by displacement alone.

Fig. 88.



Glasses for keeping Immersion Oil.*—Dr. W. Behrens describes a convenient bottle for keeping immersion oil, which has been made by the firm of Zeiss. It is of cylindrical form, 60 mm. in height and 30 mm. in diameter. It has a wide neck with a clear diameter of 15 mm., and holds 20 ccm. of liquid. Above the ground neck fits a cap, to the centre of which is attached a cylindrical solid glass rod reaching nearly to the bottom of the bottle. This rod has at its upper end a glass hemisphere which is cemented by shellac into a corresponding hole in the glass cap. It is 60 mm. long and 1·5 mm. in diameter. At its lower end it is not simply swollen, but is terminated by a small glass ball of 2 mm. diameter, which prevents the oil from dropping off.

(4) Photomicrography.

Magnesium Flash-Light in Photomicrography.†—Dr. R. Neuhauss gives an account of different flash-lights which have been made use of for photomicrographical purposes. By mixing different powders it is

* Zeitschr. f. Wiss. Mikr., viii. (1891) pp. 184–5. † Tom. cit., pp. 181–4.

possible to insure the presence of rays near the red end of the spectrum which are serviceable in taking coloured preparations. Newcomb was amongst the first to undertake experiments of this kind. He mixed 1 part of magnesium powder with 5–7 parts of pure nitrate of soda, and obtained thus an intensely yellow light. Röhmann and Galewsky made many experiments with a number of different mixtures and obtained good results with the following receipt:—Mixture A. Magnesium, finely powdered, 9·6 grm.; potassium perchlorate, free from water, 13·8 grm. Mixture B. Barium tartrate, free from water, 5·7 grm.; potassium perchlorate, free from water, 2·7 grm. 10 parts of A mixed with 1 part of B and 0·5 grm. of salt, free from water, added. From 1 to 3 grm. of this powder are used. Röhmann and Galewsky also recommended other mixtures, in one of which acetate of copper was employed.

As the result of a number of spectrographic investigations, the author comes to the conclusion that all complicated mixtures of salts of barium, copper, &c., such as these, must give place to the so-called smokeless flash-powder of Gaedicke. This powder consists of a mixture of magnesium and permanganate of potash which burns quickly, giving an intense light with little smoke. If the flash-light is taken with the spectrograph on an ordinary plate, not the slightest effect is shown in the red, yellow, and green, but some bright lines are produced on the border between the green and blue, joining on to the bright zone in the blue and violet. The effect is quite different on the erythrosin plate. In this case the bright zone begins already in the yellow by the Fraunhöfer line D. In the centre between the lines D and E the silver deposit on the negative is very thick, and gives the impression that here there was more light effective than in the whole of the blue and violet together. Between the lines E and F the light effect gradually diminishes. In the blue and violet the effect is the same as on the ordinary plate. By using the erythrosin plate and interposing the yellow-green Zettnow filter, the blue and violet light is completely absorbed, and there remains only the strong maximum in the yellow-green between the lines D and E. These are exactly the relations which are wanted in photomicrography, and as they are found in sunlight. The maxima and minima of the light effect of this flash-light are distributed on the erythrosin plate exactly as with sunlight, only the maximum in the yellow-green is much more intense.

Coloured Photomicrograms.* — MM. Lumière, of Lyon, are the authors of a process for mechanically colouring photomicrograms. The best results have been obtained by the following methods. A carbon paper poor in colouring matter is chosen and sensitized in a solution of bichromate of potassium containing—water, 650 grm.; bichromate of potassium, 25 grm.; alcohol, 350 grm. After five minutes' immersion the paper is dried and then exposed in the press. The duration of impression is determined by means of a photometer. The image is then developed on a thin ground glass by the usual methods. The positive is washed in cold water, immersed in alcohol for ten minutes, and finally dried. If properly done the proof is faint, sometimes scarcely visible. In order to colour it, solutions of the colours used in micrography, such

* Bull. Soc. Belg. Micr., xvii. (1891) pp. 121–6.

as methyl-violet and blue, &c., are prepared. The concentration which appears to be most suitable varies between 1/100 and 1/500 according to the solubility and the colouring power of the substance. When insoluble in water the colour is dissolved in as small a quantity of alcohol as possible, and the solution is then diluted with water.

The colouring solution is poured over the positive. After a few seconds the liquid penetrates the gelatin, which retains the colour. If the coloration is too intense, the proof is washed with water. The decoloration is in this way generally effected slowly and regularly, and the washing is continued until the right tint is obtained.

When the decoloration by water is not sufficient, alcohol is used. It is then much more rapid, so that the operation must be conducted with more care. The final washing is in all cases with ordinary water.

To obtain a double coloration, as for example in the case of a microbe coloured red on a blue ground, the positive is first treated with a very intense colour. In the case of the microbe a 1 per cent. solution of magenta-red would be used. The proof is thus coloured in all its parts, the microbe deep red and the ground light red. A partial decoloration, first with water and afterwards if necessary with alcohol, is then effected. When the ground begins to lose its tint the proof is treated with the colour required for the ground. A weak solution, such as the aqueous 0·2 per cent. solution of cotton-blue, is used. For projection, it is necessary to varnish in order to get rid of the grained appearance of the surface. The projected images are then much more brilliant.

(5) Microscopical Optics and Manipulation.

Probable Limits to the Capacity of the Microscope.*—Dr. S. Czapski discusses the question of the limits to the resolving power of the Microscope. So long ago as the beginning of the century it was recognized that increased magnification was not the only thing necessary to render the details of a microscopic object clearly visible. With the same magnifying power, the same perfection in the correction for aberration, &c., and with the same method of illumination, systems having the larger angular aperture always showed superiority in definition and resolving power. The explanation of this "specific function of the angular aperture" came almost simultaneously from Abbe and Helmholtz. The theory of Helmholtz supposes the object to be self-luminous, so that it has not so direct a bearing as that of Abbe upon the ordinary Microscopic practice, in which the preparation is illuminated by reflected or transmitted light. However, the two theories, although thus divergent in their points of departure and in most of their consequences, lead in one point almost to the same result. With central illumination—i. e., according to Helmholtz, when the pencils of rays from the luminous points of the object occupy the whole aperture of the Microscope; or, according to Abbe, when the object is met directly only by one small axial pencil—the resolving power according to both theories is determined by the same formula. This formula shows upon what factors and

* Zeitschr. f. Wiss Mikr., viii. (1891) pp. 145-55.

in what way upon these, the resolving power of the Microscope depends. The deduction, thus made, that the resolving power does depend upon certain factors, leads at once to the consideration of a limiting value for it. Naturally, inquiries of this kind, as to how far we can hope to advance, have only a relative value, and can necessarily be only considered from the point of view of our present resources.

The fundamental formula for the capacity of the Microscope given by both the theory of Abbe and that of Helmholtz for central illumination is

$$\delta = \frac{\lambda}{a}$$

where δ denotes the smallest distance of the elements of a regular structure which can be distinguished by an optically perfect objective, λ the wave-length of the effective light (in vacuo), and a the aperture of the system. This equation shows that δ, the smallness of which is a measure of the capacity of the Microscope, can be diminished in two, and in only two, ways. We can either (1) increase a, or (2) diminish λ.

Since the work of Abbe and Helmholtz, increase in the magnitude of a, i. e. of the aperture, has been the great aim of all opticians who have attempted the improvement of the Microscope. Now $a = n \sin u$ where n denotes the refractive index of the medium in front of the first lens of the system, and u the angle made with the axis by the extreme ray from a central point of the object which can traverse the system. On purely geometrical grounds this angle u cannot exceed 65°, in order that a certain, even though very small, space may intervene between object and system (for the cover-glass and room for adjustment). Thus the value of $\sin u$ can scarcely exceed 0·95. When, as is generally the case, this geometrical limit has been reached, the aperture can only be increased by raising the value of n the refractive index of the medium in front of the objective. We are thus led to the principle of immersion systems. With respect to these it must be borne in mind that it is not sufficient simply to interpose between object and objective an "immersion liquid" of high refractive index: it is also essential that no medium shall be present between object and immersion liquid, even in the microscopically thinnest layer, whose refractive index is less than that of the immersion liquid. Otherwise, however high may be the refractive index of the latter, the aperture of the system will be reduced by total reflection to the magnitude $a' = n'$, if n' is the lowest refractive index of any layer occurring between object and immersion liquid.* Now for most preparations we are compelled to use cover-glasses. Those usually employed, which can be easily made and are consequently moderate in price, have refractive indices of 1·52 to 1·53. The limit of aperture to be attained by the use of such glasses is therefore only about 1·44 to 1·45. To obtain higher apertures, cover-glasses of high refractive indices must be used, and here many difficulties are met with.

The firm of Schott and Genossen have prepared glasses having refractive indices as high as 2·0. But cover-glasses made of such glass are very costly owing to the loss of material involved in their construction, since they have to be ground down to the required thickness of

* See this Journal, 1890, p. 11.

0·15 to 0·2 mm. from thicker blocks. The use of these cover-glasses also raises another difficulty, for, as above stated, no medium must intervene between object and objective with a lower refractive index than the number of the aperture, so that the object must be mounted in a medium whose refractive index has the required height. We do possess mounting media with refractive indices above 2·0; but the use of such media and the preparation of objects with them have their inconvenient side.

They consist chiefly of arsenic and phosphorus compounds which are liable to give off poisonous vapours or to explode during the preparation of the object. Experiments with the system of aperture 1·60 made with such mounting media have also shown that they are apt to attack the cover-glass so that the surface becomes rough and loses its transparency. Better results, no doubt, would have been obtained by the use of a different kind of glass, but in any case it is certain that the cover-glass of high refractive index will be more sensitive than the ordinary cover-glass, so that the choice of suitable mounting media will be considerably more limited than formerly. Altogether, then, the preparation of objects for these high apertures will be a much more difficult and costly process than with the apertures at present in use.

Another difficulty arises when the object is of organic nature and is attacked by these highly refractive mounting media. A large class also of organic bodies requires to be placed in special media as like their natural surroundings as possible. Such media have refractive indices from 1·33 to 1·6 at the highest. This circumstance therefore sets a limit for such substances to any extension of the aperture, and in this case recourse must be had to the second method for increasing the capacity of the Microscope, which consists in diminishing λ, the wave-length of the effective light.

Now the absolute energy of the sun's rays is different in different parts of the spectrum, and the sensitiveness of the eye varies for the different colours. The strength of impression of white daylight on the eye is therefore represented by a curve. The maximum point of this curve lies at $\lambda = 0 \cdot 55\,\mu$, so that from waves of this wave-length and those near to it the eye will receive by far the strongest impression, so much so that the partial images corresponding to the smaller and larger wave-lengths will be to a great extent rendered ineffective. But if these more energetic rays of wave-length $0 \cdot 55\,\mu$ and those of greater wave-length be in any way excluded, and only rays of shorter wave-length admitted to the eye, then, under favourable circumstances—i. e. with a sufficiently intense source of light—the light of these short waves can be made to a certain extent effective. Thus it is well known what an astonishing increase there is in the resolving power of an objective when, either by the use of monochromatic light, or by the interposition of absorption glasses, a preparation is observed under pure blue illumination. Often a preparation which with ordinary illumination is beyond the limits of resolution, with monochromatic blue light, with the same objective, and under otherwise exactly the same conditions, is clearly resolved. In fact, the eye is sufficiently sensitive for the wave-length $0 \cdot 44\,\mu$ to receive quite an intense impression when other light is excluded. A diminution of the effective wave-length from $0 \cdot 55$ to $0 \cdot 44\,\mu$, however, is equivalent to an increase of the aperture, e. g. from 1·40 to 1·75, so that here we have a very considerable advance by very simple means.

