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JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A RECORD OF CURRENT RESEARCHES RELATING TO

INVERTEBRATA, CRYPTOGAMIA, MICROSCOPY, &c.

Edited, under the direction of the Publication Committee, by

FRANK CRISP, LL.B., B.A., F.L.S.,

One of the Secretaries of the Society;

WITH THE ASSISTANCE OF

T. JEFFERY PARKER, B.Sc.,
Lecturer on Biology at Bedford College, London,

A. W. BENNETT, M.A., B.Sc.,
Lecturer on Botany at St. Thomas's Hospital,

F. JEFFREY BELL, M.A.,
Professor of Comparative Anatomy in King's College,

AND

S. O. RIDLEY, B.A.,
Of the British Museum,

FELLOWS OF THE SOCIETY.

VOL. III.

PUBLISHED FOR THE SOCIETY BY

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1880.

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nos. 1-3

PREFACE.

The present volume of the Journal has been continued on the same plan as the previous one; but it is intended in future volumes to subdivide "Microscopy" into two parts, "(α) Collecting, Mounting, and Examining Objects," and "(β) Instruments, Accessories, &c."

As the result of endeavours made to ascertain the views of the Fellows, it has been found that a desire exists that the pages occupied by the Bibliography should be devoted to an extension of the abstracts of important biological and microscopical papers, instead of including the titles simply of all such papers. Recognizing that the Editors exist for the Journal, and not the Journal for the Editors, it is intended to give effect to this wish, though not without some personal regret. The aim of the Journal has been, as before explained, to give the Fellows full information as to what has been published in the current periodical literature of all countries; and as it is impossible to do this completely—at any rate at present—by means of abstracts, the Bibliography was intended to supply some of the omissions, so that the Fellows might still feel assured that there was no paper that was not, in some form, brought under their notice.

As great importance must attach to the nearest approach to completeness in this respect, it is proposed to incorporate with the Record of Current Researches, bibliographical notes of papers that it may be impossible to abstract, either for want of space or for other reasons.

Some of the parts of the Journal are now out of print—the number required having been in excess of the expected demand. The Publication Committee would have been glad to avoid commencing a new series at so early a period, but they have come to the conclusion that under the circumstances this will be the better course, so that it may be possible for future Fellows to commence with a complete series rather than with one which must always remain incomplete.

Additional title-pages are supplied with this volume, so that Fellows desirous of binding it in two parts can do so. The Council, after consideration, were of opinion that it will be better to have one volume only for each year, rather than to multiply the number of indexes, which, in previous cases, has been found to add much to the difficulty of finding any given subject.

As with the former volume, every endeavour has been made to render the contents and index as efficient as possible; and it is hoped that no difficulty will be found in readily referring to any note contained in the Record.

In addition to the Publication Committee, the best acknowledgments are due to the Associate Editors, Messrs. Parker,* Bennett, Bell, and Ridley, the more so that they have to look for their reward in the hope that their exertions may be of some benefit to all who are desirous of keeping *au courant* with the contents of the fast increasing periodical literature relating to Biology and Microscopy.

Among other Fellows for whose assistance acknowledgments are due should be mentioned Mr. C. J. Fox and Mr. F. H. Ward; also Mr. John Mayall, jun., whose co-operation in regard to microscopical subjects (properly so called) has been of the greatest value.

FRANK CRISP.

* Mr. T. J. Parker was unfortunately obliged to sever his connection with the Journal on his appointment to a professorship in New Zealand.

THE

Royal Microscopical Society.

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

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

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

Ordinary Fellows are elected on a Certificate of Recommendation signed by three Fellows, stating the names, residence, description, &c., of the Candidate, of whom one of the proposers must have personal knowledge. The Certificate is read at a Monthly Meeting, and the Candidate balloted for at the succeeding Meeting.

The Annual Subscription is £2 2*s*., payable in advance on election, and subsequently on 1st January annually, with an Entrance Fee of £2 2*s*. Future payments of the former may be compounded for at any time for £31 10*s*. Fellows elected at a meeting subsequent to that in June are only called upon for one-half of the year's subscription, and Fellows absent from the United Kingdom for a year, or permanently residing abroad, are exempt from one-half the subscription during absence.

Honorary Fellows (limited to 50), consisting of persons eminent in Microscopical or Biological Science, are elected on the recommendation of three Fellows and the approval of the Council.

Ex-officio Fellows (limited to 100) consist of the Presidents for the time being of such Societies at home and abroad as the Council may recommend and a Monthly Meeting approve. They are entitled to receive the Society's Publications, and to exercise all other privileges of Fellows, except voting, but are not required to pay any Entrance Fee or Annual Subscription.

The Council, by whom the affairs of the Society are managed, is elected annually, and is composed of the President, four Vice-Presidents, Treasurer, two Secretaries, and twelve other Fellows.

The Meetings are held on the second Wednesday in each month, from October to June, in the Society's Library at King's College, Strand, W.C. (commencing at 8 P.M.). Visitors are admitted by the introduction of Fellows.

In each Session two additional evenings ("Scientific Evenings") are devoted to the exhibition of 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, with a Record of Current Researches relating to Invertebrata, Cryptogamia, Microscopy, &c., is published bi-monthly, and is forwarded *gratis* 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 on Mondays, Tuesdays, Thursdays, and Fridays, from 11 A.M. to 4 P.M., and on Wednesdays from 7 to 10 P.M. It is closed during August.

Forms of proposal for Fellowship, and any further information, may be obtained by application to the Secretaries, or Assistant-Secretary, at the Library of the Society, King's College, Strand, W.C.

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VOL. III. No. 1.

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THE JOURNAL for February 1879 (Vol. II., No. 1).

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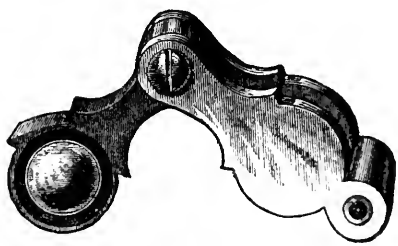

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The Journal comprises:

(1.) The TRANSACTIONS and the PROCEEDINGS of the Society: being the Papers read and Reports of the business transacted, at the Meetings of the Society, including any observations or discussions on the subjects brought forward.

(2.) BIBLIOGRAPHY and RECORD OF CURRENT RESEARCHES relating to the *Invertebrata* and *Cryptogamia*, with the *Embryology* and *Histology* of the higher Animals and Plants, and *Microscopy* (properly so called): being a classified list of the contents, so far as they relate to the above subjects, of more than 300 British and Foreign Journals, Transactions, &c., and abstracts of or extracts from the more important of the articles noted. (See extract from Preface to Vol. II. on next page.)

Authors of Papers printed in the Transactions are entitled to 20 copies of their communications *gratis*. Extra copies can be had at the price of 12*s.* 6*d.* per half-sheet of 8 pages, or less, including cover, for a minimum number of 100 copies, and 6*s.* per 100 plates, if plain. Prepayment by P.O.O. is requested.

All communications as to the Journal should be addressed to the Editor, Royal Microscopical Society, King's College, Strand, W.C.

Printed for the Society by
WILLIAMS AND NORGATE,
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EXTRACT FROM THE PREFACE TO VOL. II.

"In addition to the 'Transactions' and 'Proceedings' of the Society, the 'Bibliography' and 'Record' now form a large part of each number. The former provides a classified Index, in English, to the contents of upwards of three hundred British and Foreign Scientific Journals and Transactions, whilst the latter consists of abstracts of or extracts from the more important of the articles noted in the Bibliography.

The object of this part of the Journal is to meet a wish which has been for many years expressed by the Fellows—not only those resident in the country, to whom the Library is less accessible, but those in London also—that steps should be taken for obviating to some extent the difficulty that has hitherto existed (owing to the great development in modern times of Periodical Scientific Literature) in ascertaining what is being done by Biologists of this and other countries.

Whilst the Annual Records published in this country and abroad (all of which are to be found in the Library) are invaluable as books of reference beyond anything to which a Journal issued bi-monthly could attain, the feeling has been that a more *readable* account of the results of research would be useful, and, if possible, one not so much out of date. As an instance, Mr. Geddes' very interesting researches on Chlorophyll in the Green Planariæ may be referred to. In ordinary course a more or less brief reference to this observation would appear in the Annual Summaries of the second (in a few cases the first) year after its announcement. It is obviously very desirable that the Fellows should, in such a case, be in possession of fuller and earlier information of the author's views.

As the Society's domain includes the *Invertebruta* and the *Cryptogamia* generally, with the *Embryology* and *Histology* of the higher Animals and Plants, and *Microscopy* (properly so called), the Bibliography and Record extend to those subjects also."

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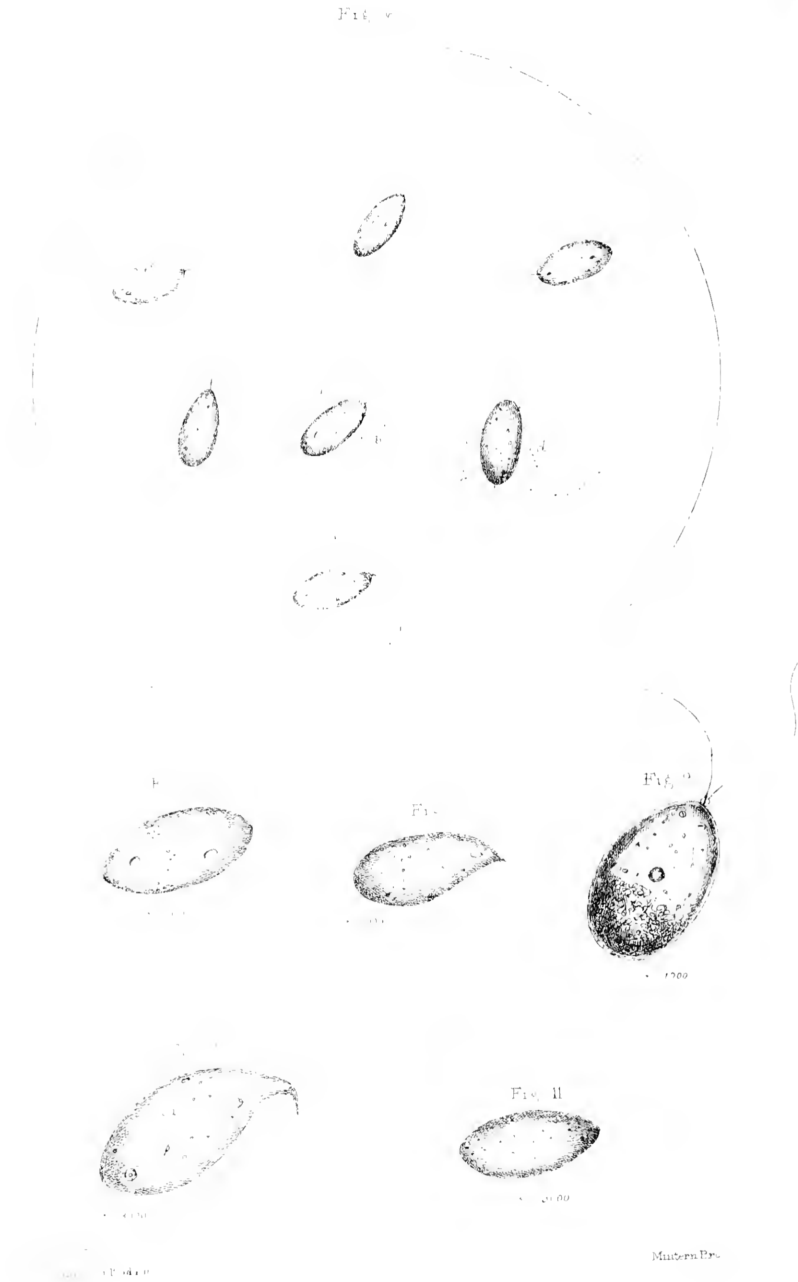

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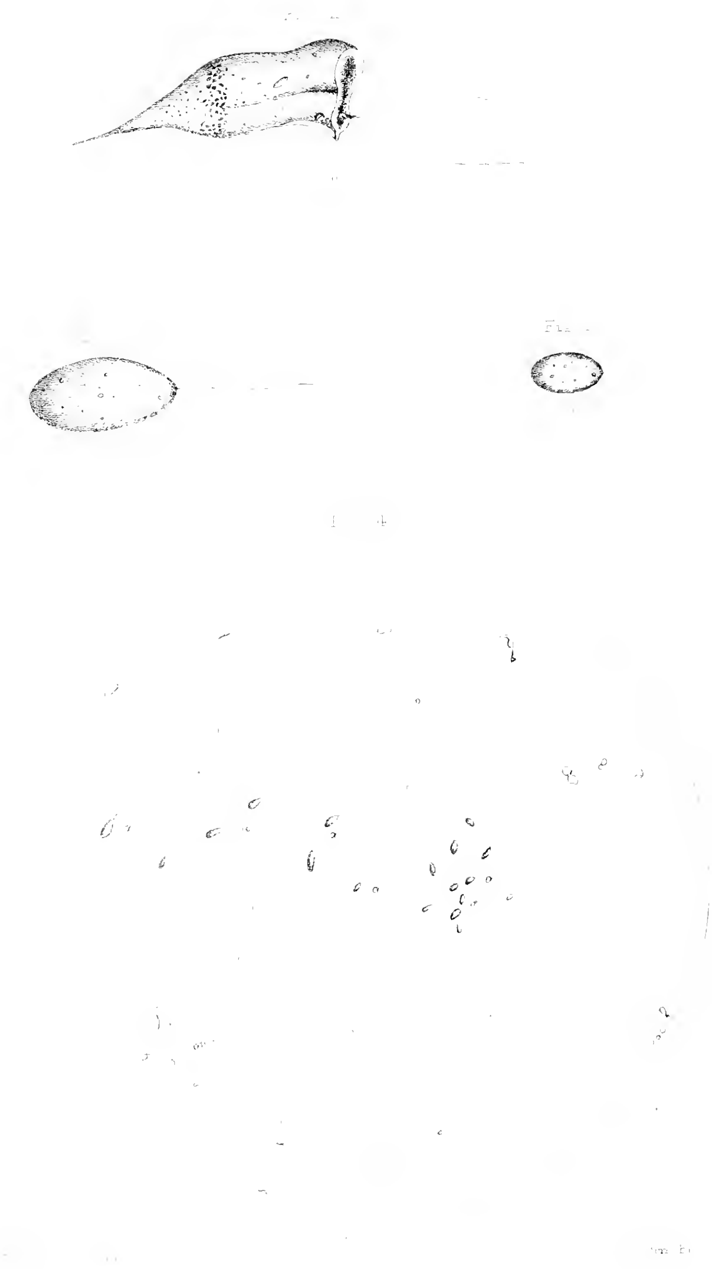
Thermal Death Point of known Monad Germs



Illustrating Mr. Dallinger's paper on the
Thermal Death Point of known Monad Germs

JOURNAL

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ROYAL MICROSCOPICAL SOCIETY.

FEBRUARY, 1880.

TRANSACTIONS OF THE SOCIETY.

I.—*On a Series of Experiments made to determine the Thermal Death-point of known Monad Germs when the Heat is endured in a Fluid.* By the Rev. W. H. DALLINGER, F.R.M.S.

(*Read 10th December*, 1879.)

PLATES I. AND II.

IN a group of papers on "The Life-Histories" of a series of well-marked monad forms, read before this Society between the years 1873 and 1876,* it was shown that in every instance when the organism was steadily followed in its developmental history, its vital continuity as a distinct form was secured by a process which was, without doubt, the practical equivalent of a genetic one.

In the set of observations here referred to six monads—quite distinct in all respects—varying in their longest diameter from the $\frac{1}{4000}$ of an inch to the $\frac{1}{1000}$ of an inch, were carefully followed from their ordinary condition, through a series of well-observed changes, into a condition in which slightly dissimilar states of the same form blended, becoming a still sac. This sac, it was shown, in every case ultimately emitted germs—exquisitely minute semi-opaque atoms—in enormous multitudes. But in one instance these were so minute as, at first, to defy disclosure by our finest and most powerful optical aids, however carefully employed, and the demonstration of the existence of germs in this case was only effected by watching a space over which the apparently glairy fluid that had poured forth from the sac had passed; and then by repeated observation it was seen that what in the issue proved to be germs, did arise, being then of the apparent size of the least of the germs of the other monads whose sac-contents were at once shown to be such. But they were not in the same condition as these, that being always semi-opaque, while these, when they appeared, had a slightly yellowish tint and were transparent, and when persistently

* See 'Monthly Microscopical Journal,' vols. x.-xiii.

followed developed into the parent form. It was thus manifest that in one instance of the six a germ was produced, *too small to be discovered on its emission from the sac* by the most powerful lenses at our disposal.

In every case the demonstrated germs were followed into the adult condition; and it was then apparent that multiplication was carried on to an enormous extent by "fission," which was both simple (into two) and multiple (into some multiple of two). But after a more or less definitely marked lapse of time the living processes were rejuvenated by the equivalent of a genetic process, as above stated.

Now in the interests of an important Biological question, dealing with the mode of origin of the lowest septic organisms, it was of moment to determine whether these demonstrated germs could resist heat better than the adults, and if so in what degree.

The accomplishment of this is by no means an easy task. It is a matter requiring great care, patience, and the education that comes of repeated failure, to follow a given form through its metamorphoses into the condition of a germ-sac, and then to watch until the emission of the germs is demonstrated. But to subject these to varying heat conditions and subsequently study their behaviour, is manifestly a matter requiring the utmost delicacy of treatment. To do it at all, and obtain reliable results, the particular germs emitted under the eye of the investigator should be exposed to the required tests, and then the results of each exposure studied, by an observer who had familiarized himself with the developmental behaviour of the germ, when not subjected to the given heat conditions. In this way alone, so far as I can perceive, could it be determined what heat conditions arrested or finally destroyed the vital action of the germ.

The only manner in which this could be done, so far at least as the capacity of myself and colleague to devise extended, was to demonstrate the spore emission of the several monads on separate slips of glass; and when it had taken place, instantly—while the spore was freshly emitted—to expose it to a slowly increasing temperature *in air* until the desired point was reached. Then to slowly cool it, and remoisten the space under the cover, by capillarity, with every conceivable precaution, and then, under proper conditions for preventing evaporation, to examine the "field" steadily to discover whether development of the germs ensued or not.*

* An admirable method for the introduction of *sterilized* pabulum, which should always be ready at hand, was ultimately employed. It consisted in filling by capillarity the delicate glass "vaccine tubes" in which the lymph is taken by the physician, and kept—with pabulum proved to be suitable for the monads—hermetically sealing the tubes, and then subjecting these with their contents to a germ-destroying temperature in a Papin's digester. They would thus be ready when required; and on breaking the ends of these, and placing one end in con-

This was done very carefully on a large series of glass slips for each of the six forms of monads whose life-history had been worked out. By this means it was shown that the thermal death-point was not a fixed one, but that it varied with the forms. Taking, however, an average or mean of the results presented by the whole six, it was seen that the germs could resist the destructive action of heat better than the adult in the proportion of 11 to 6. In short, they possess nearly double the capacity for resisting heat.*

Now I felt at the time these experiments were being made, and

tact with the edge of the air space between the "cover" and the slip of glass containing the germs that had been exposed to heat, the fluid is withdrawn from the tube to the space between the two glass surfaces where the fluid is needed, because of the greater capillary attraction of the latter. If these fine glass tubes of pabulum be kept in absolute alcohol, and the whole process be manipulated rapidly and firmly, the least conceivable danger of the communication of any form of minute life is secured; but certainly not absolute freedom from the possibility. But in this instance it is not needful that such certainty should exist; only the development of a known set of germs, in a known position, and with a known developmental history, is being studied—and this repeatedly before any conclusion could be arrived at; and therefore although it would be a benefit to exclude a great accession of other forms, it was not absolutely necessary.

* In a paper on "The Conditions favouring Fermentation," &c., read before the Linnean Society, Dr. Bastian refers in a most perplexing way to these experiments. He entirely misunderstands them. He desires to show that the evidence these experiments yield is "contradictory," and to this end attempts to tabulate, in a manner peculiarly unsatisfactory to the discovery of what our facts were intended to show, what he calls "the results." In doing this he distinguishes between spores and sporules, a distinction nowhere made in the papers in question. These words, with others, such as germ, germule, &c., were employed, as they had been by other investigators, synonymously. They all referred to a minute organic product, giving rise by development to a known organic form: this is manifest enough upon the surface, for nowhere is any attempt to distinguish one from the other made; and as the papers were written at intervals, quite distinct from each other, it was natural enough that the same word in meaning, although perhaps not in form, should be used. And this is the fact. It is plain, then, that in seeking to set up an unwarranted distinction between what is in every case the same thing, our critic is introducing error of the most confusing kind. But beyond this, and of yet more importance, is the fact that he tabulates the results, as though the various temperatures to which the sporules, spores, germs, or whatever other name these minute genetic products may be called, were exposed, *were the same for all the forms*, and that therefore the variety of results points to uncertainty. In reality, however, as a careful reading of the papers will show, the variety of results is dependent on the various heat-resisting capacity of the specific forms studied separately. Dr. Bastian has therefore changed the separate details of heat-condition for each monad into one generic "table," headed "Nature of Heat Exposure." Then throwing the details all together, and introducing a distinction between "spores" and "sporules," he gets at results which do not present enough "unity of results" for the "uniformity of conditions" employed. This is not surprising. But it should be observed at the same time, that "unity of result" in a large series of experiments on such delicate vital subjects, under such complex and difficult circumstances, is scarcely to be looked for by those who only claim the use of ordinary powers in the projection and carrying out of experiments. Indeed, under such circumstances, it may be fairly suspected that "unity of result" implies the possibility of unity of error. If the results of investigation had been very much more diverse than they are (and they present no approach to the diversity Dr. Bastian's doubtless unwitting error of interpretation would involve), this would not vitiate them, for the inference is made not from the *negative* but from the *positive* results in every case.

I have felt increasingly ever since, that their defect was that they were made on the germs in what was practically a *dry heat*. No doubt a moist heat was endured for a little while, during the process of the evaporation of the fluid in which they were contained; but the critical temperature was endured without question in a dry condition. It is well known that organic forms can endure this much more successfully than heat endured when they are immersed in a fluid. This has been well illustrated in the case of vegetable seeds. Moreover, the death-point of the adult monad has been very accurately determined, but the determination of this has been effected by means of fluid heat. So that it is plain enough that the same conditions had not been observed in reference to the germ. This, however, was never contended: it was merely affirmed that by the process employed it was sufficiently plain that the germ had a heat-resisting capacity far in excess of the mature organism.

It is none the less manifest that it would be important if possible to extend the researches to a discovery of the actual effect upon these germs of heat endured in fluid. But the difficulties to be encountered must be clearly understood. What we want to decide is whether the germ of a given monad, which has actually been seen to be poured out in normal conditions, can germinate after a certain exposure to heat, when the germ is immersed in a fluid; and if so, what is the limit of temperature.

Now Dr. Bastian thinks this a matter quite easy of accomplishment!* I have elsewhere expressed my surprise at his view of this matter; † for certainly it indicates the omission of an important factor in reaching an accurate conclusion. It is, of course, well known that the germs of these and similar organisms are emitted from the sac into a fluid which favours, perhaps excites, immediate germination. But it is a fact of the greatest importance to the student of these organisms, that when these extremely minute organic atoms are *first emitted* from the sac, they are in the majority of cases relatively quite opaque; but in the course of from thirty to sixty minutes, all opacity is gone, and the minute growing particle becomes distinctly oval and transparent, having a very slight yellowish or yellowish-brown colour, but transmitting the light more readily than the fluid in which it is contained. But as this change is absolutely correlated with increase of size, and sometimes of form, it becomes plain that it is a direct result of *germination*. Now to all who take into account everything that must be considered to form an accurate judgment on this question, it must be palpable that the power of a given organism

* "Conditions favouring Fermentation," &c., 'Journ. Linn. Soc. (Zool.),' xiv. p. 78.

† "On the Life-history of a Minute Septic Organism," 'Proc. Roy. Soc.,' xxvii. (1878) p. 332.

to resist the action of heat must be dependent upon the *condition in which it may be* when submitting to that test. It is known that growing or developing organisms in different stages are differently affected by surrounding conditions. Thus a *germinating* seed has less capacity to resist heat than one in which such activity has not been set up. Hence it is, that from a long-continued series of experiments I am convinced that it must be on the spores in their *freshly emitted state* that our experiments must be made if we would arrive at *positive results.*

Dr. Bastian says "It would have been *perfectly easy* to have put one or two drops of the fluid into a small tube, to have hermetically sealed it, and then to have heated it for ten minutes or more to different degrees before subjecting the fluid to a prolonged microscopical examination upon a carefully prepared slide." *

It is plain that however "easy" this method might have been, it would have been to all intents and purposes useless. There could have been no certainty that the spores, in the only condition serviceable for experiment—that is in the freshly emitted state—would be in the "one or two drops." They might have been; and spores in various stages of development in all probability would have been; but of these latter we make no affirmation; and without certainty as to the former, experiment is worse than waste of time. Partly developed germs almost certainly succumb at a temperature nearly as low as the adult—but if the germ, before germination begins, can resist *any* higher temperature, it is plain that we must know that they are *there, in the condition required,* before the heating is begun. And when we remember that in a given field of view under the Microscope, where monads are kept alive in the moist chamber stage,† that fission may be the only phenomenon discoverable in a given form for four or six days, and that in all cases the sporing condition is relatively rare, it is plain that any attempt at deduction from so happy and "easy" a method as Dr. Bastian's "one or two drops" heated in a sealed tube could have led to no result having the remotest scientific value.

What is required then is some arrangement which will enable us to be assured, that germs seen to be emitted from a given sac are at once submitted to heat in fluid, and then that the fluid shall be capable of examination for an indefinite period with competent optical powers.

The piece of glass apparatus which I am about to describe, meets these necessities. It would not, however, be competent by itself; it is as a supplement to the method of inquiry by dry heat, that it specially serves. By that method we can follow the germ after heating from its first germinal activity to its adult condition.

* "Conditions favouring Fermentation," loc. cit., p. 78 (note).

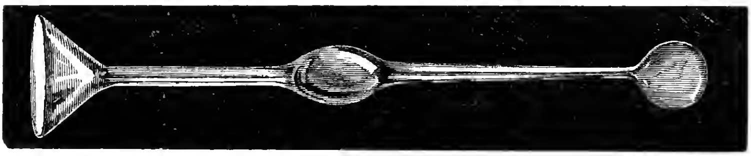
† Vide 'Mon. Micr. Journ.,' xi. p. 97, &c.

By this we can see it (if a destructive heat should not have been used) in various recognizable stages of development, and follow them to the final stage, and determine relatively the thermal death-point as compared with that in air.

The instrument was devised and first used by me in recently working out all the points of the "Life-history of a Minute Septic Organism."* But I have also applied it gradually to the determination of the point of heat destructive to the germs of each of the six monads whose life-histories have been detailed in the Transactions of this Society, and the results, which appear to me to be of considerable importance, I shall proceed briefly to state.

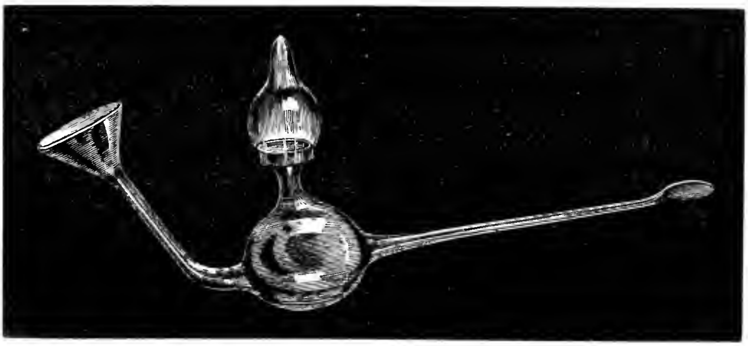
It is necessary, however, that the nature of the apparatus used should be understood. It is formed throughout of blown glass, and is, in brief, a small vessel capable of receiving the putrescent fluid containing a given organism, as a reservoir communicating with a cell into which the fluid will flow, and in which the behaviour of the organism in any stage can be microscopically

Fig. 1.



studied; and the whole is so arranged that it can be heated and closed hermetically and examined for an indefinite time.

Fig. 2.

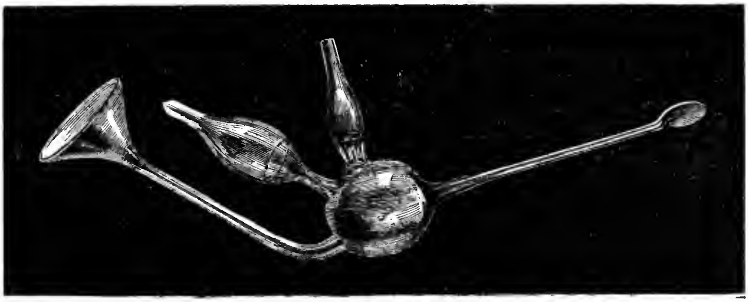


Drawings made directly from the instruments are given in Figs. 1, 2, and 3. But it is only by means of a diagram that they can be fully understood. Fig. 4 is a diagram of Fig. 2. A is

* 'Proc. Roy. Soc.,' xxvii. (1878) p. 332.

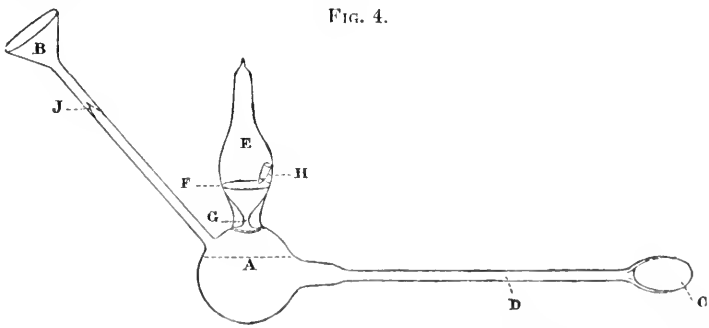
a hollow bulb intended as a reservoir for the infusion containing any organism we may desire to study. The infusion is put in through the funnel and tube B. The bulb A opens into a tube D on the opposite side, and this tube terminates in a delicate closed and flattened cell C. In a microscopical point of view this cell is the most important part of the apparatus. It is a flattened bulb, and its upper and under walls are films of glass,

Fig. 3.



varying in different pieces of the apparatus from the $\frac{1}{30}$ to the $\frac{1}{200}$ of an inch in thickness; and the space between these walls may vary from the $\frac{1}{20}$ to the $\frac{1}{100}$ of an inch in depth. We thus have a perfect cell, completely closed, the contents of which can readily be studied with the aid of the most powerful lenses. The walls of the cell are of course not as absolutely even and smooth

Fig. 4.



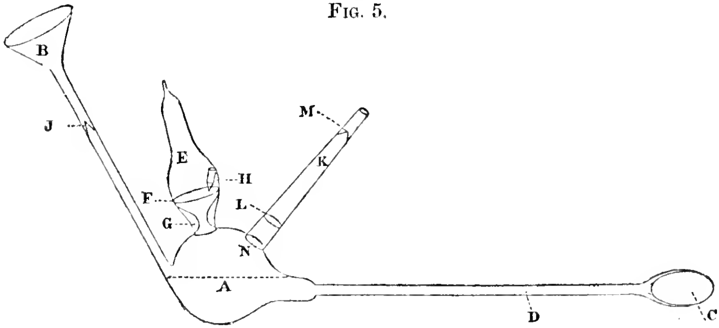
as the thin "covering glass" usually employed with high-power lenses; but it is in the majority of cases beautifully level and clear, when the manner of its production is remembered. Of course, I should never have employed these cells for the purpose of discovering delicate and unknown details; but they answer admirably for determining the presence or absence of phenomena, the nature of which is well known beforehand.

It is manifest then, that if a fluid be put in the bulb and stand at the level of the dotted line A, it will fill and be in communication with the cell C.

E is a hollow bulb filled with calcined air, and hermetically sealed; but it does not communicate with the bulb A on account of the presence of a thin glass partition or septum F. The object of this is, that when, by boiling, the air has been driven out of the bulb A, and the whole interior space has been hermetically sealed at J, air may be again introduced, which is accomplished thus: H is a pointed piece of platinum wire, heavy enough by a sharp shake to break the septum F, but too large in diameter to pass through the neck G, but of course the calcined air immediately enters and restores to the fluid its normal conditions.

Fig. 5 is precisely the same as the above, the same letters referring to the same parts in both; but it has an addition to it

Fig. 5.



marked M N. This is a tube opening at N into the bulb A, but until needed the communication of the tube with the interior of the bulb is prevented by the thin partition L. The object of this is, that supposing a given infusion to have become sterilized in relation to a certain organism, by any ascertained temperature, to determine whether nevertheless the fluid is still capable of sustaining the organism if it be reintroduced. To do this, a piece of platinum wire, as before, is taken and touched with a fluid in which the living organism abounds; it is then placed in the tube K. The tube is then sealed at M; the piece of platinum is shaken sharply, breaks the septum L, and falls into the fluid, inoculating it.

The first matter to be determined, and this with accuracy, is the death-point, by heat endured in a fluid, of the adult organism. This was tested in succession for the whole six organisms, but to make the method of doing this quite plain, it will be enough to give the manipulative details in one case, and state the results in the others. I select for this purpose the monad which I call for working purposes the Uniflagellate, the life-history of which is given in vol. xi. of the 'Monthly Microscopical Journal,' pp. 69–72. A piece of apparatus similar to Fig. 2 (and in diagram, Fig. 4) was used. When the fluid containing the organism was properly inserted,* and time given for all to be at rest, a large number of the organisms were seen by the lens in the cell C (Fig. 4). The whole apparatus was now suspended in an oblong copper vessel with cold water which covered the bulb A, and a thermometer was placed in the water at each end of the vessel. This vessel of water was now heated by means of a Bunsen burner, the gas jets of which ran along a tube the shape of the vessel, and crossed by another set of jets in the middle of the parallelogram. The heat was applied slowly, causing a very gradual increase of temperature. When this had risen to 95° Fahr. the bulb was taken out and at once placed in a prepared "cradle" on the stage of the Microscope. A power of 400 diameters presented a field with seven of the forms. It was in a state palpably distinguishable from that which would be seen in a drop of the normal fluid. Four of the forms were moving, but quite sluggishly. Two were wriggling their bodies but effecting no movement of translation, as seen in Fig. 6, Plate I., where the dotted lines *a*, *b* and *c*, *d* show the positions taken successively by the body of the monad; but it neither advanced nor receded; while one form was quite still save for the lashing of the flagellum laterally as indicated in the same figure by the dotted lines *e*, *f*, being the position into which the central flagellum waved itself without intermission. But in seven minutes the former two had entirely freed themselves and sailed away; and the latter one, *e*, *f*, had commenced a lateral movement of its body and in ten minutes more was quite at liberty and swam freely. Repeating this process, the next point of heat tested was 110° Fahr. When the cell was examined there were nine monads in the field, seven of which were slowly moving their flagella, and the other two were merely jerking them at irregular intervals; but otherwise the whole was still. There was nowhere any movement of translation amongst them. But in the course of thirty-five minutes they had every one passed through stages of increasing vigour, and all but one had started off. The last moved sluggishly away in fifteen minutes more.

I next heated the fluid in a similar cell up to 130° Fahr. Here, on immediate examination, the effect was much more marked, for over all the field there was total inaction, and this was the case in the entire cell. But fixing on a field with several still forms in it, I noticed in two of the organisms a slight movement of the

* This requires a little skill in manipulation: the difficulty is to exclude the air and insert the fluid. But this may be done by using a piece of fine platinum wire, with a little of the fluid, as a piston; drawing it backwards and forwards, the air comes out in bubbles, and the fluid takes its place.

flagellum at the end of seventeen minutes: this increased in vigour and rapidity, and was repeated by the remainder, until at the end of a hundred minutes all were either swimming freely or vigorously swaying their bodies.

Temperatures of 135°, 138°, 140° and 142° Fahr. were then successively tried in the same way. At 135° Fahr. five out of six forms regained complete vigour from a state of total inaction in two hours. At 138° Fahr. only two in eleven regained the power of movement, and that but sluggishly, after six hours of watching. One of the remainder had slight indications in the flagellum and the body, but this ceased. At 140° Fahr. the field was absolutely still for eighty minutes. A slight movement in the flagella of two of the forms fixed upon was then seen; but at the expiration of eight hours there was no movement of any kind and the organisms were in the position in which they were first seen. After a heating to 142° Fahr. all was inaction from the first examination to the end of the twelfth hour. That is to say, so far as the original set of organisms were concerned there was no trace of vitality from first to last.