Photography, as was first shown by Helmholtz, affords a means by which the capacity of the Microscope may be increased. The result, however, has not always corresponded to the theory. An important point indispensable for practical success has been often overlooked. It is in all theoretical deductions tacitly or even expressly assumed that the objective used for the photograph will give with the rays of shorter wave-length equally good images as with ordinary white light. This is, however, by no means the case. In fact, with the objectives of the ordinary type, such as alone existed a few years ago, such a result could not be attained. If the objective gave good images, i. e. was corrected for light of the wave-length 0·55 μ, the images from light of wave-length 0·44 μ were so bad as to annul the theoretical advantage of the increased resolving power. The method employed to obviate this difficulty was not very successful. It consisted in spherically correcting for rays of that wave-length, e. g. $\lambda = 0 \cdot 44$, which was most effective in the photographic process, and in effecting the chromatic correction so that the image corresponding to the wave-length 0·55 should coincide with the photographically effective image. Thus the latter could be correctly adjusted by the naked eye, but the defects remained that (1) the optically effective image was in itself bad (spherically under- and chromatically over-corrected, and (2) in the photo-chemically effective parts of the spectrum the concentration of the light was very incomplete, so that owing to the under-correction of this part of the spectrum there was danger of one part obscuring the image produced by the other.

The apochromatics have rendered the greatest service in this direction. In fact the advantage of their use in photomicrography is even more pronounced than their recognized superiority in ordinary microscopic work. This is due to the fact that with these objectives the images corresponding to the different wave-lengths right up to the violet are practically coincident in position and magnitude. Since their introduction cases have continually multiplied in which structures have been made visible by photography which could not be resolved by other means. But even with the apochromatic the conditions have not always been kept upon which an advance in the capacity of the objective depends. The author considers that such an advance by means of photography depends upon the following conditions:—

The system employed should be suitably corrected, so that the images resulting from the short wave-lengths may be sharply defined and coincident in position with that which affects the eye. The second condition is that the light of the required short wave-length should be photographically effective. This requires that (1) the source of light must emit waves of the required shortness, and these with sufficient intensity; (2) the rays corresponding to the larger wave-lengths must be excluded in such a way that the intensity of the short-wave rays shall not be too much reduced; (3) the photographic plate must be sufficiently sensitive for the light of the required wave-length; (4) all media between source of light and photographic plate must transmit the rays of the required short wave-length. This last requirement draws the limits to the possible advance narrowest. The ordinary glasses, it is well known, only transmit a very small pencil of light of wave-length 0·3 μ. It appears, therefore, that the use of light of wave-length 0·35 μ is almost the extreme point which we can hope to reach without increasing the difficulties of the work beyond measure. The use of the wave-length 0·35 μ instead of the mean wave-length of ordinary daylight, $\lambda = 0 \cdot 55$, would be equivalent to a raising of the aperture from e. g. 1·40 to 2·20, while the use of the wave-length 0·30 μ would raise it to 2·57. Under these circumstances, by central illumination, structures would be resolved which contained in the length of a millimetre, in the first case 4000 elements and in the second 4667 (distance apart of elements 0·25 μ and 0·21 μ respectively), while the corresponding numbers now with aperture 1·40 and white illumination are 2545 and 0·39 μ.

Measurement of Lenses.*—Prof. S. P. Thompson, F.R.S., read, at the British Association, a paper on "Some points connected with the Measurement of Lenses." He said that although lenses were used in so many departments of practical optical work—as, for example, in the making of telescopes, Microscopes, spectacles, and cameras—yet there is no uniform system of describing the properties of a lens. Moreover, all the text-books of the subject refer only to the particular case of thin lenses. He showed how all the properties of a lens could be indicated by specifying the position of four points, the two focal points and the two so-called "Gauss points," where the principal planes of the lens intersect the axis of it. No method has previously been given for the accurate determination of the Gauss points, and Prof. Thompson described an apparatus by means of which he can do this in the case of any lens or combination of lenses. The theory of the apparatus was also explained in detail. The testing of lenses having become a matter of importance in photography, the Kew Observatory has recently instituted a special department for the purpose; but it was not proposed to guarantee any great accuracy (say, within a quarter of an inch or so) in the measured focal lengths. Prof. Thompson hopes that the committee of the British Association, which he has been instrumental in establishing, will communicate with the authorities of the Kew Observatory, and induce them to carry their measurements to a greater degree of accuracy than they have previously contemplated.

Photographic Optics.†—Mr. A. Caplatzi writes, "There has just appeared under this title a work by Dr. Hugo Schroeder, which will be welcomed by practical opticians and amateurs alike. The latter will find in it an ample reply to the many requests for information addressed to these columns, and the former a practical treatise forming a reliable guide in their lucrative business of photo lens-making. In this royal octavo of some 200 pages a hard blow has been dealt to rule-of-thumb work. Those who will carefully peruse it need no longer work in darkness and uncertainty, but can do it in broad daylight and full conviction that every step forward will bring them one degree nearer to a successful result. And those students who have hitherto derived their optical knowledge from the meagre contents of text-books only, will be surprised at the number of further considerations requiring attention before a

* English Mechanic. liv. (1891) p. 36. † Tom. cit., p. 18.

practical plan for the construction of photo lenses can be laid down, and they cannot fail to admire the skill and patience that has given us the good lenses we possess, without clearly understanding the numerous conditions they must satisfy. Though the work deals mainly with the construction of photo lenses, it will prove itself as useful for the combination of any other kind of lenses, as the formation of images and the correction of chromatic and spherical aberrations, astigmatism, and diaphragms have been masterly treated. Actinism, of course, need not be taken into account in telescopic and microscopic lenses.

The work is preceded by a valuable list of the principal optical works that have appeared since Newton in English, French, German, and Italian, including fragmentary dissertations contributed to the learned societies, with annotations by the author. Whilst it numbers some 200 works on general optics, only six or seven refer specially to photography. First among these are Petzval's, published in 1843, 1857, and 1858. Dr. H. Zinken, Voightlaender's son-in-law; Dr. Lorenzo Billotti, Schiaparelli's assistant at Milan; and Prof. Seidel, Steinheil's friend, at Munich, also contributed considerably to the perfection of photographic optics. Still, nothing complete and easily understood appeared until the work under notice was called forth by Prof. W. Vogel in Berlin to form a supplement to his new 'Handbook of Photography.'

It is unfortunate that most of this valuable information is in German. The present complete treatise, however, will no doubt soon also appear in an English dress. Meanwhile I shall be pleased to help those who may desire to know something more of the practical rules and formulæ developed by the author, if the editor will afford me space. Dr. Hugo Schroeder possesses the rare advantage of being a linguist and practical optician, as well as a mathematician, and this advantage enabled him to simplify much that was hitherto obscure, and to bring together information that was scattered about in many inaccessible writings. He dissects all the lenses in actual use, and shows on what principles they have been constructed, and how they can be still further improved."

(6) Miscellaneous.

New Edition of Carpenter on the Microscope.*—We are glad to be able to call attention to the new (seventh) edition of the late Dr. Carpenter's well-known work on the Microscope. Dr. Dallinger has been engaged on this work for a considerable time, and has devoted much attention to it. When the last edition of this work was published the new era in microscopical optics had just opened; now, ten years later, it is necessary to give a full account of the work of Prof. Abbe. The consequence is that Dr. Dallinger has had to completely rewrite the first seven chapters. These, he tells us, "represent the experience of a lifetime, confirmed and aided by the advice and practical help of some of the most experienced men in the world, and they may be read by any one familiar with the use of algebraic symbols and the

* 'The Microscope and its Revelations,' by the late W. B. Carpenter. 7th ed., in which the first seven chapters have been entirely rewritten and the text throughout reconstructed, enlarged and revised by the Rev. W. H. Dallinger, LL.D., F.R.S., &c. xviii. and 1099 pp., 21 pls., and 800 wood engravings. London, 1891.

practice of the rule of three. They are not in any sense abstruse, and they are everywhere practical."

The second chapter deals with the Principles and Theory of Vision with the Compound Microscope, and of it Pro . Abbe, who saw the proofs, says, "I find the whole . . . much more adequate to the purposes of the book than I should have been able to write it. . . . I feel the greatest satisfaction in seeing my views represented in this book so intensively and extensively."

Dr. Dallinger has not shrunk from calling to his aid a number of specialists, among whom we may mention Mr. Crisp, the late Mr. Mayall, Mr. E. M. Nelson, Mr. W. T. Suffolk, and Dr. Sorby. Many sections of the book have been rewritten, nineteen new plates have been prepared, as well as 300 additional woodcuts, for many of which the editor returns his thanks to the officers of the Society.

Death of Mr. Walter H. Bulloch.—We regret to hear of the death, on Friday, November 6th, of Mr. Walter Hutchison Bulloch, the well-known optician of Chicago. The deceased was a prominent member of the Chicago Academy of Sciences and the local Microscopical Society. He joined the Royal Microscopical Society in 1882.

Universal Microscopic Exhibition at Antwerp.* — The following particulars are obtained from the 'Chemiker Zeitung':—

The "Exposition de Microscopie Générale, de Produits Végétaux et d'Horticulture" has just come to an end. It was projected by Dr. Henri van Heurck, Director of the Antwerp Botanical Garden, a microscopist of reputation. The plan of the promoters allowed of a strange mixture of products. Thus, along with brewed drinks, "schnaps" of all kinds (i. e. inferior liquors), were to be found pianos, mineral oils, guano, and other manures.

J. D. Möller, of Wedel, in Holstein, exhibited a collection of diatoms, including not fewer than 4026 distinct forms. Not only photographs of these species were on view, but the original specimens could be examined under a number of Microscopes.

The firm of Lumière & Collar, of Lyon, exhibited coloured transparent figures of microbes, just as they appear to the eye under the Microscope.

Along with Microscopes there were exhibited ovens for the cultivation of bacteria, apparatus for sterilizing, &c.

Among the exhibitors of instruments, a prominent place belongs to the establishment of Carl Zeiss of Jena. Their display included a selection of Microscopes, from the simplest to the most complex, combined with appliances for photographic projection, a set showing all the single parts of which a perfect Microscope is composed, and a collection illustrating the production of lenses from the crude glass through every stage of grinding.

Watson & Sons, of Holborn, exhibited a large selection of Microscopes for various purposes, especially an instrument made according to the indications of Dr. van Heurck, adapted for delicate researches and for photomicrography.

M. Nachet, of Paris, displayed instruments for research, general, scientific, and technical.

* Chemical News. lxiv. (1891) p. 169.

Powell & Lealand, of London, exhibited a large Microscope, said to be the most perfect as regards its stand. Hartnack, of Potsdam, had Microscopes and object-glasses, with photomicrographic fittings. J. Deby, London, displayed a collection of instruments by various modern makers with manifold appliances for illumination, arrangement for obtaining monochromatic light, as also a rich and interesting collection of preparations.

Adnet, and also Wainsegg, of Paris, and Seibert, of Vienna, exhibited a variety of bacteriological apparatus.

It strikes us as remarkable that no spectroscopic apparatus seems to have been exhibited.

The 'Chemiker Zeitung' remarks, with perfect justice, that it is impossible for an expert to pronounce on the value of any instrument, so long as it can only be seen in a glass case.

Meeting of American Microscopists.*—Dr. J. S. Billings, of the Army Medical Staff, in welcoming the visitors to Washington, said:—

"The President, Ladies and Gentlemen: It is my pleasant duty this morning to bid you welcome to Washington and to say to you that you are to make yourselves very much at home here.