It was thus plain that a temperature of from 140° to 142° Fahr. is absolutely destructive of the adult organism.

Pursuing this mode of inquiry in relation to the whole of the six monads as opportunity permitted, the following results were reached, viz.:—

1. Three of the organisms shown in Figs. 7, 8, and 9, Plate I., and whose life-histories are given respectively in the 'Monthly Microscopical Journal,' vol. x. pp. 53–58, vol. xi. pp. 7–10, and vol. xii. pp. 261–270, were killed in the adult state at a temperature of 140° Fahr.

2. Two of the organisms portrayed in Figs. 10 and 11, Plate I. (whose histories are detailed respectively in vol. x. pp. 245–249, and vol. xi. pp. 69–72 ibid.), were killed in the adult condition between 140° and 142° Fahr.; and

3. One, the last, and largest, of these six monads, seen at Fig. 12, Plate II. (an account of which is given in vol. xiii. pp. 185–197 ibid.), was wholly destroyed in its adult condition at 138° Fahr.

Now, between these points of temperature, viz. 138° and 142° Fahr., there is little doubt but the majority of the septic organisms are killed when in the mature stage. It is certainly true of these forms, which are in many senses typical.

Having ascertained this, we are prepared to study the effect of higher temperatures upon the spores.

It has been already shown that it is needful first to be quite sure that the spores, in the condition required, are actually in the fluid exposed to the testing temperature. Now we can only see the spore-emission from the sac by steadily following a given form through some of the familiar preceding stages into the condition of the still sac from which the spore is emitted, and seeing the emission take place. This must be effected in the moist chamber stage devised, as will be remembered, for constant observation, without the evaporation of the fluid containing the organisms. But under ordinary circumstances it would be impossible, when the contents of a sac had been seen to be emitted, to transfer them from this stage to the piece of apparatus for heat testing. To do this, however, a piece of very thin cover-glass was made to rest upon the floor of the stage, and take its place, having the drop of fluid to be examined placed upon it, and covered as usual. But both of these delicate pieces of glass had been marked in convenient places with the diamond, to facilitate subsequent fracture into small pieces. In this way, then, with the stage worked in the usual way, the fluid was hunted and watched, and fresh drops taken if needful, until a cyst of the form under examination was found, and then watched, until it opened and deposited its spores. The circles of thin glass on which this happened were immediately taken off the stage, and broken in the funnel B, Fig. 4, the cell of which had been previously properly prepared. A quantity of the septic fluid containing the organism was now poured down the tube over the glass, washing the whole as it passed and carrying a large number of the delicate broken fragments with it. In this way the larger quantity of the freshly emitted spore was carried into the reservoir A. I select as illustrative of the method of study the same organism as illustrated our method in finding the death-point of the adult. It is shown at Fig. 11.

The whole apparatus containing the fluid (Figs. 2 and 4) was suspended in an oblong copper vessel, and covered with small fragments of solid white paraffin, the temperature of which was, after melting, indicated by thermometers, and this allowed of a slow raising of the fluid to the boiling-point, as indicated by gentle ebullition in the bulb A. This was continued for five minutes. The tube J, Fig. 4, was then hermetically closed before the ebullition had ceased, and the whole was removed from the paraffin, and the cell carefully wiped whilst hot. The piece of platinum H was now shaken sharply upon the septum F, and the calcined air contained in E was admitted into the bulb A, the platinum remaining on the top of the passage G, which is too small to admit of its entrance into A.

In this way it will be seen that the normal conditions of the fluid were as far as possible restored.

I at once proceeded to microscopical examination, employing an immersion lens giving 1200 diameters. Nothing could at first be seen but powerful Brownian movement of the smaller particles diffused over the cell, not more than half-a-dozen little particles that could be distinguished as having possibly been monads, could be seen. And it continued thus, in the first experiment, for a little over five hours. At the end of this time there was a quick passage across the edge of the field, which, on being further searched for, and followed, was seen to be one of the monads in question, only it had attained to but half its development. Fig. 13 (Plate II.) is a drawing of it magnified to the same extent as the one in Fig. 11, and placed for comparison at 13*a*, magnified to the same extent as 13; and this was followed for two hours, when it had attained the full size and entered upon fission. Meantime the cell had become inhabited by many other partially and fully developed forms of the same organism.

This was repeated, and with very similar results.

It is thus plain that a temperature of 212° was not destructive of this germ.

For the employment of higher temperatures a digester was, of course, needful. For this purpose simple tubes terminating in a cell, such as are seen in Fig. 1, were used; the bulb or reservoir and appendage for air being dispensed with. So that, in fact, in this condition we have nothing but the tube with a slight enlargement at one point, terminating in a funnel, for receiving the spores and septic fluid at one end, and in a delicate cell for microscopic work at the other.

As before, the spores were found and at once placed in the tube, the cell of which had been previously filled to prevent delay when the spores on the broken glass were ready to be put in.

When experiments were made upon the spores of the six monads *in a dry heat*, it was found that the utmost temperatures the spores could resist, without devitalization, ranged, in the various forms, from 250° Fahr. to 300° Fahr. The one we are now considering could, by means of its spores, just survive a temperature of 300° Fahr. This was repeatedly witnessed by myself and colleague, and has been confirmed by two carefully arranged subsequent tests, conducted on the same principle. After enduring this temperature for from five to ten minutes, the spores properly remoistened developed, in some instances, as before. Beyond this temperature they were destroyed.

I determined, therefore, to begin with this in the case of heat endured in fluid.

In one of the tubes the actual spore was inserted, and the tube hermetically sealed. As control experiments, five other tubes were filled with the fluid containing the organism, but in which there was no *à priori* certainty that the spore would be. These were also hermetically sealed.

The whole six tubes were placed in a small digester and heated up to 300° Fahr., kept at that heat for ten minutes, and then allowed slowly to cool.

When cool, the specially prepared cell was at once carefully examined with an immersion lens giving 2000 diameters. Nothing could be seen but violent Brownian movement. The same was true in every respect of the other five cells, which were continuously examined by rotation. The five control cells were kept under examination for eight days, and the cell in which the spores had been inserted for fourteen days, but no trace of the monad appeared, and, in fact, they are sterile to this day.

The fluid in these cells was manifestly devitalized, or rather the action of the heat upon the spores had been destructive. I next repeated the whole experiment as before, but at a temperature of 275° Fahr. The results were precisely similar, there was no subsequent appearance of the living monad in any stage.

The next experiment was made at 265° Fahr., one cell being germ-inoculated, and five not so, as before.

On examination everything was as in the former instances, and continued so for two hours and a half. The cells had been examined in rotation as before, special attention being given to the real experimental cell. At the end of this time I became convinced that I could see on the floor of one part of the cell, what I had not been able to see in earlier examinations; and I had a strong suspicion of the same phenomenon in one other of the cells. I of course confined myself to the one specially prepared; and in the course of an hour there was no doubt whatever that the monad whose spore had been inserted, was in the cell in a developing condition. In Fig. 14 (Plate II.) I give a drawing with *camera lucida* of the field forty-five minutes after my detection of the new feature. It will be seen by comparison of the groups *a*, *a* with the illustrations given of the developmental history of this form,* that these are stages in that development, and they were, in this instance, steadily followed into the adult stage, and into the remarkable condition of multiple fission characteristic of this monad.

By a series of further experiments, with temperatures ranging between 265° and 270° Fahr., the conclusion was reached, that this organism, so far as our experience had gone the most successful in heat-resistance of all the monads, had its spore destroyed at a temperature of from 267° to 268° Fahr. when the heat was sustained in its normal fluid.

Each of the other five forms was subjected by means of its spores to precisely the same test; and with the following results, viz.:—

One (the "Calycine" portrayed in Fig. 12) had its spore devitalized *in fluid at the normal boiling-point of water*, 212° Fahr. In a dry heat it could endure 250° Fahr.

* 'Mon. Micr. Journ.,' xi. p. 69, &c.

Another ("Biflagellate," vide Fig. 9) also resisted by its germs 250° Fahr. in dry heat, but could only survive 232° Fahr. in the fluid heat.

One of the forms ("Cerco-monad," vide Fig. 7) which could survive 260° Fahr. dry heat, was destroyed at 238° Fahr. in fluid heat.

There were two that could just survive 300° Fahr. in the dry heat, viz. the one ("Uniflagellate," Fig. 11) concerning which the details of these experiments have been given; and the "Springing Monad" (Fig. 10). These were destroyed in fluid at 268° Fahr. and 252° Fahr. respectively.

One other remains (the "Hooked Monad," Fig. 8). In this form, however, the emitted contents of the sac were in an active condition—moving freely, in fact. These survived exposure to a temperature of 180° Fahr. in air, but were wholly destroyed at 150° Fahr. in fluid.

To these may be added the results of investigations made by me on a new form and published last year in the 'Proceedings' of the Royal Society.* In air its limit of temperature for the spores was 250° Fahr. In fluid heat they were wholly devitalized between 220° Fahr. and 222° Fahr.

Averaging these results, then, and taking the mean death-point by heat for the *mature* form as 140° Fahr., we find the mean heat-resisting power of the seven monads, by means of their spores, to be greater than the resistance possessed by the adult, in dry heat, as 1 to 1·82 or nearly as 5 to 9; in heat endured as a fluid, as 1 to 1·6 or 5 to 8; while the average difference of the destructiveness of heat in air and heat in fluid is as 0·87 to 1 or nearly 9 to 10.

On these facts it may be remarked:—

1. That the six (out of these seven) monads, that produced spores proper, whose spores, speaking generally, were the smallest, were the best able to survive the heat conditions imposed. Indeed the one that poured out spores invisible until growth had made them large enough to be seen, not only reached the highest temperature, but resisted it more efficiently than the other which just survived this temperature, but whose spores, though seen with great difficulty, were yet much more easily seen.

It is noticeable that the spores of both these were ejected from the sac in what appeared like a glairy fluid.

But the monad (Fig. 12) whose spore was just devitalized at the boiling-point of water, was the largest of the group, and produced the largest spores—easily discoverable with 1800 diameters—and they were *not* interfused with a glairy fluid, but ejected as simple masses of spores, which rolled over the field.

* No. 187.

2. In determining the point of devitalization of this largest monad the extremest precaution was used. So low a death-point (relatively) at first suggested possible error. But four experiments with careful controls gave precisely the same result. At two degrees below the boiling-point there was a feeble survival (as to numbers) but it was not to be mistaken. The boiling-point endured for ten minutes was totally destructive of the spores of this form. And after a week of its total absence in one case, ten days in another, and fourteen days in a third, the additional test provided at K, Fig. 5, was employed. That is to say it was used to make it plain that nothing had occurred to the pabulum which made it unfit to sustain this special organism. A piece of platinum was touched at its point with a little of the fluid containing the organism in abundance. This was inserted in the tube K resting on the thin septum L. The tube was then closed at M and the platinum shaken upon the septum, breaking it, and so admitting the charged platinum into A, inoculating it. The result was the appearance of this special organism in the cell in full vigour, in every case, in the course of from two to five hours.

3. The bearing of these results on the deeper questions of Biology is plain; at least they show on the most superficial glance, the error of assuming the Abiogenetic origin of septic organisms that may have arisen in closed vessels, *because* they were heated to a sufficient temperature to destroy the adult, or to any temperature less than that *known* to be destructive of the germ. They show equally the need of enlarged and earnest work in this somewhat difficult, but most fruitful field of labour. The question of the *present* origin of living things, or living matter in any form, will be most surely narrowed by degrees and settled, so far at least as our present optical aids can carry us, here. The question of "Spontaneous Generation" *versus* Abiogenesis, is, in its final form, a question for the Biologist, or rather for Biology. It can avail little in the quest for truth, in this matter, to assume the issue, and work up to it: nothing is easier than this in such an inquiry. With modern students of Biology, I suspect that, at the beginning, the bias of the mind was towards the present or continued transition of the not-living into the living, without the intervention of living things. This on a superficial view at least, seemed to be required by the doctrine of Evolution, and at least represented my own view in approaching the question. But the *facts* were eloquent; besides which a closer study of the great doctrine of development shows that it by no means involves, but the rather disallows, the existence of continued transformation of the not-living into the living unless passed through, so to speak, the alembic of life. To suppose any hesitancy on the part of any truly scientific mind in receiving the evidences of abiogenesis if they could be satisfactorily

shown, is too ridiculous for refutation. It would be more than weakness, however, to receive as evidence what is not such. Let *truth* come from whence it may, and point never so grimly to where it may, he would be recreant to science who would for one moment hesitate to receive it. But not less false is it to the foundation principles of true science, to accept as true, what must constitute the roots of vast generalizations, except on evidence which no future scrutiny or analysis can shake.

II.—*On a Part of the Life-cycle of Clathrocystis æruginosa (Kutzing's Species).* By Professor P. Martin Duncan, M.B. (Lond.), F.R.S., F.R.M.S., &c.

(*Read 10th December*, 1879.)

Vast quantities of this beautifully green Palmellaceous fresh-water alga have lately obstructed the sand-filtering beds, attached to one of the great reservoirs of drinking water, in the neighbourhood of Leicester. Owing to the kindness of Mr. Alderman Paget of that town, I have had the opportunity of studying some points in the history of the form, which is evidently that microscopic gelatinous body with green gonidia, which from its rarity excited the attention of Henfrey in 1856, and was described by him in 'Trans. Micr. Soc. Lond.,' vol. iv. p. 53.

The whole of the literature of the form and its synonyms were detailed in that essay, and therefore it is not necessary to refer to them, but simply to recapitulate the characteristics and that part of the natural history which was then known. Henfrey gives the following generic diagnosis of "Clathrocystis:—Frond, a microscopic gelatinous body, at first solid, then saccate, ultimately clathrate (fragments of the broken fronds occurring in irregularly lobed forms), composed of a colourless matrix, in which are embedded innumerable minute gonidia, which multiply by division within the frond as it increases in size. No zoospores or resting spores observed.

"*Clathrocystis æruginosa.*—Fronds floating in vast strata upon fresh-water pools, forming a bright green scum, presenting to the naked eye a finely granular appearance: when dried appearing like a crust of verdigris. Gonidia of green cells, with a distinct membrane, $\frac{1}{8000}$ inch in diameter, leaving a hyaline border at the surface of the fronds. Full-grown fronds $\frac{1}{50}$ to $\frac{1}{15}$ inch in diameter. On fresh-water lakes."

Henfrey remarks that "this remarkable form does not appear to have been observed hitherto in Britain. We found it in the autumn of 1855, forming a scum, extending over a large portion of the surface of the lake in the Royal Botanic Gardens at Kew. A portion of it, brought home and preserved in a room in a basin of water, continued to grow healthily until the middle of winter." The same observer states that as the growth by division of gonidia into two or four, occurs principally at the periphery, the frond becomes hollow: then the outside gives way, and as growth proceeds, orifices and a clumsy lattice-work appearance occur. He describes the ragged lobes being broken into irregular fragments, and that each recommences the expanding growth, and in time becomes a latticed frond. He moreover notices that the gelatinous frond always presents a transparent border or peripheral stratum without gonidia, and that there is no limiting membrane. In the winter, Henfrey saw the gelatinous masses becoming brown, swelling up, and sinking in flocculent clouds. "They appear," he states, "to become half dissolved, and to allow the green cells to become free." "Perhaps these reproduce the fronds in the next season. No zoospores were ever detected."

In the sixth volume of the 'Quarterly Journal of Microscopical Science,' Mr. Fred. Currey, F.R.S., Sec. Linnean Society, notices *Clathrocystis æruginosa*, and the presence of secondary cells in large ones (in gonidia). He observed the presence of numerous Spirilla on most of the fronds, but he does not distinguish or delineate the hyaline external layer (page 215).

During a prolonged examination of specimens which were not exposed to unusual heat or pressure, I had, for some hours, the opportunity of watching them actively increasing, but not after the fashion described by Henfrey.

The fronds were about $\frac{1}{25}$ inch in diameter, showed the delicate investing hyaline coat; and the gonidia, tolerably numerous, were distinctly distant from one another, those of the periphery projecting slightly beyond the symmetrical curves of the outside, but being, of course, covered by the hyaline substance. Reflected light gave the usual intense green colour, which was, of course, lost to transmitted light.

This, under the use of a Zeiss's $\frac{1}{8}$-inch focus object-glass, exposed several interesting structures. The hyaline, perfect in some instances, had extremely delicate dark lines placed radially in others, and its extent was considerable. The absence of any hollow within the fronds was evident, and their matrix was glairy and homogeneous. The gonidia, elliptical in outline, had always one small but very refractive spot, and if two were present, a delicate line separated them. Very few of the fronds presented ragged edges, or were deformed.

Minute after minute, whilst using a power of 40 diameters, the constriction of several fronds in their midst was observed, and then, very suddenly, they separated into two portions; each part immediately assuming a globular form. More than one fission was not observed in any frond.

One of the most marked characteristics of the assemblage of fronds is that the hyaline coat keeps them separate. They cannot approach closely. Hence, when the fissiparous division occurred, there was a general pushing about, for the separation was active and not passive, and each half retained an irregularly disposed hyaline which soon became equally distributed.

On using a higher magnifying power, this relation of the hyaline investment could be well seen. After a while this fissiparity ceased, and before it had done so, a most remarkable movement began amongst the gonidia. They shot out at regular intervals, one after the other, on all sides of the frond, about one moving every five seconds. Each passed through the hyaline, being ejected with force, and carrying a definite amount of homogeneous substance with it. The escape was on all sides, and regular as to time and place; hence, after a while, the frond was surrounded by concentric rings of gonidia, each one being distinct, and separated from its neighbours by its hyaline.

The escape became slower and slower, and ceased, the fronds having lost about one-third of their gonidia, and their homogeneous substance having become thinner. The hyaline was not ragged, but the dark lines were more distinct in it. One fact was evident, that the hyaline surrounding the mass of escaped gonidia occupied a space larger than the whole frond.

No independent motion was noticed in the gonidia after their ejection, but they were jostled here and there by new outcomers; they always reta ined their coat of hyaline, and never came in absolute contact. Subsequent watching under high powers indicated that division of the gonidia occurred longitudinally, and in some rare instances a tetrad condition was observed.

The division of the gonidia was accompanied by a growth of hyaline and homogeneous substance, so that they soon separated and formed small globular aggregates, miniatures of the parent frond.

III.—*Some Remarks on the Apertometer.*

By Professor E. Abbe, Hon. F.R.M.S.*

(*Read* 14*th January*, 1880.)

Several papers have recently been published by Professor Hamilton L. Smith, Dr. Woodward, Mr. Wenham, and Mr. R. Hitchcock,† relating to the measurement of apertures, which touch from different points of view the use and performance of the apertometer. In order to remove certain difficulties which have been met with in the application of my method, and some objections which have been made to it, I beg to give here some further explanations as to the arrangement of the apparatus and the principles on which it is based. From the discussions, I infer that some essential points in my method of measurement have not received due attention, owing perhaps to the very brief—though exhaustive—explanation in Mr. Zeiss' description of the instrument.‡

In measuring the apertures of an objective by observing the limits of its telescopic field of vision, "the real area of field in the microscopic action of the lens, or the central part of this area, must be made to act as the area of aperture in telescopic vision." Or, the same condition expressed in another way: the diaphragm, through which in this telescopic observation the image-forming pencils have access to the eye of the observer, must be in such a position as to be conjugate to the same focus in front of the objective, from which the rays start in microscopic observation.

With the view of rendering clear the meaning of this condition as well as its necessity, I may refer to a general proposition which, though derived from the A B C of optics, applies to many important questions in the theory of optical instruments.

Let L be any system of lenses which takes in and transmits rays from different objects, and O and O′ two limited areas in planes perpendicular to the axis, which in position and figure are in the relation of an object to its image in respect to L, i. e. which are situated at conjugate points of the axis and are conjugate one to another as to their linear extension, then all the rays entering the system L through the area O will leave the system through the area O′; and no single ray can emerge from L through the area O′ which has not entered L through the area O, from whatever objects the rays considered may start, or towards whatever points they may proceed. (It is the same thing, whether O is considered to be the object and O′ the image or *vice versâ*.)

* The original paper is written by Professor Abbe in English.
† 'Am. Quart. Micr. Journ.,' i. (1879) pp. 194, 272, 280, 284.
‡ This Journal, i. (1878) p. 19.

This proposition is directly derived from the elementary notion of conjugate points in optics: that all rays diverging in different directions from one point are gathered in, or pass through, the other conjugate point after their passage through the system, setting aside spherical aberration.

Now let O′ be the clear opening of a diaphragm in any position *at the back* of an objective L, and O the real or virtual image of this opening as it is projected by the system to the other side. By virtue of the proposition above, this diaphragm will exclude from the passage through the system all rays which have not entered through the area of its conjugate image in front, and will admit all rays which have entered through this area. Therefore *any diaphragm at the back of an object-glass acts in every respect exactly like a similar diaphragm at the conjugate focus in front,* the clear diameter of which is to the clear diameter of the former one in the ratio of the linear amplification at the pair of conjugate foci in question.

In applying my apertometric method, there is in every case such a diaphragm behind the objective limiting the pencils from external objects (from the index-pointers, for instance, on the glass disk) in their passage to the observer's eye. It may be either an eye-hole at the end of the tube, or the pupil of the eye itself; and when an auxiliary Microscope is used, this limiting diaphragm may be either a stop belonging to its object-lens, or the brasswork of the lens itself if there is no such stop. Therefore all the pencils of light by which the telescopic image becomes visible to the eye of the observer must in their *entrance* to the objective have passed the area of the image conjugate to this diaphragm in respect to the objective, or to the objective and the auxiliary lens together. In consequence of this, the conjugate focus, where the image of the said diaphragm would be formed, will represent in every case the apex of the angle which is to be measured as the angle of aperture; this point therefore, *and no other*, must be made to coincide with the focus of the objective in its ordinary microscopic performance, *and* also with the centre of the divided circle of the measuring apparatus.

If an objective is focussed to the centre of the measuring circle by means of an eye-piece and a long tube, or, as is recommended by Professor H. L. Smith,* without any eye-piece, a point very near to the front principal focus of the objective—in the latter case even inside this focus—is made to coincide with the centre. If now, as Professor Smith does, the telescopic image is observed by the naked eye through an eye-hole at the end of a tube of perhaps 4 inches length, the conjugate image of this eye-hole, i.e. the apex of the angle-defining pencils, must obviously occur at a less

* This Journal, ii. (1879) p. 776.

or greater distance beyond the centre, according to the focal length of the objective in question; and the distance may be very considerable with a low-power objective. The excentricity of the apex will not permit a correct evaluation of the angle in every case; but if, as in Professor Smith's apparatus, the rays have to pass to air from this excentrical point by a spherical surface, their divergence of course must be considerably increased by the refraction at this surface. With the same apparatus Professor Smith will obtain the true angular aperture of a low-power objective, either by focussing the objective with an eye-piece on his 4-inch tube, or observing the telescopic image by an eye-hole at a considerable distance from the objective.

In applying the method of telescopic observation by means of an auxiliary Microscope (acting as a terrestrial eye-piece) for enabling more accurate observation in the case of object-glasses of short focal length, any 2-inch to 4-inch lens may be used. But if the objective has been focussed previously to the centre of the divided circle by an eye-piece on the 10-inch tube, and afterwards an ordinary 2-inch or 4-inch lens is put to the draw-tube without any further precautions, the result will be incorrect. The clear aperture of the auxiliary lens representing now the critical diaphragm spoken of above, and this diaphragm being at the distance of a few inches only from the objective, the conjugate focus to it, i. e. the apex of the aperture angle will be at a considerable distance from the ordinary focus of the objective, and from the centre of the measuring apparatus, at least in the case of an objective of low or moderate power. Moreover, as a 2-inch or 4-inch lens generally has a clear aperture of 0·5 inch or more, the area of entrance of the image-forming pencils to the objective (which is in this case the image of the auxiliary lens projected in front of the objective) will be a considerable part of the focal length of the objective, much too large for admitting a good definition of objects situated so far from the aplanatic focus. For these reasons a correct application of the method requires a suitable stop behind the auxiliary lens, as expressly stated in the original description of the apertometer. The position and the diameter of this stop must be regulated in such a way, that its clear area in respect to the auxiliary lens corresponds to, or is optically conjugate with, a *small* central part of the field of the eye-piece applied in the previous focussing of the objective. According to this condition, the correct place of this stop may be easily calculated from the focal length of the auxiliary lens and the length of tube, for which apertures have to be measured. This place will be always somewhat within the posterior principal focus of the auxiliary lens.

Reducing the clear opening of the diaphragm, in the case of an auxiliary lens, to a small part of its focal length, or applying a small eye-hole in the case of an observation by the naked eye, the area of entrance of the image-forming pencils may be diminished to an extremely small diameter, owing to the inverse action of the amplification of the objective. With a $\frac{1}{12}$-inch objective, for example, there is no lack of light, and no other inconvenience, if this entrance-area is reduced to a diameter of one-thousandth of an inch. *The pencils crossing in the apex at the conjugate focus of the objective may be made in this way to define the angle of aperture practically like single rays.*

The foregoing remarks should explain all the discrepancies which have appeared to some observers in using the apertometer, and they will be applicable more or less to every method of measuring apertures.

The irregularities observed by Professor H. L. Smith with low-power objectives will disappear at once, as soon as he focusses the objective *not* by the naked eye but by an eye-piece, and takes care that the position of the diaphragm in this eye-piece corresponds virtually (i. e. the action of the field-lens considered) to the position into which the eye-hole at the end of this tube is brought afterwards. Repeating his measurements in this way with the apparatus figured on p. 775 of his paper, he will find the correct angle of the lowest powers as of the highest, but, of course, the angle corresponding to a length of tube of 4 inches, according to the description of his apparatus. In the case of a low-power objective, this angle may be sometimes considerably less, sometimes considerably larger, than the aperture of the same objective on the 10-inch tube, both cases being equally possible, though not equally frequent. Professor Smith's own method of observation is subject to exactly the same conditions for obtaining correct results, the position and the *diameter* of the illuminating area (tissue-paper or ground glass) at the end of his tube requiring special precautions. Both methods will yield similar results with low or high powers, if both are applied with the same precautions. But for both methods Professor Smith will do well to exclude another source of errors in his apparatus by taking away the magnifying lens at the end of the swinging arm *between* the centre *g* and the eye-hole *f*, applying this lens *outside* the eye-hole, if he cannot dispense with it.

A stop with a small circular hole at the centre of Professor Smith's apparatus, as suggested by Dr. Woodward in his paper, will not correct by itself a faulty adjustment of the objective or the diaphragm, and will be quite unnecessary if the adjustment is made correctly. But in the case of a coarsely incorrect adjustment the observation would be practically impossible; the limits of the aperture would be invisible as long as the conjugate area to the critical diaphragm does not approximately coincide with the circular hole.

With regard to the manner in which apertures are indicated by the apertometer—what Dr. Woodward calls the "arbitrary scale of my own invention"—and the objections made against it by different writers, the following explanations may be useful:—

The application of such a scale, instead of a simple angular division of the glass disk, would be unwise if this scale were intended as a device for making out the angle of an objective in crown glass, or even balsam angles or air angles. But the idea from which this part of the arrangement has arisen has no such aim, as Mr. J. W. Stephenson * and Mr. R. Hitchcock † have clearly explained. My intention has been to introduce practically as a matter of simple and direct observation a new expression of aperture, quite apart from the angles, which may be conveniently applied by microscopists in all scientific discussions pertaining to apertures.

In my opinion, apertures, until recently, have not been measured in any strict sense of the word. *Apertures cannot be measured by degrees.* Angles being measured by degrees, the angular aperture i. e. the *angle of* aperture can be likewise, of course. But the angle by itself is no measure of aperture—at least, nobody has attempted to prove such an hypothesis. An angle is a mere indication or statement of an aperture, just as a number of degrees on the thermometer may exactly indicate a quantity of heat, under given circumstances, but does not measure it. Just so the angle of divergence of the gold-leaves in an electroscope indicates or determines an electric charge, but does not measure it. There is not one point of view from which apertures can be compared *quantitatively* by means of the angles, because there is not one function in the performance of the Microscope in respect to which twice the angle represents the double effect, and three times the angle the triple effect, except when the angles do not exceed a few degrees. Neither the quantity of light, nor the resolving power, nor any other performance connected with the aperture, is increased in the ratio of 1:2 if the angle (air or balsam or interior angle) is increased, say, from 60° to 120°. Moreover, apertures cannot be directly compared as to greater or less, by the angles, as long as they do not relate to exactly the same medium. For example, no comparison by means of degrees can be made between a dry lens and an immersion lens, except by reducing the angles to an entirely arbitrary common medium which has no actual existence either for both objectives or, at least, for one of them.

None of these defects of the angular expression of aperture can be overcome by introducing, as Dr. Woodward suggests, the "first interior angle" of the objective. The adoption of this plan, on the contrary, would appear to me to be a serious change for the worse.

* This Journal, i. (1878) p. 51.

† 'Am. Quart. Journ.,' i. (1879) p. 286.

It withdraws the basis even of an indisputable indication of aperture, making the angle to depend on two practically inaccessible elements of very uncertain character—the refractive index and the external curvature of the front lens. Crown glass is a variable thing. In the crown fronts, for instance, of Mr. Zeiss' different objectives, the refractive index of the ray D varies from 1·501 to 1·544, i. e. in the range of 3 per cent. of the average value, and nobody, except the maker, can know what may be the index in any given objective without dismounting it.

But there are many low-power object-glasses the front lens of which is made of flint. Ought an interior angle of, say, 37° in such a flint front of 1·62 refractive index to be considered as denoting less aperture and less resolving power than 40° "interior angle" in a crown front of 1·50? Moreover, what would be the signification of "first interior angle" if the front lens has not a plane external surface, but a curved one? I have at my disposal a dry $\frac{1}{8}$ objective, made for a special purpose, the numerical aperture of which is 0·91 (air angle = 132°); but the first interior angle, within the crown front of 1·513 refractive index, is 87°, owing to a concave surface of the front lens. If this objective were to be compared with other glasses of ordinary construction by the interior angle, and if this angle, in fact, had the prominent signification which Dr. Woodward proposes, the glass spoken of would range among immersion lenses, which, of course, neither Dr. Woodward nor anybody else will concede.

I may briefly signalize the principal conclusions by which, in my opinion, the product $n \,.\, \sin w = a$ (a, numerical aperture; w, semi-angle of aperture; n, refractive index of the *external* medium to which the angle relates) can be demonstrated as the true and general measure of aperture.

1. The expression of aperture, as a *quantity*, must be based on the evaluation of the number, or quantity, of rays collected by the objective from one point of the object and transmitted to one point of the image.

No ray can exist in the wide-angled cone of light, emanating from the object, which is not contained in the contracted cone of light going from the objective to the microscopic image, *et vice versâ*. As soon as this latter cone of light is reduced to a narrow-angled pencil, owing to the distance of the apex, it is unquestionable, from well-established optical principles, that double or triple the angle represents double or triple the number of rays contained in one section plane through the axis. Therefore the capacity of an objective of collecting rays, i. e. its aperture, is proportionate to the angle of the narrow-angled pencil on the side of the image, other circumstances being equal.

On a theorem announced long ago by Professor Helmholtz and myself, the angle of the emerging pencil (a narrow-angled pencil considered only) does not vary with the angle of the wide-angled entering pencil or with the angle of aperture, but does vary with the *sine* of the semi-angle, and if different working media are considered at the same time, with the product $a = n . \sin w$—aplanatic foci supposed. If there are any two objectives different in focal length and different in working media, for example a dry $\frac{1}{4}$ and an immersion $\frac{1}{12}$, which yield equal values of this number a, the pencils forming the microscopic image will be equal in angle as soon as equal amplification of the images is attained in any way whatever (by projecting the images to different distances or by interposing other lenses); and if the value of a for one objective is greater in any ratio, the angle of the image-forming pencil will be greater in the same ratio.* For this reason the said product must be considered as the true quantitative expression of aperture.

2. In addition to, partially in consequence of, these statements, it may be strictly proved that all principal functions of microscopic vision depend upon the expression of numerical aperture and cannot be indicated in a general and exhaustive manner apart from it.

The illuminating power of an objective, i. e. the brightness of image attainable with any definite amplification, is *proportionate* to the square of a, where a may relate to the whole aperture or to that part of it which is made active by the illuminating pencil.

The depth of focus is inversely proportionate to a, any particular amplification considered.

The resolving power, defined by the minimum distance δ of separable elements in regular structures, is expressed by the equations

$$\delta = \frac{\lambda}{a} \text{ and } \delta = \frac{1}{2} \frac{\lambda}{a}$$

(λ denoting the wave-length of the image-forming rays); the former relating to the case of a strictly axial pencil, the latter to the case of the utmost oblique incidence of the illuminating pencil.

3. The practical usefulness of this expression of aperture is shown by the following considerations:—

The numerical value is an *absolute* measure, in the strict sense of metrological science, by defining apertures without regard to changeable or accessory elements (as, for instance, the refractive index of the working medium) and comparing them with a natural standard unit. *This unit of aperture is the capacity of an objective of collecting the whole hemisphere of rays emanating from one luminous point within a medium of the refractive index* 1·00, and is

* From the proposition referred to above may be derived a new method of measuring apertures, quite different, in principle and in process, from the methods hitherto applied, which will be described hereafter.

readily represented by any objective yielding $n \cdot \sin w = 1$. This would be an immersion lens, the water or balsam angle of which is double the critical angle within water or balsam. But any definite part of the unit can be represented by a dry objective,—for example, the half of the unit by an objective of 60° air angle.

By the value of a any two objectives performing with different media are directly compared, without needing the introduction of a merely hypothetical angle (as, for instance, the balsam angle of a dry lens) which has no real existence in the performance of the system.

The *numerical value* affords at once a clear and exhaustive expression of the relation between any two objectives in respect to all significant functions of the optical performance as far as they depend on aperture; while by adhering to the *angles* the judgment would be greatly misled. Comparing two dry lenses of 110° and 140° angular aperture in air, the increase of aperture in the latter seems, according to the angles, equal to 27 per cent. Comparing the true measures (num. ap.) 0·82 and 0·94, the real difference is reduced to not quite 15 per cent. Again, taking the case of an objective of 1·40 numerical aperture on the homogeneous-immersion system, its balsam angle (138°) looks remote from the ultimate limit of 180°, and there appears ample range for further increase of aperture and resolving power. But, in fact, the aperture is brought within 7–8 per cent. of the ultimate limit which in every objective is the refractive index of the least refractive medium between the object and the first convex surface of the system. As long as there is not used a substance of much higher refractive power than crown glass as a mounting medium, working medium, and front lens, the utmost increase of the angle of the entering cone of rays would increase very slightly the angle of the image-forming pencil on the other side; and as from nothing, nothing can come, the advance in performance would remain practically inappreciable.

From these explanations it will, I hope, be understood that the application of the numerical scale in the apertometer is not a mere fancy, but a deliberate attempt to get rid of the serious defects appertaining to the method at present in use.

I add a few remarks relative to the degree of accuracy attained by the apertometer, as I cannot agree with Dr. Woodward in the objections he makes to the construction of the apparatus on this point.

Dr. Woodward is mistaken in supposing errors to be introduced by the reflecting surface of the glass disk. This subject was carefully examined before I adopted the arrangement in question. The angle included by any two symmetrical lines of the division has a *maximum* value if the apex coincides, by reflexion, with the exact centre of the circle. It is thus seen that deviations of the apex within the upper surface of the disk will change the angle by quantities of "second order" only; and such deviations could be increased up to 2 mm. without any appreciable fault remaining in the *middle* of both readings. The single readings may differ one from the other by some degrees, but the mean will yield the correct value; and as the observer *must* always make both readings, and take the mean, the difference is absolutely unimportant. For my own use I often apply a disk without any central mark; the silvered glass with the circular hole on the disks made by Mr. Zeiss being intended principally not for centring, but for preventing measurement with incorrect adjustment of the objective.

There is no other mechanical condition for the correct performance of the disk, but that the line of intersection between the inclined surface and the upper surface of the disk must pass through the exact centre of the circular division; the angle does not need 45° exactly. Just the same condition must be fulfilled with Dr. Woodward's apparatus; and as it is not more difficult to grind an inclined face than it is to grind a plane surface, it follows that the convenience of manipulation afforded by the reflecting surface in my arrangement is not obtained by a sacrifice of accuracy.

In engraving circular divisions of unequal intervals by means of a dividing machine, according to a calculated table, there is no greater source of error, provided the maker is not a dunce; and if the index of the glass plate has been correctly measured, the reliability of such a scale will not be inferior to that of a division into degrees. Whether the scale has been made on the base of the right refractive index may be ascertained by the observer by precisely the same method which Dr. Woodward suggests for observing the index of a disk divided into degrees. He may ascertain that any immersion lens with an aperture exceeding unity, yields exactly the unit by the mean of both readings, when it is applied to the apertometer as a dry lens; and this, indeed, is the method used by Mr. Zeiss for testing every plate before sending it away, in order to prevent accidental use of a wrong crown. In order to have the front lens separated from the disk by an infinitely thin film of air only, and to prevent the projecting brasswork of the objective ($\frac{1}{8}$) from stopping-off the utmost oblique rays, a drop of soft balsam is placed on the disk, and after it has dried superficially the objective is slightly pressed down upon it.

The divisions of the scale on the apertometer disk go from 0·05 to 0·05 of the numerical unit. The intervals being equal to 2 mm. on the average, no observer will find any difficulty in estimating at a glance the fifths of an interval. The possible error of this estimation will hardly exceed half the unit of the second decimal, since nobody with a moderate amount of care would read ·03 if the point in question is decidedly nearer to ·02 than to ·03. The error of measurement will be limited, therefore, to about $\frac{1}{2}$ per cent. of the unit, corresponding to half a degree, or 30′ in angle, as far as the actual reading is concerned.

An exactness of *reading* to this extent is evidently more than sufficient. An unavoidable amount of uncertainty resulting from the nature of the object, and many other sources of slight error, will always limit the real exactness of *observation* beyond 1 per cent. of the unit, different observers and different methods of equal reliability being supposed. In low powers slight deviations in the length of tube; in high powers slight alterations of the cover-adjustment, will admit of much greater difference than the error of reading will introduce. It should be observed that in high-angled objectives the aperture has not the same value for different colours, owing to the difference of focal length (or of amplification), even in objectives, which are perfectly achromatic in the ordinary sense. In the case of very large angles, the aperture, angular or numerical, will be greater for the blue rays than for the red, generally by more than 1 per cent. Last, not least, there is no possible interest, either practical or scientific, appertaining to single degrees, or half-degrees, of aperture angles; for no microscopist in the world will be able to make out any difference in the performance of objectives, as long as the numerical apertures do not differ by *several* per cent., other circumstances being equal.

For these reasons I consider all attempts at very accurate measurements of this kind to be useless.

There has been made another objection, from quite a different point of view, by Mr. Wenham,* who declares the apertometer to measure the angle of field, instead of, or in addition to, the angle of aperture. I hope Mr. Wenham will abandon this objection after having considered the dioptrical proposition spoken of early in this paper, and its bearing on the subject. By reducing to a pin-hole the critical diaphragm in apertometric observation he will be able to confine the entering pencils to one-hundredth of the ordinary field of vision of the object-glass. But then he will at once perceive that a greater or less diameter of the entrance-area has no influence at all on the outcome of the observation, not even if this area should be much greater than the field of vision in the ordinary microscopic use of the objective, provided the diaphragm be in its correct position. Too large a field taken as entrance-area in telescopic vision will deteriorate definition and for this reason

* 'Am. Quar. Micr. Journ.,' i. (1879) p. 280.

will make the true position of the index-pointers uncertain, but will add nothing substantially to the reading of aperture.

The size of the field has practically no influence by the method in question.

As to the observation on the oil-immersion $\frac{1}{8}$, to which Mr. Wenham alludes in proof of his assertion, its fallacy will be obvious on a moment's reflection. When a microscopist observes any object of say 7 mm. in diameter, and wants to observe its whole extension within one field of vision, he certainly will take care that the stop in his eye-piece does not confine the field to 6, or 4, or 3 mm. Now the telescopic image of distant objects, delineated on the back of an oil-immersion $\frac{1}{8}$, must extend to upwards of 7 mm., as is evident at once to everybody from the diameter of the back lens; and for observing the *limits* of this telescopic image the whole must, of course, be within the field of the auxiliary Microscope. Why did Mr. Wenham expect then to see the limits of the aperture whilst using eye-pieces, the stops of which confine the field of vision of the auxiliary Microscope to perhaps 3, or 4, or 6 mm.?

A few words on the origin of the apertometer. Dr. Woodward, in his paper "Description of a New Apertometer,"* speaks of my arrangement and every part of my method as a "modification" of an apparatus described by Mr. R. B. Tolles in 1873. I am aware of Mr. Tolles' priority in the description of the semicircular glass disk, and I highly appreciate his merits in the propagation of sound ideas about the aperture subject; but Dr. Woodward will allow me to observe that two principal features of my arrangement, the observation of the telescopic field of vision of an objective and the numerical indication of the aperture, have obviously no connection at all with a glass disk. In fact, I have applied this method of observation with the naked eye and with an auxiliary Microscope, since 1870, in measuring air angles by means of a divided rule fixed below the stage of a vertical stand at a definite distance (100 mm.) from the focal point of the objective, black disks moved along this rule being used as indicators for marking the limits of the telescopic field on the scale; an arrangement which I use even now with objectives of moderate air angle, the rule being divided after the numerical scale. Shortly afterwards, when I felt the necessity of extending measurement to apertures approaching or exceeding the maximum air angle, I interposed a semicircular lens of well-known refractive index, centred in the stage-hole of the stand, between the objective and the scale, in order to prevent the angular extension of the cone of rays in its passage to air and the total reflexion of the oblique pencils—a device essentially identical with the arrangement described and

* 'Am. Quart. Micr. Journ.,' i. (1879) p. 284.

figured by Professor H. L. Smith in the paper quoted above. But I soon abandoned this method as being inconvenient, because a very slight deviation of the focus or apex from the centre of the lens must introduce a perceptible error, owing to the refraction of the spherical surface, unless the lens were very large. Since 1871, for measuring great apertures I have used a *rectangular* plate of crown glass 100 mm. in length and 60 mm. in breadth, three edges ground, and one, on the long side of the rectangle, polished to an angle of 45°, for allowing the plate to be applied on the stage of an ordinary Microscope. The scale of numerical aperture was engraved along the three perpendicular edges according to previous computation, and index-pointers used as now. In this shape (which is briefly described and figured in Nägeli and Schwendener, 'Das Mikroskop,' 2nd ed. p. 170) the apparatus has been used for a long time by Mr. Zeiss and myself; many microscopists have seen, and some of them have the appliance. I explained and demonstrated its use at the meeting of the Gesellschaft für Medicin und Naturwissenschaft of Jena, November 1, 1872. On the basis of measurements made by this rectangular plate Mr. Zeiss in his catalogue of August 1872 stated his immersion objectives to yield an aperture of 108 degrees water angle, thus exceeding the maximum air angle by several degrees.

The only part of the apparatus, besides the name, which is of more recent origin, is the circular shape of the glass disk, which was adopted by Mr. Zeiss when he began to make the apertometer for sale.

The description of my arrangement has been delayed for so long a time because I proposed to explain the method of aperture-measurement and allied methods for measuring focal lengths, amplifications, &c., in connection with a more exhaustive discussion of the aperture theme. Now, as priority results from literary publicity only, the application of the glass disk for measuring apertures belongs to Mr. Tolles, of course. But as to those parts of my arrangement which have not been described by others, the foregoing remarks will show them to be independent of Mr. Tolles' or any other apparatus.

IV.—*A Further Contribution to the Knowledge of British Oribatidæ.* (Part I.) By A. D. Michael, F.L.S., F.R.M.S. (with the assistance of C. F. George, M.R.C.S.E.).

(*Read 14th January*, 1880.)

Plates III. and IV.

In this Journal, some time since,* I related the results of my collection of, and observations regarding, the British representatives of this family of *Acarina* during the year 1878. Throughout the

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EXPLANATION OF PLATES III. AND IV.

Plate III.

Fig. 1.—*Leiosoma palmicincta.* Full-grown nymph, dorsal aspect, × about 55. The central ellipse with the innermost set of scales attached to it is the larval notogastral skin, the other rows of scales belong to the successive nymphal skins.

Fig. 2.—The same. Nymph nearly full grown, ventral aspect, × about 30. *a*, scales of the present skin; *b*, true edge of the body; *c*, flattened expansion of the margin of the abdomen; *d*, arched central part of ditto, bearing, *e*, anal plates; *f*, plates which will be called the genital plates in the adult; *g*, mouth organs.

Fig. 3.—The same. One of the hairs or scales. *a*, edge of body; *b*, brown apophysis; *c*, lateral points of ditto; *d*, colourless dotted head of central point of ditto; *e*, membranous expansion with black nervures.

Fig. 4.—The same. Perfect creature, × about 40. *a*, stigmatic hairs; *b*, interstigmatic ditto.

Fig. 5.—The same. Mandible, × about 115.

Fig. 6.—The same. Other mouth organs, × about 115. *a*, labium; *b*, maxilla; *c*, palpus; *d*, lingula.

Plate IV.

Fig. 1.—*Oribata quadricornuta*, × about 100. *a*, upper and outer point (or horn) of the tectum; *b*, inner and lower ditto; *c*, spine from centre of anterior margin of each half of the tectum; *d*, stigmatic hair; *e*, interstigmatic hair (or spine); *f*, thin chitinous protecting ridge or blade, standing nearly on edge, along the side of the rostrum; *g*, concave projections from cephalothorax forming a deep cavity for the reception of each coxa of the first pair of legs; *h*, wing-like expansion of the abdomen protecting the second and third pairs of legs.

Fig. 2.—The same. Nymph full grown, × about 115.

Fig. 3.—The same. Hood of the rostrum (perfect creature), × about 300. *a*, rounded hood showing the buccal cavity and labium through the transparency of the chitine; *b*, flat, depressed, horizontal ridge; *c*, remarkable pectinated spine proceeding from the hood.

Fig. 4.—The same. Mandible (perfect creature), × about 250.

Fig. 5.—The same. Other mouth organs (perfect creature), × about 500. *a*, labium; *b*, maxilla; *c*, palpus and attachment thereof to maxillary lip.

Fig. 6.—*Oribata sphagni*, × about 165. *a*, wing-like expansion of abdomen become almost abortive.

Fig. 7.—The same. Nymph full grown, × about 170.

Fig. 8.—The same. Mandible (perfect creature), × about 220. *a*, one of the projections which form attachments for the great retractor muscles.

Fig. 9.—The same. Other mouth organs (perfect creature), × about 160 (letters as in No. 5).

Fig. 10.—*Tegeocranus labyrinthicus.* Young nymph (amplification depends on age).

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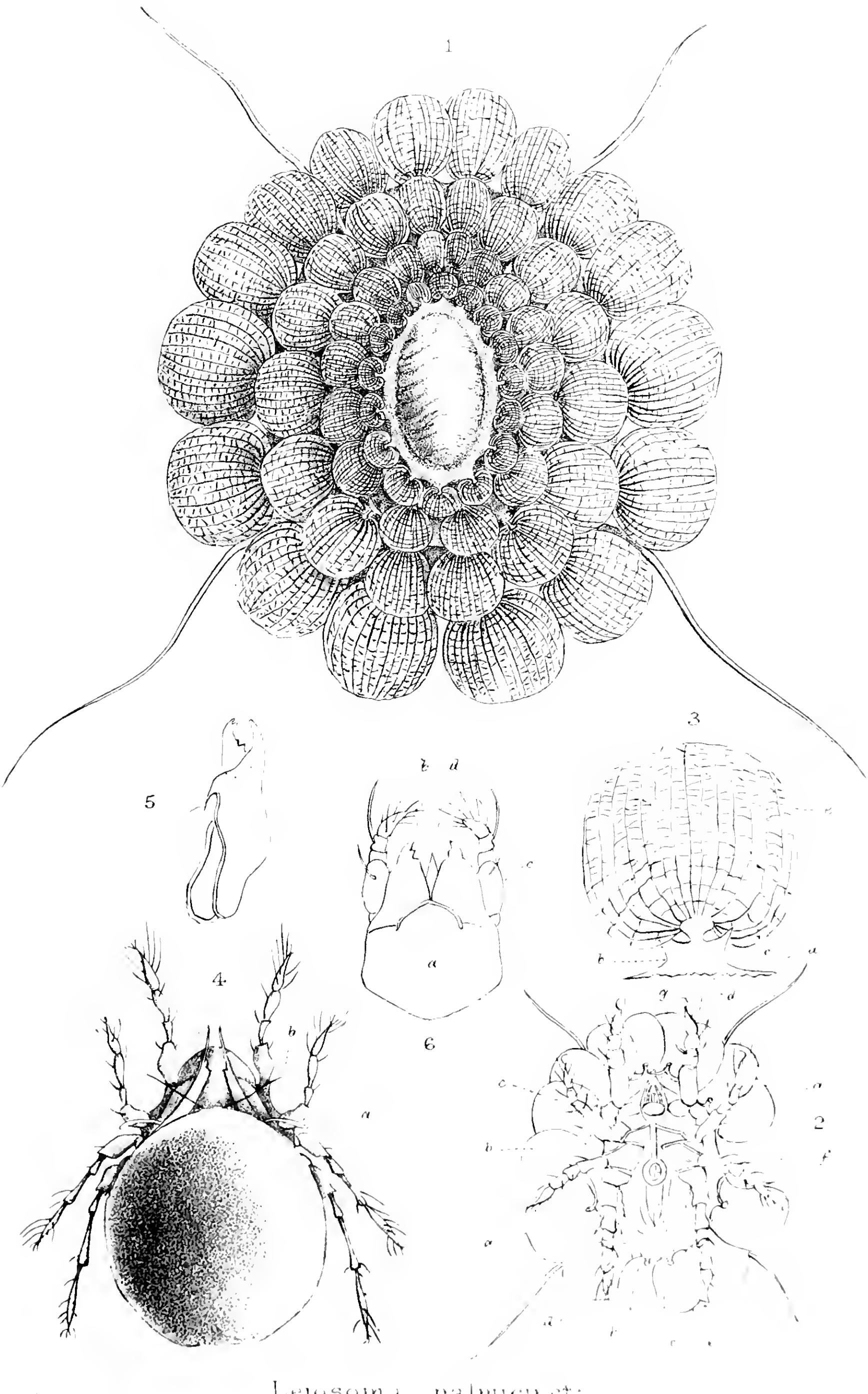
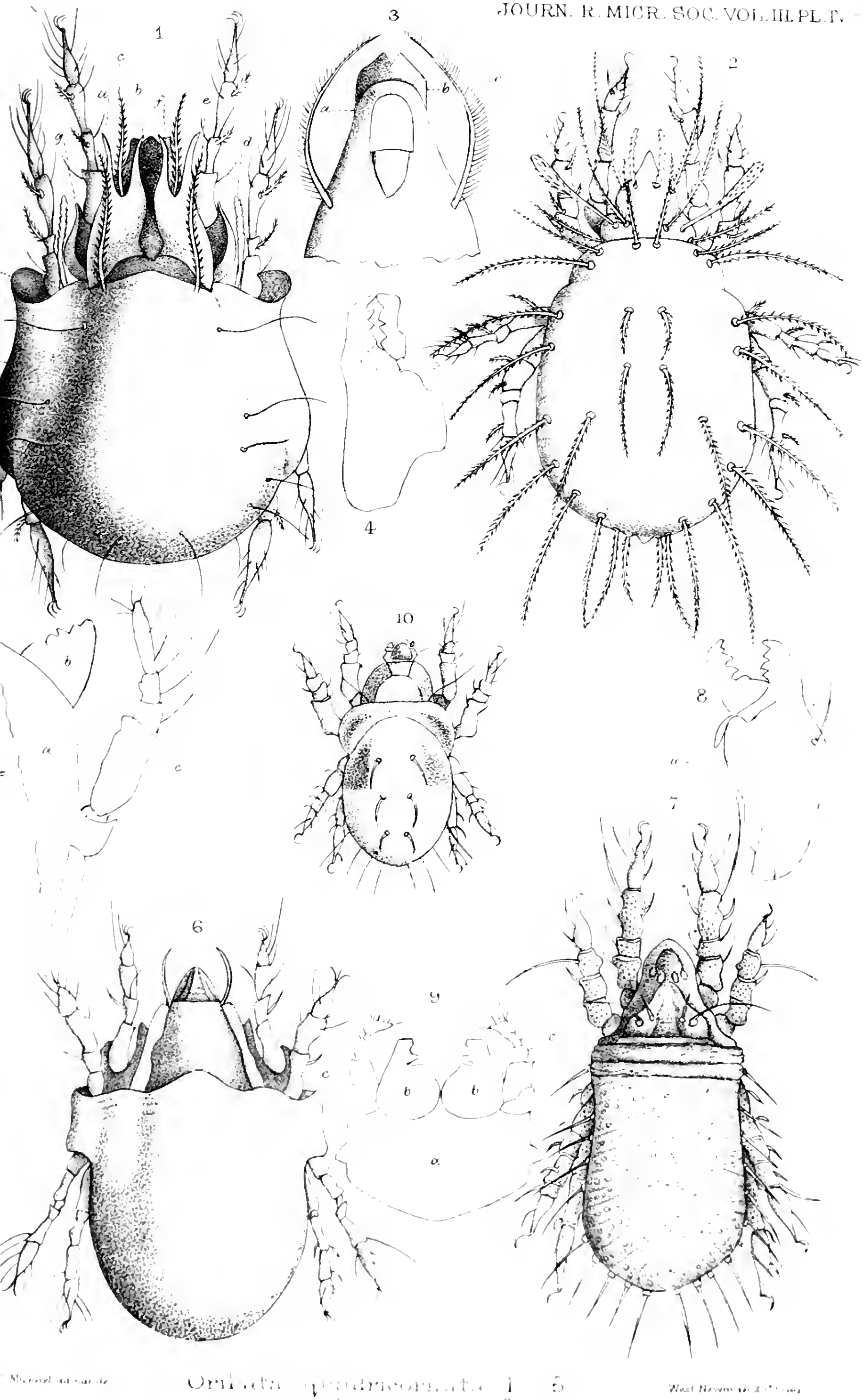
* Vol. ii. (1879) p. 225.



A D Michael ad nat del.

Leiosoma palmicincta



Michael ad nat. del.

Oribata quadricornuta 1 – 5
" sphagni 6 – 9
Tegeocranus labyrinthicus 10

West Newman & Co. imp.

year 1879 I have continued to investigate the same subject, and, as I expected, I find that the field is far from being exhausted; indeed, material pours in upon me much faster than I can deal with it.

I must first of all thank Mr. George, of Kirton Lindsey, for the assistance he has rendered me by sending specimens, both mature and in earlier stages.

I have devoted myself greatly to tracing the life-histories of the various species, as any knowledge based upon an acquaintance with the adult only, is necessarily imperfect, although I am not able to follow Megnin * to the extent of his expressed opinion that no one should name a species of *Acarina* unless he is acquainted with the larva, nymph in all stages, and adult male and female, and that all names not based upon such a knowledge may be disregarded; it seems to me that such a rule would be attended with grave inconveniences, but I fully agree with him that the knowledge of the life-histories is of the greatest importance, and, among the *Oribatidæ*, the nymphs are often so singular and interesting that they would be well worth the attention of the naturalist for themselves alone.

My own searches and observations during 1879 have been conducted at Epping Forest, the neighbourhood of Tamworth, and at the Land's End, Cornwall. Mr. George, as before, has collected at Kirton Lindsey, in Lincolnshire.

I am not aware that since my last paper any further bibliography has appeared which it is necessary to notice.

Life-histories.

As far as I am aware, the only writers who have made any attempt to study this subject with respect to the *Oribatidæ* have been Nicolet † and Claparède.‡ The former traced the nymphs of eleven species, and, as far as my experience yet goes, very correctly, with the exception of *Nothrus sylvestris* and *N. palustris*, as to which I have a few words to say in a later part of this paper. He makes some other assertions as to nymphs which he has not actually traced, which I hardly think are quite so happy.

Nicolet's coloured illustrations of the nymphs are extremely good; of course it would naturally happen, with the first person in the field, that those nymphs which he would trace would be chiefly the most common and most easy to breed, and this is so with the majority of Nicolet's species.

* "Mémoire sur les Hypopes," Robin's 'Journal de l'Anatomie et de la Physiologie,' 1874, p. 225 *et seq.* "Mémoire sur les Gamasides," ibid., 1876, p. 289, &c.

† 'Archives du Muséum,' 1855, t. 7.

‡ "Studien an Acariden," in 'Zeitschrift für wiss. Zool.,' 1868.

Claparède has traced, with his accustomed care and minuteness, the whole development of *Hoplophora dasypus*, or as he calls it *H. contractilis.* This is one of the eleven species Nicolet traced; he calls it *H. nitens.*

Although these two are the only writers who have treated of the nymphs as nymphs, they are not the only ones who have noticed the creatures; C. L. Koch,* in his work on the *Acarina*, &c., has figured and described many of them, but he has supposed them all to be adults of separate species, and even made them the types of new genera, which error he has confirmed in his subsequent work.†

Nicolet pointed out Koch's error in many instances, and also expressed his opinion that the whole of Koch's genera, *Murcia*, *Celæno*, *Hypochthonius*, &c., consisted of nymphs; I believe Nicolet is correct in this, but, of course, he could only assign Koch's so-called species to their respective adult forms in those instances where he himself had traced the life-histories. It will be seen by the latter part of this paper that among the species whose histories I have traced, as I believe for the first time, are six nymphs which had been figured and named by Koch as distinct species.

I have pointed out in my former paper that it is very difficult to avoid falling into Koch's mistake, and that it was very natural that he should have made it; in confirmation of this, and to show how necessary it is that the life-histories should be known, I may mention that one or two present writers appear to be doing the same thing.

The life-history, for the purposes of identification, may usually be practically confined to a description of the nymph, as the young larva escapes from the egg, small, and with six legs only, but in other respects generally much like the nymph, although instances of difference occur, as *Tegeocranus latus*, described in my last paper.

The nymph, in every instance that I have traced, changes its skin three times, so that in those species where the adult carries the cast notogastral skins, it carries four, viz. one larval and three nymphal skins, consequently, in the species which carry the cast skins, it is easy to tell at what stage of maturity the animal has arrived by the number of cast skins on its back.

The appearance of the nymph usually varies considerably during the different stages of its growth. When it first emerges from the larval skin it is usually flatter on the back than it subsequently becomes, and it is often narrower in proportion than the full-grown nymph; moreover, in the inert stage, which precedes the change to the perfect creature, and also each change of skin, the depressions and wrinkles, with which the back is marked in so

* 'Deutschland's Crustaceen, Miriapoden und Arachniden.'

† 'Uebersicht des Arachnidensystems.'

many species, are apt to get almost obliterated, the skin puffing up into an arched form; this does not occur in all instances, but it does so frequently enough to make it wise, whenever a nymph has been drawn or described from an inert specimen, to record the fact. Another change in the nymph as it matures is that it is usually whiter and softer at first than in the more advanced stages; as a rule it becomes a little harder and darker with each change of skin, but it never becomes anything approaching as hard or dark as the perfect creature, and some species do not get at all darker during the nymphal stage. The chitinous exo-skeleton appears to develop first on the cephalothorax and legs, particularly on the anterior dorsal surface of the former. The abdomen does not ever assume a chitinous appearance in any nymph that I have observed. When the perfect creature first emerges from the nymphal skin it is generally somewhat light coloured and soft looking, and it is often some hours before the full hardness and darkness are acquired.

It seems to me that when the life-histories are fully known, they will probably be of service in determining whether the genera into which the *Oribatidæ* have usually been divided are natural or only artificial groups; thus, in some strongly marked genera, as for instance *Nothrus* and *Damæus*, the nymph is usually sufficiently like the perfect creature to enable the observer to predict with some confidence what the nymph will turn out to be, indeed in most instances the resemblance is very close in these two genera. In other strongly marked genera, as *Oribata*, *Tegeocranus*, *Leiosoma*, &c., the nymph is so different that it would be impossible to make any guess whatever from resemblance to the adult; but in some of these genera, as *Oribata*, there is a certain pervading character about most of the nymphs which would give an indication of the genus they belong to. On the other hand, in the genus *Pelops*, the separation of which from *Oribata* depends upon highly artificial distinctions, the nymphs have much the same leading feature as in *Oribata*. In the genus *Hoplophora*, which is undoubtedly a natural group, the nymphs have a strong likeness to each other; there are other genera in which no rule can be traced, but it remains to be seen whether these will eventually turn out to be differentiated by distinctions of importance.

Another interesting point, which one observes in studying the immature forms of the *Oribatidæ*, is that in the earliest stages the abdomen often exhibits decided traces of segmentation; these usually vanish with advancing age, so much so indeed that the unsegmented abdomen is a characteristic, not merely of the family, but of the order; the segmentation has not, in any instance that I have seen, proceeded to the extent of making one segment movable upon the other, but is still sufficiently marked to be distinguishable.

I have mentioned above that the change from nymph to perfect creature, and each change of skin, is preceded by an inert stage, which usually lasts some days, and in some instances some two or three weeks, the time varies greatly: during this stage they appear perfectly dead, and, as before stated, they frequently puff up, the skin becoming inflated; if they be mounted for microscopic specimens when in this state, they usually collapse altogether. I have also remarked that if, after this puffing up occurs, the back shrinks and becomes concave before the ecdysis, it is a tolerably sure sign that the animal is dead. In several instances the day before the perfect creature (or more mature nymph) emerges, I have observed a slow, but regular, rhythmic pulsation taking place within the inert creature; in many instances a large squarish brown patch is seen through the semi-transparent dorsal surface of the abdomen; this Claparède considers to be the liver; it sends out two long cones or horns anteriorly, one on each side; each of these ends in most instances in a black glandular-looking spot, very near the air-sac which lies immediately within each stigma; it is by this spot that the pulsation may be most clearly seen; it may be observed to be suddenly retracted, and then very slowly advanced again to the old position, to be once more retracted as soon as it reaches it. I have never noticed the pulsation in the active creature, nor in the inert one until a day or so before emerging. I have specially noticed this movement in the inert nymphs of *Notaspis bipilis* and *Oribata Lapidaria*.

Although many of the nymphs are extremely curious, I had not at all expected to be able, in this paper, to introduce any unrecorded creature rivalling in beauty and interest the extraordinary nymph of *Tegeocranus latus* figured in my last paper; indeed, I had quite abandoned all hope of doing so, when one day, at the Land's End, just as I was throwing away a piece of moss which I had been examining, I suddenly noticed a creature on it which might well have been mistaken for a vegetable rather than an animal organism, but which, you will probably think, is not surpassed, even by the last-named nymph. I succeeded in breeding my capture through its changes, and it turned out to be the nymph of an unrecorded species of *Leiosoma*, which I propose to call *palmicincta*.

The nymph is fully described in its place in the second part of this paper. Like *T. latus*, it carries the dorsal abdominal portions of all its cast skins concentrically upon its back, but instead of carrying them flat as *latus* does, they rise in a low pyramid; each skin is bordered by a series of beautiful palmate hairs, or scales, of remarkable size, projecting from its edge; each scale is formed of black, radiating nervures reticulated by transverse ones, the whole being covered by a transparent membrane, which in daylight displays iridescent colours. These beautiful objects make a broad border round the abdomen, entirely covering the cephalothorax and legs, so that not a trace of those parts can be seen from above, and the whole creature looks not unlike one of the fish-scale flowers which the natives of Brazil make so skilfully. The nymph is very inactive, usually remaining quite stationary in one place, and it must be difficult for any predatory creature to detect it. The mature form is as different from the nymph as can well be imagined; it is nearly black, and polished, does not carry any of its cast skins, hardly has a hair about it, and the few it possesses are quite fine.

In the latter part of this paper I have described the various nymphs, fifteen in number, which I have traced through to the perfect creature during the present season; the descriptions are all carefully taken from living specimens, and the same remark applies to the drawings of the nymphal and adult forms which will be found in the plates; these plates really should have been coloured in order to have done justice to the nymphs; in the adults it is not important, but in the nymphs colour varies much, and is characteristic.

Finally, I may say that, in every instance, I have traced the creature by actually breeding it from the nymphal stage, in confinement, in a glass cell not containing any other creature whatever, and in nearly every instance I have actually seen the perfect form emerge from the nymphal skin. I have, in several cases, preserved and mounted for the Microscope the adult which emerged and the skin from which it escaped; and I have also succeeded in mounting specimens in the act of emerging, so as to preserve evidence of the nymph being that of the adult to which it is assigned. When I have not succeeded in breeding the species from one stage to the other, I have omitted all mention of the nymph from this paper, however strong the probability may be of the two creatures forming the nymphal and adult stage of the same species. The single exception to this rule is in the remarks made below as to the probable nymph of *Nothrus palustris*; these became necessary in connection with another subject.

Different Modes of carrying the Cast Dorso-abdominal Skins.

In studying the nymphs for the foregoing part of this paper, I have been much struck by the almost fanciful variety of the modes in which they, and indeed the adults also, carry the cast skins. The portion of the skin carried usually includes almost the whole of the dorso-abdominal skin, and in every instance that I have seen, it includes the posterior portion, but the mode of carrying varies greatly, and is quite characteristic of species; the same species always carrying them the same way. The skins do not split with a ragged or destroyed edge, but quite evenly, and to a regular shape, as if cut with a knife; thus in *Scutovertex sculptus* the dorso-abdominal portion splits neatly off, and the creature emerges through the opening, leaving the rest of the skin uninjured, and looking like a manufactured article with a cover which takes off.

In the nymph of *Tegeocranus latus* the dorso-abdominal cast skins lie flat on the back like a round buckler, forming a series of concentric ellipses. In the nymph and adult of *Nothrus theleproctus* the skin that is carried is what is usually called shield-shaped, but instead of lying concentrically, the posterior extremities all start from almost the same point, so that the anterior margins are far wider apart than the posterior, and they look as if the top ones had slipped back; the edge of each skin is a little curled down so as to increase the apparent thickness. In the nymphs of *Oribata quadricornuta* the skins are piled up in an irregular lump on the back, while in the nymphs of *Leiosoma palmicincta* they also rise concentrically from the back, but in a regular cone, like a series of limpets of diminishing size. In the mature *Damæus verticilipes* the cast skins also assume a conical form, but a far more elongated one, and, instead of standing straight up, they are fixed on the hinder part of the abdomen, and extend far beyond the posterior margin of the body, so that the *Damæus*, which really has a short, rounded abdomen, seems to have a long pointed one. The strangest instance, however, that I have seen is in the adult of *Nothrus segnis;* the abdomen of the nymph of this species ends in two long, conical, tail-like projections; these are not found in the adult, but, as usual in the genus, there is a great resemblance between the nymph and perfect form, and these conical projections are replaced by bifid apophyses, which, however, are concealed during the whole life of the creature, unless some accident removes the cast skin, because, although the adult does not retain the dorsal skin, yet it keeps the skin of the two conical projections, each of which contains one of the apophyses as in a bag, and to each cone of skin is attached a long, narrow strip of the nymphal skin which makes a sort of light border along the side and hind margin of the adult, and gives it a very curious appearance: the apophyses can usually be well seen through the cone of skin, particularly when rendered transparent by turpentine, &c. This arrangement is shown at Plate V. Fig. 5.

Aquatic or Amphibious Species.

As far as I know, all previous writers have treated the *Oribatidæ* as a purely terrestrial family; a year or two ago, however, when searching for rotifers in pond water which I had obtained near Epping, I was struck by a mite, apparently at home in the water, and which seemed to be a nymph of one of the *Oribatidæ*. I secured a sketch of the creature, and endeavoured to breed it to the perfect form, but I was not successful; and as I have great hesitation about putting forward any theory relying upon a single specimen, I held my tongue about it, hoping to investigate the matter further. This year I returned to the locality, and discovered my old friend in *Sphagnum*, and again attempted to breed it through, but without success; the search after this acarid, however, revealed two other nymphs, both apparently those of *Oribatidæ;* with these two I was more fortunate, and, notwithstanding the difficulty presented by their aquatic residence, I was able to trace their life-histories; with them I found two adult species, one of which unquestionably belonged to the typical genus *Oribata*, although somewhat modified from the land species, the flexible wing-like expansions of the abdomen being far less developed, and seeming as though they had a tendency to become abortive, but all the characters of the genus are clearly developed. This *Oribata* I subsequently ascertained was the perfect form of one of my nymphs; I found plenty of it, and succeeded in breeding several: as far as I can ascertain, it is unrecorded, and I propose (if that be the case) to call the species *Oribata sphagni;* the adult is figured at Plate IV. Fig. 6, and the nymph at Fig. 7; the full description will be found in the second part of this paper. The nymph is sluggish, and lies concealed in the narrow part of the *Sphagnum* leaf near the point, and consequently is difficult to detect, and far from easy to observe in a state of nature when detected; neither this, nor any of the aquatic or amphibious species which I have found, are free-swimming creatures, nor is their organization such as to enable them to do so; they crawl on the *Sphagnum* and aquatic weeds, chiefly the former, usually on the submerged parts, their mode of life reminding me greatly of the *Halicaridæ* found in the sea crawling upon *Hydrozoa*, although the *Oribatidæ* are vegetable, and the *Halicaridæ* probably animal feeders.

It might naturally be supposed that the second adult would turn out to be the mature form of the second nymph, but this was not the case; I have a suspicion that it is the mature form of the nymph which originally attracted my attention, but as I have hitherto failed to breed it, this suspicion remains unconfirmed. I have not figured or described it in this paper.

The history of the second nymph is an interesting one to me, but, in order to explain wherein that interest lies, I fear I must make a short digression. I have before stated that the larvæ and nymphs of the *Oribatidæ* are usually soft and light-coloured, the adults being hard and dark; the adults vary in hardness and darkness according to species and genus, chiefly by genera, and where the adult will be very dark the full-grown nymph is generally darker than the equally mature nymph of a species which will, when perfect, be comparatively light; amongst the *Oribatidæ*, probably the perfect creatures of the genus *Nothrus* are lighter and softer than those of any other genus, and one would therefore expect the nymphs to be very light-coloured and soft; this expectation is confirmed by fact in all known instances, subject to the question of the species I am now about to discuss. The genus *Nothrus* is one in which the adults are tridactyle with homodactyle claws; now every known larva and nymph of the family *Oribatidæ* is monodactyle, but the adults vary according to genus (in Nicolet's classification); four only of Nicolet's genera are monodactyle, the others (as defined by him) being all tridactyle, and *Nothrus* is one of the latter group; moreover, *Nothrus* is one of those genera in which the nymph usually resembles the perfect form. This genus includes a species called *N. palustris*, which name was given to it by C. L. Koch,* who says he found it in damp meadows. This species might well be taken as a type of the genus *Nothrus* (as defined by Nicolet), which is a natural group; it presents all the characters in a high degree. Included in Koch's genus *Nothrus* is another species, *N. bistriatus*,† which appears to be properly classed as a *Nothrus*. Nicolet, however, figures ‡ what he says is Koch's *N. bistriatus*; it seems to me entirely different, and does not appear to be properly included in the genus at all; it is very hard and dark, and has not the general appearance nor the formation of a *Nothrus*. Nicolet says correctly that his *bistriatus* has only one claw, and then proceeds to say that it is not a perfect form at all, but is the nymph of *palustris*. There would not be anything surprising in Koch describing as a fresh species what was only a nymph, as he does this with every nymph of the family which he found, but the appearance of the creature is very unlike a nymph, except in the one particular of being monodactyle, and Nicolet evidently felt this, for he expressly says that it might be mistaken for a perfect creature, and, contrary to his usual habit, he states how he knows that it is a nymph. As a rule he does not state how he ascertained a fact, which it seems to me is to be regretted, but here he gives his reason, and it is a convincing one: he says he *saw* his *bistriatus* change into *palustris*. The passage is as follows:—"*Cette larve, telle que je l'ai figurée, est à la pénultième mue, ses téguments sont déjà solides, elle pourrait être prise pour un animal adult, si ses tarses n'étaient monodactyles. Je ne connais pas son état primordial, mais j'ai assisté a sa transformation en Nothrus palustris.*" Nicolet's figure and description of his *bistriatus* are both given with his accustomed accuracy, and are

* Loc. cit., Heft 29, pl. 13. † Ibid., pl. 21.
‡ Loc. cit., pl. 7, fig. 7.

perfectly unmistakable.* It had often struck me that it was odd the nymph of *palustris* should present characters so opposed to those of all other known nymphs of the family, but when a writer of Nicolet's accuracy states that he has actually seen the transformation, one does not suspect that he can be in error, and accordingly in my former paper † I treated *bistriatus* as being the nymph of *palustris* (on the authority of Nicolet), and mentioned its occurrence here.