Washington, as the capital of the country, is, in fact, the natural and proper home of all national associations, and they are beginning to discover this, for the number of such gatherings here increases every year. Within the last twenty years this city has become not only one of the most beautiful cities in the world, but has become one of the great scientific and literary centres of this country. The needs of different departments of the Government for accurate and precise information upon many subjects connected with their work have brought together here in the different bureaus many men specially trained in modern methods of investigation and research, each working some particular line, and more or less of an expert upon some one particular subject, yet also interested in the general progress of knowledge and the results obtained by his fellow-workers. Hence it is that our local scientific societies are numerous, well attended, and have an abundant supply of material to interest their members; more so, probably, than the majority of local societies in other larger cities. Among these associations, we number an active and flourishing Microscopical Society, for although the Government has no department or bureau exclusively devoted to this subject, yet in almost every department and in many of the bureaus there are, and must be men who are familiar with the use of the Microscope, or they could not answer the questions which are liable to come before them at any moment. You may be sure, therefore, that the American Microscopical Society will always find an appreciative and interested audience for its papers and discussions here.

Of the numerous bureaus of the Government which make use of and are interested in the Microscope and microscopic technique, there is none which makes more constant use of this method of investigation, and none which in times past has done more to stimulate improvements in microscopy, than the medical department of the army, including the Army Medical Museum. The improvements in microscopic objectives

* Amer. Mon. Micr. Journ., xii. (1891) pp. 193-5.

which have been made during the last thirty years, have been, to a considerable extent, stimulated, suggested, and given definite direction by the application of photomicrography to the testing of such objectives as to resolving power and flatness of field under different conditions of illumination. Photomicrography with high powers became a practical and useful process when the use of direct sunlight as a means of illumination was introduced. This was first done in this country by Prof. O. N. Rood, of Columbia College, New York, in 1860–1. It was first suggested and applied in this country to histological preparations in the spring of 1864 in a military hospital here, in Washington, by two assistant-surgeons in the army, James William Thomas and William R. Norris, both now well-known ophthalmologists in Philadelphia. These gentlemen brought the results obtained by them to the attention of Dr. J. J. Woodward, of the army, who was engaged in the collection of materials for the preparations of the medical history of the war and the formation of an army medical museum, and by his direction the process was taken up, extended, and improved by Dr. Edward Curtis, now of New York, who was then engaged in making microscopic preparations to illustrate the pathological histology of certain camp diseases. Subsequently Dr. Woodward himself took the matter up, studying especially the optical combinations and technique of illumination adapted to secure the best results, and applying these methods as a means of minutely and accurately comparing the powers and performances of different objectives, and of making of such performances records whose accuracy could not be questioned, and which could readily be compared with each other.

When Dr. Woodward was doing the greater part of his testing work homogeneous immersion objectives were unknown, and with high powers the proper adjustment of the cover correction was a matter of the greatest importance to secure the best results, and was also often a matter of considerable difficulty. Dr. Woodward's skill and patience in making these adjustments and in regulation of the illumination were unrivalled. He often spent half an hour and more in securing a single cover correction, and the makers of microscopic objectives, both in this country and abroad, came to recognize the fact that he was not only absolutely impartial to his tests, but would get from each lens the very best work of which it was capable. The result was that they were glad to send him lenses for trial and to obtain his suggestions as to the possible means of improvement, which in this way was strongly stimulated. Since his death, microscopic and photomicrographic work have been carried on steadily in the museum, but on somewhat different lines, consisting mainly in the practical application of these methods to pathological research and to bacteriology. We shall be very glad to have you spend as much time at the Museum as you can spare, and to show you what we are doing there. In connection with this I wish to invite your attention to two cases at the south end of the main Museum hall which contain a number of Microscopes illustrating the development of and changes in this instrument and its accessories, from the time of the first known compound Microscope of Janssen, in 1685, down to the present time. In bringing together this collection during the last ten years, I have been greatly aided by [the late] Mr. John Mayall [Jun.] of London, who has had so much to do with the formation of the magnificent collection of Mr. Crisp. Permit me to remind you, that as citizens and sovereigns of the Republic, the Medical Museum belongs to you, and that as American microscopists its collection of Microscopes and of microscopic slides and material should be a matter for your special interest and care. The collection is very far from being complete, it is only the beginning of what I hope will one day be gathered and carefully preserved in it, namely a specimen of every different form of Microscope, and especially of the earlier forms of American makers, of which we have none, and also specimens of the best work of American microscopists which can be shown by permanent preparations, and to secure this I ask your assistance.

The library of the Surgeon-General's office, connected with the Museum, is rich in books and journals relating to the Microscope and its uses, especially in its applications to biology and the medical sciences, and it is available to all who wish to use it. If you are not familiar with its resources and its index, I hope you will become so while you are here."

Recreative Microscopy.*—Mr. Henry Ebbage communicates the following note:—" A pretty object for entertaining friends is the arborescent growth of silver crystals. To show this, dissolve a small crystal of silver nitrate (or a piece of lunar caustic) in a few drops of rain-water. Place a drop of this solution in the centre of a slip of glass, and arrange it under a low power of the Microscope, concentrating the light from above by means of a stand condensing lens. Now take a piece of copper bell-wire $1\frac{1}{2}$ in. long, and bend it like a capital L, then bend the longer limb to form a hook, which will rest anchor-fashion when laid down. Place this at the side of the drop of solution, allowing the hook to dip into it at the edge. Chemical exchange results, copper going into solution, and silver crystallizing out.

N.B.—Do not spill the solution as it stains black."

β. Technique.†

(1) Collecting Objects, including Culture Processes.

Methods of Bacteriological Research.‡—In an article of twelve pages Dr. Kirchner gives a compressed but clear account of all the methods of bacteriological research, and this is prefaced by a review of the general morphological and biological characteristics of bacteria.

The most important of the microscopical and cultivation methods are described with an accuracy of detail so that they are available for practical work.

At the end of the article are considered the examination of water, air, and soil, and also that of infectious diseases.

* English Mechanic, liv. (1891) p. 19.

† 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.

‡ 'Handwörterbuch der Gesundheitspflege,' pp. 69–80. See Centralbl. f. Bakteriol. u. Parasitenk., x. (1891) p. 234.

Silicate-jelly as a Nutrient Substratum.*—Herr P. Sleskin, who has used the substratum of silicic acid, relates his experience in following out the preparation of the silicic acid as directed by Kühne, and its further modification according to Winogradsky, for cultivating nitrifying organisms. Three volumes of silicate of soda diluted to a specific gravity of 1·08 are mixed with 1 volume of hydrochloric acid (equal volumes of HCl sp. gr. 1·17 and H_2O). The two ingredients having been thoroughly mixed by stirring, the solution is dialysed in running water for about eleven days. The dialyser used was 19 cm. in diameter, and the layer of silicic acid 4–5 cm. thick. The fluid thus obtained has a specific gravity of 100·1 (about), is slightly opalescent, but transparent and liquid. In this condition it may be kept, for some time at least, in sterilized flasks. The next step is to evaporate the silicic acid down to 3/5 to 1/2 its volume in flasks plugged with cotton-wool.

The nutrient salts to be added are—Ammonium sulphate, 0·4; magnesium sulphate, 0·5; potassium phosphate, 0·1; calcium chlorate, a trace; sodium carbonate, 0·6–0·9. All the sulphates are mixed together and dissolved in as little water as possible; so too are the soda and potash salts, the extremely dilute calcium chlorate forming a third solution. All three are sterilized apart and thus preserved.

The two first saline solutions are mixed with the thickened silicic acid and the calcium chlorate afterwards added. A few flakes from precipitated salts are usually visible, but these do not interfere with the transparency of the medium, which is a fluid with the consistence of oil, and which, after having been poured into capsules, slowly and of its own accord thickens in a few hours to a jelly.

Substitutes for Agar and Gelatin.†—Herr Marpmann says that a perfectly bright and clear nutrient medium having all the properties of agar may be prepared in the following manner, by using an alga, *Sphærococcus confervoides*, found in the Mediterranean:—30 parts of alga are macerated in 2 parts hydrochloric acid and 1 litre water for two hours. The mixture is then washed thoroughly with water until blue litmus-paper no longer turns red. After decanting, there are added 700 parts water, 40 parts glycerin, 20 parts Koch's liquid pepton, 2 parts beaten-up albumen. The mixture is next boiled in a steamer for 20 minutes, then neutralized and filtered through a syrup-filter.

As a substitute for gelatin the author uses chondrin, which he extracts from rib and ear cartilage by boiling in a Papin's digester under a pressure of two atmospheres. The chondrin is filtered while hot through an ordinary paper filter, and when cold it is found to have set more firmly than gelatin. Besides this greater firmness, chondrin possesses the additional advantage of being more slowly liquefied by peptonizing microbes and of not losing its consistence after prolonged boiling, at least not till 140° C. are reached.

Miniature Tank for Microscopical Purposes.‡—Dr. Thomas S. Stevens remarks:—"Any collector from ponds and ditches, who has reached over the contents of a round bottle with a lens, knows how difficult it is to see and capture the interesting objects it may contain,

* Centralbl. f. Bakteriol. u. Parasitenk., x. (1891) pp. 209–13.
† Tom. cit., pp. 122–4. ‡ Microscope, xi. (1891) p. 156.

on account of the distortion produced by the convex sides of the bottle. At a trifling cost a small flat aquarium, or large zoophyte trough, may be made that will obviate this difficulty.

Take two pieces of plate glass about 6 in. square, and from a dealer in rubber goods obtain a strip of pure rubber packing about 3/4 in. square, and so long that when bent into a horse-shoe or U shape the ends will just come to the top edge of the glass sides, while the curve shall not quite reach the bottom. If the rubber is flush with the lower edge, or a trifle below, the tank will not stand firm when finished. This rubber strip, bent into proper form, is to be cemented between the two glass sides. This may be easiest done by marking on a soft pine board a square exactly the size of the glass, and on this square bending the rubber strip into a U shape; keep it in position by placing pins or tacks, not through, but at the sides of the packing, at various points, so as to hold it in shape. Smear the upper side of the packing thoroughly with cement, lay on one of the glass sides, being careful to have it in position, press it firmly on the cement and place a weight above it to hold it down, and leave it overnight for the cement to harden. Smear the other side of the rubber strip with cement and place the other glass upon it, being careful to have the edges of both sides parallel. Weight it down, leave to harden as before, and the tank is done. The cement that I have used is Van Stain's Strateria. No doubt there are others that would answer the purpose as well. Marine glue would probably be better. The rubber packing comes in different sizes, from 1/4 to $1\frac{1}{4}$ in. in thickness. The aquarium may therefore be varied, both in size and transverse depth, to suit the needs and taste of the maker."

Apparatus for Gathering and Examining Microscopic Objects.*— Mr. G. M. Hopkins writes:—"One of the difficulties experienced by the beginner in microscopy is the finding and gathering of objects for examination. As a rule, cumbersome apparatus has been used. The conventional apparatus consists of a staff, to which are fitted a knife, a spoon, a hook, and a net; but a great deal can be accomplished with far less apparatus than this.

The engraving (fig. 89) illustrates a simple device by means of which the amateur microscopist can supply himself with as much material as may be required. It consists of an ordinary tea or dessert-spoon, and a wire loop of suitable size to extend around the bowl of the spoon, having the ends of the wires bent at right angles and hooked in opposite directions. To the loop is fitted a conical cheese-cloth bag, and to the bottom of the bag, upon the outside, is attached a strong string, which extends over the top and down to the bottom of the bag, where it is again fastened. The spoon is inserted between the bent ends of the loop and turned, and the point of the bowl is slipped through the loop.

The instrument is used in the manner shown in fig. 89, that is to say, it is scraped along the surface of objects submerged in the water, the water passing through the cloth, and the objects being retained by the conical bag. When a quantity of material has accumulated, the bag is turned inside out by pulling the string, and the pointed end of the bag

* English Mechanic, liii. (1891) p. 426.