I will now return to my second aquatic nymph. I had collected several, and had watched them carefully, and at last one began to exhibit signs of an approaching change to the perfect creature. I was curious to see what would emerge, and finally I saw the transformation take place under my eyes on the stage of my Microscope, and, to my utter amazement, the animal which emerged was Nicolet's *bistriatus* (which he calls the nymph of *palustris*), and I subsequently bred several. I compared them most carefully with Nicolet's figure and description and with the mounted specimens I had previously caught on land, but could not detect any difference; the creatures seemed identical, and, as the result of many subsequent observations, I have not any doubt about their being so; in order to satisfy myself, however, I thought it would be best to collect some living specimens on land and compare them with the living ones from the water. In collecting these I was further surprised to find with them nymphs and larvæ exactly like those found in the water, and which I had supposed to be entirely aquatic. I then endeavoured to breed them to the perfect stage, in which I was successful, and, as I expected, Nicolet's *bistriatus* again emerged. It therefore appeared that I was dealing with an amphibious species. In order to make sure of this I transferred some of the nymphs caught on dry land into *Sphagnum* and water, and watched them; they did not seem any the worse for their change of habitat, but lived on apparently quite as comfortably as before, and went through their transformations into the perfect form just as if they had been left on land. I kept the adult which had emerged for some time in water and sphagnum and it seemed quite content. I should have liked to have tried the converse experiment of placing the aquatic specimens on dry moss and seeing how they throve, but unfortunately by the time I had arrived at this stage the season was far advanced, my stay at Epping was terminating, and I could not find any more aquatic nymphs. The above facts convince me that, in spite of Nicolet's positive assertion and his general accuracy, he is somehow in error in this instance. I will shortly summarize

* The matter is complicated in Nicolet by a double printer's error (of which there are several similar in his work), by which in the list of contents of plate 2, and in the description, the wrong reference is given for the nymph of *palustris*. The right reference is plate 7, fig. 7, and this is correctly stated in the contents of plate 7.

† This Journal, vol. ii. (1879) p. 224.

the reasons, viz. firstly, I have, as stated above, bred a nymph of the ordinary class of appearance through the transformation several times and seen it change into *bistriatus*, and it would be something utterly opposed to the whole natural history of *Oribatidæ* that after the change from the soft, light-coloured, nymphal stage, to the hard, apparently adult, stage, the seeming adult should pass through a new transformation into a different adult, lighter and softer than itself; it would be introducing a new stage unknown among *Oribatidæ*, and indeed unknown among *Acarina*, and it would be quite exceptional for a nymph of one of the *Oribatidæ* to be harder and darker than the adult; secondly, in the genus *Nothrus* one would expect the nymph to resemble the adult instead of being totally different from it, and a nymph *does* exist which resembles *palustris* very closely (being light-coloured, as might be expected). I am indebted to my friend, Mr. George, for three or four living specimens of this nymph, which I am sorry to say I did not succeed in breeding through, but it looks the right size for *palustris*, which cannot be said of *bistriatus*, so that although I have not bred it, it seems very probable that it is the real nymph of *palustris*, and moreover it is figured by Koch as a separate species under the name of *Nothrus palliatus*,* and Nicolet says in one place (p. 389) that Koch's *palliatus* is a nymph of *palustris* in a different stage; while in another place (p. 396) he says it is the nymph of *N. sylvestris*. I do not know of any instance among the *Oribatidæ* where the nymph at different ages varies at all to the extent of the wide divergence between Koch's *palliatus* and Nicolet's *bistriatus*.

If, then, other zoologists should agree with me that these facts show that *bistriatus* is not a nymph, but an adult, what genus does that adult belong to? Clearly not to *Nothrus*, because it has monodactyle claws, and I venture to think that it is one of the *Hermannia*, although the back is not as arched as is usual in that genus; but if it be not one of the *Hermannia* then it does not belong to any existing genus, and I cannot see any distinction of sufficient importance to justify a new one, the form and position of the epimera, the palpi, the labium, and maxillæ, all of them important and characteristic points, agree well with Hermannia, and so do the general form of the cephalothorax, the position of the stigmata, and the form of the stigmatic hairs, and these points seem to me to outweigh the somewhat unusual form and marking of the abdomen.

Before leaving the subject of these aquatic or semiaquatic *Oribatidæ* I may remark that, in most of them, the stigmata and stigmatic hairs, especially the latter, are less developed than in the terrestrial species; this doubtless is a modification useful in consequence of the different medium in which the creature lives.

* Loc. cit., Heft 30, pl. 4.

New Species, &c.

Among the species which I have found this year are four, which, as far as I know, are entirely unrecorded; these will be found described in their proper places in the second part of this paper, and figured. I may call attention to the species which I propose (provisionally) to call *Oribata quadricornuta*, as being very singular, particularly in respect to the tectum; this and some other curious details are shown at Plate IV. Figs. 1 and 3.

It is curious to observe the tenacity of life exhibited by these minute beings under some circumstances; as an instance I may mention that I wished to stain some with osmic acid. I did not take the precaution of previously killing them, as from the deadly effect of this acid on low forms of life I did not doubt their instant death.

The creatures were placed in a sufficient quantity of 1 per cent. solution, and, as I knew that they did not take the stain readily, I left them in several hours; from the acid they were passed into 50 per cent. alcohol, in which they remained some hours; they were then passed into absolute alcohol, where they remained for some hours. On coming to mount them, I found them all alive, and apparently not much the worse.

Summary.

The result of my work during 1879 on this subject may be roughly stated as follows:—

The life-histories of fifteen species have been traced for the first time; of these the miniature forms of six had been previously described and treated as separate species; the remainder I believe not to have been recorded before. Fifteen species which I believe have not been previously recorded as British, have been found, and are described where necessary; of these, four are believed to be quite new, five have been previously found in France, four in Germany, one in both of those countries, and one in Spitzbergen; this raises the entire number of species found by Mr. George and myself to fifty-nine. The above observations as to habits, &c., have also been made.

In addition to the above I have at least five or six other species which I believe are unrecorded, but I have not had time to investigate them, and, even if I had, I should scarcely have liked to add to the length of this already extended paper, nor could they have been figured even in the number of plates with which the Society has enabled me to illustrate it.*

* Part II., with Plates V. and VI., will appear in the April number of this Journal.

V.—*The Classificatory Significance of Raphides in Hydrangea.* By George Gulliver, F.R.S.

(*Read 10th December*, 1879.)

In the last edition of Professor Lionel Beale's excellent book, 'How to Work with the Microscope,' a brief notice, illustrated by two plates, is given of some of my results concerning the value of raphides as characters in systematic botany. Since that abstract was written, I have been referring to my notes, extending over several years of time and to many species of the order Saxifragaceæ, and in no case was there any appearance of raphides in these plants. On the other hand, these beautiful crystals, within their oval cells, are always abundantly present in Hydrangea. Here then is a natural and sharp diagnostic between the Saxifrages and Hydrangeas. The raphides and their cells are easily exposed by smashing up a bit of the leaf or young stem in a drop of water on the object-plate, and still better by boiling a fragment of the plant in a solution of caustic potass in a test tube over a spirit lamp. A few minutes' boiling will suffice, and a very deep object-glass is not required to bring the objects plainly into view.

Though many of the best botanical systematists have long persisted in arranging the Hydrangeas with the Saxifrages, other eminent botanists, of whom the late Professor Lindley was one, doubted the accuracy of this arrangement, and accordingly made a distinct order of the Hydrangeas. Hence Lindley's Hydrangeaceæ. And the present observations afford a new and unexpected addition to the facts with which he supported his views.

The *Hydrangea hortensis* is the deciduous shrub so common in our gardens that it may be had for examination at any time. This species was introduced from China to Britain upwards of a century since. Another member of the genus, *Hydrangea Thunbergii*, affords in Japan a kind of tea so much esteemed that it is called in that country Ama-tojà, which means the Tea of Heaven.

VI.—*On a Simple Revolving Object-Holder.*

By Washington Teasdale, F.R.M.S.

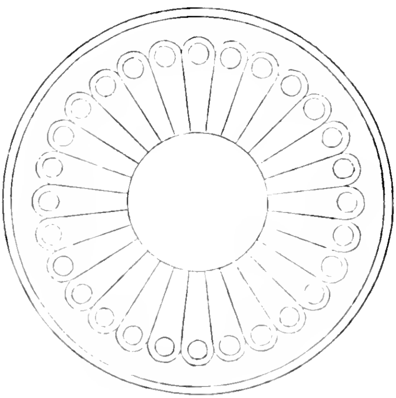
(*Read* 10*th December*, 1879.)

The growing tendency of specialists in late years to make type slides of allied objects, induces me to suggest a mode of displaying them, which I have found very convenient for illustrating a connected series of *low-power* objects. The idea of a revolving object-holder, although not a new one, has not hitherto been worked out in a simple and satisfactory form for general adoption.

The one here described was roughly made by me and exhibited at a conversazione about three years ago.

Fig. 6 represents the "slide" itself, which is a disk, 6 inches in diameter, of cardboard, wood, ebonite, or other light and suitable material, pierced near its periphery with say twenty-four holes ½ inch in diameter; this is cemented upon another disk of equal size, of black cardboard for opaque objects and glass for transparent ones.

Fig. 6.

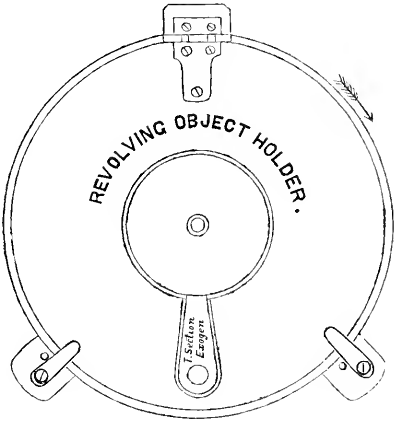


To support this I use a light triangular frame, preferably of close-grained, well-seasoned wood, and fixed to the stage of the Microscope by a stiff brass clamp, furnished with a milled-head clamp screw passing through a slot, and having a circular fork to allow to pass the usual 1½-inch sub-stage tube of the cheaper class of instruments.

As a cover to preserve the objects from dust and allow only one of them to be seen at a time, I provide another light disk, slightly smaller, say 5½ inches diameter, which may be made a very neat one and of any suitable material, with an opening through which one object and its label only can be seen.

Fig. 7 represents the upper view of the whole of the arrangement, the cover-disk hinged to the top of the supporting frame and

FIG. 7.



held down flat by spring clips to its other extremities. These clips turn to the right when it is desired to raise and throw back the hinged cover for the purpose of changing the object-disks on the central pivot, but are prevented by a stop-pin from slipping or moving to the left when the disk is moved (in direct rotation) to bring successive objects into the field.

Suitable objects for presenting thus will readily suggest themselves, say for example, sections of exogens, endogens, and acrogens; growth and development of various forms of animal and vegetable life, and comparison of all kinds of fossil organic remains with the allied forms of the present day.

RECORD

OF CURRENT RESEARCHES RELATING TO

INVERTEBRATA, CRYPTOGAMIA, MICROSCOPY, &c.*

ZOOLOGY.

A. GENERAL, including Embryology and Histology of the Vertebrata.

Development of the Allantois and the Gastrula of the Vertebrata.† — A short time ago Professor Kuppfer (with Professor Benecke) examined the development of *Lacerta agilis* and *Emys europæa*, and observed the development, by invagination of the ectoderm, of a blindly ending sac, the relations of the orifice of which were the same as that of the prostoma (or gastrula-mouth) of *Amphioxus*, and of the anus of Rusconi in the Batrachians; or, in other words, the gastrula-cavity was in these Reptilia found to communicate with the medullary groove. This gastrula-cavity does not, however, become converted into the primitive enteron, and its epithelium does not become connected with the enteric glandular layer; longitudinal sections revealed the fact that the gastrula-cavity of the Chelonian embryo was continued into the hind-gut, and that, therefore, it formed the rudiment of the allantois.

Returning to the subject last summer, Kuppfer made a series of sections with the view of determining the relations which subsist between the allantois and the medullary tube; starting from behind, he found that in his first three sections the dorsal medulla was solid; in the fourth there was a cleft-like lumen, and in it and in the next three it was possible to make out a canal which took a ventral direction from the floor of the central canal and opened into the epithelial sac of the allantois; that is, the allantois is provided with a hollow stalk which passes into the dorsal medulla. This "myelo-allantoid" canal is covered by a regularly arranged cylindrical epithelium, and has on either side an umbilical vessel. This important discovery allows us to carry the gastræa theory into the great division of the Amniote Vertebrata, and does much to explain the phylogenetic history of the allantois.

Describing ‡ the gastrulation of the salamander, Kuppfer points out that the gastrula-mouth does not appear until two ridges have

* ☞ It should be understood that the Society do not hold themselves responsible for the views of the authors of the papers, &c., referred to, nor for the manner in which those views may be expressed, the object of the Record being to present a summary of the papers *as actually published*. Objections and corrections should therefore, for the most part, be addressed to the authors.

† 'Zool. Anzeiger,' ii. (1879) p. 520.

‡ Loc. cit., p. 593.

been formed on the dorsal surface of the egg; then, towards the hinder end of these ridges, and between them, there appears a small depression, which becomes converted into a funnel-shaped invagination; this is the prostoma or anus of Rusconi. Observation of median sections shows that the invagination presses towards the central yolk-cells, and also reveals the presence of a primitive enteric cavity; in later stages a communication is to be observed between the invaginated sac and the primitive enteron, which is effected by means of a narrow cleft. When we compare this process with what obtains in *Petromyzon* we find that the essential difference lies in the greater width of the prostoma. What we know of the mode of formation of the gastrula in the Ganoids leads us to see a marked resemblance between them and the Salamanders; and we may sum up what happens in saying that in all these three forms the invagination is directed towards the yolk-cells which fill up the interior of the egg; with these yolk-cells, the cells of the invaginated endoderm become connected, and, with them, they bound the primitive enteric tube; this last and the neural tube communicate for a time by means of the prostoma.

In the Teleostei the relations are not quite the same; but what it is of importance to note is that the blastoderm does undergo an invagination which has just the same relations as in the already mentioned Vertebrata (in the middle line of the caudal end of the embryo), and that this invagination gives rise to an epithelial sac; the latter was regarded by Kuppfer as the allantois, and he now sees that it represents the primitive endoderm, although it is never, as in the Reptilia, invested by a mesodermal layer; it is not converted into the enteric epithelium, for this is derived from a set of cells which appear to arise by free-cell-formation and which may be known as the *secondary endoderm;* of this we may distinguish two series, one belonging to the enteron and one to the epithelium of the yolk-sac. Availing himself of Mr. Balfour's results, the author comes to the conclusion that in the Elasmobranch fishes the method of development is more similar to that which is seen in the Ganoids and Batrachia than to what obtains in the Teleostei; the cells of the secondary endoderm, although they form the greater part of the investment of the yolk-sac, do not form the whole of it.

With regard to Mr. Balfour's observations on the Lacertilia,* Kuppfer thinks the difference in their results is chiefly due to the condition of the English observer's specimens, and he believes that the neurenteric canal of Balfour is his myelo-allantoid canal; it may be noted that the presence of this canal has been observed by Kuppfer in a chick three days old, where it is about 1 mm. long, and opens into the dorsal medulla by an extremely narrow slit ($\frac{1}{50}$ mm.). Twenty-seven years ago Bischoff observed in the guinea-pig the presence of a process, which beginning from the margin of the embryonic shield grew inwards and downwards, and which, altogether similar to the same development in the Reptilian egg, was the earliest rudiment of the allantois.

* 'Quart. Journ. Micr. Sci.,' xix. (1879).

Absence of the Amnion in the Chick.*—M. Dareste draws attention to the occasional absence of the amnion in the chick, and states that in some cases the embryo is, notwithstanding, quite normally constituted, although it is possible that it would not have lived to break the shell; this is almost certain from the fact that the absence of the amnion would, by hindering the complete development of the allantois, produce asphyxiation of the embryo. Anomalies or death are in such cases produced in various ways; thus, the embryo dies by "desiccation" if brought against the investing membrane of the shell, and all goes to show that the function of the amnion is to protect the embryo against the mechanical forces which tend to compress it. In an "anamniotic" embryo of five days M. Dareste was able to observe very active contractions, which is an interesting point, inasmuch as independent contractions of the embryo have not hitherto been observed until the seventh day; and the movements as observed by von Baer and Vulpian, have been attributed to the contractility of the amnion, which is first displayed on the sixth day; it is now seen that the embryo itself becomes contractile before the amnion, and it seems certain that the contractile elements are first developed in the epidermic layer of the embryo and thence propagated to the epidermic layer of the amnion, which is in structural connection with it.

This mode of activity is entirely independent of nervous influence; and is greatly affected by the temperature to which the animal is exposed, being most obvious from 35° to 40° C., so that it comes to be comparable to the contractile activity of the chick's heart, a very well known phenomenon, first observed by Harvey.

Development of Parrots.†—Max Braun calls attention to a point in the development of the spinal cord of *Melopsittacus undulatus;* in examining an embryo, which was at a stage corresponding to that of the third day in the chick, he observed, in front of the posterior extremity of the medulla, a small cleft in the medullary canal which opened into the endoderm, and so put into communication the rudimentary intestine and the medullary canal. Treated with a weak solution of chromic acid, this was rendered much more distinct; making transverse sections, and numbering them from behind forwards, he found that, in section 44, the medulla was completely closed; in section 39 the medullary canal opened into the endoderm, and remained open for one-fifth of a millimetre. After this the endoderm was closed up. The cleft was found in some later stages, but gradually disappeared. The author has sought for signs of it in the chick, but in vain; he thinks, however, that he has been able to discern it in the pigeon, and Gasser has lately noticed its presence in the goose. Professor Rauber has given the name of blastostoma to this curious cleft.‡

Development of the Ova of Salamandra maculosa and Anguis fragilis. §—Dr. Born, of Breslau, communicates a somewhat fragmentary but very interesting note on an attempt to develop the oval

* 'Comptes Rendus,' lxxxviii. (1879) p. 1329.
† 'Rev. Internat. Sci.,' ii. (1879) p. 359.
‡ 'Zool. Anzeiger,' ii. (1879) p. 502. § Ibid., p. 580.

of viviparous or ovoviviparous amphibia and reptiles external to their mother. In June he opened a female *Salamandra maculata*, in which he found fifteen ova, with embryos from 9 to 10 mm. long; three of these were placed in a cylindrical vessel, of about 300 cubic cm. capacity, which contained a $\frac{3}{4}$ per cent. solution of salt; air was passed through by Greiner's apparatus. At first the embryos did well and continued to develop, but the fluid was not sufficiently dense, and it soon became evident that by osmosis the gelatinous covering was becoming swollen out; as a result, two eggs were one morning found to be dying; the third embryo lived for three weeks, and when dead it was found to have increased to 12½ mm. in length; the yolk had been considerably used up, and the eyes were distinctly pigmented. Similar experiments were made on the ova of *Anguis fragilis*, but it was not found possible to prevent osmosis and consequent death, which is clearly due to the asphyxia resulting from the vascular layer being withdrawn from the surface of the egg.* It is to be hoped that a more useful fluid may soon be found; the amniotic fluid is unfortunately very prone to putrefaction.

Minute Structure of Cells.†—Impressed by the complexity of cell-structure, Professor Julius Arnold has subjected to a critical examination the characters of (1) ganglion-cells, (2) smooth and striated muscular fibres, (3) glandular, (4) hepatic, and (5) salivary gland cells; (6) epithelium, both that of the mucous membrane and that which is ciliated; (7) the lens which is stated to be a specially suitable subject for examination, while (8) cartilage and (9) embryonic cells are also studied. The author passes to certain pathological conditions, of which he says that when their characters are compared with those of normal tissues certain differences and certain resemblances are found; thus, in both cases, the filamentar structure is very much the same, while in other points the abnormal cells give an indication of the increase in them of the nutrient processes. In both normal and pathological relations, cells possess a complicated structure; the two constituents, as ordinarily distinguished by us, the cell-body and the cell-nucleus, consist of a ground-substance as well as of granules, sets of granules, and filaments; these latter may become very complicated in the more highly developed forms of cells. He would regard a cell as consisting of a nucleus and of an investing mass, both of which contain in a homogeneous ground-substance granules and filaments; further observations are necessary before we can say whether the names of paraplasma and protoplasma as applied by Kuppfer to the two constituent parts of a cell, are or are not justified by morphological, genetic, and functional relations; but whatever future results may lead to, Dr. Arnold has no doubt that they will demonstrate that the structure of the cell is not so simple as it is ordinarily considered to be.

Nucleus in Cell-division.‡—In discussing the changes undergone by the nucleus in cell-division, Professor W. Flemming distinguishes

* Cf. Note by M. Dareste, *ante*, p. 49.
† 'Archiv path. Anat. u. Phys.' (Virchow), lxxvii. (1879) p. 181.
‡ Ibid., p. 1.

two methods of division which have been described by various observers, the *direct* and the *indirect*.

In the direct method, which was, until recently, supposed to be the normal one, the nucleolus first divides, then the nucleus, and finally the cell.

In the indirect method, the nucleus first of all undergoes metamorphosis, separating into a network of highly refracting filaments (kernfigur), which take up colouring matters strongly, and an intermediate substance not affected by staining fluids. The nuclear network goes through a definite series of changes,* and finally divides into two equal or subequal masses, which retreat from one another and go through, in inverse order, the changes undergone by the mother nucleus, finally forming the nuclei of the two daughter-cells. The cell-body divides after the young nuclei have separated from one another, but before they have assumed the characteristics of quiescent nuclei.

It is this indirect cell-division which recent researches have shown to be of such wide occurrence.† As to the direct method, Flemming states his disbelief that it ever takes place. The chief facts in its favour are the occurrence of bi- or multi-nucleate nuclei, of reniform or biscuit-shaped nuclei and of bi- or multi-nucleate cells. He considers that multinucleate cells are cells in which indirect division has begun, but has undergone arrest; that the formation of several nuclei in one cell by direct division has never been observed, except in one doubtful case, and that the steps of the apparently direct division in motile cells (leucocytes, &c.), are probably homologous with, but simpler than, those which characterize the indirect division of fixed cells.

Professor Flemming remarks on the fact that the indirect method has only been discovered of late years, and considers that this is due to the tissues not having been examined in the living state; in the case of preserved tissues, to their not having been placed living into the preservative solution; to the fact that cell-division probably exhibits periodicity, going on vigorously at certain times, and but little, or not at all, in the intervals; and, lastly, to the circumstance of the most suitable reagent for preserving and staining not having been used.

He is quite convinced that all cases in which cell-division has been thoroughly and certainly followed out, show the process to be an indirect one; that is, to be due to a filamentous metamorphosis of the nucleus.

As to reagents, Flemming states that Müller's fluid and potassium bichromate are unsuited for observing the division-figures of the nucleus, and recommends a 0·1 to 0·2 per cent. solution of chromic acid, or a saturated solution of picric acid. After treatment with one of these fluids the tissues should be thoroughly washed, and stained either with hæmatoxylin or with Hermann's aniline staining fluid—the latter not answering well for picric acid preparations.

* See this Journal, ii. (1879) p. 137.

† Ibid., pp. 137, 273, 692.

Ganglion-cells in the Arachnoid Membrane.*—Dr. Löwe calls attention to his previous discovery of large ganglion-cells on the olfactory bulbs of the rabbit, lying on the interior layers of the arachnoid. These cells together make up a small ganglion, whose exact position is on the outside of the olfactory nerve-bundles of the bulb, at about the middle of its lateral surface; it is found represented in every vertical section of the bulb from front to back. The cells lie beneath the investing arachnoid, and the pia mater sends out a sheath which envelopes separately each cell of the ganglion, so that, though closely connected with, it is yet shut off from the nerve-fibres. The cells are round, and exhibit no processes.

Their function is apparently sensory, and possibly connected with sensations of *headache*.

Similar cells are found also on the convex surface of the cerebrum: the arachnoid may be shown to contain them here by transferring the freshly exposed brain to a vessel containing some perosmic acid; in this case the cells are found sparingly, and here also without apparent connection with the abundant nerves which pass close to them in the membrane. They are round cells, enclosed in distinct capsules, and lie close beside the nerve-stems.

This is an important addition to our knowledge of the sympathetic system, although as long ago as 1850 Luschka and Rudinger had traced sympathetic and other nerves into the dura mater; later, Rainey and Bourgery demonstrated nerves in the arachnoid, and assigned them to the sympathetic, but neither in these nor other researches had the presence of peripheral nerve-cells been shown.

Scales of Osseous Fishes.†—Professor Carlet publishes a short memoir on this subject, and the following is a summary of his chief conclusions. The scales are singly or doubly refractive, according as they are young or old; as the organic matter constituting the scales is always singly refractive, it is clear that the doubly refractive condition is due to its impregnation by inorganic salts, which become either more abundant or more compact as the animal grows older; investigations with the aid of picrocarmine reveal the fact that the peripheral and the deeper parts of a scale are younger than the central and the more superficial parts. In those fishes in which the scales are imbricated, they are placed in hexagonal prismatic cavities, and the facets of these prisms become so folded as to form two planes, one of which becomes attached to the posterior edge of the scale next in front, while the other passes over the subjacent scale. The so-called spinules which are connected with some of the scales, are shown to be hypodermic in origin, just as are the other parts; and it is by the fact that the scales are not of epidermic origin that we are able to show that they should not be compared with the hairs of mammals or the feathers of birds, which are epidermic structures. The most important point in their "physiology" seems to be that they are only displaced *passively*; but this change in their position is easily effected, owing to the extremely loose character of the tissue in which they are implanted.

* 'Arch. Mikr. Anat.,' xvi. (1879) p. 613.
† 'Ann. Sci. Nat.,' viii. (1879) art. 8.

B. INVERTEBRATA.

Mollusca.

Homologies of the Cephalopoda.*—Mr. J. F. Blake draws attention to some points in the anatomical structure of the various groups of the Mollusca, and suggests that the arms of the Cephalopoda are homologous with the opposite portion of the "architroch" to that which forms the velum, and that they are another example of the retention of primitive formations as functional organs. If this view be correct it will be necessary to find elsewhere than in the arms the part which is homologous with the foot of the other Mollusca. Mr. Blake knows of only one structure which he can suggest, and that is the median valve which is found within the funnel.

An interesting fact to which the author calls attention is the evidence which every new fact in the developmental history of the Dibranchiate Cephalopoda affords as to the retention of their embryonic stages by the *Nautilus*. For example, not only is the funnel of the *Nautilus* always, and that of the Dibranchiata during embryonic stages only, formed of two distinct halves, but the ink-bag, which is never found in the *Nautilus*, only appears late in the history of the Dibranchiata, and the eye of the *Nautilus* remains permanently in a condition which is transitory in the other group. Nor is this all: the Tetrabranch has the auditory organs close to the eyes; but in the Dibranchiata the eyes gradually leave this position, and grow closer and closer till they meet on the ventral side. The author inclines to Valenciennes' view, that the eight or six processes on which the tentacles of the *Nautilus* are found are homologous with the eight arms of the *Octopus*. An interesting arrangement of the shell is noted, and further details are promised in a forthcoming monograph.

New American Cephalopoda.†—Among the numerous additions recently made to the marine fauna of the eastern coast of North America are two new Cephalopods, both belonging to the eight-armed division.

The more interesting one (*Stauroteuthis syrtensis*) is the second known representative of the remarkable family of Cirroteuthidæ, characterized by the presence of a pair of fins, one on each side of the body, supported by a transverse cartilage; by the presence of a great web surrounding and uniting all the arms nearly to their tips; and by the presence of two slender cirri between the suckers, along the greater part of the length of the arms. This species differs so widely from *Cirroteuthis Mülleri* Esch., the only representative of the family hitherto described, that it is necessary to constitute for it a new genus.

Stauroteuthis, gen. nov.

Allied to *Cirroteuthis*, but with the mantle united to the head all around, and to the dorsal side of the slender siphon laterally and ventrally. Fins triangular, in advance of the middle of the body.

* 'Ann. and Mag. Nat. Hist.,' iv. (1879) p. 303.
† 'Am. Journ. Sci. and Arts,' xviii. (1879) p. 468.

Dorsal cartilage forming a median angle directed backward. Body flattened, soft, bordered by a membrane. Eyes covered by the integument. Web not reaching the tips of the arms, the edge concave in the intervals. Suckers in one row. Cirri absent between the basal and terminal suckers. Right arm of second pair is altered in the male at the tip.

The other species is a true *Octopus* (*O. piscatorum*), and is easily distinguished from *O. Bairdii* by its more elongated body; its much longer and more tapered arms, with shorter web; by the absence of the large, rough, pointed papilla, or cirrus, above the eyes; and by its general smoothness. The white colour of the under side of the neck, siphon, and mantle-border, also appears to be characteristic.

Locomotion of Land Snails.*—We have already dealt with Dr. Simroth's first paper on this subject; † he now continues his observations, directing especial attention to *Limax cinereoniger*.

His chief conclusions are these: the action of the locomotor waves is to be distinguished from any movement of any other part of a gasteropod's body by the fact that it has a peculiar connection with the will (œsophageal ring); not only is it set in action voluntarily, but it is brought to a stop by the same influence. It has been already shown that there is a difference in the results of different muscles, and Simroth now points out that the voluntary musculature is contractile; and the locomotor—which is thus far automatic, that having set it in action the will can in no way influence its activity, save by stopping it—is extensile. Upon this extensile system the will has just the influence that we have over a watch; set in action, it must go on by its own relations like the wheels of the watch over which we have no individual control. The contractile musculature may be divided into two parts, one of which is set parallel to the long axis of the body, while the other is at right angles to this. The extensile system is made up of longitudinal bundles which pass, anteriorly and posteriorly, into the integument; its automatic action is influenced by a special nerve-plexus, which is in connection with the pedal nerves, and which, from its functional relations, seems to stand midway between the sympathetic and the cerebro-spinal system of the Vertebrata. So long as this locomotor group of muscles is alone in activity, the animal continues uninterruptedly on a straight course; should it move to the right or left, it is only because the muscles of one side are in special activity. An interesting relation is noticed between the circulatory system and the locomotor muscles; the foot can only contract so long as it is swollen out by blood; for this purpose there is placed in the middle line of the foot of *Limax* a sinus, which forms a veritable corpus cavernosum; and while this swelling has a distinct influence on the foot itself, it also seems not unreasonable to suppose that it is of importance in the considerable alteration in material ("metabolism") which must go hand in hand with any large amount of muscular activity.

* 'Zeitschr. wiss. Zool.,' xxxii (1879) p. 284

† This Journal, ii. (1879) p. 399.

Viviparity of Helix Studeriana.*—Three species of *Helix* have already been shown to be viviparous—*Helix* (*Partula*) *gibba*, *H. rupestris*, and *H. inæqualis*. To these a fourth is now added, M. C. Viguier having examined the portions of two specimens (in alcohol) of *H. Studeriana* (Férussac) brought from the Seychelles in 1875 by the naturalist of one of the 'Venus' expeditions.

The first specimen consisted of the uterus only. It was of a dull white colour, and perfectly opaque. When opened, it was found that its walls were excessively thin and transparent; but it was filled with a white, granular substance, which, falling to the bottom of the vessel, allowed two membranous sacs to be seen, which were filled with the same white substance, and each contained a young *Helix*. The animals measured ·009 to ·01 mm. in diameter, and had a spire of nearly two whorls. In the centre of the foot was a kind of cord spirally twisted and formed by the rolling up of the membrane of the sac. It was ascertained to be continuous with the internal organs, which, however, it was impossible to make out, having regard to the condition of the specimens. The same granular, white substance, probably a nutritive vitellus, filled the interior of this cord, which was not traversed by any vessels.

It is not suggested that there is here a case of true placentation, as has been observed in the *Salpæ*. The young animal is suspended by its cord in the interior of the sac, which is simply contiguous to and not continuous with the walls of the uterus.

The second specimen consisted of the uterus and its attendant organs. In this case the walls were transparent, and two young animals (·014 to ·015 mm. in diameter) could be seen through them, with only scattered clots of white substance, the animals being more fully developed than in the first specimen.

The necessity of preserving the specimens, which are unique, prevented any closer examination.

Organs of Taste in Heteropoda.†—F. Todaro and C. Milone found in sections prepared from the so-called "proboscis" of Pterotrachea, preserved in Owen's fluid, a special epithelial protuberance in the form of a bulb or knob, which they consider the gustatory organ. This was first found in the epithelium of the mucous membrane of the mouth, and afterwards in the external epithelium of the anterior extremity of the "proboscis" surrounding the oral aperture.

The gustatory papillæ were found in very long, cylindrical epithelium-cells of the proboscis; this stratum of cells is covered by a thick cuticular layer on which arise towards the bottom of the cavity the cuticular teeth and the radula. In the mouth itself the cylindrical epithelium is placed in the connective fibrillar tissue of the mucosa. The gustatory papillæ of the oral mucosa are found disposed in series (two or three series on each side) along the lateral wall, extending from the base of the cavity, i. e. in front of the radula, to the labial margin, and continue spread irregularly in the external skin.

* 'Comptes Rendus,' lxxxix. (1879) p. 866.
† 'Trans. R. Accad. dei Lincei,' iii. (1879) p. 251.

The authors say that the gustatory papillæ of the Pterotrachea have the same structure as those of the Mammalia. The internal cone is surrounded outside by sensitive cells with a large vesicular nucleus, occupying the greater part of their body. These are connected with nervous fibrillæ, and have on the peripheral extremity a long sensitive hair. The sensitive hairs of the gustatory cells of the oral papillæ traverse the canal of the cuticular layer, and reach the level of the gustatory pore; whereas in the organs of the external skin, where the cuticular layer is thin, the sensitive hairs start from the gustatory pore and rise above the surface in the form of a brush.

Each sensitive organ receives a nervous fibre, which is much more apparent in the organs of the external skin, and it is here clearly seen how a nervous fibre separates from the main nerve to each organ, passing through the cartilaginous layer to the base of the papilla.

The nerve of the Pterotrachea possesses a transparent elastic sheath and an axis-cylinder which is clearly seen to be formed of fibrillæ. When the nerve reaches the base of the gustatory organ it is without a sheath, and the fibrillæ of the axis-cylinder separate, penetrating into the gustatory corpuscles, and join with the central extremity of the gustatory cell.

The authors promise to extend their investigations to other species of Heteropoda.

Development of the Chitons.*—All the forms examined by Professor Kowalewsky were monœcious, and the males were observed to emit their sperm through two orifices, which are placed superiorly to the branchiæ. The females laid their eggs somewhat later, and, in many cases, during the night; they were similarly passed out from two suprabranchial orifices, and seemed for a time to remain attached to the gills, where they were fertilized by the spermatozoa contained in the stream of water which passed over these organs. In *Chiton Polii* the ova passed through their early stages of development before leaving the protection afforded them by the gills; in some species the investing chorion became impregnated with calcic carbonate.

Cleavage is regular, but after the appearance of the sixty-fourth blastomere the sphere becomes divided into two halves, and the cells in the upper divide more rapidly than those in the lower region; this gives rise to a stage in which the embryo forms a somewhat elongated sphere and contains a small blastocœle. The gastrula now begins to be formed in the following fashion: the lower and median portions of the half which contains the larger cells begin to be invaginated; a ring, formed of two rows of cells, is formed around the egg, and divides it into a superior (cephalic) hemisphere, and an inferior (invagination) hemisphere; the cells of the latter, which are much the largest, develop cilia, and on the half of the embryo which lies opposite to the invagination orifice there is differentiated a group of three or four cells, which, by developing cilia, form the anterior tuft. The gastrula has now the form of a body in which the blastopore is placed at the inferior pole, and in which there is a double row of ciliated cells,

* 'Zool. Anzeiger,' ii. (1879) p. 469.

and an anterior tuft of cilia; a remnant of the segmentation cavity is still to be observed at the superior end.

As the embryo elongates, the mouth (blastopore) passes, according to the author, on to the ventral side; losing its rounded form it becomes oval, and then finally cleft-like, and comes to lie in a kind of deep groove. Being set close to the ciliated ring, it may be observed to have the form of an elongated tube, opening by its interior orifice into the digestive tract, and by its exterior to the surrounding medium. The walls of this tube soon fuse, and the cells form a plate which lies between the body-wall and the wall of the enteric tract. The mesoderm has meanwhile commenced to develop; arising from the lateral and lower cells of the endoderm, without, however, yet forming a continuous layer.

The next step is that in which the embryo elongates, its outer cells diminish in size, and the cilia set up an active rotatory movement. A circular groove soon separates the anterior from the posterior portion of the body, and the whole of the ventral side forming a flattened plate becomes developed into the foot of the larva; at the same time there appear on the dorsal side six or seven transverse grooves, which divide the back of the larva into a corresponding number of half-rings. At this time the embryo breaks through its chorion. The enteric tract arises from the gastrula invagination; the muscles become developed in the mesoderm, and the nervous system, which consists, even at this early period, of two lateral and of two median trunks, together with cephalic ganglia, appears to arise chiefly from the large-celled plate which is developed at the point where the primitive mouth disappears. Even before the formation of the foot two black dots may be seen, which are evidently eyes and are provided with small lenses.

In this condition the larva may swim about for an indefinite time; when it fixes itself by its foot the ring of cilia disappears, and the spicules which form the shell begin to be developed. Appearing during the larval stage, in some forms, the calcareous spicules have at first the form of simple spicules, first developed in the cephalic region. When enough are present to form a closely set group, they fix their lower ends deep into the tissue. After these bodies are developed there appear a median and two lateral minute calcareous plates in each division of the body, which soon fuse and form the proper shells, while the earlier spicules are forced to the margin of the body, partly to disappear.

It is finally stated in this preliminary communication that the whole of the dorsal surface of the embryo is covered with large cylindrical cells, altogether similar to the cells found in the mantles of other molluscan embryos.

Spermatogenesis in Paludina vivipara.*—In a memoir referring to what has been previously written on this subject, and summing up his own results, M. Duval says that his previous conclusion—that the two forms of spermatozoa noticed in this mollusc are but stages in the development of a single form—has been since refuted.

* 'Rev. Sci. Nat.,' i. (1879) p. 211.

Of the two kinds of spermatozooids found, the one, the so-called *vermiform spermatozooid*, is a long tube, whose finer end terminates in a slight enlargement, the other, broader one ending in a tuft of cilia. Their movements present a remarkable difference from those usually observed in spermatozoa; they are *reptant*, and move by a slow, serpentine undulation of the body, aided by irregular vibrations of the cilia, and by a right-and-left movement of the head.

The *filiform spermatozooids*, on the other hand, possess a cork-screw-shaped cephalic end made up of fine bends, and a fine, thread-like caudal termination. They are half the length of the vermiform kind, and move very rapidly, by means of a rotation of the cephalic end, together with vibrating oscillations of the caudal end.

With regard to the development of these forms, which both occur, together with mother-cells, in April in the testis, they may be distinguished at an early stage. In sections of the testis, taken at the beginning of April, were recognized mother-cells of two different sizes, attached to its wall. The mother-cells contain, near their attached side, a dark oval nucleus (the "*principal nucleus*"; so named in *Helix*); round this lie a number of smaller nuclei in the protoplasm.

The evolution of spermatozoa from these cells is first traced at a somewhat later stage, in which their attached side is shown by the action of osmic acid to be full of granular, fatty matter, which veils the nucleus when stained. In al ohol preparations this, the principal nucleus, is seen to be long and oval, and to be surrounded by a number of smaller nuclei enclosed in cells clustered racemosely; these cells are the *spermatoblasts*. The disproportion between the two sizes of generative masses is still maintained. The smaller spermatoblasts now undergo a very rapid transformation, resulting in the production of bundles of the smaller, *filiform*, male elements arranged parallel with each other. The complete development of the larger, *vermiform*, elements, follows this circumstance thus. At the time at which the small ones are fully developed (the end of April), the spermatoblasts of the former are pyriform, nucleated cells, connected with the gland-wall by a short pedicle, and are distinct from each other at their distal ends, while they meet proximally in the mass which contains the principal nucleus. Towards the end of May, some bunches present spermatoblasts much elongated, into a racquet-like shape, whose volume and the distinctness of whose nuclei has become less, and on whose larger (distal) ends small ciliated appendages occur. Another bunch at this time, looked at as a whole, has the appearance of a *bundle*, which is made up of very elongated sub-cylindrical spermatoblasts, containing traces of nuclei at the free ends, which are slightly dilated, and now carry manifest *cilia*. Finally, side by side with the last, may be found bunches of completely developed spermatozooids, almost perfectly cylindrical, with no traces of nuclei, still implanted in the basal mass containing fatty granules.

Thus the two kinds of spermatozooids are developed independently at somewhat different periods. A more careful study of the larger kind by teasing and examination of the fragments of the gland, instead of by sections, as hitherto, shows large, pear-shaped, nucleated spermatoblasts, but also provided with cilia, to occur. The cilia penetrate deeply into the cell-substance, and meet at a certain dark spot; another cell, still containing the nucleus, will show the cylindrical body of the spermatozooid traversing the cell, with the cilia at one of its ends. It may, perhaps, prove to be developed from the dark spot just mentioned. It is determined satisfactorily that the spermatozooid is formed within the cell, and does not result simply from its elongation, for it may be found in a still more advanced state still enveloped to a greater or less extent by a sheath containing protoplasm with or without a nucleus.

In both kinds of sperm-cells three parts—tail, body, and head—may be shown by reagents to be present, and quite distinct from each other. Exposure in a damp chamber for thirty-six hours has the effect of killing and causing the dissolution of the large forms, while the small ones remain recognizable in all their parts, and sometimes motile.

C. Siebold has attempted to show the two forms to be mere stages of one, but later regarded the vermiform one as a spermatophore. Leydig gives a fact confirmatory of their distinctness, viz. that the two forms are to be found within the envelope of the ovum. Kölliker argues, from others' observations, that the large forms are mother-cells for the small ones. Baudelot considers the large forms—his "ciliiferous tubes"—to be a *stage* of the filiform, which are the fully developed spermatozoa.

Embryology of the American Oyster.*—All the writers upon the development of the oyster, from Home (1827) to Möbius (1877), state that the eggs are fertilized inside the shell of the parent, and that the young are carried inside the mantle-cavity until they are provided with shells of their own; that they leave the parent in a somewhat advanced state of development, and that their free-swimming life is of short duration, and lasts only until they find a suitable place to attach themselves.

Mr. W. K. Brooks, of the John Hopkins University, U.S., says that in 1879 he carefully examined the gills and mantles of more than one thousand oysters (from one bed), but never found a single fertilized egg or embryo inside the mantle-cavity of an adult, although he found females with the ovaries full of ripe eggs, others half empty, and some almost entirely so, with all the intermediate stages; so that he concludes that there is an important difference in the breeding habits of American and European oysters, the eggs of the former being fertilized outside the body of the parent. During the period which the European oyster passes inside the mantle-cavity of the parent, the young American oyster swims at large in the open ocean.

The more important points in the development of the oyster, also established by the author by means of the artificial fertilization of a large number of eggs taken from the ovaries, are:—

1. The oyster is practically unisexual, since at the breeding season each individual contains either eggs or spermatozoa exclusively.

* 'Am. Journ. Sci. and Arts,' xviii. (1879) p. 425.

2. Segmentation takes place very rapidly, and follows substantially the course described for other Lamellibranchs by Lovén and Flemming.

3. Segmentation is completed in about two hours, and gives rise to a gastrula, with ectoderm, endoderm, digestive cavity and blastopore, and a circlet of cilia or velum. At this stage of development the embryos crowd to the surface of the water, and form a dense layer, a little less than a quarter of an inch thick.

4. The blastopore closes up; the endoderm separates entirely from the ectoderm, and the two valves of the shell are formed separate from each other at the edges of the furrow formed by the closure of the blastopore.

5. The digestive cavity enlarges and becomes ciliated, and the mouth pushes in as an invagination of the ectoderm at a point directly opposite that which the blastopore had occupied. The anus makes its appearance close to the mouth.

6. The embryos scatter to various depths, and swim by the action of the cilia of the velum. The shells grow down over the digestive tract and velum, and the embryo assumes a form so similar to many marine Lamellibranch embryos which are captured by the dip-net at the surface of the ocean, that it is not possible to identify them as oysters without tracing them from the egg. The oldest ones raised in aquaria were almost exactly like the embryos of *Cardium* figured by Lovén.

7. The ovaries of oysters less than 1½ inch in length, and probably not more than one year old, were fertilized with semen from males of the same sizes, and developed normally.

A detailed account of these observations is to be published in the Report of the Maryland Fish Commission for 1879.

Molluscoida.

New Species of Polyzoa.*—Mr. C. M. Maplestone describes a new species of Cheilostomatous Polyzoa, which presents peculiar features.

Bicellaria annulata.—Cells elongated, contracted in front below, aperture oval; four to five marginal incurved spines on outside edge; one spine on summit of aperture extending behind superior cell; one spine on lower portion of aperture extending inward underneath marginal spines; back of cell with a bifurcate elevation; cells growing on a corneous, tubular, spindle-shaped growth, with annulated branches bearing cells.

The peculiarity of the species is the structure upon which the cells grow; and from the ringed appearance of the individual spindles and the more strongly annulated branches the specific designation is derived. In fact the author almost thinks that a new genus is requisite for its reception.

Mr. J. R. Y. Goldstein also describes † a new species belonging to the Gymnolæmata of Allman (suborder *Ctenostomata*, family *Serialaridæ*).

Serialaria Woodsii.—Polypidom of a brown colour, light to dark; horny, fistular, branched, forming dense tufts, three to four inches in height; branches alternate, spreading, subdichotomous towards the

* 'Quart. Journ. Micr. Soc. Vict.,' i. (1879) p. 19. † Ibid.

extremities; basal tube corrugately jointed between the internodes; cells tubulous, *biserial*, unilateral, adnate to each other, gradually shorter outwards, apertures thickened, arranged in companies of five to ten pairs on each internode, straight, and much inclined outwards. Two tapering, slender, hollow processes, jointed to basal tube immediately behind the outer cells of an internode; not constant, sometimes a fresh branch taking the place of one. These setaceous processes frequently have septæ across them at irregular intervals, and are sometimes branched. Their length varies much, often three times the length of an internode, sometimes quite short, one of a pair frequently much shorter than its fellow, and sometimes club-shaped. Masses are frequently found cast upon the beach without these appendages, as they soon drop off when dead. Ovicells not seen. The animal has eight tentacles.

The only species with which it has any affinities is *Serialaria Australis*, described by Rev. J. E. Tenison Woods, in a paper read before the Royal Society of N. S. W. 4th July, 1877, and, like it, has peculiar characteristics, notably the fact of the cells being biserial, which will necessitate a modification of Lamarck's generic description.

Mr. Maplestone recently obtained the same species alive, and found on a cursory examination that the tentacular crown seemed to arise from a calyx, as in the fresh-water Polyzoa.

Arthropoda.

Unicorneal Eye in Tracheata.*—An important paper on the structure of the simple eyes or stemmata of Myriapods and Arachnids, is contributed by Prof. V. Graber, who has investigated among Myriapods, *Scolopendra*, *Julus*, and *Lithobius*, and among Arachnids, *Scorpio*, *Buthus*, *Epeira*, *Tegenaria*, and *Thomisus*.

The simple eye is formed externally by a doubly convex thickening of the chitinous cuticle; this thickening, the *cornea-lens*, resembles the general cuticle not only in its lamellar structure, but also in the presence of fine pore-canals.

Just as the cornea-lens is formed by a thickening of the cuticle, so the next layer, the so-called *vitreous body*, is a special development of the hypoderm, with which it is perfectly continuous. It consists of a single layer of transparent, double-contoured cylindrical cells, separated by small intercellular spaces. The so-called *iris* of *Buthus*, &c., is produced by a development of pigment in the cells of the same layer which lie beneath the circumference of the cornea-lens.

Beneath the hypoderm cells is a delicate inner cuticle or limiting membrane (hypodermale Grenzhaut): this, on reaching the eye, splits into two layers, one of which, the *præretinal lamella* or so-called hyaloid membrane, bounds internally the cells of the vitreous body, thus having the same relation to them as the whole inner cuticle has to the hypoderm, while the other layer passes directly inwards, i. e. away from the surface of the body, and forms an investment or *sclerotic* to the whole retina. The latter is therefore enclosed between these two layers of the inner cuticle, which together form a capsule perforated only by the optic nerve.

* 'Arch. Mikr. Anat.,' xvii. (1879) p. 58.

The presence of the præretinal lamella between the vitreous body and the retina is an argument against Grenacher's theory of the hypodermal (though it does not exclude the ectodermic) origin of the arthropod retina.*

The author's description of the retina differs in many important respects from that of former observers, e. g. Grenacher. The optic nerve, piercing the sclerotic, breaks up into a great number of fibres, each of which is in direct connection with one of the visual cylinders (Retinaschlauch or Endschlauch), a large globular nerve-cell with vesicular nucleus and granular nucleolus occurring at the junction between the two. In the distal or corneal end of each visual cylinder is embedded a highly refractive rod, bluntly pointed at its distal end, but at the opposite or proximal end breaking up into delicate fibrils, which are probably directly continuous with the protoplasm of the nerve-cell, and through it with the fibres of the optic nerve. Besides the large nucleus in the nerve-cell, there is a nucleus in the corneal end of the visual cylinder beyond the distal end of the crystalline rod, and probably another in the middle of the cylinder. The presence of these nuclei renders untenable the view of Grenacher that each segment of the visual apparatus is the equivalent of a single cell: they show that at least two and probably three cells contribute to its formation. Probably, therefore, the visual segment of the single eye is not directly comparable with that of the compound eye.

The visual cylinders do not all pass directly to the vitreous body, or rather to the præretinal lamella, and so lie in the direct path of the light-rays; those situated peripherally turn outwards, and end against the inner surface of the sclerotic, of which they probably form the matrix, just as the cells of the vitreous body are the matrix of the præretinal lamella.

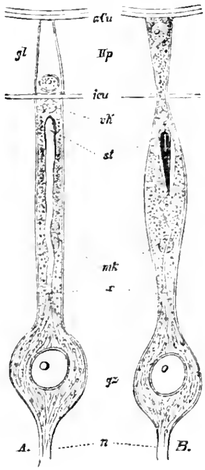
Another important point about the visual cylinders is that they are not truly isolated structures, but are arranged in groups of five, the distal pointed ends of the crystalline rods of each group bending inwards or towards the axis of the group. Each group thus forms a pentamerous, retinula-like, perceptive organ, of higher order than the single visual segment.

In the course of his remarks on the retina, Graber enters upon a comparison of a visual segment of the simple eye (Fig. 8, A) with an acoustic segment (tympanale Endschlauch) of the auditory organ of *Acridium* (B). In both the nerve (*n*) dilates into a nerve-cell (*gz*), which is followed by a protoplasmic visual or acoustic cylinder, in which are enclosed an anterior (*vk*) and a middle (*mk*) nucleus, and a rod-like body (*st*) in direct connection, through the ganglionic corpuscle, with the nerve. The acoustic cylinder is continued distally

* If the suggestion here made by Graber turns out to be correct, the comparison between the arthropod and the vertebrate retina will be far simpler than it is now assumed to be. For if the retinal rods of the simple eye of the Tracheata are not derived from the hypoderm or general epiblast, it is possible that both they and the fibres of the optic nerve may be formed from the cells of a special optic outgrowth of the brain, and be thus, like the vertebrate rods and cones, of indirect epiblastic origin. But careful embryological investigations are necessary to settle the question, which is by no means decided by the presence of the præretinal lamella.

into a nucleated body (*Hp*) which, although not separated from the cylinder by a cuticular membrane, seems to answer to a cell of the vitreous body (*gl*). The comparison—interesting as illustrating the fundamental similarity of sense organs—is illustrated by the woodcut reproduced. The paper is moreover accompanied by three plates.

FIG. 8.



A, diagram of a visual segment of *Buthus;* B, diagram of an acoustic segment of *Acridium.* *acu*, outer cuticle; *Hp*, hypoderm; *gl*, vitreous body; *icu*, inner cuticle; *vk*, distal nucleus; *st*, crystalline rod; *mk*, middle nucleus; *x*, axial cord; *gz*, nerve-cell; *n*, optic or auditory nerve.

a. Insecta.

Blastoderm and Yolk-balls in Insects.*—In a paper on this subject Dr. Alexander Brandt of St. Petersburg comes to the following conclusions:—

The yolk-balls (Dotterballen) of insects are not the morphological equivalents of cells, but are elements of a higher order. They do not originate in a diffusion (Zerfliessen oder Aufgehen), through the yolk, of the protoplasm of the intravitelline germ-cells, or, to put it in another way, by a deposition (Einlagerung) of yolk-substance in the protoplasm of these intravitelline cells, but by the accretion (Umlagerung) of yolk-spherules around them. The yolk-balls are, therefore, like the egg itself, and unlike the germ-cells, not primary cells (cellulæ primariæ s. cyta), but secondary cells (cellulæ secundariæ s. metacyta).

Correlation of Mutilation in the Larva with Deformity in the Imago.†—M. Mélise has operated upon ten selected silkworms by cutting off the right metathoracic leg of each. All went through their

* 'Arch. Mikr. Anat.,' xvii. (1879) p. 43.
† 'Comptes Rendus Soc. Entomol. Belg.,' 1879; see 'Proc. Entomol. Soc. London,' 1879, p. xxxii.

transformations, and the operation caused, apparently, little inconvenience, for they recommenced feeding almost immediately afterwards. The effect on the moths produced from these larvæ was as follows:—One was deprived of three tarsal joints, but the claw was developed. Three were deprived of three tarsal joints, and of the claw also. Three had only the femur and tibia. One had the leg "amputated" in the middle of the femur. The two others had only a stump scarcely a millimetre in length. M. Mélise adds that in not one of the moths was the leg absolutely absent, and that the variation in the amount of deformity probably resulted from the difficulty of performing the amputation in the larvæ at precisely the same place in each. In the case of insects with incomplete metamorphoses parallel experiments have often been made, and with similar results; but, Mr. M'Lachlan points out, with Lepidoptera they have been so few as to render confirmatory evidence of the statements of other experimenters of much value.

Morphology and Ancestry of Insects.*—Mr. Wood-Mason makes use of the following observations on certain of the Orthoptera in support of the theory that insects have been derived from crustacean ancestry:—

The position, he considers, of the *antennæ* of the Thysanuran *Machilis*, relatively to the eyes and mandibles, point to a homology with the antennæ proper of crustacea; but further, in *Machilis maritima* the two-jointed peduncle of the antenna shows a small blunt papilla on its inner side near the distal end; an Indian species of the allied form, *Lepisma*, has a minute but movable appendage in the same position on the peduncle. Now, in the Myriapod *Pauropus*, Sir John Lubbock has shown the antenna to be biramose, the two rami springing from the peduncle, which is two-jointed in an early stage; this condition is practically that of the crustacean antenna, with its *protopodite*, *endopodite* and *exopodite*, with which the antenna of *Machilis* is thus connected through the medium of *Lepisma* and *Pauropus*. The ripe embryos of *Blatta* (*Panesthia*) *javanica* show a similarly placed tubercle on their two-jointed antennary peduncle.

Again, the *mandible* in *Machilis* has three joints, the second representing the second and third of Myriapoda; while in the embryo of the above-mentioned *Blatta*, *four* are indicated by three folds by which the mandible is constricted; only one existing in the adult, whose ancestor nevertheless appears to have had the four joints typical in Myriapoda. The mandible in *Machilis* is bifid in front, being divided into a molar and cutting segment by a deep fork containing an integumental fold: in *Lepisma* the fork is a notch and in the cockroaches it is still a notch; the two divisions probably represent an endopodite and exopodite, which seems confirmed—among other proofs—by the presence in some Staphylinid beetles of a movable appendage articulated to the jaw in the same position as the usual molar process, which is absent in them, and probably represents the endopodite of the crustacean mandible.

On each of the four posterior *legs* of *Machilis* is to be found, as

* 'Trans. Entomol. Soc. Lond.,' 1879, p. 145.

shown by Sir J. Lubbock, an appendage articulated to the suture which constricts the coxa, on the upper side of the leg; in *Lepisma* and *Blatta* the coxa is two-jointed and articulates with a basal joint; so the accessory appendage in *Machilis* represents an exopodite articulated to a three-jointed protopodite, the condition shown by the crustacean *Peneus*, &c.

In the Myriapod *Scolopendrella* almost all the legs possess an appendage similar to the previous one, on the inner side of the first free basal joint, apparently representing an endopodite; this necessitates the leg itself being regarded as an exopodite, whereas that of insects must be an endopodite.

The movable *appendages* of the *abdominal* sterna in *Machilis* are articulated to an intervening sclerite—which is probably the condensed protopodite—and represent exopodites, the endopodites of the series appearing only in the four styles of the ovipositor. In *Lepisma* a more median series of setæ in the anterior abdominal segments probably constitutes the endopodites which correspond to the exopodites formed by the more lateral series of setæ.

Within the apex of the basal joint of the first seven abdominal limbs in *Machilis* lie some glandular pouches, in varying numbers; they occur also in *Nicoletia* and *Campodea*, and probably represent *segmental organs*, for the probable openings of these organs in *Peripatus* are similarly placed. They appear to be represented in the Collembola by the median ventral sucker; for this shows traces of being originally double, in the median slit of *Podura* and *Lepisma*, and in its bifurcation in *Orchesella*, the *Smynthuridæ* and *Papiriidæ*. Their apparent absence in the generative segment may be due to their conversion into genital or accessory genital apertures and ducts. The *styles* of the ninth abdominal segment of male *Blattidæ* apparently represent the external abdominal appendages of the Thysanura; in one species the female carries a double appendage on the *eighth* segment, and on the ninth the styles which correspond to the male styles, while beneath is a flattened pair of organs corresponding in their position, and probably in their morphological significance, to the long setose appendages of the ovipositor of *Machilis*.

Direction of the Flight of Insects.*—The difference in the flight of birds and insects has been shown by M. Marey to consist in the power possessed by the former of modifying the angle at which the wing vibrates, and so changing the direction of flight; whilst insects, with a few exceptions, are deprived of this power, the muscles not being attached to the wing but to the portion of the thorax that supports it.

After numerous experiments on insects of all orders, M. Jousset de Bellesme concludes that the direction of the flight of insects is determined by the position of the head and thorax, this position depending on the respective positions of the centre of gravity and the axis of suspension. These two elements are sometimes both movable; more frequently, however, it is the centre of gravity alone that is displaced.

* 'Comptes Rendus,' lxxxix. (1879) p. 980.

In a very few insects alone are the functions of motion and direction combined. Of these *Æshna* (Neuroptera) is the type, which flies after the manner of a bird: it owes this faculty to the muscles of flight being attached to the wing itself. It is to be noted, nevertheless, that the abdomen is long and flexible, thereby aiding slightly in the modifications of its course; this is especially visible in the genus *Agrion*.

The Lepidoptera ought probably to be ranged in this category; but the anatomy of their thoracic muscles is not yet sufficiently worked out.

It is in the Hymenoptera that the first signs of separation between the functions of translation and direction become apparent. The wings have acquired a strict automatism (the axis of suspension remaining fixed), and furnish the motor power only. The abdomen is pedunculated and very mobile. As it is bent or straightened, so the centre of gravity is carried forwards or backwards. In the Cynipidæ and Ichneumonidæ this modification is remarkably developed; if the movement of the abdomen is impeded, they cease to be able to control the direction of flight.

In the Orthoptera the abdomen has but little mobility, and the function of direction falls to the posterior legs. These being already adapted for leaping are not very efficient in guiding the flight, so that the Locustidæ and Acrididæ turn very badly.

In other insects, such as the Coleoptera, the change of direction is effected by the elytra. Raised during flight over the thorax, they form a mobile mass above the centre of gravity, the smallest displacement of which influences the position of the latter. The removal of the elytra leaves the motor function intact, but deprives the insect of any power of directing its flight, which is always up or down or horizontal.

Presenting an intermediate case between the latter and the Diptera are a small group, the Cetonidæ, which fly with the elytra down. In this case the elytra act on the axis of suspension.

In the Diptera the power of direction has arrived at remarkable perfection; the second pair of wings is transformed into special organs—the halteres—for directing the flight. The halteres act by displacing the axis of suspension, and experiment shows that deprived of these the insect on attempting to fly falls at once; but if a small weight is attached to the abdomen, so as to bring the centre of gravity behind the axis of suspension, the power of direction is immediately restored.

Nervous System and Classification of Diptera.*—The well-known variety of development presented by the nervous system of insects is well illustrated by M. Künckel's account of the different arrangements in the Diptera, which he finds to mark out their true zoological groups with great distinctness. The principles thus followed were adopted by Cuvier for the animal kingdom, and by Brandt † specially for the group of Hymenoptera.

* 'Comptes Rendus,' lxxxix. (1879), p. 491.
† See this Journal, ii. (1879), p. 863.

In each family of the Diptera these organs manifest a single structural plan; while a gradual modification is undergone as we pass from one family to another; the highest rank belonging, not as Dufour stated, to those forms showing the greatest number of centres, but to those in which concentration is carried to its utmost limit.

Another conclusion which has been reached by this study is, that the previous opinions as to *concentration*, during the process of development, being a rule for the nervous centres in insects, must be abandoned in the face of the fact that no less than five families of this order exhibit a *decentralization* or disunion during the process of development.

The order may, according to these facts, be divided as follows:—

I. Diptera in which some *ganglia become united together* in the passage to the nymph stage:—Families, Tipulidæ, &c. (embracing the old group Nemocera).

II. Diptera in which *ganglia become disunited*—some being transferred to the abdomen—during metamorphosis:—Tabanidæ, Syrphidæ, Conopidæ, Stratiomydæ, the Acalypteran Muscidæ, Sepsinæ, Platystominæ.

III. Diptera in which the *thoracic and abdominal ganglia remain united* during metamorphosis:—Muscidæ calypteratæ, Œstridæ, Hippoboscidæ, Nycteribiidæ. It should here be noted that the *embryo* always has the ganglia distinct from each other.

The above divisions are further broken up thus:—

Group 1. *Two or three thoracic, six abdominal* centres:—Xylophagidæ, &c., including all the Nemocera but those of the next two groups and of the seventh.
„ 2. *Three thoracic, five abdominal*:—Scenopinidæ.
„ 3. *Two thoracic, five abdominal*:—Therevidæ.
„ 4. *One thoracic, five abdominal*:—Tabanidæ, Stratiomydæ.
„ 5. *One thoracic, two abdominal*:—Syrphidæ.
„ 6. *One thoracic, one abdominal*:—Conopidæ, Acalypteran Muscidæ.
„ 7. *Two thoracic, no abdominal*:—Dolichopodidæ.
„ 8. *A single thoracico-abdominal* ganglion:—The families included in the third of the three primary groups—Hippoboscidæ, &c.

Homologies of the Parts of the Labium in Orthoptera.*—Although this organ has been described as unpaired, yet M. Chatin considers it comparable in its various parts to the jaws of the masticating insects. M. Brullé failed when attempting a similar study on the Coleoptera; but it is in the Orthoptera that the solution is to be found. Thus in *Locusta viridissima*, the large basal piece of the labium represents the united second maxillæ; an upper plate, the united first pair; a palpigerous appendage is distinguishable with care from the latter, carrying the palps; a lamina is placed internally to the palps, and carries two lobes, the external of which is shown by development and study of different genera to be the galea, the internal lobe being

* 'Comptes Rendus,' lxxxix. (1879) p. 652.

the sub-galea. Near the end of the intermaxilla a piece—distinct from it, as shown in *Mantis*, *Empusa*, and the mole-crickets—represents the premaxilla, the last organ of the jaw to be accounted for.

Oviposition of Blatta Orientalis.*—The chitinous structures connected with this function are described in a preliminary paper by Dr. H. Kadi, as follows:—

The genital opening in the female is surrounded by two shovel-shaped processes of the seventh abdominal segment, which fuse in the median line; their edges are produced into sheet-like membranes, ordinarily folded up, which enclose a space, the "vulva," underlying the last dorsal segment. At the bottom of the vulva is the entrance to the vagina, which projects forwards as a cæcal tube into the body-cavity; among numerous other chitinous structures which it contains may be mentioned three pairs of palpoid organs. The vagina also contains several sets of openings. Through the ventral wall enter the two oviducts; almost opposite, on the dorsal wall, is placed the receptaculum seminis, behind which occur a right and a left accessory (cement) gland. These glands are asymmetrically developed; the left is much the largest, and consists of a dichotomously branched efferent duct and of long, opaque, white cæcal tubes, which lie on the fat-body and contain crystals of oxalate of lime; the right is inconspicuous, lies among the tubes of the left, and is devoid of the milk-white colour and of the crystals which characterize the left gland; their function is that of forming the egg-capsule. When the "cocoon" (egg-capsule) is to be formed, the vulva closes its two external valves together, the cement secretion spreads over its inner surface and hardens posteriorly while the ova are being passed into the cavity which it lines. The capsule thus formed, when it contains a certain number of eggs, is partially extruded, becoming brown by the action of the air; its hinder part bears the impression of the triangular seam formed by the junction of the vulvar valves; the hinder soft part receives these eggs through its open end, and when full is pushed into the vulva, where it lies until sufficiently hard—the membranous edges of this organ being held by Dufour to constitute an amnion—when it falls out.

The vulva, if examined, shows at this stage the opening of the vagina with its palps protruding from it. The palps act by grasping and moulding the hinder end of the capsule, whose upper edge or crest is shaped in a ridge formed by the two dorsal edges of the vulvar plates. After an egg has entered the capsule, the latter moves backwards a little, and being again grasped by the vaginal palps, a second of the sixteen tooth-like impressions which it ultimately bears is formed on it by their contact, and in this way the ultimate shape of the capsule is attained. The capsule contains sixteen ova, arranged in alternating rows, owing to their extrusion alternately from one and the other oviduct; the ova from the duct of one side cross over, and are deposited in the *opposite* side of the capsule—a conclusion drawn from the positions of the micropyles in eggs in the oviducts and those in the capsule respectively: thus the convex side of the egg, carrying

* 'Zool. Anzeiger,' ii. (1879), p. 632.

the numerous micropyles, which looks *backwards* when in the oviduct, rests in the side of the capsule, and thus has an *outward* aspect.

The exposition of the arrangements by which the ova are moved, the complete history of the formation of the capsule, and the morphological importance of the chitinous generative organs are postponed for a future communication.

β. Myriapoda.

New Genus of the Geophilidæ.*—A new genus, *Bothriogaster*, is instituted by Dr. Sseliwanoff to include the already known form *Geophilus signatus* Kessler, and two new species, to be called *B. affinis* and *B. Meinerti*, belonging to this group of Chilopodous Myriapoda. They are characterized by a depressed form; the head-plate entirely covers the mouth-organs above; there is no distinct frontal plate; the upper lip is not divided, and carries teeth; and the mandibles have one toothed and several comb-like lamellæ. The maxillæ are bi-arthrous; the lower lip is not dentate; the claw of the second maxillipede has no accessory tooth; and the outer præscutella are much larger than the stigma-plates. The pleural pores are numerous, and lie in four deep cavities on the upper and under surfaces; there are no anal pores; the anal feet are six-jointed, unarmed. Some apposed ventral plates present a strong horseshoe-shaped depression in their front edge. The last ventral shield carries a deep median groove; the male genital palps are two-jointed.

B. signatus is from 70 to 145 mm. long, the head and frontal plates together are broader than long—it occurs at Samarcand. *B. affinis* is from 72 to 102 mm. long, the head and frontal plate together of the same length as breadth—from the Caucasus and Sarepta. *B. Meinerti* agrees with the latter in its head and frontal plate characters; the length of the body is from 91 to 96 mm. It is of a bright yellowish-brown colour, whereas the other species are pale yellow—from European Turkey.

γ. Arachnida.

Hydrachnidæ of the Lake of Geneva.†—In one of the contributions to the knowledge of the fauna of this lake, published under the direction of Dr. Forel, M. Lebert describes the comparatively large number of these forms which occur there. They exhibit three states of distribution: *Littoral* (to a depth of 8 metres); *Deep* (from 20 to 300 metres); *Parasitic*, on *Anodonta*. Of these, the littoral claims the larger number of species. They are remarkable for their generally dull coloration, although some striking exceptions are mentioned below. In common with, he considers, all Hydrachnidæ, they have two pairs of eyes, sometimes confluent, whose characters are valuable aids to classification. The presence of a circum-genital area provided generally with peculiar disks, formerly described as suckers, is constant for most species which have been examined as to this point; the disks occur mostly to the number of six, and being in the majority of

* 'Zool. Anzeiger,' ii. (1879) p. 620.
† 'Bull. Soc. Vaud. Sci. Nat.,' xvi. (1879) p. 327.

cases almost invariable in this respect for each species, afford good classificatory characters.

Among the forms described which are new to science is *Campognatha Schnetzleri*, forming the second of the two known species of the genus, both occurring in deep water in the lake. Of the remaining new species, *Hygrobates nigro-maculatus*, *Limnesia variegata*, *tricolor*, *tesselata*, *triangularis*, *cassidiformis*, are littoral, and exhibit the six abdominal disks.

In a new genus, *Neumania*, is placed a swimming form (*N. nigra*) with confluent eyes, the back carrying a large white cross on a black ground; the genital opening is surrounded by triangular plates covered with black spots. Another species, *N. alba*, differs chiefly in the absence of a true genital area. Of the two *Arrenuri* (*A. tuberculatus* and *biscissus*), the first has its genital orifice surrounded by two pairs of plates, the outer punctate, but neither with "disks." In *Nesœa magna* and *N. lutescens* the genital area is indistinct, and bears in the one case four, in the other five "disks"; the back of the former species is singularly marbled with chocolate on a yellow ground. The name *Pachygaster tau-insignitus* is given to a species distinguished by a complicated genital area with six disks. In *Piona accentuata* the area is invisible. *Brachypoda* is a minute type, only ·56 mm. in length, in the only species, *B. paradoxa*, here described; the legs are short and stout, the fourth pair carrying a considerable spur after the fourth joint, the following joints being excessively hirsute. In all, including a *Campognatha* already described by the author, and *Atax crassipes*, and *A. ypsilophorus*, nineteen species occur in this fauna, of which seventeen, and among them the types of four genera peculiar to it, are not elsewhere known. The only parasitic form is *Atax ypsilophorus*.

δ. Crustacea.

Action of Poisons on Crustacea.*—M. Yung finds the Crustacea to be very sensitive to the action of the chief poisons. Experiments on Macrura and Brachyura show that *curare* acts as on Vertebrata, but slowly, producing sluggishness in the movements, which is converted into paralysis by strong doses. *Strychnine* acts with great rapidity and violence, causing sensible tetanus. It cannot be introduced into the system by the branchiæ. *Atropine* causes exhaustion, never death. The heart's action is slackened, after a slight acceleration, by *Digitaline*. *Nicotine* is distinguished by its very rapid production of muscular rigidity and of quickened pulsations of the heart.

New Podophthalmous Crustacea.†—Dr. J. G. de Man describes (in English) three new genera and ten new species from the Leyden Museum.

Limnocarcinus (λίμνη, a marsh) is a new genus of the family of Gecarcinadæ (subfamily Gecarcininæ of Wood-Mason). Front not united to the internal suborbital lobes, as is the case in *Hylæocarcinus* Wood-Mason; the flagella of the antennæ projecting into the

* 'Comptes Rendus,' lxxxix. (1879) p. 183.

† 'Notes from R. Zool. Mus. Netherl.,' i. (1879) p. 53.

interspaces between the front and the internal suborbital lobes. The third joint of the external maxillipedes with an obtuse-angled emargination in its anterior border; the three terminal joints, however, fully visible externally when the maxillipedes are properly closed, the latter having quite the same shape and form as in *Pelocarcinus Lalandei* M. Edw. This genus evidently presents a remarkable transition from *Pelocarcinus* M. Edw. to *Hylæocarcinus* Wood-Mason, as the latter genus is intermediate between *Pelocarcinus* and *Gecarcinus*.

Malacosoma is a new genus of the Pinnotheridæ. It has the characteristic physiognomy of *Pinnotheres*, but it differs by the structure of the external maxillipedes. The second joint (ischiognathite M. Edw.) is rectangular, and but a little longer than broad; the third joint (merognathite M. Edw.) is quadrangular, shorter than the second, and the terminal joints are affixed to its internal angle. The internal margins of the second and third joints of the external maxillipedes are straight, and consequently the two maxillipedes are lying close to each other. The exopodites (exognathe M. Edw.) of these outer foot-jaws are stout, and almost half as broad as the third joint. The integument is as weak as in *Pinnotheres*, and therefore it is possible that *Malacosoma* has also the same manner of life as the crustaceans belonging to the group of *Pinnotheres*.