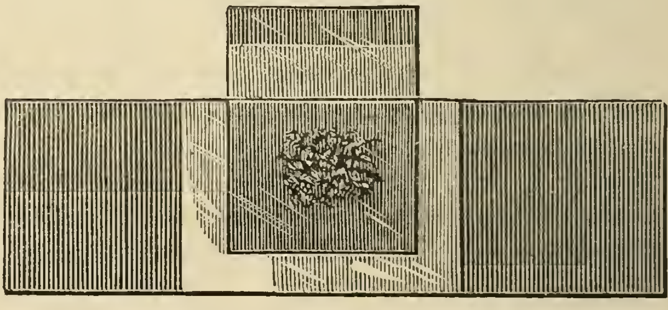
is dipped a number of times in water contained in a wide-mouthed bottle. The operation is then repeated. The objects thus washed from the bag are retained in the bottle for examination.

Fig. 89.

Gathering microscopic objects.

The common method of examining small objects of this kind is to place a drop of water containing some of the objects upon a glass slide by means of a drop-tube, then to apply a cover-glass, and remove the surplus water by the application of a piece of blotting-paper. This answers very well for the smaller objects, but the larger ones must be examined in a tank like that shown in fig. 90. This tank consists

Fig. 90.



Tank for microscopic objects.

of a glass slide, to which are attached three glass slips, by means of cement (bicycle-tire cement answers well for this purpose), the strips forming the bottom and ends of the tank. The front of the tank is formed of a piece of a glass slip attached to the strips by means of cement. To vary the thickness of the body of water contained in the tank when necessary, one or more glass slips are inserted behind the object."

(2) Preparing Objects.

Preserving Fluid.*—Prof. Strobel strongly recommends "il liquido Caggiati" as a preserving medium for entire animals and for anatomical preparations. Though it cannot be used in extremes of heat or cold, it is otherwise most advantageous; it is economical and simple, is not inflammable, and does not remove the colour of the objects preserved. Its composition in cubic centimetres is distilled water 1000, creosote 20, alcohol (at 75) 100 parts.

Investigation of Fowl's Ovum.†—Prof. M. Holl removed the ovary from a just killed hen, and fixed it either with chrom-osmium-acetic acid or 1/3 platinum chloride or Kleinenberg's fluid. After gradual hardening in alcohol, staining was effected with borax-carmine or hæmatoxylin, and after treatment with toluol, imbedding in paraffin followed.

Preparation of Embryos of Amphibia.‡—Mr. H. H. Field, in his investigations into the development of the pronephros and segmental duct of Amphibians, made use of the ordinary histological methods; many, however, of the hardening reagents and stains gave thoroughly unsatisfactory results. Embryos of *Rana* and *Bufo* can be satisfactorily killed in Kleinenberg's picrosulphuric mixture, and can be then successfully stained in Orth's lithium-carmine. The object should be exposed to the action of the stain as long as possible, but care must be taken to guard against maceration; with this object it was often found advantageous to stain the object twice, removing it after the first staining to strong alcohol. In passing the stained objects through grades of alcohol it is important to keep a little picric acid dissolved in the several fluids, in order to prevent the alcohol from extracting the yellow stain from the specimen. Embryos thus treated showed a very effective double stain; the nuclei are bright carmine, and contrast with the yellow colour imparted by the picric acid to the yolk-spherules among which they are found. Merkel's fluid is a good killing reagent, and should be followed by hæmatoxylin, and the decolorizing watched with care.

For *Amblystoma* the best treatment was Fol's chromic-osmic-acetic mixture, followed by Czokor's cochineal.

Investigation of Brain and Olfactory Organ of Triton and Ichthyophis.§—Dr. R. Burchhardt recommends for young Amphibian larvæ which still contain a considerable quantity of yolk, preservation in Rabl's fluid, and coloration with borax-carmine or alum-cochineal. For older larvæ Rabl's fluid, Altmann's process for chrom-acetic acid (1 per cent. chromic acid 10 hours, 5 per cent. acetic acid 24 hours, alcohol in slowly increasing quantities, and then 1/2 per cent. osmic acid for 5 hours). The preparations should be washed in water and stained with borax-carmine or Delafield's hæmatoxylin. Specially exact results were obtained by fixing with osmic acid and staining with hæmatoxylin. Excellent results are also to be obtained by the combination of borax-carmine with nigrosin or Lyon's blue in a weak

* Neptunia, i. (1891) pp. 301–2.
† SB. K. Akad. Wiss. Wien, xcix. (1890) p. 369.
‡ Bull. Mus. Comp. Zool., xxi. (1891) p. 203.
§ Zeitschr. f. Wiss. Zool., lii. (1891) p. 370.

alcoholic solution; fixing by picric acid will improve the results. Adult Amphibia should be decalcified and fixed with chromic and nitric acids; they should be stained with borax-carmine.

Preparing Epithelium of Mid-gut of Arthropods.*—Sig. O. Visart opens the living animal, keeping it immersed in running water, and injects by the anus a concentrated solution of methyl-blue in alcohol at 80. The gut is then ligatured, and left for a quarter of an hour. On opening the gut, the epithelium is found completely separate from the tunica propria, and furnishes most satisfactory preparations.

Mode of Preparing Crustacean Eyes.†—Mr. G. H. Parker states that most of his specimens were stained in Czokor's alum-cochineal and mounted in benzol-balsam. The agent used in depigmenting sections was an aqueous solution (1/4 per cent.) of potassic hydrate.

Preparing Segmental Organs of Hirudinea.‡—Prof. H. Bolsius found the following combination useful; after staining with hæmatoxylin the leech was washed for half an hour in a nearly concentrated solution of pure picric acid. By this double coloration the nucleus was stained by the hæmatoxylin, while the protoplasm of the segmental cells was yellow. This method introduces much variety into the coloration of the other tissues of the body. The muciparous cells are blue, the spermatozoa have cherry-red nuclei, the ova are rosy, the epithelial cells of the intestine violet-red with very deep nuclei, the ganglia are deep lilac, the nerve-chain almost black, the lymphatic and blood-cavities yellow to brown, the muscles are straw-coloured with red nuclei, and the connective tissue is of a clear yellow colour.

Eismond's Method of Studying living Infusoria.§—M. A. Certes reports that this method ‖ gives excellent results. He has attempted to improve on it by the addition of colouring matters, and he has fully succeeded with methyl-blue and violet dahlia No. 170; with the latter the species studied did not live long; with the other, survival is very much longer, unless the solution is too concentrated.

Demonstration of Presence of Iron in Chromatin by Micro-chemical Methods.¶—Dr. A. B. Macallum states that he has discovered a method of employing ammonium sulphide as a reagent for iron, by which he is able to show the presence of the latter in the chromatin of the nuclei of a very large number of species of cells hardened in alcohol. The iron does not here occur combined as an albuminate, but rather in a condition comparable to the combination seen in potassium ferro-cyanide or hæmatin. Experiments with vegetable cells and such animal cells as those of the corneal epithelium of Amphibia show that the iron found is not due to the presence of hæmatin. Moreover, when chromatin is very abundant the iron reaction is very marked, while it is feeble in cells poor in chromatin. In the chromatin loops and filaments of karyokinetic figures the iron reaction is intense and sharply confined

* Atti Soc. Tosc. Sci. Nat., vii. (1891) pp. 277–85.
† Bull. Mus. Comp. Zool., xxi. (1891) p. 141.
‡ La Cellule, vii. (1891) pp. 5–6.
§ Bull. Soc. Zool. France, xvi. (1891) pp. 93–4.
‖ See this Journal, *ante*, p. 141.
¶ Proc. Roy. Soc. Lond., xlix. (1891) pp. 488–9.

to these structures. So far as the author's studies have gone he has not met with an instance of the chromatin of a cell not containing iron.

Culture of Terrestrial Algæ.*—Prof. A. Borzì gives the results of his long experience in the cultivation of terrestrial Chlorophyceæ, whether mixed or pure. It is essential in either case to have a contrivance for the constant and regular supply of fresh water. A porous substratum furnishes the best results, and he finds the most convenient to be a white calcareous tufa known in Sicily as "Syracuse stone" (pietra di Siracusa). The light must be allowed to reach the glass vessel in which the algæ are grown from one side only; the side where the fresh water is received and the surplus water drawn off must be the least illuminated; the zoospores will then collect on the wall of the vessel and form a green layer visible to the naked eye. It is impracticable to obtain as absolute purity in the culture of unicellular algæ as in that of bacteria. The plan recommended by the author to obtain comparative purity is a purely mechanical one,—removing the organism to be examined by means of a capillary glass tube, placing it in a drop of pure water, and repeating this process many times. He strongly approves Beyerinck's gelatin method † for the culture of algæ.

Re-softening dried Algæ.‡—Herr J. Reinke recommends eau de Javelle as an excellent medium for restoring dried algæ to an almost fresh condition. Even if they are quite black, the blackening will disappear with prolonged maceration.

Demonstrating Fungi in Cells.§—For demonstrating fungi within cells filled with plasma, Herr H. Möller advises that the fresh material should be treated with chloral hydrate either after the method of A. Meyer (5 : 2), or still better, in cold saturated solution. In this strength not only the starch but the cytoplasm are soon dissolved, and the process may be hastened by heating in a water-bath. It is necessary to constantly change the chloral hydrate, and at each interval wash the sections in water. By this procedure almost all the contents of the cell are dispersed, while the plasma of the fungi is unaffected, so that when stained a good picture is obtained.

Modes of Investigating Chemical Bacteriology of Sewage.‖—Sir H. E. Roscoe and Mr. J. Lunt have carefully recorded by means of photographs the microscopic and macroscopic appearances of the organisms found in sewage; they consider this to be of much importance, as bacteriological descriptions of organisms are frequently of little value from the want of accurate representations of the microscopic preparations and pure cultures.

For the isolation of micro-organisms the methods of gelatin plate-culture and of dilution were used, as well as two in which spore-forming organisms were isolated, or anaerobic organisms were isolated and cultivated. The anaerobic organisms were isolated by carrying crude sewage through three cultivations in pure hydrogen; spore-forming organisms were isolated by heating sterile broth in which a sowing had been made

* Neptunia, i. (1891) pp. 198–208. † Cf. this Journal, *ante*, p. 130.
‡ Ber. Deutsch. Bot. Gesell., vii. (1890) p. 211. § Tom. cit., p. 215.
‖ Proc. Roy. Soc. Lond., xlix. (1891) pp. 455–7.

from crude sewage to 80° for ten minutes; the still living spores were then further isolated by plate cultivation, either with or without previous incubation of the broth tube.

When the micro-organisms were to be photographed, they were stained with methyl-violet, and as this stain transmits chemically active rays, actinic contrast was obtained by using a coloured screen and isochromatic plates; the apparatus employed was of the simplest kind, and the source of illumination was a common duplex paraffin lamp.

Simple Method for obtaining Leprosy Bacilli from living Lepers.*—Dr. A. Favrat and Dr. F. Christmann state that by the following method, which also possesses the merit of improving the patient's appearance, leprosy bacilli can be easily obtained in quantity. The skin is first purified with soap, 1 per cent. sublimate solution, alcohol, and ether. One or more nodules are then burnt with a Paquelin's cautery. The cauterized place is then coated over with collodion, and lastly is protected by aseptic bandages. After 3–4 days (not later), the bandage having been removed and the sore washed with spirit, the scab is raised with a red-hot spoon and the subjacent layer of matter scraped off or inoculated directly on the cultivation medium. The sore rapidly heals, and no trace of the leprosy nodule remains.