Hypsilograpsus has its external maxillipedes similar to those of *Gnathograpsus* Alph. M. Edw., but it may be distinguished by the very thick body, the very convex carapace, and the very deflexed front. In these points it differs too much from *Gnathograpsus* to be ranged in that genus.

Change in Colour in the Isopoda.*—Dr. Mayer gives a short account of his observations on some species of *Idothea*, in which this change in coloration is so well marked. He says that if two equally brown specimens are taken, and one is placed in a black and one in a white vessel, there is, within half an hour, a marked difference between them, so that while the white one is hardly to be distinguished from the vessel, the brown one will have become quite dark. When one eye is extirpated, the animal operated on may still change its colour; but if *both* are removed, the creature never exhibits this power. These experiments are in support of the already enunciated views of Pouchet and Jourdain.

Blind Isopod from the Lake of Geneva.†—The Isopod, *Asellus Forelii*, described by M. Blanc, is, as might have been expected, found at a distance from the light, viz. at from 75 to 300 metres below the surface, and is interesting by way of comparison with the other blind Crustacea which have lately attracted so much attention, as it has been confounded hitherto with one of these, *Asellus Sieboldii*, or with *A. cavaticus*. It also much resembles *A. aquaticus*. Its length is 5 mm. as against 8 mm. of *A. cavaticus*. Its antennæ also exhibit flagella of four to five joints, the second pair having never more than twenty-six. The thorax agrees with that of *A. cavaticus* in form, also the thoracic limbs. Of the abdominal limbs, the first in the male is slightly smaller and less

* Loc. cit., p. 521. † 'Bull. Soc. Vaud. Sci. Nat.,' xvi. (1879) p. 377.

hirsute than in *A. cavaticus*, while the broad enveloping form which they take in *A. aquaticus* readily distinguishes that species. The number of olfactory organs carried by the antennæ never exceeds *three* in either sex. These are the chief points distinguishing species which are evidently closely allied.

With regard to the absence of vision, common to this and allied species, this is not always absolute, for two young specimens occurred with eyes possessing pigment-spots; these were from depths of 200 and 300 metres—a remarkable fact, seeing that total obscurity has been shown to exist at 100 metres. To account for this exception, the theory of *atavism* may be advanced—that the specimens in question were descended from an *Asellus* which had only recently lost its sight, and that they have reproduced the organs. Cases of *heredity* are not likely to occur sporadically in such a way as that only two specimens are found occurring side by side with numbers of totally blind but specifically identical forms. Against the hypothesis of heredity in this case must be set the improbability of some few individuals of the species occurring, as these do, under exactly the same unfavourable external conditions as those which have become blind, and yet preserving organs which adapt them for seeing; against which improbability the possible shortness of the time of exposure to these conditions argues but feebly.

The sense of hearing has been attributed by Sars to certain pedunculated hairs borne by the first thoracic limb and the antennæ; they consist of a delicate membrane containing a granular material, and carry a few minute terminal hairs; those on the legs are carried by its first joint, and are covered by the terga of the segments during walking. De Rougemont's theory that they represent a sixth sense, or one which would transmit impressions of change in the surrounding medium, appears the most probable one for these abyssal organisms: the position of those on the legs forbids the idea of a tactile function.

The sense of touch is assigned to the three pairs of *hyaline rods* * found on the joints of the lesser antennæ, and to some hairs on the end of the antennæ and caudal appendages.

Smell is represented by three cylinders inserted into minute, truncate-cone-shaped eminences on the last three joints of the antennæ; they are formed by a membrane with double contour containing granular matter. In *A. cavaticus* they appear to vary considerably in number, but all authors agree in finding six joints which carry them in one or other of the specimens examined. *A. aquaticus* has from four to five such organs. In the last two species they are developed, in point of *size*, inversely with regard to the presence of visual organs, being small in the species which has eyes. The specimens of *A. Forelii* which had eyes had the olfactory organs of the same length as in the eye-bearing *A. aquaticus*. Embryos of *A. Forelii* are devoid of eyes, but at an early stage agree in all respects with the other two species, and only at a later embryonic stage become distinguishable from *H. aquaticus* by the inferior proportions of the antennæ and antennules.

The interesting question as to the origin of the species is raised

* Humbert, 'Bull. Soc. Vaud. Sci. Nat.,' xiv. Nos. 75 and 76.

by the author. The structural characters point to *A. aquaticus* as the ancestor, but at present the districts occupied by the two forms have not been shown to communicate. A descent from an extinct form is improbable, as it demands a strain upon the laws of heredity or atavism to account for the occurrence of the few specimens with eyes. It is easier to conceive of a connection with *A. cavaticus*, an inhabitant of neighbouring wells and pools, and of a transference of the species either from these to the lake, with accompanying structural modifications, or *vice versâ*. The differences in structure already mentioned seem to justify its separation from *A. cavaticus* as a distinct species peculiar to the deep region of the lake.

Anatomy of the Amphipoda.*—Professor Wrześniowski, of Warsaw, deals in detail with the anatomy of *Goplana polonica*, *Pallasea cancellus*, and two varieties of *Gammarus pulex*.

In the first-mentioned form the hypodermis and the fatty body are both made up of small polygonal cells, which are provided with nuclei and nucleoli, and are not separated from one another by any intercellular substance. That their structure is not essentially the same is shown by what obtains in *Pallasea cancellus*, for in this form the hypodermis consists of a layer of typically arranged cylindrical epithelial, while the fatty body is made up of larger, rounded, or angular cells; the former belongs to the series of epidermal and the latter to the series of connective-tissue formations. The fatty body is described as enveloping the entire tract, and as, while filling up the interspace between it and the heart, forming a serous investment for the latter; this fatty body is, moreover, continued on to various other organs, which it connects with one another and with the body-wall. It is of interest to note that the first joint of the lower antennæ appears to be completely filled up by it; and on either side of the enteric tract it forms regions to which Weissman gave the name of plates (*Leptodora hyalina*). In starving amphipods, the fatty body disappears almost completely.

The flexor muscles of the trunk consist of two series; of these, one is directed forwards and downwards, and is to be found in each of the segments from the fifth to the tenth. In the last three segments there is a common flexor, and in the more anterior this system appears to be completely absent. The other series is made up of longitudinal bands, which form two layers on either side, and pass from one segment to the next succeeding; they are found in the ventral region, and have a direction parallel to the ventral surface. This system of "longitudinal" muscles is regularly disposed from the fourth to the ninth segment. In the tenth the upper layer is alone found, and, as before, there is a fused muscle for the last three somites. The extensor muscles form strong bands on either side, which are better developed than are the flexors. The abdominal appendages are moved by a complicated system of muscles; the first, or basal, joint has a flexor and an extensor, which are capable of moving the whole foot backwards and forwards, while the two terminal branches have also their special muscles.

* 'Zool. Anzeiger,' ii. (1879) pp. 447, 465.

The nervous system of *Goplana polonica* is described as consisting, in young examples, of a cerebroid portion, which, from a lateral view, may be seen to be made up of three succeeding parts, united above to a common stalk; from this stalk there are given off the nerves for the optic organs and for the œsophageal commissure. Connected with the ganglionic portion there is on either side an irregularly triangular lobe, the tip of which is directed downwards; the commissures are described as embracing rather the stomach than the œsophagus. There are three abdominal in addition to the seven thoracic ganglia, and the first of the latter group is of a very considerable size. The auditory hairs were examined in *Calliscma Branickii*; on the basal joint of the upper antennæ we find, in both sexes, very delicate setæ, which are beset at their tip by extremely delicate hairs, and are arranged in two rows; one row passes to the lower, and the other to the anterior margin of the antennary joint; of one set of setæ there are fifteen, and of the other thirteen. Each seta is chitinous in structure, and has a tubular basis, which is continued into a goblet-shaped enlargement. The nerves supplying these organs were traced to nearly the extremity, and they, as well as the hairs, showed a very remarkable agreement with the structures of similar function in the Decapodous Crustacea. The author is of opinion that these bodies are undoubtedly auditory in function, but he is careful to point out that all bodies of similar structure may not be the same; as, for example, the darkly contoured setæ on the hindermost pair of swimming feet found in some amphipods.

On the fourth and fifth basal joints of the antennæ there are to be observed pale sensory setæ, which are more numerous in the male than in the female; these bodies have a rounded base, and diminish gradually towards their extremity; they are supplied by the antennary nerve, which forms a ganglionic enlargement in their neighbourhood. The flagellar portion of the lower antennæ has its cuticle considerably thickened, and provided with distinct pore-canals; at the upper margin this thickness suddenly diminishes, and a wide pore-canal is to be observed, in which there is placed a pale seta, to the base of which there is attached a small plate, which is triangular when looked at from the side; this organ is likewise supplied by the antennary nerve, the branches of which appear to end in the cuticular plate. The writer thinks that these sensory setæ very much resemble the tactile flagella described by Hensen as obtaining in the Decapoda.

Coming * to the so-called calceoli (slipper-shaped organs of Stebbing), Professor Wrzesniowski states that they are occasionally to be found on the upper, as well as on the lower pair of antennæ; and he confirms the statement of Dybowski as to their not being confined to the male sex; forming a thin-walled, flattened, and stalked vesicle, they have connected with them a large ganglion formed by the antennary nerve. In *Goplana polonica* the calceoli appear to be confined to the superior antennæ of the male; there are several present, and each forms a lanceolate plate; this is, of course, an

* Loc. cit., p. 487.

extreme modification of the flattened vesicle. On the inner surface the cuticle forms strongly projecting and greatly developed costæ; the wall is formed by a thin membrane, and is provided at its base with an irregularly circular ring (this basal ring appears to be lost in all spirit specimens); and the nerve supply consists of a number of bundles of nerve-fibrillæ, which pass to the margins of the calceolus. By their structure they appear, as G. O. Sars has already noted, to be olfactory organs. Although the calceoli may be easily examined in the fresh state, their investigation is aided by placing them for fifteen or thirty minutes in alcohol.

There still remain for description another set of sensory organs, the function of which is more obscure. Three different kinds of sensory setæ have been observed on the anterior margin of the second pair of maxillæ, where they are arranged in three rows; some of the setæ are darkly contoured and pinnate; others have thin walls, are slightly bent, and are open at their tip; while others have thick walls and are more curved; the first set have not yet been observed to be connected with nerves, while the second and third are supplied by the maxillary nerve, and the branches are provided with a large number of ganglia; in each set of setæ the nerve endings differ in character, and it is possible that the lowest series represent tactile organs, while those in which the setæ are open at the tip are gustatory organs.

The digestive tract is described * as being enveloped along its whole length by a layer of the fatty body, having the majority of its muscular fibres arranged transversely in the region of the small intestine, and with a rectal portion which is well supplied by two layers of muscles, the external set transversely, and the internal longitudinally. The epithelium of the small intestine consists of low, thick cells, with darkly granular contents, while further on the cells are high and the contents much finer. The name of cervical gland is given to the cæcal diverticulum which is found posteriorly to the stomach, and it is described as having a very narrow lumen and a thick epithelial investment formed of closely set cells arranged in two layers. The author, after describing the circular muscles of the hepatic tubes, states that the liver-cells form a single layer, the constituents of which are, in *G. polonica*, cylindrical towards the blind end, and more rounded and less high as they approach the orifice. Non-nucleated vesicles, which were apparently metamorphosed cells, were to be observed between the liver-cells, and their presence seems to be in correlation with the secretion of bile. The tubular glands at the commencement of the rectum are now called rectal glands; their structure is described, and they are stated to contain only a clear fluid and no solid contents, so that their homology with the Malpighian vessels (Sars) is on this, as well as on other grounds, to be considered doubtful. An unpaired gland—anal gland—which seems to have hitherto escaped observation, is described; opening just in front of the anus into the intestine, it is placed in the telson, and has a rather thick membrana propria. The lumen is compelled, by the difference in size of the epithelial

* Loc. cit., p. 511.

cells, to take an excentric direction. The only light that its discoverer can throw on its function is the statement that its contents are watery.

The shell-gland is next described,* and the heart; this organ extends from the cephalic region to the sixth thoracic segment, gradually increasing in width as it passes backwards; at each end there is an arterial ostium, and in the second, third, and fourth thoracic segments a pair of venous ostia. Invested in an outer layer of connective tissue, the heart of *Pallasea cancellus* has its muscular layer made up of closely-set transversely-striated muscles, each of the fibres of which forms a long spiral coil. The arterial ostia are each provided with a membranous diaphragm, in the centre of which there is a cleft; the edges of the cleft appear to be provided with a sphincter muscle, and there also seem to be other more delicate circular muscles. There are also lateral muscular membranes which contract at the systole and open the cleft, while at the diastole the fibres of the diaphragm contract and so completely shut off the lumen of the cardiac tubes from the two aortæ. The venous ostia are found to have the structure described by Weissmann in *Leptodora hyalina*, while the observations of Valette St. George and G. v. Sars, which showed that the ostia of the right are directed downwards and backwards, and of the left side downwards and forwards, are confirmed.

The series of papers concludes † with an account of the arteries and of the peripheral circulation; in none of the species examined by the author are there any arteries given off from the sides of the heart. Claus reports that a similar arrangement is to be seen in the Gammarida, but it does not obtain in all the Amphipoda. The presence of an afferent vein, in addition to the narrower artery, in each antenna is noted, and it is pointed out that this arrangement was observed in *Caprella* by Goodsir in 1842. The structure of the walls of the arteries is described, and it is shown that they are formed by a membrane which is thickened at regular intervals. The course of the circulation in the Crustacea is a matter of importance and of interest, and as the conclusions of the author are somewhat at variance with those of preceding observers, he enters into them in some detail. We must here content ourselves with stating that the arterial blood from the two great arteries and their branches passes into currents which bathe the various viscera and then pass into the appendages, whence they issue as venous currents, which pass directly into the dorsal venous sinus; thence the blood passes directly into the heart, without taking any especial course through the gills; these last structures receive the blood in just the same way as the jointed appendages, and there is, consequently, no distinction in these creatures which can justify us in speaking of distinct arterial and venous streams. In the young *Göplana polonica* the blood-plasma was of a yellowish red, and in the adult of a more or less greenish colour, and the colour of the blood has a distinct influence on the colour of the animal. The blood-corpuscles are of a considerable size. Fat drops were to be observed in the blood-plasma.

* Loc. cit., p. 536. † Loc. cit., p. 564.

Development of Moina rectirostris.*—After giving an account of the development of this form, Dr. Grobben enters into a consideration of the anatomy of the Phyllopoda. In the earliest period of development we have to do with a very small egg, the protoplasm of which is more finely granular at the animal pole; the nucleus is placed rather nearer to this pole, but there is, in addition to the nucleus, another body, small and more or less rounded, which presents the same tinge with carmine as the nucleus, and appears to be a part of the ovarian nucleus, which, while being converted into a directive corpuscle, is making its way towards the periphery. The nutritive yolk consists of a few refractive, almost colourless, spheres and a layer of small granules, which are set amongst the spheres, which, red, blue, or violet in colour, make up the greater part of the yolk. Cleavage soon commences after the eggs are laid, and, as ordinarily, commences by a division of the nucleus. A meridional groove appears on the surface of the egg, and the yolk material begins to take up a central position, and neither this nor the next succeeding divisions succeed in completely separating the yolk into separate cells; in other words, cleavage is superficial. At the stage of cleavage in which there are seventeen cells, it is possible to see a central one, which is coarsely granular, and which, from its future history, may be called the *genital cell.* Shortly after this the endodermal cells can be seen to be eight in number, and to be smaller than those of the ectoderm. Passing on to the gastrula stage, we find in optical section a layer of cylindrical cells pushing their way into the blastocœle and connected at one point with two large genital cells, and at another with five cells, which belong to the mesoderm; the greater part of the blastula-cavity is occupied by the food-yolk. When the gastrula mouth closes the genital cells leave their position near it to pass inwards and under the endoderm.

In the second period of development the small egg begins to grow, and the greatest increase takes place in the cells of the mesoderm, which now extends not only as far forwards as the frontal plate, but along the sides and over the whole of the ventral surface; the largest of its constituent cells are to be found in the hindermost region; the genital cells form a bilaterally symmetrical plate below the endoderm. Soon the embryo becomes divided into two portions; the anterior one becomes the cephalic segment, while the posterior forms the rudiment of the trunk. On either side of the former there appears an ear-shaped process, which is the rudiment of the second pair of antennæ; the mouth forms a small depression between them. As the hinder portion grows, a new segment is nipped off at its anterior end, on which there soon appear the rudiments of the mandibles. The *Nauplius* stage is now reached; into the details of the arrangement of all the parts of the embryo it is impossible to enter, but it may be noted that the ecdysis which obtains in so many allied forms is not seen in *Moina*; probably, as Dr. Grobben thinks, because the creature swims in albuminous matter, and the presence of a second

* 'Arbeit. Zool. Inst. Würzburg,' ii. (1879) p. 203.

cuticle would considerably interfere with its diffusion into the body of the embryo.

Coming to the stage in which there are two thoracic segments developed, we find we have a creature in which the two pairs of antennæ and the mandibles are well developed, but as yet there are no maxillary appendages. The frontal plate consists of two layers, and is divided into two portions; the œsophagus still ends blindly. The genital segment has widened out transversely, and there is evidence of a constriction in the median line. Four pairs of thoracic appendages become developed before the maxillæ appear, as indeed does the retina of the compound eye, and the cerebral portions developed from the frontal plate; the genital rudiment is divided into two distinct portions, which proceed to take up a more lateral position. With the appearance of the knob which forms the rudiment of the first maxilla, the four anterior pairs of thoracic appendages become differentiated into an outer and an inner ramus, and the branchial saccule begins to be developed. The ganglionic cord becomes laid down in the two lateral thickenings of ectoderm which lie on either side of the primitive groove. The author then shows that the shell-gland is mesodermal in origin, and after describing the separation of the central nervous system from the ectoderm and the metamorphoses undergone by the mouth-organs, comes to the point at which the heart is first apparent. Henceforward the changes that take place are those in which the creature assumes more and more its adult characters.

In some "theoretical considerations" the author draws attention to the characters of the animal pole, and points out that there is evidence of a polar differentiation in the ovum; this is, of course, to be associated with the superficial mode of cleavage, but it is of importance as being a qualitative difference, and not merely a quantitative difference, such as is expressed in the "polar arrangement" of the yolk. Turning to the arrangement of the genital cells, the author is not in agreement with Gegenbaur in regarding the generative apparatus as being primitively single; he supports his position by a reference to *Branchipus*, "the oldest Phyllopod," where, as Claus has shown, the generative apparatus is paired, and by the consideration that the mesodermal bands are themselves primitively paired; when they are not so, and when the genital cell arises singly, it is because of the changes necessitated by a superficial mode of cleavage, so that the phenomena are consequently merely secondary.

The body of *Moina* may be divided into a cephalic segment, a number (eight) of thoracic segments, and a terminal one; to the first belong the antennæ; the mandibular segment is the first of the thoracic; and appendages are never developed on the last of all. The question of the presence of a trochosphere stage * is thus resolved; there is, of course, no double circlet of cilia, but all the other organs, with the exception of the head-kidneys, are certainly present. In that the shell-gland arises from the mesoderm, it resembles the segmental organs (nephridia) of the Annulata.

* Hatschek: see this Journal, ii. (1879) p. 566.

The early appearance of the rudiments of the generative organs is not only to be observed in *Moina;* Metschnikoff had already noted it in the case of *Miastor* and *Aphis;* and in all these three forms eggs are developed parthenogenetically. What is the connection between these two phenomena? is the early development of the generative organs the cause of parthenogenesis, or has parthenogenesis effected their earlier appearance? The latter would appear to be the better reason, inasmuch as no such early development has been observed in the parthenogenetic Lepidoptera and Hymenoptera. Again, the organs in question do not exhibit their activity till all the other organs are fully developed, and natural selection could not, therefore, have exerted any influence in fixing the earlier date of their appearance.

It is of especial interest to note that there is a directive corpuscle in the developing ovum, inasmuch as it has been supposed that the absence of this body might be associated with the absence of an immediate fertilizing agent.* Dr. Grobben is, however, of opinion that parthenogenesis is a mode of sexual reproduction, although he appears to agree with Weissmann in regarding it as *unisexual*, and he looks upon the ejection of the corpuscle as due to the fact that the parthenogenetic egg has been derived from one which was fertilized. In fine, he distinguishes the mode observed in *Moina* from true parthenogenesis by a grouping of the phenomena which may be thus recapitulated:—Reproduction may take place (1) by means of the germ-layers of the mother—asexual reproduction; and this may be (*a*) by fission or (*b*) by gemmation; (2) by means of one cell aided by another cell—sexual reproduction; and this may be unisexual, i. e. (*a*) parthenogenetic, or (*b*) bisexual.

In all cases of heterogony there is a periodic appearance of the male. Kurz thinks that the male appears among the Cladocera only when the female finds the quantity and quality of the water it inhabits insufficient, and Weissmann regards its appearance as owing to the general conditions of existence. Grobben looks on the male as being produced from the necessity of its occasional presence for an effectual development by means of fertilization.

Compound Eye and Cervical Organ of the Phyllopoda.†—In the developmental history of *Moina*, we may see that the eye becomes overgrown by a fold of the ectoderm from behind and from the ventral side, and that it thus becomes covered by two membranes; one is in direct connection with the cornea, and the other forms an integumentary investment; and this arrangement is constant among the Phyllopoda. It is obvious that it has for its purpose to protect the eye, and we may expect that in all cases where the eye is movable without being stalked, similar arrangements will be found to obtain, and the author suggests that observations should be made on the Copepoda, Ostracoda, and Arachnida with this special point in view.

The importance of the cervical organ lies in the light which it

* Cf. Balfour, 'Quart. Journ. Micr. Sci.' (1878).

† 'Arbeit. Zool. Inst. Würzburg,' ii. (1879) loc. cit.

seems to shed on the phylogeny of some of the Crustacea. Among the Branchiopoda, which may be regarded as the stem-form of the Cladocera, it is greatly developed not only in the larval stage, but throughout life (*Apus*, *Branchipus*, Claus); in *Artemia* it disappears in the adult form (Leydig). In the Estherida it has as yet been only observed in *Limnadia*, but it is also to be found in *Estheria* and *Limnetis*; in a species of the former it was observed to form a large shield, distinctly marked off, and consisting of nucleated cells with coarsely granular contents; this was the arrangement in the larva, but in adult specimens of other species of the same genus it was found to be proportionately small; *Limnetis* has an oval cervical shield. In the Cladocera this organ is likewise to be observed; the larval *Moina rectirostris* has one, but it is lost in the adult; in *M. paradoxa* it is retained throughout life. The organ has also been found in the embryo of *Gammarus*, though it is as yet unknown among the Copepoda or Thoracostraca, save for certain indications presented by the larva of *Cyclops serrulatus* and *Ergasilus Sieboldi*.

This important paper is illustrated by 76 figures.

New or rare Crustacea from the Coasts of France.*—In this (twenty-ninth) communication M. Hesse describes ten new Crustacea, seven of which belong to the genus *Cycnus* Kroyer, and the remaining three to *Kroyeria* Van Beneden. Belonging to the siphonostomatous division of the Copepoda, they attach themselves to the branchiæ of various fishes; small in size and really transparent they get a reddish colour from the blood they suck, and they would be with difficulty distinguished from the branchiæ, were it not that their dark-coloured ovigerous tubes are so long as to project from the rest of the body. As to *Kroyeria*, M. Hesse states his belief that they would be better placed with the Pachycephalida than with the Peltocephalida, but he does not consider that he is entitled to speak at all dogmatically on the subject.

Dealing with their "biologie," the author says that the sudden change of condition to which the species in question were subjected makes it impossible for him to say very much on the subject. They are with difficulty separated from the branchiæ, and the attempt to remove them is often accompanied by mutilation of the specimens; it is, however, necessary to do so, for the mucus in which they are encased putrefies rapidly. The species of *Kroyeria* exhibited the greater amount of activity, and when we compare the structure of their appendages with those of *Cycnus* we find greater differences than would be expected in forms living under very much the same conditions. The mouth is not only similar in function but in structure; though the form of the cephalic region differs considerably; in *Cycnus* it is widest diagonally, and in *Kroyeria* longest vertically; in the former there are two and in the latter three "rings attached to the head." The females differ not only in having in the one case broad and short ovigerous tubes containing a few large ova, and in the other long narrow tubes with closely packed eggs, but in the former (*Cycnus*)

* 'Ann. Sci. Nat.,' viii. (1879) art. No. 11.

the eyes are absent, although they are well-developed in their males. Finally, and omitting other points, we have to note that the "caudal appendages" are very short in *Cycnus* and very long in *Kroyeria*.

The new forms described receive the following specific names: (I.) *Cycnus:* 1. *crenilabri;* 2. *labri mixti;* 3. *labri donavaini;* 4. *acantholabri enoleti;* 5. *labri trimaculati;* 6. *pagelli bogneravei;* 7. *canthari grisei.* (II.) *Kroyeria:* 8. *scylli caniculæ;* 9. *carchariæ glauci;* 10. *acanthias vulgaris.*

New Parasitic Copepod.*—Paul Mayer, in continuation of his carcinological studies, describes a new form—*Ive balanoglossi*—which was first found by Dr. Spengel in *Balanoglossus minutus;* principally in the branchial region. The larger examples were observed to have lost nearly all connection with their host; of a tubular form, their cephalic end is much thicker than their caudal; the mouth organs and the thoracic appendages are greatly reduced in size, and the female measures 9 mm. and the male 3·5 mm. (in their contracted state). The abdominal region is excessively mobile, the anterior portion almost passive, while the animal changes its position by a wormlike contraction and expansion of its body. The first pair of antennæ hardly exhibit any segmentation, the second pair is simply hook-shaped; the only gnathites are a pair of appendages which are provided with strong hooks, and a pair of movable chitinous rods, which are placed at the side of the mouth, and may possibly be the remnants of the mandibles; the first set, which seem to be maxillipedes, serve to attach the male to the female. The ventral ganglionated cord seems to be fused into a single ganglion, from which two well-developed nerves, which give off a number of branches, pass very nearly to the end of the body. The enteric tract forms a simple tube, without any anal orifice; the lumen of the œsophagus is completely obliterated by the folds developed on its wall, and is provided with a strong chitinous *intima*. There are no special circulatory organs, but there are a large number of glands in the body; peculiar among these are the rosette-like dermal glands, each of which consists of an aggregation of elongated cells; as to the characters of their secretion the author has no observations to offer. The generative organs are stated to be normal in character, and the *Nauplius*-form has nothing remarkable; it has, however, no eye, and the place of this organ is occupied by a grey mass; two large vesicles, of unknown function, lie in the hinder third of the body.

The author was not able to observe the successive stages of development, and he is therefore unable to speak definitely as to the systematic position of this creature. He thinks that it is sufficiently clear that it is one of the Lernæida, from the described forms of which it seems principally to differ in having only two, instead of four pairs of thoracic feet. The abdominal furca is small, and the males are found either singly or in pairs near the generative orifice of the female.

* 'Mitth. Zool. Stat. Neapel,' I. iv. (1879) p. 514.

Vermes.

Development of the Heart of Criodrilus.*—Dr. F. Vejdovsky has published a preliminary notice on this subject, of which he gave an account to the Royal Bohemian Society of Sciences on July 4th, 1879. He finds that the heart of *Criodrilus* commences from two completely separated rudiments; these gradually approximate on the cardiac side of the enteron until they become completely one, and form an unpaired dorsal vessel or heart. Although these rudiments do, in their primitive characters, resemble the lateral vessels, there is, later on, developed in the neighbourhood of each half a layer which consists of transverse and of longitudinal muscles; this layer becomes covered by larger peritoneal cells, which are subsequently modified into the colossal peritoneal (or "chloragogal") cells. Kowalevsky has already shown that in *Lumbricus* the heart has a similar origin; and the supposition, justified by these observations, that in the Annelides the heart is always thus developed, is supported not inconsiderably by the observation of Quatrefages, who has shown that in the Hermellidæ there are in the posterior region two dorsal vessels, which only fuse into an unpaired heart in the thorax. These facts bear, further, on the relationship between the Annelides on the one hand, and the Arthropoda and Vertebrata on the other. Claus has shown that in Apus the dorsal vessel is primitively formed of two symmetrical halves and Metschnikoff has established the same relation in *Geophilus;* while Hensen, Kölliker, and Gasser report a similar mode of development for the vertebrate heart.

The very first stages of development were not observed; but in a section made across the anal segment (which in *Criodrilus* is not terminal) the author observed two sets of vessels, one above and one below the ventral ganglionic cord. The trunks which arise from the upper pair, which lie at the sides of the cœlom, anastomose with the loops of the lower one, and also give off a large number of lateral capillaries; the perivisceral loops are also formed by the upper pair, while on either side of the anal groove there is a large vessel, with which they communicate. In other sections the two vessels were observed to lie in the cardiac half of the cœlom, although not above the intestine; further on the two vessels begin to approximate, though they are separated from one another by the paired muscular bands, which attach the intestine to the body-wall. Yet again these bands become single, and the dorsal vessels lose their simple structure, while they become surrounded by a muscular layer and by a peritoneal investment; in the next stage the vessels lie close to one another, and the muscles of attachment are inserted into the peritoneal coating. The two vessels then become completely united. The heart of *Criodrilus* is stated to be best developed in the median segment of the trunk.

Typhloscolex Mülleri W. Busch.†—This pelagic Annelide is studied by Professor R. Greeff, in an appendix to his paper, already reported.‡

* SB. Böhm. Gesell. Wiss., 4th July, 1879 (separate copy).
† 'Zeitsch. wiss. Zool.,' xxxii. (1879) p. 661.
‡ This Journal, ii. (1879) p. 883.

1. *Systematic.*—The author considers that the differences between *Typhloscolex*, *Sagitella*,* and *Acicularia* are of merely specific value, and that the two latter genera ought therefore to be merged in the first-named. If the anterior row of setæ found in some forms should turn out to be a constant and not merely a larval character, there will be three species of *Typhloscolex*, namely:—

(*a*) *T. Mülleri*, with anterior row of setæ (including *Sagitella Kowalevskii* N. Wagner, form *b*; larva of *Acicularia Virchowii* Greeff; *Sagitella barbata* Uljanin).

(*b*) *T. Kowalevskii*, without anterior row of setæ (*Sagitella Kowalevskii* N. Wagner, form *a*; *Acicularia Virchowii* Langerhans; *Sagitella Kowalevskii* Uljanin).

(*c*) *T. præcox* Uljanin.

If, on the other hand, the setæ are proved by further study to be a larval character, all these forms will be included in the one species, *T. Mülleri*.

2. *Digestive Organs.*—The alimentary canal consists not, as usually described, of two, but of three parts: a muscular œsophagus, in connection with which is the remarkable glandular proboscis, a glandular stomach, and an intestine.

The œsophagus is lined with a layer of cells, external to which are the strong, radially disposed muscle-cells, and then much thinner layers of longitudinal and circular fibres. The "retort-shaped organ" or proboscis already referred to, lies, as described by Uljanin, in a dorsal pouch of the gullet, its narrow end projecting into the mouth. It is indistinctly divided into a right and a left half, and in section shows an irregular network of fibres, with interspersed nuclei.

On each side of this body is a smaller flask-shaped glandular organ, a duct from the pointed end of which comes into close relation with the proboscis. Greeff thinks, but has not been able to prove, that the flask-shaped organs are glands, pouring their secretion into the retort-shaped organ, which must thus act as a bladder or receptacle for the secretion.

In the hitherto undistinguished stomach the epithelial cells are radially elongated to such an extent as to resemble the muscle-cells of the gullet. They are seen, however, to be continuous with the epithelium of that part of the canal; and the muscular layer of the stomach, as well as that of the intestine, is quite insignificant. The epithelial cells of the intestine are greatly vacuolated, so as to resemble the cells of the notochord.†

3. *Rod-containing Organs.*—The author extends his former account ‡ of the cup-like, rod-containing organs (Stäbchenbündel) discovered by him in the parapodia. He has observed the development of these organs, each from a single cell of the parapodium, some cells being seen in which the nucleus, or often two nuclei, still remained, and was surrounded by a circle of rods. These latter are found to be

* This Journal, ii. (1879) p. 425.
† Or the endoderm-cells of a Hydrozoon.
‡ This Journal, ii. (1879) p. 883.

hollow, thick-walled tubes. From the abundant nerve-supply of the parapodia, and from the fact that some of the nerve-fibres can be distinctly traced to the organs in question, Graber is inclined to think that they are sensory in function.

4. *Reproductive Organs.*—The author has confirmed his former statement, that *Typhloscolex* (*Acicularia*) is diœcious and not, as Uljanin states, hermaphrodite.

Worm Fauna of Madeira.*—Dr. Paul Langerhans contributes a paper of eighty pages, illustrated by three plates, on the *Syllidæ* of Madeira. He gives a revision of the family, dividing it into three tribes—*Syllideæ*, *Exogoneæ*, and *Autolyteæ*. He also describes one new genus—*Opisthodonta*—and splits up the genus *Syllis* into four subgenera as follows:—

1. *Syllis* with single setæ in all segments (*Haplosyllis*).
2. *Syllis* with similar compound setæ in all segments (*Typosyllis*).
3. *Syllis* with similar compound setæ in all segments, but having besides on many, or on nearly all the segments, single setæ of strikingly different form: these may be either compound or simple (*Ehlersia*).
4. *Syllis* with compound setæ in the hinder segments, simple in the middle, and sometimes also in the anterior segments (*Syllis* proper).

The various species of these subgenera, as well as those of the other genera of the family, are fully described.

In his concluding remarks, the author gives some interesting facts as to the disposition of the setæ of *Syllis gracilis*. In this species some (16–21) of the anterior segments have the usual compound setæ. Then follow a few (2–4) with mixed armature—that is, with both the compound setæ and the simple setæ characteristic of the species; then a very variable number (26–77) with simple setæ only; then a few (2–11) with both kinds; and, finally, the remaining 3–13 with only the compound kind.

It will be seen that the greatest variation is in the middle segments bearing the simple setæ, and, according to the characteristic mode of formation of the segments in these worms, these segments are the youngest. In correspondence with this, it was found that young specimens of *Syllis gracilis* had no segments with simple setæ, but only those with compound and mixed setæ: these, then, corresponded exactly to the subgenus *Ehlersia*. In others, again, still younger, both simple and mixed setæ were absent, only compound ones present, this stage corresponding to the subgenus *Typosyllis*. Similarly young individuals of *Ehlersia rosea* were found, having only the compound setæ characteristic of the whole genus Syllis (*Syllis Forsteri*). It would thus seem that the three subgenera, *Typosyllis*, *Ehlersia*, and *Syllis* proper, represent three stages in the evolution of the whole genus *Syllis*—*Typosyllis* being the oldest, *Syllis* proper the youngest form. According to this view, the simple seta is a further development of the compound one, not *vice versâ*, and Langerhans

* 'Zeitsch. wiss. Zool.' xxxii. (1879) p. 513.

brings forward evidence to show that this is the case; that, in fact, the simple seta has been formed by this fusion of the terminal segment of the compound seta with its stem.

In a second paper, with the same title,* Langerhans gives detailed descriptions of genera and species of Aphroditidæ, Amphinomidæ, Palmyridæ, Lycoridæ, Eunicidæ, Glyceridæ, Nephthydeæ, Hesionidæ, Phyllodocidæ, and Alciopidæ.

Branched Syllis.†—Dr. McIntosh notes a remarkable branched *Syllis* (*S. ramosa*), which was found in a Hexactinellid sponge dredged near Zebu by the officers of the 'Challenger' Expedition; the tangled masses made up by various portions are rarely found to present any head, although, of course, such must be present. The body of the animal is made up of a number of narrow segments, which are provided with laterally set feet; the setæ appear to be remarkable from the fact that their dilated distal portion has a simple terminal process ankylosed to it. Budding appears to take place on any and every occasion, laterally, or terminally, or wherever the surface is broken. It is remarkable that the number of buds seems to be indefinite.

As the paper is in English, and is very brief, we need not detail the account of the two female buds which the author observed. It is to be hoped that it will not be long before figures are published in illustration.

Organization of Echiurus Pallasii.‡—Dr. Spengel finds that the integument of this form consists of a thick cuticle of an epithelial layer formed of cubical cells, and of a subjacent connective tissue. Unicellular glands form groups of varying size and are regularly arranged on the trunk, while they are also found on the dorsal side of the so-called proboscis. The cœlom is lined by a layer of flattened cells attached to the dermo-muscular tube, and continued on to all the organs which are placed in the cœlom. This latter, which extends even into the proboscis, is filled with a fluid in which not only are there cells with pale processes and brownish pigment-corpuscles, but also generative products.