Microscopical examination reveals an enormous quantity of bacilli, together with pus corpuscles and broken-down matter. The bacilli lie scattered about without any definite arrangement, occasionally being observed in little heaps, but never inside cells.

Cultivations made from the bacilli were unsuccessful, while the inoculation experiments are as yet unconcluded.

(4) Staining and Injecting.

Method for fixing Preparations treated by Sublimate or Silver (Golgi's Method.).†—Sig. A. Obregia gives a method for rendering preparations treated by Golgi's sublimate or silver procedure so permanent that they may be afterwards stained and protected with a cover-glass.

The sublimate or silver preparations are sectioned without any imbedding or after having been imbedded in paraffin or celloidin. In the latter case care must be taken not to use alcohol weaker than 94 or 95 per cent., at any rate for the silver preparation. The sections are then transferred from absolute alcohol to the following mixture:—1 per cent. gold chloride solution, 8–10 drops, and absolute alcohol, 10 ccm., which should have been made half an hour previously, and exposed to diffuse light. After sections are deposited therein, the vessel containing them is placed in the dark. The silver is gradually replaced by gold, and the mercury changed into gold amalgam. Finally, black delicate designs appear on a white field. According to the thickness of the section, the fluid is allowed to act from fifteen to thirty minutes, but even longer is not harmful. Thereupon the sections are quickly washed first in 50 per cent. alcohol, then in distilled water, and finally in a 10 per cent. solution of hyposulphite of soda, in which, according to

* Centralbl. f. Bakteriol. u Parasitenk., x. (1891) pp. 119–22.

† Amer. Mon. Micr. Journ., xii. (1891) p. 210. See Virchow's Archiv, cxxii. (1890).

their thickness, they remain from five to ten minutes. A longer immersion bleaches too much, so that the finer fibres disappear. Last of all they are thoroughly washed in distilled water twice renewed.

Sections thus fixed can afterwards be stained by any method, e. g. Weigert's, Pal's, &c., after which they are cleared up with creosote, imbedded in dammar, and protected with a cover-glass.

Throughout the procedure the sections must be manipulated with glass instruments, and not allowed to touch any metallic substance.

Rapid Staining of Elastic Fibres.*—Sig. E. Burci fixes the objects in alcohol, Müller's fluid, or corrosive sublimate; stains the sections with carmine or hæmatoxylin; washes them in water; dips them for a minute or two in saturated alcoholic solution of aurantia (ditrinitrophenylamine). The sections are then passed rapidly through absolute alcohol, cleared, and mounted as usual.

New Method of Spore-staining.†—Dr. H. Moeller describes the following method for staining spores. The cover-glass preparation, having been dried in the air, is passed thrice through the flame or immersed for two minutes in absolute alcohol. It is then placed in chloroform for two minutes, and afterwards washed with water; then for 1/2–2 minutes in 5 per cent. chromic acid, and again thoroughly washed with water. The preparation is then stained with carbol fuchsin, being boiled in the flame for 60 seconds; the carbol fuchsin having been poured off, the stain is decolorized in 5 per cent. sulphuric acid, after which the cover-glass is thoroughly washed with water. It is then contrast-stained by immersion for 30 seconds in aqueous solution of methylen-blue or malachite-green. The spores should be dark red and the rest of the bacterium green or blue.

Hæmalum and Hæmacalcium, Staining Solution made from Hæmatoxylin Crystals.‡—Dr. Paul Mayer highly recommends the use of two staining solutions made from hæmatein, the essential staining constituent of logwood. When pure, hæmatein is a brown-red powder and crystallizes with one or three equivalents of water. It is most frequently found in commerce as hæmateinum crystallizatum, a compound of hæmatein and about 9 per cent. of ammonia, and is more properly designated ammonia-hæmatein. When pure, hæmatein and its ammonia compounds should not only be perfectly soluble in distilled water and alcohol, but should remain so on addition of acetic acid. From hæmatein is prepared a solution called, for short, hæmalum.

1 grm. of the pigment is dissolved by the aid of heat in 50 ccm. of 90 per cent. alcohol, and then added to a solution of 50 grm. of alum in 1 litre of distilled water. When cold it may be necessary to filter, but if the constituents have been pure this is quite superfluous. The solution is ready for use at once. It may be necessary to add a thymol crystal in order to prevent the formation of fungi.

For staining sections, hæmatein is used like Boehmer's hæmatoxylin, and if required the preparations may afterwards be washed with ordinary water, distilled water, or 1 per cent. alum solution.

* Atti Soc. Tosc. Sci. Nat., vii. (1891) pp. 251–3.

† Centralbl. f. Bakteriol. u. Parasitenk., x. (1891) pp. 273–7.

‡ Mittheil. Zool. Stat. zu Neapel, x. (1891) pp. 170–86.

Hæmacalcium, which is proposed as a substitute for Kleinenberg's hæmatoxylin, is made with the following ingredients:—hæmatein or ammonia-hæmatein, 1 grm.; aluminium chloride, 1 grm.; calcium chloride, 50 grm.; acetic acid, 10 ccm.; 70 per cent. alcohol, 600 ccm. The first two substances are to be pounded together very intimately; the acetic acid and the alcohol are then to be added, with or without the aid of heat. Last of all, the calcium chloride is added. The fluid is of a red-violet hue. After having been washed in neutral 70 per cent. alcohol the preparations are violet or blue, and rarely require to be treated with acidulated alcohol. If too red they may be treated with 2 per cent. aluminium chloride dissolved in alcohol.

Fraenkel on Gabbet's Stain for Tubercle Bacilli.*—Dr. B. Fraenkel seems to think that the method known as Gabbet's, the original communication of which was in the 'Lancet,' 1887, p. 757, is really the same in principle as one published by him in 1884. Gabbet's method consists in decolorizing with a mixture of H_2SO_4 and methylen-blue. Fraenkel's decolorizer, as given in No. 13 of Berlin. Klin. Wochenschr. for 1884, is nitric acid, besides which the formula includes alcohol. What should be the criterion for determining what is or what is not a new principle in bacteriology must remain open. At any rate, the formula given by Dr. Glorieux, published in Bull. Soc. Belge de Microscopie, 1886, pp. 44–8, is much nearer in principle than Fraenkel's, and differs from Gabbet's merely in that the latter contains no alcohol.

Syringes and their Sterilization.†—Dr. Tavel describes a syringe which is easily sterilized. Though chiefly intended for surgical purposes, it is useful in the bacteriological laboratory. The principle of the apparatus consists in avoiding the trouble of having to sterilize the piston part, which is quite disconnected from the syringe-needle portion. The piston, half the rod of which is notched, is furnished at the end with a screw and tap. To this screw is screwed on a metal cap, and into this latter fits the graduated glass holder or syringe, terminating at its other end in a steel needle. For laboratory work the author discards the piston portion, using the syringe-needle and adapting this for injection purposes by means of a Y-shaped glass tube. To the arms of the Y are fitted the syringe-needle and the bellows by means of rubber tubes.

The apparatus used for sterilizing these syringe-needles is then described. It is an ordinary rectangular vessel heated by gas, the jet of which is regulated by Reichert's thermo-regulator, but instead of water the reservoir contains paraffin. In this the syringe-needles, inclosed in test-tubes plugged with cotton-wool, are suspended, and thus are sterilized with hot air. The regulator is adjusted for 155°, so that the inside of the syringes may be kept at 150°, a temperature which is maintained for two hours. Higher temperatures are injurious to the steel of the needles. The sterilizing over, the test-tubes are taken out and wiped. The needles, kept inside till required, remain perfectly aseptic.

* Deutsch. Med. Wochenschr., No. 15, 1891. See Centralbl. f. Bakteriol. u. Parasitenk., x. (1891) pp. 234.

† Annales de Micrographie, iii. (1891) pp. 564–73 (3 figs.).

(6) Miscellaneous.

Microchemical Reactions of Tannin.*—Mr. S. Le M. Moore distinguishes three kinds of tannin in plants, known by their different reactions with Nessler's fluid, viz.:—(1) tannin giving an immediate brown precipitate, occasionally with brown-pink tendency; (2) tannin giving a yellow colour, quickly becoming red-brown, and, finally, a cold-brown precipitate; (3) tannin giving a yellow colour, the yellow substance readily diffusing through the cell-walls into the surrounding fluid, thus leaving the cells colourless after a varying lapse of time. In addition to the functions hitherto ascribed to tannin, the author believes that it may have a more general relation to the turgescence of the cell; and that tannin is also most likely used up in the lignification of the cell-wall.

Cleansing Used Slides and Cover-glasses.†—Dr. F. Knauer says that the slides and cover-glasses of old preparations may be made as good as new by the following method, which he has adopted for some time past. 60–80 (say) slides are placed in a vessel holding about half a litre of 10 per cent. lysol solution and boiled for twenty to thirty minutes. The still seething vessel is then placed straight away under a strong current of running water until it streams back quite clear, after which the glasses are taken out and dried on a clean cloth. If the preparations be of comparatively recent date a 5 per cent. solution is quite sufficient.

Dr. J. B. Nias ‡ says:—"Bacteriologists and others who find themselves with accumulations of Microscope slides may be glad of the following hint for cleaning them. It is not given in any text-book that I can discover. Instead of warming the slides one by one over a flame, pushing off the cover, and then scraping away the balsam and cleaning with alcohol, I put all my slides together into a saucepan with a lump of washing soda, and boil them. The heat of boiling is enough to soften most cements and all ordinary resins used for mounting, and I then fish out the slides one by one, push off the cover-glasses, and put them back. The action of the soda is to convert the balsam or other resin into a grumous mass, which is easily wiped off with a little rinsing. Cover-glasses can also be recovered for future use in the same way, if desired. I think this method may be of service to laboratory attendants. Neither do I find anything on the surface of new covers and slides which will resist the action of hot water and soda; and so I prefer this way to the use of strong sulphuric acid and alcohol, or the other methods given in the text-books. The exact quantity of soda to be used is immaterial; a piece about the size of a mandarin orange to half a pint of water will do."

Method for the Estimation of the actual number of Tubercle Bacilli in Phthisical Sputum.§—Dr. G. H. F. Nuttall describes with great lucidity a method which he has devised for estimating the actual number of tubercle bacilli in sputum. Naturally enough the procedure

* Journ. Linn. Soc., xxvii. (1891) pp. 527–38.
† Centralbl. f. Bakteriol. u. Parasitenk., x. (1891) pp. 8–9.
‡ Lancet, 1891, p. 1414.
§ Johns Hopkins Hospital Bulletin, No. 13, 1891 (5 figs.).

is complicated, but as the separate stages or details are quite simple, and as the method is applicable not only to sputum but to any fluid containing micro-organisms, it seems probable that it may succeed where several other methods having a similar object have failed. Owing to its length we can only give the coarser details of the process, and for the finer ones must refer to the original, wherein the minutest particulars will be found.

The sputum is mixed with 5 per cent. caustic potash solution until it becomes perfectly fluid. The mixture is then shaken in a "milk-punch shake," in order that the bacilli may be evenly distributed throughout the fluid. The sputum is then transferred to a burette and dropped out on cover-glasses. The flow of sputum from the burette is regulated by means of a groove filed on one side of the aperture of the stop-cock. By this device the equable flow of a series of equal-sized drops was insured. The equal size of drops containing an equal number of organisms is, of course, the great desideratum. The best size for the drops was found to be 100–150 to the cubic centimetre of sputum.

The next step is to spread the sputum on the cover-glass so as to form a thin film. This is done on a turntable, the sputum being spread by means of a fine platinum needle, the point of which is bent at an angle of about 45°. The cover-glasses, kept in a perfectly horizontal position, are to be dried at 35–40°, and then surrounded by a ring of paint composed of lampblack and serum. The layer of sputum is next to be covered with a thin film of sterilized serum, which is coagulated at a temperature of 80°–90° C., and then the caustic potash must be extracted from the sputum by means of alcohol, the solvent action of the latter being aided by heating in the thermostat. The main object of the serum film is to prevent any of the bacilli being removed during manipulation. The sputum is then stained with phenol-fuchsin and decolorized by alternate immersion in alcohol and weak sulphuric acid. After having been washed with water, the preparations are merely dried on blotting-paper and then mounted in balsam.

The next part of the method deals with the actual counting and the apparatus necessary thereto. In a No. 12 eye-piece is inserted a diaphragm made of black paper in which a small hole has been cut. The aperture of the diaphragm is traversed by a hair-line. In order to be quite accurate about the fields, the latter are indicated by fixing a cork to one of the screws of the mechanical stage. The cork is armed with a thin wooden indicator terminating in a needle. The needle is made to point to the radial divisions on a cardboard scale placed by the side of the Microscope. The scale is affixed to a wooden circle, the centre of which is cut out in order to allow the stage-screw to be easily manipulated through the aperture. By this simple apparatus the size of the drop in fields is measured. The number of fields varies from 180–220, and the method of calculation is from a given case as follows:— A drop 200 field-widths in diameter is found to contain (average of 500 fields) 5 bacilli to the field; then $200^2 \times 0 \cdot 7854 = 31{,}416$ (area of drop in fields) $\times\ 5 = 157{,}080$ bacilli to the drop.

The bacilli are counted as they pass under the hair-line of the diaphragm, and their number is registered by a machine known as the "adding and counting register," which is fixed to the tightening-bar of the Microscope.

After giving illustrative cases, the author makes some remarks on the multiplication of tubercle bacilli in sputum outside the body, and then gives a short demonstration of the accuracy of the method.

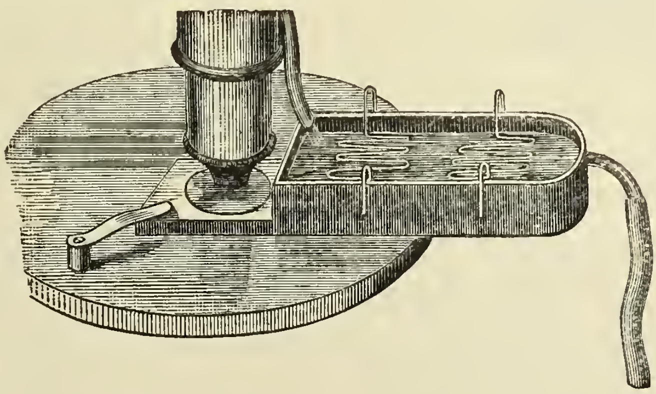
Colloidal Clay for Filtering Fluids containing Bacteria.*—Dr. H. Aronson uses argillaceous earth, from which he prepares the hydroxide of aluminium for filtering purposes in the bacteriological laboratory. The aluminium hydroxide is precipitated as a gelatin-like snowy mass from a 12 per cent. solution of sulphate of alumina or alum by means of excess of ammonia. After settling, the supernatant fluid is partly decanted and partly siphoned off, and the residue washed with distilled water until its reaction is completely neutral. The colloidal mass is then spread on the plate of Hirsch's porcelain filter and distributed so as to form an even layer, and the whole then sterilized in an incubator at 140°; previously to this any excess of fluid may be removed by a suction-pump in the usual way.

In this way is obtained a filter-mass which is at once uniform and homogeneous. Occasionally, after removal from the incubator, cracks and fissures may develope in the mass; these may be avoided by adding a little boiling sterile water before the mass have had time to cool.

The filtrates obtained by means of this medium seem to have been successful in most cases. The apparatus, however, will tolerate only very low suction-pressures, as anything like a high pressure produces cracks and clefts in the filter-mass.

Some Suggestions in Microscopy.†—Mr. G. M. Hopkins, writing in the 'Scientific American,' says:—"An object which always interests the microscopist, and excites the wonder and admiration of those who regard things microscopic from the point of popular interest, is the circulating

Fig. 91.



blood in living creatures. Nothing in this line has proved more satisfactory than the microscopic view of the circulation of blood in the tail of a goldfish. Thanks to Mr. Kent's invention of the fish-trough, the arrangement of the fish for this purpose has been rendered comparatively simple and easy.

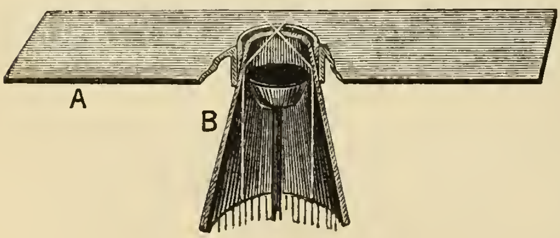
* Archiv f. Kinderheilkunde, xiv. (1891) pp. 54–8.
† English Mechanic, liii. (1891) p. 494.

The trough consists of a metallic vessel provided with a thin extension at one end near the bottom furnished with glass-covered apertures, above and below. The body of the fish between the gills and tail is wrapped with a strip of soft cloth, and the trough being filled with water, the fish is placed therein, with its tail projecting into the extension between the glass covers. The tank is arranged on the microscopic stage with the tail of the fish in position for examination. So long as the fish remains quiescent all goes well, and the beautiful phenomenon may be witnessed with great satisfaction; but the subject soon becomes impatient, and at the most inopportune moment either withdraws its tail from the field or jumps out of the tank, thus causing a delay which is sometimes embarrassing.

The uneasiness of the fish is caused partly by its unnatural position, and partly by the vitiation of the water. The latter trouble has been remedied by the writer by inserting a discharge-spout in one end of the trough, and providing a tube for continually supplying fresh water. The other difficulty has been surmounted by providing two wire grids, each having spring clips at their ends for clamping the wall of the tank. These grids are pushed downward near the body and head of the fish, so as to closely confine the little prisoner without doing it the least injury. With these two improvements the examination may be carried on comfortably for an hour or more.

In fig. 92 is shown a simple device for dark-ground illumination. Although it does not take the place of the parabolic illuminator or the spot-lens for objectives of low angle, it answers an excellent purpose. To a metallic slide A, having a central aperture surrounded by a collar, is fitted a funnel B, of bright tin or nickel-plated metal, which is provided with a downwardly projecting axially arranged wire, upon which is placed a wooden button capable of sliding up or down the wire, the button being of sufficient size to prevent the passage of direct light to the objective. The light by which the illumination is effected passes the button, and, striking the walls of the conical reflector, is thrown on the object."

Fig. 92.



Artificial Sea-water.*—Dr. D. Levi-Morenos has some notes on the composition of artificially prepared salt water as used with success in aquaria, and in keeping oysters, for instance, in good health. Gosse's recipe suggested the following proportions:—Sodium chloride 100, magnesium sulphate 8·8, magnesium chloride 14·3, potassium chloride 3. These salts, dissolved and filtered, were added to fresh water till the average density of natural salt water was reached. In Perrier's aquarium the water contained the following salts in the proportions stated:—Sodium chloride 78, magnesium sulphate 5, magnesium chloride 11, potassium chloride 3, calcium sulphate 3.

* Neptunia, i. (1891) pp. 162–4.

PROCEEDINGS OF THE SOCIETY.

Meeting of 21st October, 1891, at 20, Hanover Square, W., the President (Dr. R. Braithwaite, F.L.S.) in the Chair.

The Minutes of the meeting of 17th June last were read and confirmed, and were signed by the President.

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

	From
Bennett, A. W., An Introduction to the Study of Flowerless Plants. pp. ii. and 86, text illust. (8vo, London, 1891)	*The Author.*
De Toni, J. B., Sylloge Algarum, vol. ii. p. cxxxii. (8vo, Patavii, 1891)	*The Author.*
A slide showing transverse sections of Cotton	*Mr. W. Hutchinson.*
Mills, F. W., Photography applied to the Microscope. pp. 61, text illust., 1 pl. (8vo, London, 1891)	*The Author.*
Vierteljahrschrift d. Nat. Gesell. Zürich, Bd. i.–ii., v.–ix., xi.–xvi., xviii.–xxiii., xxxiv.–xxxvi.)	*The Society.*

The Secretary said that the Fellows of the Society would probably remember that during the course of their last session a question arose as to the desirability of taking steps to register the Society as a Friendly Society, and that though several special meetings were held to consider the matter, no definite action was taken, and on December 17th, on the motion of Mr. J. M. Allen, seconded by the Rev. Canon Carr, it was resolved "that this special meeting be adjourned *sine die.*" The Council had again had the matter under their consideration, and had decided to make the next meeting of the Society special for the purpose of dealing with it.

The President then gave formal notice that the meeting of the Society to be held on November 18th would be made special for the further consideration of the question of the desirability of registering the Society in accordance with the terms of the Friendly Societies Act.

The President said that the pleasure with which he met the Fellows of the Society after their vacation was very sadly marred by the circumstance that since they last assembled there they had lost one of their Secretaries by death. Little, indeed, did they think when they saw him at their last meeting, so active and so lively, that they should never see him again. The loss they had sustained was one which the Society could hardly hope to replace, because perhaps there was no living person who knew more about the Microscope and its applications than did their deceased friend Mr. Mayall. The difficulty in which they were placed had, however, for the present been met by the kindness of Dr. Dallinger, who had himself undertaken to fill up the vacant place—at any rate until the end of the current session. He hoped that there were some amongst the younger Fellows of the Society, who were training for mathematical and scientific work, who were qualifying themselves for filling a position such as that, seeing how few there were who could be found to occupy it with distinction.

Prof. F. Jeffrey Bell did not know that he could add much to what the Fellows of the Society had already read and heard as to the severe loss which they had suffered. Those who attended their meetings were able to form some idea of the knowledge which Mr. Mayall possessed, and the remarkable critical power which he brought to bear upon subjects which came before them. But whilst there were some present who could speak as to Mr. Mayall's knowledge far better than he could, no one knew him better in the character of a colleague or could speak more highly of him as such, more especially when he remembered what the Society had passed through during the period of his association with it as one of its Secretaries. They had been uprooted from the place where they had for so long a time flourished, and they had also lost one who was their right-hand man for many years; but in the important business of their removal, and pending the appointment of an Assistant Secretary, Mr. Mayall showed a degree of activity which enabled those two important matters to be carried though successfully and with very little trouble to any one else concerned. To supply the place of such a colleague would be no easy task, for he did not think they would be able to find another who, whilst possessed of equal knowledge of those subjects which came before them, would be able to give the amount of ungrudging service to the Society which Mr. Mayall had constantly done. Although not unprepared for the announcement, the telegram which he received during his holiday conveying the intimation of his death came to him as a blow, and produced a sense of sadness which long remained.

Mr. F. Crisp said that Prof. Bell had anticipated much of what he was going to say, although he could not only speak of Mr. Mayall as a colleague in the Society but also as an intimate personal friend. As regarded his knowledge, no one not closely acquainted with him could estimate the loss to Microscopy which had occurred by his death, for there was no one in the world who knew so much of the history of the Microscope as he did, whilst his name would have to be included in any list of the half-dozen best manipulators to be found in this or any other country. Having known him so well personally he could say that he had always found him certainly to be of a most amiable character. Some persons there were who thought him to be cantankerous, but those who knew him better, knew him to be far otherwise; and although there was one point upon which they used to differ, this was but the exception which proved the rule. Both personally, and as regarded the Society, he felt they had sustained a very great loss which it would take many years to get over.

Dr. W. H. Dallinger having, amidst considerable applause, taken his seat on the platform as one of the Secretaries, said he was very much obliged to those present for the kindly expression of their feelings towards him under the circumstances; it would help him in his work.