The nervous system is formed by a ventral cord, which is almost completely circular, and forms a wide commissural ring; the ganglionic cells form two continuous bands on either side. Near the dorsal surface of the cord there is, in the middle line, a canal-like cavity, which is always found filled with a coagulum; first seen by Greeff, it may be compared to the axial canal or neural canal of other Annelides.

The pouches of the ventral setæ are stated to have an external investment of muscular and connective tissue and to be lined internally by epithelium. The cells at the base are the largest in size, and are the only parts which give rise to the setæ. The enteric tract is of a considerable length and is greatly coiled; there is an œsophagus, the

* 'Zeitsch. wiss. Zool.,' xxxiii. (1879) p. 267.
† 'Journ. Linn. Soc. (Zool.),' xiv. (1879) p. 720.
‡ 'Zool. Anzeiger,' ii. (1879) p. 542.

walls of which are formed by a thin layer of longitudinal muscles, a thicker layer of circular fibres, and a cylindrical ciliated epithelium; the pharynx is short, and the remaining portions of the enteron may be broken up into three parts; in addition to these there may be made out a "Nebendarm" altogether similar to the structure found in *Bonellia*, and described by Rolando as a "vaisseau que longe l'intestin." Just before the anus there are two brown tubes (anal vesicles), which are provided with a number of ciliated infundibula, and are lined by a flattened epithelium, devoid of cilia, and filled with a brown pigment. The so-called segmental organs form two pairs of thin-walled tubes, which are connected with the cœlom by a ciliated infundibulum, and often to the exterior by a short efferent canal. Brown pigment-granules can be made out in the epithelium, and there are two layers of muscular fibres, of which the inner has a longitudinal, and the outer a circular direction. These organs also serve as efferent ducts for the generative products.

The vascular system is stated to consist of a dorsal and of a ventral longitudinal vessel; the former breaks up, at the hinder end of the pharynx, into two branches, which embrace the enteric canal, and unite on the ventral aspect, only, however, to again divide into two vessels, which open into the ventral blood-canal. This latter also gives rise to two anterior vessels, which open by a transverse vessel into the dorsal blood-canal. No communication was observed between the developed blood-vascular system and the cœlom.

The generative products are developed in the hindermost region of the ventral blood-vessel; a whitish spot may be seen to consist of a close aggregation of rounded cells with large, clear nuclei ("primitive ova"). Balls of these cells, varying in size, break off and pass into the cœlom, where each cell continuing to grow separates the yolk material from the protoplasm of the egg. In the male the cells do not become free so soon; the cells undergo continual division, and the small nuclei are converted into the head of the spermatozoon, very much as in *Sipunculus*.

Natural History of the Orthonectida.* — This group † has now been studied by Professor Elias Metschnikoff, who has had an opportunity of examining *Rhopalura Giardi* (sp. nov.) from the peritoneal cavity of *Amphiura squamata*. The body of the parasite is irregularly pyriform, and was found attached to the viscera of its host. On examination rounded protoplasmic diverticula may be seen, which best call to mind the blunt processes of the Rhizopoda. At first sight veritable Protozoa, they are seen to be more differentiated owing to the constant presence of ova in their bodies; these ova form small rounded cells, with a clear and only slightly granular contents, provided with a large nucleus, and with a nucleolus. They are the so-called "endodermal" cells of Giard; exhibiting a regular division, they give rise to a blastula, in the cavity of which a few cells are to be observed; these are the indications of a bilaminate condition. The tubes in which the generative products are developed are either male

* 'Zool. Anzeiger,' ii. (1879) p. 547.
† See this Journal, ii. (1879) p. 886.

or female, never both; and the Ophiurid host often only contains specimens of one sex.

The chief differences between the development of the two sexes lies in their difference in size; in the male the inner layer is always much smaller than in the female, and contains much smaller cells. In the matured female larva the ectoderm consists of a layer of ciliated cells, which are divided into nine horizontal rows ("segments"); the second of these has, however, no cilia, and contains highly refractive corpuscles. The ectodermal cells form elongated six-sided prisms, which have their long axis directed parallel to the long axis of the body. The inner layer is formed of rounded or polygonal cells exactly similar to the above-mentioned ova. The author is not inclined to give to this layer the title of an endoderm.

Metschnikoff has not, unfortunately, been able to observe the entrance of the free female larvæ into the Ophiurid, nor has he been able to observe the processes of metamorphosis in which the ectodermal cilia disappear. In the more mature males there are only six "segments," and here again the second one is not provided with cilia.

The writer comes to the conclusion that the Orthonectida are a group of the Metazoa which have become degraded by parasitism, and is not, at present, inclined to regard them as intermediate between the Protozoa and Metazoa, although he allows that a systematic position cannot yet be definitely assigned to them.

In a subsequent communication,* M. Giard makes some observations on Metschnikoff's paper. He states that though a similar view has often suggested itself to his own mind, he does not feel as yet justified in giving in his adhesion to the hypothesis that the so-called "ovoid form" is the female of *(Mac)Intoshia gigas;* several differences may indeed be discerned between *(Mac)Intoshia gigas* and its supposed female *Rhopalura ophiocomæ;* thus, in the former, the non-ciliated second "segment" is never provided with the highly refractive corpuscles, while the anterior part of the body is much flattened, and the second segment has on its lower surface a groove of some depth. The writer is strongly opposed to Metschnikoff's view of the musculoid bands of the endoderm being formed by the contours of the tails of the spermatozoa, for they are visible in young examples, are constant in number, and have always the same oblique disposition; nor can he see why the Russian naturalist refuses the name of endoderm to a layer which arises in just the same way as in so many other animals; and, as a communication from Professor Leuchart has lately informed the author, in *Distoma*, among other Vermes. In conclusion, the author re-asserts his belief that the gastrula by invagination is the primitive type, and cites in support the observation of Van Beneden on the Digemida, of Kowalevsky on *Actinia*, &c., and of Keller on *Chalinula*.

Nervous System of the Plathelminthes.†—Dr. Arnold Lang has an important paper on the comparative anatomy and histology of the nervous system of these worms, which was first carefully

* 'Comptes Rendus,' lxxxix. (1879) p. 1046.
† 'Mitth. Zool. Stat. Neapel,' i. (1879) p. 459.

investigated in 1826 by K. E. von Baer, who described two delicate bright bands following a longitudinal course and placed in the ventral region of the body. Dugès, two years later, described a system which he looked upon as being vascular; it consisted of two primary longitudinal trunks passing into one another at either end, and connected by transverse anastomoses; this is the nervous system as described by Dr. Lang. It was not till 1848 that any further details as to a nervous system were given by any anatomist; but in that year Quatrefages described a "double ganglion" whence radiated nerves, and which was situated in a "lacuna" of the body. The circulatory system of Dugès was regarded as being of a nervous nature. Various later anatomists have also contributed to the literature of the subject, and among these the most notable are Metschnikoff and Moseley.

The author's own investigations have been singularly aided by a most fortunate discovery in the shape of a marine Planarian of complete transparency, a pair of which were found in March 1878, in the neighbourhood of Punta di Campanella; for the present he places this new form in the genus *Planocera*, and gives it the specific name of *Graffii*. Without compressing the animal in any way he was enabled to investigate its structure under a magnifying power of 300 diameters; the enteric canal was very distinct, and finely branched; what was most striking was the presence of a delicate network of colourless cords, with a sharp contour, most easily visible in the outer regions of the body; the meshes of the network, which increased in size from within outwards, were distinctly polygonal in form. Towards the middle of the body the cords increased in thickness, and passed into a number of well-developed trunks, which all converged to a common centre; this centre is a transparent bilobed knot, which is placed between and behind the two conical tentacles which are found at the end of the anterior third of the body, and in front of the proboscis; in position and in form this knot had just the same characters as the "brain" of *Proceros*, *Leptoplana*, and other marine Planarians. The brain, therefore, is a largish knot, transversely oval in form, and not very distinctly divided into two lobes; entirely homogeneous when looked at under a low power, it is, under higher magnification, seen to consist of fibrous bands, and of ganglion-cells. A large number of nerves are given off from it, and these are so large and so numerous that it is difficult to make out the proximal portion of their course; ten or eleven nerves could be counted on either side of the middle line, while in the middle itself there ran an unpaired and thinner nerve; the strongest are those which pass most far back. A short distance from the brain the ten largest nerves are connected by a commissure; and as we trace them through the body we find that they and their branches are constantly connected together by fine anastomosing nerve-filaments; and this whole system may be seen to lie under the digestive system and the generative organs; it is only the optic and tentacular nerves which take on a dorsal position. The brain lies in a pyriform space (lacuna of earlier observers), which is formed by the separation from it of the pigment of the body and of the genital organs, and from the divarication of the main trunks of the enteron, of which only a thin branch traverses the space; at times, of course, these enteric branches dilate, and by their dilatation diminish the extent of the cavity; it was probably this diminution which gave rise to the view that the parts now under description were contractile, and which led to the nervous system being regarded as circulatory in function. A large number of fairly developed eyes lie around this cerebral space.

With regard to the other marine Planaria, the author states that in all the species of *Stylochus* and *Planocera* which he examined, the only differences which are found in them from what he saw in *P. Graffii*, lay in the different extent of the division of the two halves of the cerebroid mass, in the degree of development of the finely granular portion, and in the relations of the anterior and posterior nerve-trunks. In the Leptoplanida the brain is distinctly bilobed, and the lateral nerve-trunks diverge during their course to be approximated towards one another at the hinder end of the body. In *Thysanozoon*, *Proceros*, and the other genera in which there are tentacles or tentacle-folds at the anterior end, the brain lies very much more forward.

To sum up Lang's anatomical results: the brain always lies, in the marine Dendrocœla, in front of the proboscis and of the mouth; it is always embedded in the muscles and parenchyma of the body, and is always more ventral than dorsal in position. All the nerves given off from it gradually pass to the margins of the body. From a histological examination, it is found that the central nervous system is enclosed in a thin structureless capsule to which there is closely applied a layer of muscular fibres; the constituent portions of the cerebrum are ganglion-cells and fibrous bands, and these constituents are always symmetrically arranged around a vertical median plane; no nerves are seen to be given off at a sagittal plane. The ganglion-cells vary greatly in character, and may be unipolar, bi- or multipolar, the last being the largest, and exceeding in size any of the cells of the body, saving always the ova. The vesicular nucleus is large and has a distinct contour, within which there is a dark and rounded nucleolus; in the smaller cells the nucleus is of very much the same size as in the larger ones. The ganglion-cells generally form the outer portion of the cerebrum, while the central part is formed of a substance which is made up of extremely fine fibres, and is altogether free from nuclei or ganglion-cells. The investigation of sections has convinced the author that the nerves are connected with the ganglion-cells and the fibrous substance of the brain, and this point, as well as the fact that the nervous matter fills the cerebral capsule, seems to be sufficient to settle the vexed question as to whether the system under investigation is nervous or circulatory.

The nerve-fibres are delicate and are stained with difficulty; nuclei and ganglion-cells, the majority of which are bipolar, are found embedded in them, and the largest (multipolar) are specially developed at the anastomoses. The author was not able to discover any circulatory or water-vascular system.

Classification and Phylogeny of the Turbellaria.*—Paul Hallez gives a sketch of the results to which he has been led by his studies. After noticing the various views which have been held by different naturalists as to the affinities of this lowly group, he comes to a consideration of the classification suggested by Ehrenberg, who proposed to divide the Turbellaria into the Dendrocœla and Rhabdocœla, according as the intestine was or was not branched. Speaking generally, this arrangement has held its own up to the present day; but evidence has been gradually accumulating to show that the character chosen by Ehrenberg is not the most important or valuable; for example, the Planaria of the Lake of Geneva, discovered by Du Plessis, has been shown by Graff to be a Dendrocœlous form with a straight intestine.

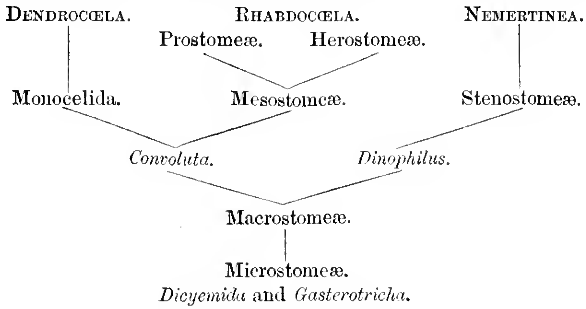
When, however, we consider by what characters the two groups of Turbellaria are to be distinguished from one another, we find that there is a series of forms which appears to present a mixture of the characters of the two suborders; such are the genera *Opistomum*, *Monocelis*, and *Turbella*. Studying the more distinct forms, Hallez finds that there is a marked difference in the extent to which the reticulum of connective tissue is developed; in the Dendrocœla it occupies nearly the whole of the body-cavity, while in the Rhabdocœla it is much more feebly developed. This difference, as well as the others on which our author insists, will be best displayed by a table:—

Rhabdocœla.	*Dendrocœla.*
1. Reticulum not well developed.	Reticulum nearly obliterates the whole of the body-cavity.
2. Pharynx dolioliform (cask-shaped).	Pharynx tubuliform.
3. Water-vessels present.	No water-vessels.
4. Ovaries and testicles: ordinarily one pair.	Ovaries and testicles: more than one pair.
5. Body more or less cylindrical.	Body more or less flattened.

Embryological investigations seem to prove that the rhabdocœlous is more ancient than the dendrocœlous form, but it still remains to be shown what members of the former group most resemble the ancestor of the Dendrocœla; led by the characters of the mouth, the absence of any proper wall to the intestine, and the multiple character of the generative organs, Hallez is of opinion that the now existing *Convoluta* and *Nadina* stand nearest to the stem-form. The Nemertinea appear to pass into the Rhabdocœla through *Stenostomum* and *Dinophilus*, the latter of which has an anus and a proboscis as well as the lateral ciliated pits, in which points it resembles the Nemertinea (Rhynchocœla) and differs from the rest of the Turbellaria; the Microstomeæ are looked upon as being the simplest of the group, and as consequently the most closely allied to the Dicyemida and Gasterotricha. We add the phylogenetic table by which the author expresses his views as to the affinities of the different forms,

* 'Rev. Internat. Sci.,' iv. (1879) p. 466.

and will only add with him that further investigations in the domain of embryology are necessary for the confirmation of his speculations.



New Land Nemertine.*—Under the name of *Geonemertes chalicophora* Dr. Ludwig Graff describes a new form which he found in one of the palm-houses at the Zoological Gardens at Frankfurt; milk-white in colour and from 10–12 mm. long, at the most, it resembles in very many points *G. palæensis*.† There are in the skin some specially remarkable deposits which take the place of the more common rod-shaped bodies; these have the form of oval flattened bodies, which are highly refractive and are principally made up of calcic carbonate. Although dorso-ventral muscular fibres are present, they are arranged somewhat irregularly and do not form distinct dissepiments as in the marine Nemertinea (Hubrecht).

As in *Malacobdella* and *G. palæensis*, and as in them only among the Nemertinea, the oral orifice serves also as the orifice for the proboscis. It is of interest to note that in this form as in most of the Turbellaria the cells of the enteric epithelium are only distinct during their resting (or hunger) stage, when they form more or less high cylindrical cells, which are fringed on their enteric face by a layer of hyaline protoplasm. When nutriment is introduced they elongate, surround the food particles by amœboid processes, and form a number of vacuoles; then they fuse completely with their neighbours, the lumen of the tube disappears, and the whole cavity becomes filled up with a protoplasmic network, rich in vacuoles and containing the food. This latter becomes dissolved and is diffused, apparently through the basal end of the cells, into the perienteric fluid; at the termination of this process the enteric cells are seen to have returned to their original size. That the process of digestion is really of this type in *Geonemertes* as in the allied forms, is rendered certain by the evidence afforded by different sections through the epithelium. The author notes the presence of three kinds of connective tissue; in the cephalic region it is spongy, and made up of highly refractive cells, between which there are set delicate cells, nucleated but without a membrane, together with muscular and connective fibres; more posteriorly and ventrally there is the second kind

* 'Morphol. Jahrbuch,' v. (1879) p. 130.
† See this Journal, ii. (1879) p. 724.

of tissue of extremely delicate and branched fibrils, which are closely united to form a network, by which the enteron and the sheath of the proboscis are connected with the body-wall. The third modification is found within the sheath of the proboscis as well as in the enteron, and around the generative follicles; it consists of a finely granular substance in which there are embedded fine refracting branched fibrils with spindle-shaped nuclei. The cells which are found in all these three forms of connective tissue are also to be found floating freely in the cœlom.

Dr. Graff is of opinion that the Nemertine under description was imported from Australia with the palm (*Corypha australis*) in the earth around which it was found. The connection between it and *G. palæensis* is evidently very close; both resemble other Nemertina enopla in the structure of their proboscis, of their nervous system and of their body-wall; but they are both distinguished, as we have already noted, by the opening of the proboscis into the mouth, and by the constant hermaphrodite arrangements; in the former point they are remarkable for agreeing with Malacobdella.

Excretory System of the Trematoda.*—Professor Bütschli takes occasion to point out that the presence of a ciliated orifice to the canals of this system is not so doubtful as B. Hatschek seems to imagine, nor are the same funnel-shaped openings absent from all the Platodes. Thiry reported their existence in the *Cercaria macrocerca*, and Bütschli has himself observed ciliated infundibula opening into the interspaces in the parenchyma of other Cercariæ; and he observed, moreover, that their arrangement was bilaterally symmetrical; several ciliated funnels are attached to a common stem, and they have on the whole a very remarkable resemblance to the organs of similar function in the Rotatoria.

New Trematode.†—Dr. Taschenberg describes the parasite which he found on the gill-lamellæ of *Pelamys sarda* at Naples; rounded yellowish structures were found on examination to be connective-tissue cysts, which always enclosed two long worms, closely intercoiled. Each animal was about 3 cm. long, and the most anterior portion is spatulate and white; the colour of the rest of the body is yellowish, with greyish transverse stripings. The yellow colour is due to the large mass of coiled tubes, which contain a considerable quantity of ova. This form is to be distinguished from *Monostomum* by the complete absence of any sucker, and, on account of its mode of life, Taschenberg proposes to call it *Didymozoon*. The genus may be briefly defined thus: elongated and occasionally reniform or circular worms, with a distinct neck, but without suckers. The intestine may or may not be present. The testicular body forms a much coiled tube, and the ovarian tube accompanies it. The generative orifice is at the anterior end of the body. The ova are small, oval, and provided with a chitinous shell: the species of the genus are *D. thynni*, *D. scombri*, *D. pelamydis*, *D. sphyrænæ*, and *D. auxis*.

* 'Zool. Anzeiger,' ii. (1879) p. 588.
† 'Zeitsch. Gesammt. Naturwiss.' (Giebel), lii. (1879) p. 605.

The mode of life of these creatures would not be so remarkable were it not that both inhabitants of the cyst are in all respects similar; the history of their development is as yet unknown. The integument is extraordinarily thin, and consists of a fine cuticle and of finely granular protoplasm. The parenchyma proper forms a wide-meshed network, and there is on it a system of larger and smaller spaces in which the organs of the body are set. The mouth is placed at the anterior end of the body and leads into a pharynx, which may be rounded or may be elongated, and is best developed in *D. pelamydis.* When the enteric tract is developed the œsophagus is, as ordinarily, bifurcate, and ends blindly at the hinder end of the body. With regard to the absence in some species of any enteric tract, it is of interest to note that where it is present, there is no indication of any lining epithelium; the generative organs occupy the greater part of the body, but no ovary could be observed; in all cases observed the eggs were already well-developed; the oviduct opens at the anterior end, and the seminal duct opens in the same region. The paper is illustrated by a plate of five figures.

Contributions to American Helminthology.*—Professor Ramsay Wright describes the following new species: *Distomum asperum*, from the bile-duct of *Botaurus minor; D. reticulatum*, from the surface of the lung of the belted kingfisher; *Polystomum oblongum*, from the urinary bladder of the musk-turtle; and *Filaria triaenucha*, from the proventriculus of the bittern. *Sphyranura Osleri* is the name given to the representatives of a new genus, which were taken from the gills and buccal cavity of the common lake-lizard (*Menobranchus lateralis*); this appears to be the only form of monogenetic Trematode, with the exception of *Polystomum integerrimum*, which has yet been found in any amphibian; the author takes occasion to point out that the resemblance of the Polystomum-larva to *Gyrodactylus* is very striking, and he draws attention to the fact that "if the piscine ancestors of Amphibia had Gyrodactylus-like gill-parasites these would probably be transmitted to their descendants." Other already known forms are also referred to in the paper.

Echinodermata.

Studies on the Echinodermata.†—Dr. Hubert Ludwig publishes a preliminary notice of the contents of the first part of the second volume of his 'Morphological Studies on the Echinodermata.' He has arrived at the following results:—

(1) The stalked larva of *Antedon* has, primitively, only one stone-canal and only one pore; these always occupy the same interradius, and that the one next to that in which the rectum and anal orifice are placed; this relation of parts is also seen in the Asterida. As the primary pore of the Crinoida lies in an oral plate, it follows that the oral plates of the Comatulidæ have the same relation to the water-vascular system as the genital plates of the Echinoidea and Asterida.

(2) In all Echinodermata the coils of the enteric tract take the

* 'Canadian Journ.,' i. (1879) p. 54. † 'Zool. Anzeiger,' ii. (1879) p. 540.

same direction; in all cases it passes from left to right, save only in the Ophiurida. The peculiar second coil in the Echinoidea is seen to be the same in the Echinida and the Spatangida, if we place representatives of these two groups in the positions which Professor Lovén regards as similar.

(3) Bearing in mind the position of the stone-canal and the direction of the enteric coil, we find that the bivium and trivium of the Holothuroida are not comparable to the bivium and trivium of the Spatangida.

(4) In the Ophiurida the blood-vascular system presents the same typical relations as in the Asterida or Echinoidea; an aboral ring, hitherto unobserved, is described as giving off vessels to the generative organs, and as being connected by a cardiac plexus with the oral ring; this aboral ring is remarkable for lying partly under the radial shields, and thence passing to the ventral side of the disk, while another part passes to the genital glands, and, in fine, it has the form of a ring provided with five central diverticula, which pass towards the ventral side and come to lie just above the oral shields; this aboral ring in the Ophiurida is consequently homologous with the dorsal ring of the Asterida and Echinoidea.

(5) We now find that the oral shields of the Ophiurida are homologous with the genital plates of the Echinoidea and Asterida, while the oral plates of the Crinoida fall into the same category. From these observations it would seem to follow that the homology which Dr. Ludwig thought he had proved to exist between the first intermediary skeletal plates of the Asterida and the oral shields of the Ophiurida does not obtain, and that we are led, in addition, to see that the circum-anal area of the Echinoidea corresponds to the whole perisom of the Ophiurid disk, with the exception of the arms and oral shields.

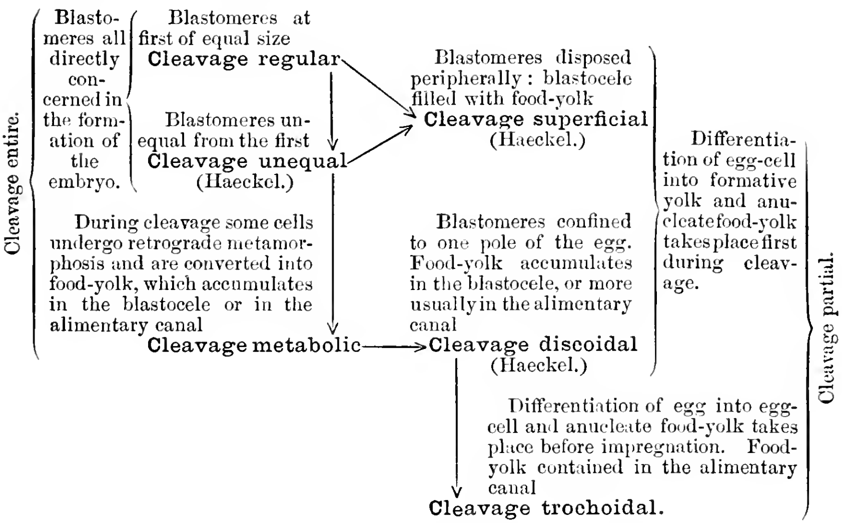
Echinodermata of the Mediterranean.* —Dr. Hubert Ludwig publishes a prodrome of a monograph of this group, in which he gives a full bibliographical list of works on this subject, and a careful account of the synonymy of the species. There are included altogether 120, but of these 27 are more or less doubtful. Of the other 93, 2 belong to the Crinoida, 19 to the Asterida, 25 Ophiurida, 18 to the Echinoidea, and 29 to the Holothuroida. When we compare this with the lists given by Sars (1857) or Heller (1868) we find a considerable increase in point of numbers, for the former only mentioned 52, and the latter 75 species. It is of interest to note that the opening of the Suez Canal has been of some influence in increasing the variety of the Mediterranean fauna.

Early Development of Echinids.†—Professor Emil Selenka has studied, at Naples, the formation of the germ-layers and the origin of the organs in *Echinus miliaris*, *Toxopneustes brevispinosus*, *Strongylocentrotus lividus*, *Arbacia pustulosa*, and *Echinocardium cordatum*.

1. *Yolk-division.*—As in other Echinoderms cleavage is complete.

* 'Mitth. Zool. Stat. Neapel,' i. (1879) p. 523.
† 'Zeitschr. wiss. Zool.,' xxxiii. (1879) p. 39.

The author makes some general remarks on cleavage, which he sums up in the following table:—



Selenka prefers to speak of *regular* rather than *primordial* (Haeckel) cleavage, because there is no evidence to show that this mode is really primitive—and indeed it is rare in the lowest Metazoa, the sponges. He adopts the word *metabolic* to include those cases in which there is an actual destruction of cells to form food material; and he distinguishes *trochoidal* from *discoidal* cleavage, because in the former the entire egg has no longer the form-value of a single cell, but of a cell *plus* added food material. Strictly speaking, therefore, the cleavage in this case is entire, not partial.

In the Echinids studied, as in other Echinoderms, there is an accumulation of coagulable nutritive material in what would otherwise be the cleavage cavity; even after the formation of the first cleavage plane the two blastomeres are separated by an intermediate layer, so that a morula, in Haeckel's sense—in which the cleavage-masses are in actual contact—cannot strictly be said to exist. This mode of division and of formation of food-yolk forms a transition to the superficial cleavage characteristic of insects.

2. *Origin of Mesoderm.*—At the completion of the blastula stage, the cells at one pole—that at which the gastrula invagination will afterwards take place—are seen to be considerably larger than those at the other pole. Along this pole, and corresponding with the axis of the future gastrula, a cleft appears, thus producing the first indication of bilateral symmetry. On either side of the cleft the (future endoderm) cells divide, and the new cells formed passing into the nutritive material filling the blastocele, form two symmetrical masses, the foundation of the mesoderm. By the rotation of the embryo the amœboid cells, of

which these masses are composed, are gradually made to run together into an equatorial ring. As development goes on the cells separate again, and resume their amœboid movements; some take on the function of skeletogenous cells, producing the skeleton as a cuticular secretion; others go to form the circular musculature of the foregut, the midgut and hindgut remaining devoid of muscle; and the remainder go to form suspensory cells connecting the alimentary canal with the body-walls.

3. *The Gastrula.*—Invagination takes place at that pole where the cells are largest; a tubular cavity is produced, the aperture of which (blastopore) becomes the larval anus. It was stated by Krohn that the blastopore served for the ingestion of nutriment until the permanent mouth was formed; but according to Selenka this is impossible, as the cilia of the archenteron all work outwards.

From the blind end of the archenteron two lateral outpushings arise, which, with the actual extremity of the archenteron connecting them, become segmented off as a single sausage-shaped sac, the *vaso-peritoneal vesicle.* This then divides into two symmetrical halves, of which one is the right peritoneal sac, while the other subsequently divides into the left peritoneal sac and the rudiment of the ambulacral system.

When metamorphosis takes place the larval mouth disappears, but the larval anus persists as the adult vent.

Cœlenterata.

Histology of Ctenophora.*—Dr. Carl Chun, of Leipzig, has a short paper on this subject, consisting mainly of adverse criticisms of the work of Buekers and Eimer. The point of chief interest in the paper is the description of the tactile papilla discovered by the author on the aboral region of *Cestus Veneris.* It consists of a number of globular vesicles with granular contents, and enclosing crystals, probably of leucin, arranged in a radiate manner; amongst these vesicles occur cells bearing tactile hairs. Both these latter and the vesicles are developed from ordinary polygonal ectoderm-cells.

Development of the Alcyonidæ.†—Professor Kowalevsky has lately been engaged in the examination of the larvæ of *Sympodium coralloides.* The youngest forms examined were provided with an ectoderm of cells somewhat flattened; these became in time more cylindrical and smaller, until in the completely matured larva the ectoderm consisted of a number of closely appressed, long, fine cells, the nuclei of which were so placed as to give it the appearance of cylinder epithelium. The gastric cavity was formed by the invagination of the free pole, and meantime the ectoderm increased considerably in thickness, and gave rise to an intermediate, transparent, and gelatinous tissue. The cells, losing their cylindrical form, became elongated and spindle-shaped, or stellate, till they formed several rows of cells, separated by a gelatinous tissue. The author is of opinion that the preceding account details the history of the origin of the mesoderm. In examining the formation of the spicules which

* 'Zool. Anzeiger,' ii. (1879) p. 329. † Ibid., p. 491.

are developed in this mesoderm, he found that the bodies in question were, just as in the Spongiæ, developed in the cells. The nucleus of the cells disappears in time, and the calcareous body, at first surrounded by the protoplasm, finally becomes completely free.

In examining *Clavularia crassa* the author had the assistance of Professor Marion. They found that the ova undergo complete segmentation, and that the spheres become arranged in two layers. The cells of the endoderm soon become separated into two layers, of which the inner is used up during the processes of metamorphosis. The observations of Marion on the succeeding stages lead him to think that the "mesoderm," with its external epithelium, should be simply regarded as representing the ectoderm, and in this view Kowalevsky completely agrees. Marion found that the history of its development was in *Clavularia* completely similar to that which was seen in *Sympodium*, with this sole exception, that the calcareous spicules appear somewhat later.

Skeleton of Corals.*—Herr von Koch finds that the ordinary dictum that the theca of the corals is the calcified basis of the supporting lamella of the polyp-wall is not always correct. He has examined a number of the Aporosa, and has observed that the theca (*Mauerblatt*) is only connected with the soft body-wall at its base. Taking as an example the common *Caryophyllia cyathus*, he shows that the mantle is formed by a supporting membrane, which is invested externally by the ectoderm and internally by the endoderm. At the base of the several chambers into which the interior of the polyp is divided there are radiating septa which, consisting principally of a calcified connective substance, are thickened towards their periphery and are also united together. The wall thus formed divides the partitions of the chambers into a central and a peripheral portion. As the polyp grows, the latter becomes completely fused into a single mass, and, with the gradual death of the creature in the peripheral portions of the base, there becomes apparent a naked, calcareous surface.

A new species of *Clavularia* (*ochracea*) is to be distinguished from *Cornularia cornucopiæ* by having the hyaline substance of the meso-skeleton very richly developed, and its ecto-skeleton far less so.

In the spicules of Alcyonaria the author has observed that the crystals are concentric and very regularly arranged, but that their axes more or less cross one another; in the examination of other forms of calcification the author states that he has met with very considerable difficulties.

Histology of Craterolophus tethys.†—This species of *Lucernaridæ* is studied by Dr. O. Kling, of Frankfurt; the account of the minute structure being preceded by a general description of the anatomy.

1. *Ectoderm.*—The cells on the aboral surface of the bell and on the pedicle are strongly pigmented cylinder-cells, provided with nematocysts and glands. They secrete a thick cuticle, divisible into

* 'Morphol. Jahrbuch,' v. (1879) p. 316.
† Ibid., p. 111.

three layers—an outer mucous layer, a middle thin, homogeneous layer, divisible into areæ corresponding with the cells, and an inner much thicker layer, composed of superposed polygonal plates corresponding with the cells, each plate being again made up of thin, highly refracting rods.

The ectoderm is not pigmented, and contains numerous nematocysts, mostly sausage-shaped, a few pear-shaped. In certain parts are batteries of nematocysts, consisting of a globular ingrowth of ectoderm, the outer layer of cells of which form an investment, while the greater number of the included cells produce nematocysts. When the animal is strongly irritated, the whole battery is discharged, cells as well as nematocysts being extruded.

2. *Mesoderm.*—This layer consists of a ground-substance of gelatinous character, containing elastic fibres, and contractile elements of two kinds. The first of these, forming the musculature of the gastric region, tentacles, &c., consists of mere muscle-processes of the ectoderm cells, like those described by Kleinenberg in *Hydra*; the ectoderm cells tapering at their inner ends, and being continued into the contractile fibres. The eight circular and longitudinal muscles consist of true fusiform muscle-cells, with distinct nucleoli; they may attain a diameter of 4 μ, and a length of as much as 5–10 mm.

3. *Endoderm.*—The cells of this layer are flagellate, and contain oval nematocysts of variable size. Amongst them are special gland-cells; probably both these and the flagellate cells secrete a digestive fluid.

Kling assigns an important digestive function to the filaments in the gastric cavity, which exhibit during life a slow vermicular movement. They are plano-convex in section, and consist of a hyaline axis surrounded by endoderm cells, of which those on the plane side are exclusively glandular, while those on the convex side are flagellate, and contain, especially towards the free end of the filament, nematocysts.

4. *Tentacles.*—The endoderm cells of the stalks of the tentacles are very large and elastic, and seem to act as antagonists to the muscular fibres which produce retraction.

The ectoderm of the knob terminating each tentacle has a very complicated structure; the isolated cells look not at all unlike retinal elements. At the outer or distal end of each cell is a thickish cuticular layer; then comes an enlargement bearing a sausage-shaped nematocyst, with a palpocil or cnidocil projecting through the cuticle; beyond the nematocyst the cell is filamentous, having, however, an enlargement near the middle containing the nucleus, and another smaller enlargement near the proximal end, where the cell usually ends in a slight swelling, from which two or three processes are given off. Owing to this complicated structure, the whole ectoderm of the knob has the appearance, in section, of being divided into a number of layers.

5. *Marginal Papillæ.*—These are, when present, usually eight in number, four being radial and four interradial. In the majority of individuals, however, they are absent, and in some they are fewer than eight. In structure they resemble undeveloped tentacles.

6. *Genital Bands.*—The chief result of the author's investigations on these structures is that the sexual products are derivatives of the endoderm, arising as ingrowths of endoderm cells, tubular at first, but soon becoming solid.

New Siphonophore.*—Under the name of *Agalmopsis utricularia* Professor Claus describes a new Mediterranean form; it is remarkable for the possession of large vesicles at the end of the nematophores, which are comparable to the vesicular appendages of *Utricularia.* They are apparently hydrostatic organs, for they are directed upwards in such a way as to keep the "grappling-lines" in a horizontal position. At the base of each there is set a crown of eight long stinging threads, so that the creature is provided with a veritable network of prehensile organs. The author points out that these parts are only modifications of what has been already observed in *A. Sarsii*; and while this leads us to associate the new form with other species of the same genus, the structural arrangements of the common stem support the view. It is to be distinguished from *A. Sarsii* by the long stalk for the nutrient polyps, and by the relatively broad hydrophyllia; between every two of these latter there are set six to nine tentacles with generative buds, and of these latter the male forms are covered by a distinct investment.

Histology of Hydra.†—Mr. T. J. Parker comes to the following conclusions on some disputed points of structure in the common *Hydra.*

1. *Ectoderm and Muscular Layer.*—Sections of ammonic bichromate specimens show the correctness of Kleinenberg's and the incorrectness of Korotneff's views as to the true connections of the fibrils of the muscular layer. The large ectoderm cells taper at their inner ends, and each is continued into one of the muscular fibres. The author considers that these are undoubtedly contractile, not, as has been suggested, nervous. He also objects to the term neuro-muscular as applied by Kleinenberg to the ectoderm cell and its contractile process, and to the term epithelio-muscle cell used by Korotneff, since the two answer to what, in the higher animals, is differentiated into sensory cell, sensory nerve, nerve-cell, motor nerve, and muscle-cell.

Kleinenberg's discovery of interstitial tissue in the distal or gastric region is confirmed, but no interstitial cells could be made out in the tentacles. This tells against the view that the nematocysts are formed entirely in these cells.

2. *Supporting Lamella.*—This was clearly made out as a distinct, though delicate, structureless membrane between the muscular layer and the endoderm.