His other work was at the present time great, and the claims upon his time were not a few, but he could only say that whatever he could do for the Society he would do with the utmost pleasure.

Mr. A. D. Michael thought they ought not to allow Dr. Dallinger to take his seat without some hearty expression of their sense of the great service he was rendering to the Society. A gentleman of his eminence in the scientific world, and who had been President of the Society, could not be called upon by any one to take the Secretaryship, and it was only his great love of science and his desire to serve the interests of the Society which induced him to accept the position. His kindness in this matter would be a great boon and would add much to the great services he had already rendered to the Society. To show how thoroughly they felt and appreciated the great sacrifices he made for the benefit of the Society he moved that a special vote of thanks be given to Dr. Dallinger for his great kindness in accepting—at least for the present—the office of Secretary of the Society.

Mr. T. H. Powell seconded the motion.

The vote of thanks having been carried by acclamation,

Dr. Dallinger thanked the Fellows for this renewed expression of their kindly feeling, and again assured them of his desire to do all that he could to serve the Society.

The Secretary read a letter from Mr. W. Hutchinson, descriptive of a mounted preparation of cotton exhibited under the Microscope in the room.

Dr. H. Schroeder exhibited a series of photomicrographs of J. D. Möller's type-slides of diatoms. He (Dr. Schroeder) said that Herr Möller had in the years 1886–90 mounted the most complete collection of diatoms ever found. The largest slide contained over 4000 diatoms, arranged in such an order that the name of each one can be found by means of the catalogue, whilst the total number mounted in Herr Möller's collection is over 25,000. Herr Möller originally intended to exhibit his collection, but owing to the difficulties that would be incurred he had abandoned this plan, and contented himself by producing the photographs.

The Society voted a cordial vote of thanks to Dr. Schroeder for the opportunity thus afforded of inspecting the photographs.

The Secretary read the following note from Surgeon V. Gunson Thorpe, R.N., On the Colouring Power of Noctilucæ :—" In the Journ. R. Micr. Soc., 1889, p. 236, there is a notice of a paper by Herr K. Möbius, in which he doubts the statement that the red colour of the sea can be produced by *Noctiluca miliaris.* It may be interesting to know, that towards the end of April 1889, when in the Mediterranean Sea, and approaching Gibraltar, at noon, the ship in which I was, passed for several miles through water coloured a bright red colour. On examination under the Microscope this appearance was found to be produced by myriads of Noctilucæ. Not a trace of *Trichodesmium erythræum* was in company with the infusorian. It was noticed that the large central protoplasmic mass of *Noctiluca* had a distinct reddish tinge, but whether this appearance was due to ingested food or to some other cause it was impossible to say."

A circular letter was read from Dr. A. M. Edwards, of Newark, New Jersey, U.S.A. asking for samples of diatomaceous earth from this country in exchange (or otherwise) for similar material from California.

Mr. F. Chapman read his paper "On the Foraminifera of the Gault of Folkestone." (See *ante*, p. 561.)

The Secretary, in thanking Mr. Chapman for his paper, said it had been very strongly recommended to the Publication Committee by Prof. Judd and also by Prof. Rupert Jones.

Sir Walter Sendall, K.C.M.G., exhibited and described a new apparatus which he had devised for making more accurate measurements of microscopic objects than were possible with the camera lucida, the inherent faults of which were explained by drawings on the blackboard.

Mr. E. M. Nelson said he had listened with much interest to this paper, and was very pleased to find that original thought was being brought to bear upon this subject by one who said he was a beginner. There could be no doubt that camera lucida measurements, when made in the ordinary way as described, were grossly incorrect, and that the apparatus which had been devised to enable corrections to be made was most ingenious and thoroughly scientific in principle. He thought, however, that there was a much simpler method of obtaining true measurements, by projecting the image for a much longer distance than the usual 10 in.; if, for instance, it was projected to a distance of 5 ft. the curve would with so large a radius be practically reduced to a straight line and measurements could then be made with very great accuracy. The camera lucida and neutral tint reflector were rough and ready means and useful only for ready reference; where expense was not an object and correctness was of importance the eye-piece micrometer would best meet the requirements. It occurred to him that in using the ordinary camera lucida another element of error was introduced in consequence of the refraction which took place when rays passed through at an angle. As regarded the remarks made about the ruled lines in micrometers, it was quite true that the first methods adopted were open to some objection, but the ruling was now done so perfectly that it was possible to arrive at measurements even as small as 1/500,000 in. with a far greater accuracy than could be attained with any machine. Fasoldt and others had ruled lines up to 1/200,000 in. apart, though they had only been seen up to 1/100,000. He had been very much interested in the description of this contrivance, which he thought would be very handy for rough measurements.

Mr. Michael said he had contended for many years that this question of curvature invalidated not only all camera lucida measurements, but all camera drawings as well, and for this reason he had long since abandoned the process and had used the eye-piece micrometer instead.

Mr. C. Beck said it might comfort some microscopists present who, after what had been said, felt inclined to throw away their camera lucidas, to know that their results could always be corrected by tangent measurement.

Sir Walter Sendall said that was so, but then the tangent method could not be used unless they could first determine accurately the centre of the field.

Dr. Dallinger thought there could be no doubt as to the value of this ingenious contrivance for obtaining measurements within certain limits, but he thought it would require a very great deal of care to be able to use it successfully with high powers, and this partly on account of its weight, if made in brass as the specimen before them. If an apparatus like that had to be hung upon the tube of a Microscope used for high powers it would be necessary to have it made of aluminium or some other light material.

Sir Walter Sendall said that he recognized the value of this suggestion, which could easily be carried out as the principle involved was susceptible of modification in any way which would tend to increase its efficiency.

The Secretary read part of Messrs. W. J. Chadwick and W. Leach's paper on the "Leach Lantern Microscope," at the conclusion of which the authors gave a demonstration, showing upon the screen a number of polariscope and other objects.

The Secretary announced that arrangements had been made for holding their next Conversazione on the evening of Monday, November 30th; they were unable to secure the use of the room for a Wednesday evening.

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

Messrs. W. J. Chadwick and W. Leach:—Leach Lantern Microscope.

Mr. F. Chapman:—Foraminifera illustrating his paper.

Mr. W. Hutchinson:—Sections of Cotton.

Mr. E. M. Nelson:—*Navicula firma* under an oil-immersion 1/12.

Mr. C. Rousselet:—A new Rotifer, *Conochilus unicornis*.

Dr. H. Schroeder:—Photomicrographs of Herr J. D. Möller's Type-Slides of Diatoms.

Sir Walter J. Sendall:—Measuring Apparatus for Camera Lucida drawings.

New Fellows.—The following were elected *Ordinary* Fellows:—Mr. Henry Crowther, Dr. Algernon W. Lyons, Dr. Frank Alvin Rogers. *Honorary* Fellow:—Dr. Édouard Bornet, of Paris.

Meeting of 18th November, 1891, at 20, Hanover Square, W., the President (Dr. R. Braithwaite, F.L.S.) in the Chair.

The President having declared the meeting to be special, in pursuance of notice given at the preceding meeting, for the purpose of considering a proposed alteration in the Bye-laws,

Prof. Bell read the Minutes of the last special meeting convened for the same purpose on 17th December, 1890, and adjourned *sine die*. He reminded the Fellows that special meetings were also held for the consideration of the matter on October 22nd and November 19th, 1890, at which it was stated that in order to obtain for the Royal Medical and Chirurgical Society an exemption from the payment of rates to the parish in which the building was situated, it was necessary that the Societies occupying the various portions of the premises should be registered as Friendly Societies, under the Friendly Societies Act. To enable the Royal Microscopical Society to be so registered, it was necessary to make an addition to their present Bye-laws, to provide that the Society should not make any gift from its funds for the private use of any person, in the terms stated in the resolution which was drawn up at the special meeting in October in the form of a new Bye-law, to be inserted immediately after Bye-law No. 53, and to be designated No. 54, which new Bye-law it was proposed to submit to the present meeting for acceptance. The difficulty in the way of the Council when this question arose, lay in the fact that on the part of both landlord and tenant mistakes had been made at the time the lease was granted, and when its terms came up for review it was thought desirable to get these matters adjusted if it was possible to do so. With this end in view, he, in connection with the late Mr. Mayall, had an interview with the Secretaries of the Royal Medical and Chirurgical Society just before the recess, at which certain propositions and requirements were submitted on behalf of the Council as conditions on which the request to register the Society might be undertaken. The result of that interview was that, with a few exceptions, their requirements were complied with, those which were excepted being such as it was quite expected by the Council that the Royal Medical and Chirurgical Society would be unable to grant. Seeing, therefore, that they had been met in that way, and also that most other Scientific Societies were now for the same reason registered under the Friendly Societies Acts, he thought their concurrence in the matter should be given.

The President having formally moved the adoption of the proposed new Bye-law, was about to put it to the meeting, when

Mr. J. M. Allen said he thought before the Fellows of the Society committed themselves to such a proceeding they ought to understand the exact position in which the matter stood. There had been a great deal of correspondence between the late Mr. Mayall and the Royal Medical and Chirurgical Society on the questions involved, and Mr. Mayall, at length, in a letter dated November 13th, had formulated their requirements under distinct heads which were as follows:—1. That their access to the rooms was too limited, and that they wanted to be able, as at King's College, to meet in their Library on Wednesday evenings from 6 to 11 o'clock. 2. That on their two Conversational Evenings they wanted the use of the North Room as well as the large Meeting Room. 3. That tables should be provided for them on these occasions. 4. That in case of alteration as to present terms of heating, a coal-cellar should be provided. 5. That they should have the use of the kitchen for their caterer on the evenings of meetings. 6. That two electric table-lamps should be provided for the use of Fellows who might want to use Microscopes in the Library. 7. That they should be allowed to fix a plate at the door with the name of the Society on it. He believed that the Royal Medical and Chirurgical Society had only agreed to some of the less important of these requests. With regard to the use of their own rooms on Wednesdays from 6 to 11, they were in future to be entitled to do so. If they wanted the use of the North Room they were told they must pay for it. Tables made up of trestles would be provided. The agreement as to coals, whatever that might be, was to be endorsed upon the lease. The use of the kitchen was declared to be impossible, in fact there seemed to be some objection even to their boiling water in a kettle. Leave was given to attach to wall-plugs lamps provided by the Royal Microscopical Society, but as there were no wall-plugs, who was to fix them? And in the matter of the door-plate, it was absolutely refused. He would suggest that the meaning of this was that whilst the Royal Medical and Chirurgical Society asked them to give what was equivalent to about 30*l.* a year, they said, we will give you in return what costs us nothing, but if you want anything more you must pay for it; and he thought before they passed the resolution before them they should obtain the use of the North Room, and as regarded the door-plate they should at least obtain an undertaking that in the event of any other Society being allowed to fix a plate outside, the same permission should be accorded to the Royal Microscopical Society. Another thing he should also like to mention, and that was the lavatory in the passage on the ground-floor was persistently kept closed against the Fellows of the Society, any one requiring to use it having to go up to one on the second floor instead.

The President said if plates were put up outside for each Society there would be six wanted.

Prof. Bell said that the terms proposed by Mr. Allen as to the name-plate were really the same as already understood, because the only reason for refusal was the fact that they had already refused others.

The President thought it was really such a trivial thing that it was hardly worth while to make a difficulty of it.

Dr. Dallinger said that the whole of the points raised by Mr. Allen had been before the Council, and had been very fully discussed, many of them during the lifetime of Mr. Mayall. He remembered that with regard to the name-plate it was specially stated that no plate except that of the parent Society would be permitted. All their requests beyond this, which it was possible to grant, were acceded to except as to the use of the North Room, and it should be remembered that these were all made beyond the actually signed agreement already entered into. They were asking what they did simply because an unfortunate omission from the deed enabled them in some measure to reopen the question as to its terms, but he thought they ought not to strain the matter to the extent of taking what might be an unfair advantage of what was after all a mistake. Everything had been fully discussed by the Council, and they had come to the conclusion that the Society would be right to close the matter as it now stood. He had been present during the discussion of these questions, and though he did not perhaps take quite the same interest in them then as he should in the position he at present occupied, he thought Prof. Bell had put the matter very fairly before them.

Mr. Allen only wished them to act as men of business, quite irrespectively of other considerations, and he did not see why they could not be men of business as well as members of a scientific Society. His point was that when the Royal Medical and Chirurgical Society said to them "Give us 30*l.* a year," they should say in reply, "Give us a *quid pro quo.*"

Mr. T. H. Gill said it was certainly a very great inconvenience to have the lavatory closed against them; he hoped that might be remedied.

Prof. Bell said, with regard to the question of giving 30*l.* a year, there was no doubt that the Royal Medical and Chirurgical Society made a great mistake in agreeing to pay their rates and taxes without inquiring first whether they were registered as a Friendly Society, and for that mistake they had to pay somewhat heavily, but if it was possible to save them this expense without it costing their own Society anything he thought they might fairly do so, and that it was putting the matter a little strongly to say the Royal Medical and Chirurgical Society wanted in exchange for this sum to give what cost it nothing. As the question of the terms of the lease was raised, they had raised some questions which had on their part also been overlooked, but with regard to the North Room the reply they got was quite a natural one. It was said, "When we gave you your lease that room was not built, and we did not decide to build it until afterwards; it is an exceedingly useful room to us, we get three guineas a night for it, and if you want it in addition to the others you must pay for it." The use of the kitchen was found to be impossible—it was a part of their library, and he believed, for that reason they could not use it themselves. With regard to the door-plate they took it to be impossible for the reason already stated, and if some of the Fellows of the Society would walk upstairs they would probably see why it was that some of the occupants should not have plates put up.

The President having put the motion to the Meeting declared it to be carried.

The following were the terms of the resolution:—That the Bye-laws of the Society be altered as follows, viz.:—By inserting immediately after Bye-law 53, the following Bye-law to be numbered 54:—

> The Society shall not make any dividend, gift, division, or bonus in money unto or between any of its members,

and to renumber all subsequent Bye-laws.

This concluded the business of the special meeting.

The ordinary meeting having been constituted,

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

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

	From
Carpenter, W. B., The Microscope and its Revelations. Seventh edition, pp. xviii. and 1099, 21 pls., text illust. (8vo, London, 1891)	*Dr. W. H. Dallinger.*
Gage, S. H., The Microscope and Histology. Part i., third edition. (8vo, Ithaca, N.Y., U.S.A., 1891)	*The Author.*

Prof. Bell called special attention to a book which he felt sure all would be glad to see, but which at first sight they would probably fail to recognize even if they looked inside it. This was a copy of the seventh edition of 'The Microscope and its Revelations.' They would find on examination that, although Dr. Carpenter's text had been preserved so far as his own special work was concerned, there was much at the beginning of the book which was new, which in fact Dr. Carpenter did not know, for the reason that many of the matters treated of had not been brought to a conclusion at the time the previous editions of the work were published; so that in the present edition it would be found that the first seven chapters were practically new, containing as they did the results of Dr. Dallinger's researches, and also a succinct and perfect account of the work of Prof. Abbe in connection with his theory of microscopical vision. Dr. Dallinger was rather inclined to undervalue his own powers, and had therefore asked Dr. Abbe to write that portion of the book, but—he was going to say fortunately for them—the state of Dr. Abbe's health prevented him from undertaking this task, so that Dr. Dallinger had himself taken it in hand, with a success which had called forth the approval of Dr. Abbe in terms which Dr. Dallinger spoke of as being more than generous. Of course it would be of great value to have Dr. Abbe's views put before them in a lucid manner which all would be able to understand, and on this ground alone Dr. Dallinger had done them a great service; but the book was also improved in many ways besides, and it would be found to contain an enormous number of new pictures in illustration. What, however, struck him more than anything else was the last part of the preface, which read as follows:—

"There certainly never was a time when the Microscope was so generally used as it now is. With many, as already stated, it is simply an instrument employed for elegant and instructive relaxation and amusement. For this there can be nothing but commendation, but it is desirable that even this end should be sought intelligently. The social influence of the Microscope as an instrument employed for recreation and pleasure will be greater in proportion as a knowledge of the general principles on which the instrument is constructed are known, and as the principles of visual interpretation are understood. The interests of these have been especially considered in the following pages, but such an employment of the Microscope, if intelligently pursued, often leads to more or less steady endeavour on the part of amateurs to understand the instrument and use it to a purpose in some special work, however modest. This is the reason of the great increase of Clubs and Societies of various kinds, not only in London and in the provinces, but throughout America; and these are doing most valuable work. Their value consists not merely in the constant accumulation of new details concerning minute vegetable and animal life, and the minute details of larger forms, but in the constant improvement of the quality of the entire Microscope on its optical and mechanical sides. It is largely to amateur microscopy that the desire and *motive* for the great improvements in object-glasses and eye-pieces, for the last twenty years are due. The men who have compared the quality of respective lenses and specific ideas as to how these could become possessed of still higher qualities, have been comparatively rarely those who have employed the Microscope for professional and educational purposes. They have the rather simply *used*—employed in the execution of their professional work—the best with which the practical optician could supply them. It has been by amateur microscopists that the opticians have been incited to the production of new and improved objectives. But it is the men who work in our biological and medical schools that ultimately reap the immense advantage—not only of greatly improved, but in the end greatly cheapened, object-glasses. It is on this account to the advantage of all that the amateur microscopist should have within his reach a handbook dealing with the principles of his instrument and his subject."

The President thought this was a very valuable book, which the "amateurs" would find to be a means of great help in the course of their studies.

Prof. Bell also called attention to another work, entitled 'The Microscope in Histology,' by Prof. S. H. Gage, which had reached its third edition, and was perhaps more satisfactory than most books of its kind.

Mr. C. Lees Curties exhibited and described a small heliostat made on the lines laid down by Mr. Comber. It would be found both simple and effective, and was adapted for use in any latitude between 15° and 70°.

Mr. J. W. Gifford read a short paper "On the Mounting of *Amphipleura pellucida*.

The President expressed the thanks of the Society to the author for his communication.

Mr. E. M. Nelson said it would be remembered that some discussion took place at their last meeting as to the value of drawings made with Dr. Beale's neutral tint reflector, and to test the matter more closely, he had made a drawing of the ten lines on a micrometer scale of 1/100 mm. under an apochromatic objective giving a magnifying power of × 850. It was not possible to draw more than five or six of these lines at one time, but he had indicated the relative position of these by dots upon paper, and found that as measured with an ordinary rule they showed a very slight displacement. He therefore came to the conclusion that the Beale's neutral tint reflector was a very good thing for the purpose of drawing objects, although for accurate measurements it was perhaps not to be recommended.

Mr. Nelson exhibited and made some remarks on a new Microscope by Mr. C. L. Curties. He began by remarking that for many years he had been strongly of opinion that the favourite Continental model, viz. that known as the Hartnack, was a design that was radically bad in many ways. The goal he aimed at was that our laboratories and schools should be furnished with Microscopes built on thoroughly sound scientific design, and of good English workmanship, instead of those built, as we may say, on haphazard design, with which, as every good microscopist knows, critical work is simply impossible.

To this end he had had, at various times, no less than three Microscopes built, each embodying various improvements. The frequent exhibition of the first of these Microscopes, both at this Society and at the Quekett Microscopical Club, bore fruit, and English Hartnacks with rack-work coarse-adjustment became common. Later still this improvement was adopted on the Continent.

The instrument exhibited had quite a novel origin. Some time ago Mr. Curties received an anonymous letter containing suggestions for the improvement of the model. These were adopted and embodied in this instrument. First, it is in all its parts of large size. The base is more extended and its height has been raised. (With regard to the size of a Microscope, Mr. Nelson suggested that it should be estimated by its height when in a horizontal position, a full-sized Microscope being one whose axis, when horizontal, is 10 in. from the table). It has a mechanical stage 5 in. in diameter, with 8/10 in. rectangular movement, and with complete rotation. The substage has rectangular and coarse and fine adjustments. The body extends from $5\frac{1}{2}$–12 in. Spiral rackwork is fitted to the coarse-adjustments of both the body and substage and the draw-tube. Both the fine-adjustments have the Campbell differential screw. The body fine-adjustment is placed in front of the coarse-adjustment, so that it only carries the body. One of the new features is the solid Jackson limb which carries both the body and substage. The lower stage-plate is of great thickness and is firmly secured to brackets on the limb. The instrument is very massive and weighs 17 lbs.

Rigid economy has been studied in the production of this instrument, so that all movements which are not considered essential in a full-sized instrument have been left out, such as rackwork and centering gear to the rotating stage, rotation to the substage, &c. If this were put forward as an ideally perfect instrument there are several points one would criticize, but taking the instrument for the purposes intended, he thought it eminently serviceable, and one with which excellent photo-micrographic work could be done.

Dr. Dallinger said he had examined this instrument, and was so much in accord with what Mr. Nelson had stated that any remarks of his own would only be a repetition of what had been already said. The best means had been here adopted to make a thoroughly good instrument at a comparatively low price.

Mr. Nelson also explained, by means of blackboard drawings, some improvements made in his apparatus for the production of pure monochromatic light for use with the Microscope.

The thanks of the meeting were voted to Mr. Nelson for his communications.

The Secretary read a letter of acknowledgment from M. Édouard Bornet, of Paris, on the receipt of the announcement that he had been elected at the last meeting an Honorary Fellow of the Society.

Mr. A. W. Bennett gave a *résumé* of his paper "On the Freshwater Algæ of South-west Surrey," describing, amongst others, some six or eight new species found during his recent vacation in the neighbourhood of Haslemere and Hindhead, drawings of which were made upon the blackboard in illustration of the subject.

The President expressed the indebtedness of the Society to Mr. Bennett for his very interesting communication, which was just the kind they wanted. The advantage of working steadily on at the same subject was abundantly shown here by the fact that he had succeeded in adding several new species to those already known. His observations on the life-history of these things were also very interesting, especially the little notes on the way in which they carried out their life in its reproductive and sporing processes. They were specially glad to get papers of this kind from Mr. Bennett upon what was in this country a rather neglected subject, and he ventured to express the hope that as further opportunities occurred he would continue his observations.

Prof. Bell said they had also received a paper from Dr. Alfred C. Stokes, descriptive of a number of new species of American Infusoria, which would be taken as read, and would appear in the Journal in due course.

The President reminded the Fellows that the Society's Conversazione would take place on November 30th as already intimated.

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

Mr. C. Lees Curties:—Heliostat for Microscopic work. An improved form of Microscope.

Mr. J. W. Gifford: *Amphipleura pellucida* under Monochromatic Light.

New Fellows:—The following were elected Ordinary Fellows:— Dr. J. Adelphi Gottlieb, Dr. Edward Gray, Dr. J. Leffingwell Hatch, Messrs. William C. Krauss, John A. Miller, Frederick William Mills, Dr. Walter N. Sherman, and Mr. Ernest Edward Wells.

INDEX OF NEW BIOLOGICAL TERMS, OR OLD TERMS WITH NEW MEANINGS, RECORDED IN THIS VOLUME.

a. ZOOLOGY.

β. BOTANY.

INDEX.

A.

B.

F.

H.

I.

J.

K.

M.

O.

P.

Q.

R.

S.

T.

U.

V.

W.

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