3. *Endoderm.*—Sections of osmic acid preparations show that the endoderm is, in all probability, ciliated throughout, each cell bearing one, two, or three flagelliform cilia, nearly or quite as long as itself.

The active amœboid movement of the endoderm cells during life is strongly insisted on: the pseudopodia sent out by them, during

* 'Arbeit. Zool. Inst. Würzburg,' ii. p. 199.

† 'Proc. Roy. Soc.,' xxx. (1880) not yet published.

digestion, being so large as nearly or quite to obliterate the digestive cavity.

Mr. Parker also suggests an explanation of the dark, greenish or brownish granules formed in the endoderm cells of all species of Hydra. He considers that these are solid food particles, derived from the alimentary canals of the prey, so that Hydra presents the characteristically protozoan mode of digestion, observed by Metschnikoff in *Turbellaria* and in sponges.* In one case, a diatom frustule was found embedded in the protoplasm of a cell.

Nematocysts were observed in the endoderm: this is another argument against Kleinenberg's view that only interstitial cells act as mother-cells of the nematocysts.

4. *Methods.*—For ordinary sections, Kleinenberg's picric acid is recommended, the animals being first killed with hot water: for demonstrating the relations of the muscular fibres the specimens were placed alive in ammonic bichromate, 1 per cent., this reagent causing a slight separation of the layers. In both cases they were afterwards treated with alcohol of gradually increasing strength. Cacao butter was used as an embedding material.

For showing the cilia of the endoderm cells, the specimens were placed alive in 1 per cent. osmic acid, kept in it for twenty-four hours, and then transferred to equal parts of glycerine and water. Sections of these were cut by the freezing method.

For demonstrating the supporting lamella, and for teasing purposes generally, acetic or osmic acid or ammonic bichromate answered best.

Early Development of Gonothyræa Lovéni.†—R. S. Bergh, of Copenhagen, has a long paper on this subject. The following are his most important results.

1. *Development of the Egg.*—The egg of *Gonothyræa* arises from a single endoderm cell; the yolk is differentiated into hyaline ectoplasm and granular endoplasm. There is no investing membrane. The germinal vesicle is spherical, and situated in the centre of the egg; it is surrounded by a distinct membrane, and contains a network of nucleoplasm, in the centre of which is the single germinal spot: the latter contains a vacuole.

As the egg grows, addition of new matter takes place only in the endoplasm and in the germinal vesicle, not in the ectoplasm. The nucleoplasm becomes dissolved in the nuclear fluid, and the germinal spot undergoes division. Gradually the distinction between ectoplasm and endoplasm disappears; the germinal vesicle assumes a peripheral position, probably by means of the amœboid movements of the yolk; the germinal spots, after repeated division, become dissolved in the nuclear fluid. By this time both egg and germinal vesicle have considerably increased in size.

The next change is the disappearance of the membrane of the germinal vesicle, its contents mingling with the surrounding yolk: the growth of the egg is now complete. Next the characteristic

* See this Journal, ii. (1879) pp. 287 and 894.

† 'Morphol. Jahrbuch,' v. (1879) p. 22.

amphiaster (Richtungs-amphiaster) appears, marking the commencement of the formation of the first polar cell. As the latter is segmented off, the female pronucleus (Eikern) appears close beneath it.

2. *Comparative Observations on the Egg.*—The early development of the egg may take place in the following different ways:—

(*a*) The changes in the germinal vesicle, up to the formation of the amphiaster or the first polar cell, take place in the centre of the egg (*Hirudinea*, *Mollusca*).

(*b*) The division and subsequent disappearance of the germinal spot takes place in the centre of the egg, but the germinal vesicle passes to the periphery before forming the amphiaster (*Hydroids*, *Batrachia*).

(*c*) The processes of division and solution of the germinal spot are slow, and take place at the periphery of the egg (*Asterids*).

(*d*) These processes again take place at the periphery, but are rapid (*Echinids*, *Medusæ*, *Siphonophora*, *Annelides*, *Lucernaridæ* ?, *Mammalia* ?).

(*e*) The germinal spot does not divide, but undergoes solution as a whole (*Ascidians* ?).

Like other recent observers, Bergh considers that there is no evidence in favour of Haeckel's theory that the egg-cell passes into the cytode stage, by the total disappearance of the germinal vesicle.

The latter part of the paper is taken up with a detailed account of the process of yolk-division in *Gonothyræa*, which closely resembles that described in *Hydra* by Kleinenberg.

The author concludes with some remarks upon segmentation and cell-division in general.

Porifera.

Structure of the Spongidæ.*—In the seventh instalment of his "Researches on the Structure and Development of Sponges," Professor F. E. Schulze gives an account of the family Spongidæ, which he defines as "those horny sponges which have small, hemispherical, ciliated chambers, provided with special efferent canals, and surrounded by connective tissue rich in granules: a skeleton consisting of a network of solid, concentrically laminated spongiolin fibres, enclosing here and there foreign bodies, but never true siliceous structures, and in which the filamentous knobbed filaments characteristic of some families (*Hircinidæ*) are absent."

The first section of the paper consists of a review of the work of former observers on the classification, &c., of Spongidæ and on the genera included in it. Of these Schulze accepts six:—*Euspongia*, *Hippospongia*, *Phyllospongia*, *Carteriospongia*, *Cacospongia*, and *Stelospongia*.

Euspongia officinalis.—Schulze distinguishes six subspecies of this sponge, of the general character of all of which he gives a description; they are *E. molissime*, *lamella*, *adriatica*, *irregularis*, *exigua*, and *tubulosa*.

As in other sponges, three layers of tissue are distinguishable, called

* 'Zeitsch. wiss. Zool.,' xxxii. (1879) p. 593.

usually ectoderm, mesoderm, and endoderm, since they probably correspond with the layers known by these names in the higher animals. But as this question is more or less *sub judice*, Schulze prefers to speak of "outer cell layer" (äussere Zellenschicht), "connective layer" (Bindesubstanzschicht), and "collar-cell layer" (Kragenzellenschicht).

The outer cell layer consists of a single layer of flattened polygonal cells with rounded nuclei; it can easily be made out in all the lacunæ and canals with the exception of the ciliated chambers, and exists also on the external surface, where, however, its existence is more difficult to demonstrate. In many examples a true cuticle can be separated from the outer surface as a delicate, hyaline, elastic lamella.

The connective layer consists, in all parts where ciliated chambers do not occur, of a hyaline, gelatinous ground-substance, with anastomosing connective-tissue corpuscles embedded in it. In the tissue immediately surrounding the ciliated chambers the ground-substance contains a great number of rounded, highly refractive granules, which give to these portions of the sponge tissue, a white, opaque appearance, by reflected light. Some of the connective-tissue corpuscles contain pigment granules. Amongst the ordinary corpuscles, rounded cells without pseudopodial processes are to be found, containing, in addition to a nucleus, highly refractive spheroids, probably of a fatty or amyloid nature; probably these are reserve materials, like the somewhat similar bodies found in *Chondrosia* and *Aplysina*.*

Contractile fibre-cells—muscle-cells of other authors—occur in the mesoderm, especially in the outer layer, around the canals, and in the sphincter-like membranes of the oscula. Spindle-shaped fibres were also found gathered into definite bundles, and usually running parallel to the canals: probably these are antagonistic to the circular fibres.

As in *Aplysina*, *Spongelia*, &c., the mesoderm bounding the cavities in which the generative products occur is modified so as to form a single layer of flat endothelial cells.

In the horny fibres, developed entirely in the mesoblast, Schulze distinguishes an axial cord of soft consistency, and a thick, laminated, highly refractive cortex, the layers of which are not composed of longitudinal fibrillæ, but are homogeneous and structureless. As to the origin of the skeleton, he states that "the horny fibre is a cuticular secretion of peculiarly modified connective-tissue cells, the *spongoblasts*," which envelope the fibres as a single layer of epithelium-like cells of variable size. It is probable that when new fibres are to be formed, ordinary mesoderm cells become somewhat altered in shape, and arranged in strings; that there is then formed in the axis of the string, partly by secretion from the cell, partly by modification of the mesodermal ground-substance, the soft axial cord; and that then, the cells, acquiring the characteristic form of spongoblasts, secrete, layer by layer, the cortical substance. The outer free ends of the principal fibres grow, probably, in virtue of a cap of irregular mesoderm cells which invest them: in growing, it is probable that they include in their

* For this and other points, cf. Schulze on *Aplysina* and *Spongelia*, this Journal, ii. (1879) p. 434.

substance sand-grains and other foreign particles adhering to the conuli, or elevations of the surface into which the ends of the chief fibres project.

The collar-cells (endoderm) resemble those of other horny sponges: they are usually elongated and cylindrical, with a rounded nucleus at the base. They form a single layer, lining the hemispherical ciliated chambers, each of which has usually four or more inhalent pores and a large exhalent canal.

The ova, as in other sponges, arise as irregular roundish cells in the hyaline ground-substance of the connective layer. The ripe eggs are oval, 0·25 mm. in diameter, with granular yolk and a large germinal vesicle with germinal spots. It was made out that, as the egg became ripe, the germinal vesicle approached the periphery, and completely lost its vesicular character, appearing merely as a bright speck.

One important point is that, in this genus, the eggs are not irregularly scattered through the mesoderm, as in other sponges, but occur in definite groups of ten to thirty, embedded in gelatinous connective stroma, and forming together a globular mass, which may be taken as the first appearance of an ovary. The period of sexual maturity is independent of the time of year.

Sperm aggregations were only found in one specimen, which contained no eggs, so that probably the sexes are distinct.

Yolk-division is regular and symmetrical: no cleavage cavity was to be seen. The oldest larva examined was somewhat elongated, convex at one pole, slightly excavated at the other, and consisted of a central mass of parenchyma-like cells, surrounded by a single layer of very small, cylindrical, ciliated cells. Pigment occurred in the outer layer, both at the convex pole and in the raised rim surrounding the depression at the opposite extremity.*

Cacospongia.—The paper concludes with a description of three species of this genus, which does not differ in any important particulars from *Euspongia.*

Histology and Gemmation of the Tethyæ.†—In addition to the following results, Dr. Bela Deszo he gives valuable hints as to methods for the study of these difficult organisms.

The cells—e. g. of the syncytium—were brought out by Beale's carmine. The gemmæ were studied by thin hand-made sections after treatment with $\frac{1}{4}$ per cent. perosmic acid and with ammonia-free carmine. By these means a very considerable complexity of histological arrangement is demonstrated to exist in *Tethya lyncurium*, which was the special form selected for study.

A distinct *epithelium*, consisting of a single layer of flattened cells, covers the outer surface of both the gemmæ and adult; in the former case they are oval in shape, in the adult they are polygonal and smaller.

An *endothelium* clothes the interior of the water-passages, and differs from the epithelium in the more massive shape of its constituent cells.

* Cf. Metschnikoff, this Journal, ii. (1879) p. 874.

† 'Arch. Mikr. Anat.,' xvi. (1879) p. 626.

The *fibre-layer* is a layer separated from the epithelium by a layer of small and one of large stellate spicules. It consists in the youngest embryos (gemmæ) of oval, granular, nucleated cells lengthened fusiformly, of about the same size as the epithelial cells. In embryos of twice the size they have become slightly larger and more elongated. In the adult they may (1) assume a true *fibre-shape* by elongation, containing a nucleus and granular protoplasm, or (2) remain *spindle-shaped*, the protoplasm remaining clear, but being longitudinally fibrillated.

The *medullary tissue* occupies the centre of the sponge, lying immediately beneath the preceding layer, and consists of an aggregation of cells which may be isolated and are distinguishable in the tissue itself; their nuclei often contain nucleoli. In the younger embryos they are roundish, oval, granular, with a large nucleus; they are almost half as large again in the older embryos; in the adult they are found again to possess the former dimensions (·0069 mm. long) and have an angular, elongated form, their nuclei often becoming invisible or being lost (it does not appear *which* is really the case).

The *water-vascular system* is absent in gemmæ of 1 mm. diameter. In those of 2 mm., however, the different tissues, as already enumerated, are developed; and within these, between the large-stellate-spicule layer and that of the small spicules, which lies directly beneath the epidermis—run the main water-canals. These send off branches with regularity to the surface, which is uniformly perforated by the *pores*, and to the central medulla. The ciliated endothelium cells which line its course rest on small stellate spicules, which in turn are surrounded by fibre-cells. To these arrangements of contractile fibres and of the vessels must be due the circulation of water through the system, and its sudden expulsion, accompanied by contraction of the body, when the sponge is removed from the sea.

The *linear spicules* range from ·0176 to ·0315 mm. in breadth in different gemmæ; three varieties between these limits exist in the adult. They are enveloped in a bi-laminate *sheath*; the inner layer being the proper sheath-layer, the other being formed by the surrounding sponge-cells; the former is distinguished, as discovered by Keller, by being more deeply stained by reagents than are the surrounding cells; its cells are also much smaller than these. In young gemmæ the sheath covers the point as well as the body of the spicule.

The *small stellates* appear in the outer part of the fibre-layer, first in one, ultimately in many rows; they are each developed from a single cell, the nucleus of which is converted into the spicule; in their youngest stages they dissolve in boiling hydrochloric acid.

The *large stellates* appear first in gemmæ of 2 mm. diameter, and form a single row beneath the last-named forms; they are developed in "giant-cells" of ·0315 mm. diameter, from the cell-nuclei.

The *gemmæ* appear first in the small-stellate layer, as aggregations of four specialized cells each, lying in a capsule composed of long fibre-cells. Of the four embryonic cells, three originate the *ectoderm* and one the *endoderm*. The endodermal cell becomes encapsuled by the multiplication of the ectoderm cells round it, and then proceeds to increase by fission, forming a single row of cells, and then—the ectoderm ceasing to multiply its cells—a double row, and so on, until the whole mass becomes globular from the internal development of endoderm cells. Now the ectoderm resumes its activity and becomes bi-laminate, the outer layer constituting the small-stellate-spicule layer, the inner forming the source of the future large-stellate- and fibre-layers, and of the medullary tissue.

The gemmæ, thus originated, on reaching a diameter of 1 mm. are supported by a pedicle of spicules; they then consist of an epithelium, a layer of small stellates, below this the fibre- and large-stellate cells, and innermost the medullary tissue, the whole diameter being traversed radially by linear spicules.

The important modifications occurring in the next—the 2 mm. diameter—stage are the development of the water-vascular system and the fuller differentiation of the spicular and cellular elements.

The bud reaches the exterior by its contact with a bundle of the radiating spicules; these gradually move towards the periphery, being met by an invagination of the more superficial small-stellate layer; the gemma arrives opposite to this opening, and is thus extruded by its spicule-bundle from the sponge. This method of development of buds is especially interesting from the few exact parallels with which it meets in other animals, the case of *Loxosoma* as lately given by Professor O. Schmidt * being one of these.

This method of development by germ-layers in a *bud* is probably more ancient than the same process exhibited by an *ovum*. The mesoderm, according to the results here set forth, is double, which F. E. Schulze † has hitherto not admitted, although he is distinguished among the upholders of the three-layered structure of sponges. Certain varieties of *T. lyncurium*, viz. var. *villosa* Schmidt, MS., and var. *lævis* Schmidt, MS., show minor divergences from the arrangements above, chiefly in the connections of the layers of stellate spicules; a similar divergence is shown by an unpublished species of Tethya from Mexico.

Faringdon (Coral-Rag) Sponges.‡—Mr. H. T. Carter draws attention to some of the difficulties which attend the view of Zittel that these sponges are "Calcispongiæ." He points out that their resemblance to the genus *Clathrina* of Gray is only illusory, inasmuch as what is hollow in the extant is solid in the fossil form. The results of his earlier microscopic examinations were such as to lead him to think that tri-radiate spicules might have been present in the coral-rag sponge, but further examination, while in some points it appeared considerably to confuse matters, seemed to prove that there were no tri-radiate spicules at all, and in a number of cases he found that the spiculation of the sponges was Lithistid, and his anticipation that some of the Faringdon forms were originally sili-

* 'Zeitschr. wiss. Zool.,' xxxi. (1878) p. 68.
† Ibid., xxviii.-xxxii. (various papers).
‡ 'Ann. and Mag. Nat. Hist.,' iv. (1879) p. 431.

ceous was thus confirmed. Dealing with the subject somewhat more theoretically, Mr. Carter points out that, although when they are cleansed from sea-water, or rather from chloride of sodium, the spicules of the calcareous sponge may be preserved indefinitely, this cleansing can hardly have taken place in the medium in which such must have flourished, while in the rich supply around his home he has never found any Calcisponge, although he has often come across a Lithistid which in appearance was very similar to the Faringdon sponge, and only differed in being silicified instead of calcified; had they been deposited in the coral rag instead of in the upper greensand they too might, he thinks, have been calcareous; and he comes to the conclusion that "most, if not all, of Professor Zittel's fossil Calcispongiæ may, after further examination, have to be transferred to other orders."

Protozoa.

Multinucleated Animal and Vegetable Protorganisms.*—M. E. Maupas recalls, as instances of the plurality of nuclei in a cell, those in *Euchelys gigas*, *Opalina*, *Actinosphærium*, the Foraminifera, &c., a fact which has much embarrassed writers on cellular morphology, some of whom, attaching great importance to the nuclei, see in their multiplicity the indication of a multicellular condition; others, on the contrary, consider them as simple fragments in no way affecting the individuality and unity of the cell.

The author has reconsidered the question, and has examined Infusoria, a fungus, *Empusa muscarina*, and four algæ (three *Cladophora* and one *Vaucheria*, one of the former being marine).

The *Empusa* was taken during its vegetative period, when it was seen to be marked with numerous bright spots very close together, which some authors describe as vacuoles, but which are really small nuclei of about 4 μ in diameter. To demonstrate this, the *Empusa* can be treated in the manner already described † for the zoospores of algæ, that is, by alcohol, picrocarmine, and crystallized acetic acid. The nuclei are very numerous, and scarcely separated from one another by more than two or three times their diameter.

The nuclei of *Vaucheria* and *Cladophora*, disguised by chlorophyll, are more difficult to show. They should be soaked in alcohol for twenty-four hours to decolour them, and then treated with picrocarmine and acetic acid. The tubes of the *Vaucheria* and the cells of the *Cladophora* will then be seen to have a great number of rose-coloured nuclei similar to those of the *Empusa*. In the marine *Cladophora* there were from 150 to 200. They are quite distinct from the amylaceous corpuscles, which do not take the rose colour.

The same was observed in four Infusoria of the genera *Enchelyodon*, *Euchelys*, *Urolepsus*, and *Oxytricha*.

Another organism observed was a fine fresh-water rhizopod, which was unprovided even with a peripheral membrane, and was composed of irregular sarcodic masses of variable dimensions, united by fine

* 'Comptes Rendus,' lxxxix. (1879) p. 250; see also *infra*, p. 111.
† Ibid., lxxxviii. (1879) p. 1274; see this Journal, ii. (1879) p. 609.

anastomosing cords. Continuing the same method, a multitude of nuclei from 5 μ to 6 μ in diameter were observed in every part of the body.

These instances, taken from such different organisms, prove the multinucleated state to be much more wide-spread than has been believed; and the author is persuaded that many more cases will be added.

As to the morphological signification of the facts, it is difficult to adopt Ed. Van Beneden's opinion, that these numerous organs are only simple fragments of a primitive nucleus; for they are capable of dividing, passing through the complicated series of phenomena which recent researches have revealed in the division of the nuclei of animal and vegetable cells. If, on the contrary, we admit with Haeckel that these organisms are composed of cells, distinct by their nuclei, but fused together by their sarcodic body, we shall have an intermediate structure, establishing the transition between unicellular and polycellular beings; and we might say with Huxley * that the multinucleate Infusoria closely approach the lowest forms of Turbellaria. But the grave objection presents itself, that in what we know of the life-history of these multinucleated organisms we see no trace of the differentiations and localizations of function which characterize the simplest Metazoa. They always behave as simple cells, in which all the parts are homodynamous.

The author thinks that his observations indicate the direction for research to fill up the hiatus between the Protozoa and Metazoa.

BOTANY.

A. GENERAL, including Embryology and Histology of the Phanerogamia.

Development of the Embryo-sac.†—M. Vesque's latest communication on this subject is mainly confirmatory of the previous remarkable observations of himself ‡ and Professor Warming, of the formation and subsequent disappearance of thick collenchymatous division-walls in the "primordial mother-cell" of the embryo-sac, in consequence of which the cells thus formed are compared by Warming to the mother-cells of the pollen of phanerogams and the spores of vascular cryptogams. To this Vesque adds the probable homology that the germinal vesicles and antipodal cells correspond to the spores and pollen-grains; the other cells, with undivided nucleus, the anticlinals, to special mother-cells arrested in their development. In the present paper he details the result of the special examination, on these points, of plants taken from a large number of natural orders.

The following is his method of observation and preparation.

The practice, until quite recently, was to detach the embryo-sac from the integuments of the ovule, and even from the surrounding

* 'A Manual of the Anatomy of Invertebrated Animals,' 1877, p. 678.

† 'Ann. Sci. Nat.,' viii. (1879) p. 261.

‡ See this Journal, ii. (1879) p. 903.

nuclear tissue. This violent process necessarily more or less completely disarranges the relative position of the contents, and leads to false results, if these are not at the same time checked by other modes of preparation. The greater part of M. Tulasne's errors are due to this defective mode of observation. Hofmeister, Schacht, and others have preferred to make longitudinal sections of the ovule, which they then observed in water or some other liquid. Observations made in this way are sufficiently exact; but the phenomena of osmose intrude, and cause displacement and destruction of the germinal vesicles and of the other minute structures contained in the sac. The process answers for young states of the ovule, especially if to the water is added about 5 per cent. of sugar.

Strasburger recommends osmic acid of 1 per cent., which has the property of making the nuclei very visible. The use of this reagent is very advantageous in certain cases; but, unfortunately, it often produces, with the organic matters contained in the cells that surround the embryo-sac, a black precipitate of such density as to prevent its use.

Another process, also recommended by Strasburger, is to fix the protoplasm by absolute alcohol. All the organs are by this means reduced to perfect immobility, and the preparation can be preserved for an indefinite time. The tissues become opaque, and must be rendered transparent, for observation, by glycerine or potash. Glycerine often makes them too transparent, so as to render the cell-walls invisible. Fixation by alcohol is necessary when the embryo-sac is studied in the nearly adult state; but it is not advisable in the young state.

M. Vesque has himself often adopted the plan of covering the blade of the razor with a layer of absolute alcohol, which, instead of destroying its cutting qualities, renders it possible to make much finer sections than with the dry razor. The tissues, which are instantaneously hardened, offer a better resistance to the knife, and the albuminoid substances do not adhere to the blade. The section should then be placed in a drop of alcohol, to which is added, some moments afterwards, glycerine or potash.

Different reagents are required for each species before commencing a serious study. It does not answer to adhere either to a single method of preparation, or to a single reagent.

Large ovules are easily cut by holding them between the thumb and index-finger of the left hand. All those preparations should be rejected in which the embryo-sac is touched; for it is possible in that case that some of the nuclei may have escaped. It is, however, sometimes useful to examine sections of this kind, as, for example, when studying the nature of the wall of the embryo-sac.

In the case of very small ovules it is, however, seldom that they can be examined in sections through the integuments. Very fine sections are then made through the ovary, with the chance of raising the integuments and exposing the nucleus or embryo-sac. It is obvious that the position of the ovules must first be observed before determining whether to make transverse or longitudinal sections of the ovary.

It is sometimes necessary to study both faces of a section. It must then be turned over—an operation which can be performed without difficulty after a little practice. For this purpose M. Vesque uses a cutting needle. When it is known beforehand that this will be required, the section may be placed between two pieces of thin glass, and can then be easily turned as often as required.

Metastasis of Germination at various Temperatures.*—A series of experiments on the changes which take place during the germination of peas has led W. Detmer to the following conclusions:—

When the seeds attain the same stage of development or germination at different temperatures, the same amount of dry substance is consumed; and as germination advances, the loss of dry substance increases; a larger amount of dry substance is lost in the same time at a higher than at a lower temperature. A comparison of the chemical composition of the seedlings grown at different temperatures with that of the seeds shows that the processes of metastasis proceed in the same way during germination when the seedlings undergo the same loss of dry substance, i. e. reach the same stage of development at different temperatures. One hundred seeds, whether they had germinated for ninety-four hours at 23° C., or for one hundred and thirty-eight hours at 19° C., had lost almost precisely the same amount of dried substance, i. e. had attained the same stage of development; and the amount of starch and dextrin that had disappeared was found to be the same in each case.

Action of Low Temperatures on the Germination of Seeds.†—Experiments on the influence of temperature on germination were first attempted in 1832, by MM. Edwards and Colin. The reduction of temperature was effected by the evaporation of sulphuric acid *in vacuo*. Seeds submitted for fifteen minutes to the low temperature of −40° C. were totally unharmed. In 1860 the question was again taken up by Professor Wartmann, and with the same result; the seeds experimented on were reduced to the still lower temperature of −110° C.

The experiments of MM. C. de Candolle and Raoul Pictet (details of which are now given) were made on *Lepidium sativum*, *Sinapis alba*, *Brassica oleracea*, and *Triticum vulgare*.

Seeds of each of these species were (27th March) placed in thin glass tubes, and enclosed, together with a thermometer, in a test-tube, which was hermetically sealed and swathed in tow. By keeping the tow constantly wet with sulphuric acid, the temperature was gradually reduced. At 4.25 P.M. it was −39° C.; at 5.0, −43°; at 6.0, −47°; at 7.0, −49°; and at 8.0 to 10.0 it was maintained at −50°. The next day but one, twenty-four of each of the seeds were planted along with others of the same species, and from the same crop, but which had not been frozen. On 23rd April all the seeds of three out of the four species had germinated, no difference whatever being

* 'Forschungen aus dem Geb. der Agriculturphysik,' ii. p. 282; see 'Naturforscher,' xii. (1879) p. 376.

† 'Arch. Sci. Phys. et Nat.,' ii (1879) p. 629.

apparent between the young plants from the frozen and unfrozen seeds. In the case of the fourth species, however—the wheat—seven only germinated, which is accounted for by the fact that alcohol, poured into the test-tube to keep the thermometer free from ice, had got into the tube containing these seeds, and spoilt them.

A second experiment was made a few days later with thirteen species, the seeds of which were placed along with fragments of metal in a single hermetically sealed tube, and this again in a test-tube as before. When $-40°$ C. was reached, liquid protoxide of nitrogen was poured into the test-tube, and the refrigeration continued for two hours, till $-80°$ C. was reached. No precaution was taken to graduate the return of the seeds to the surrounding temperature. The next day they were sown as before. All germinated and produced perfectly normal plants, with the exception of three species which were evidently of a bad stock, as both frozen and unfrozen ones remained sterile.

None of the seeds experimented on had been specially dried; they were gathered in 1877, with one exception—*Mimosa pudica*—the seeds of which were fifteen years old.

It is proposed to continue these investigations, and to extend them to a greater variety of germs, animal as well as vegetable, submitting both to still longer and more severe tests.

Influence of Light on the Penetration of the Soil by the Roots of Seedlings.*—The following results have been obtained by Dr. K. Richter:—When seeds germinate lying on the surface of the soil, the roots will only penetrate the soil under certain conditions; the following being the most important:—

1. The temperature must be at a certain minimum elevation above the zero for the germination of the particular species.

2. This minimum is much lower for the same species when the seeds are exposed to the light than when placed in the dark. The reason of this phenomenon is that, under the influence of light, a transformation takes place of light into heat, as can be shown by culture experiments at temperatures above the most favourable for the germination of the particular species.

3. A pressure of the roots on the soil, whether by the formation of root-hairs or by pressure from without, favours the penetration of the roots.

4. The influence of the nature of the soil on the power of penetration is limited to the mechanical resistance offered by the former.

5. Geotropism is necessarily a powerful factor in the power of roots to penetrate the soil. Light influences it by favouring growth by the creation of heat, and hence increasing the geotropic downward curvature. Negative heliotropism, on the contrary, notwithstanding what might have been expected, has no influence on the penetration of roots exposed to light.

* 'SB. K. Akad. Wiss. (Wien),' June 19, 1879; see 'Bot. Zeit.,' xxxvii. (1879) p. 613.

Influence of the Hygrometric State of the Air on Vegetation.*—According to M. P. Sagot, leaves transpire but little in an atmosphere charged with aqueous vapour; the axis, therefore, and the leaves, remaining strongly turgid, develop to an excessive extent, to the detriment of the flowers and the fruit. Moreover, if the amount of soil is but small, the quantity of mineral salts that accumulates in the tissues is often too small for the seeds to ripen. In a dry atmosphere, on the contrary, the transpiration being very energetic, the turgidity of the tissues is always low, and the growth therefore slow. This state of things is most favourable to the development of the flowers and fruits, as well as to the ripening of the seeds, even in poor soils; for the salts, contained in comparatively concentrated solutions, finally accumulate in considerable quantities in the tissues.

The reason is thus furnished why, in equatorial forests, the trees, which are bare of leaves during the dry season, burst into blossom under the influence of moist winds even before the rain falls, and bulbs begin to grow as soon as the air is moist. The growth of some of our vegetables, especially the cabbage, is often arrested during the drought of summer, even when they are well watered. But as soon as rain falls, however small in amount, transpiration is diminished, and the growth is at once rapidly accelerated, diminishing again afterwards, even if the rain continues; because the supply of mineral substances, accumulated during the drought, begins to exhaust itself. Vegetables such as haricot, maize, pea, corn, &c., grown in greenhouses, even in the soil, become feeble, in consequence of the too large quantity of aqueous vapour in the atmosphere. This is, however, not the case with all plants; there are some, on the contrary, such as ferns, palms, Scitamineæ, Aroideæ, Piperaceæ, Melastomaceæ, &c., which require a moist air.

The structure of the tissues varies with the degree of moisture of the air. If a shrub is transplanted in summer from a hothouse to the open air, it soon loses its leaves, which are replaced by smaller ones, more crowded and of a firmer texture. These fall in their turn when, in the autumn, the tree is replaced in the hothouse. For the same reason the leaves fall from the trees in equatorial forests at the commencement of the rainy and of the dry seasons.

Plurality of Nuclei in Vegetable Cells.†—This phenomenon, according to M. Treub, has hitherto only been observed, and that as an exception, in the cells of Algæ, especially the Siphonocladaceæ; also in the pollen-grains, pollen-tubes, and cells connected with the embryo-sac.

He now points out that it is a constant occurrence in the *vegetative* cells of some phanerogams; thus in the liber-fibres and laticiferous cells of some Euphorbiaceæ, Asclepiadeæ, Apocynaceæ, and Urticaceæ—cells which De Bary has proved to be simple and single—a plurality of nuclei occurs with some regularity: for instance, in the liber-cells of *Humulus lupulus*, *Urtica dioica*, *Vinca minor*, and in the laticiferous cells of the two last named and of *Euphorbia*, &c.

* 'Bull. Soc. Bot. France,' xxvi. (1879) p. 57; see also *ante*, p. 106.

† 'Comptes Rendus,' lxxxix. (1879) p. 494.

The method of production of these nuclei is by "division," i. e. a process of several stages, hitherto claimed for the *uni* nuclear cells alone; but he has observed it in the case of the three first-mentioned plants in the liber-cells, and in the two second in the laticiferous cells as well: the division just stops short of the formation of septa; the nuclei in one cell, sometimes numbering thirty, generally divide simultaneously.

The process of "free cell-formation" occurs in the same manner, according to Strasburger, but proceeds to the aggregation of protoplasm round the different nuclei, and thus forms new cells.

These discoveries tend to exalt the importance of the nucleus in these processes at the expense of that of the protoplasm.

Contraction of Cells through Absorption of Water.*—The contraction of cells by the loss of water is a well-known phenomenon of vegetable physiology; not so, however, that of contraction by absorption of water, which, however, according to H. de Vries, is very common in roots.

It has long been observed that the winter buds of many biennial plants, which expose their cotyledons and plumule above the surface of the soil in spring, retreat entirely beneath the surface in winter. This can obviously only take place from a contraction in length of the root. By means of horizontal marks, a contraction was measured in roots of red clover and beet planted in water or wet soil, to the extent of 10 to 15, or even in some cases of 20 to 25 per cent. The greater part of the contraction takes place during the first part of the time, a corresponding increase in thickness being manifested at the same time. This change in the form of the cells is most conspicuous in the cambial tissue of the root, decreasing with the increase in age of the cells, both in the wood and in the bark. The contractile element is, therefore, the parenchymatous cells, the rest of the cells remaining passive, and even offering considerable resistance.

The contraction on absorption of water is a phenomenon of turgidity; and contraction from increase of turgidity can only result from an unequal extensibility of the cell-walls in different directions. The very common phenomenon of transverse wrinkles on roots is a result of this contraction.

Suberization of the Membrane of Secretion-reservoirs.†—The structure of the walls of reservoirs for special secretions has been made a subject of investigation by E. Zacharias, who finds that the transformation into a corky substance is a very common phenomenon. This was especially found to be the case in all the reservoirs examined which contained a colourless or bright yellow volatile oil soluble in alcohol; while reservoirs with suberized walls containing mucilage or raphides were observed only in the genera *Aloë*, *Mesembryanthemum*, and *Hohenbergia*; suberization had not taken place in those of *Aletris fragrans*, *Orchis*, and Cactaceæ. In their earliest stages, oil, mucilage, and raphides were invariably found in all the receptacles. Only in *Batatas edulis* was protoplasm with a nucleus

* 'Bot. Zeit.,' xxxvii. (1879) p. 649.

† Ibid., pp. 617, 633.

observed with certainty in the receptacles of mature organs. Since these reservoirs are frequently found unchanged in the fallen leaves and other deciduous parts of plants, the author considers it may safely be assumed that their contents have no physiological value for the life of the plant.

Resin-passages in the Scales of the Cones of some Coniferæ.*— According to T. F. Hanausek, the arrangement of the resin-passages in the cone-scales of some Coniferæ differs from that of the resin-passages in the leaves; and he derives from this fact an argument against the foliar nature of the scales. He especially notes the invariable concurrence of resin-passages and fibrovascular bundles. In unison with Frank, but in opposition to Müller, he states that it is always a single cell that gives birth, by a larger or smaller number of complicated processes of division, to the epithelium. The resin could be detected even in the smallest intercellular spaces. He believes that it is formed by the transformation of the outer lamellæ of the cells of the epithelium. Subsequently, however, it is starch that furnishes the material for the formation of resin, vanishing in the winter from the scales of *Biota*, while the amount of resin increases at the same time manifold. A different kind of resin-passage is also found in the cone-scales, produced by chemical metamorphosis of the cell-contents and cell-walls.

Nectaries of Flowers.† — Towards the close of an elaborate account of the variation in the structure of the nectary in different flowers, Dr. W. J. Behrens thus classifies the various modes of excretion of the nectar:—

A. Through non-cuticularized epidermal cells of the nectary by diffusion.
  a. Epidermal layer filled with metaplasm.
    α. Walls of the epidermal layer as thin as those of the other cells. *Ranunculus Ficaria*, *R. polyanthemos*.
    β. The same; but the secreting cells placed in the interior of the wall of the ovary. *Agapanthus umbellatus*.
    γ. Walls of the epidermal cells somewhat thicker than those of the tissue of the nectary. *Rhinanthus major*.
  b. Epidermal layer not filled with metaplasm, but with a clear fluid. *Alchemilla vulgaris*, *Polygonum Fagopyrum*.
B. Through thin-walled non-cuticularized epidermal papillæ by diffusion. *Diervilla floribunda*.
C. By the formation of layers of a mucilaginous substance in the cell-wall beneath the cuticle.
  a. On the whole of the epidermal layer, the cuticle being raised up. *Nigella arvensis*, *Cestrum*.
  b. The same, but the secreting cells placed in the interior of the wall of the ovary. *Scilla amœna*.
  c. By the formation of mucilage at the apex of epidermal papillæ. *Abutilon*, *Althæa*, *Tropæolum majus*.

* 'Jahresb. nieder-österr. Landes-oberrealschule in Krems'; see 'Bot. Zeit.,' xxxvii. (1879) p. 695.

† 'Flora,' lxii. (1879) p. 433.

D. By fissures in the epidermal layer.
  a. On a smooth epidermis.
    α. Level. *Acer pseudo-platanus, Symphytum officinale, Parnassia palustris.*
    β. Elevated. *Epilobium angustifolium.*
  b. On a rough epidermis; depressed. *Anthriscus sylvestris, Heracleum Sphondylium, Pastinaca sativa.*
  c. On a very uneven epidermis. *Aralia Sieboldii.*

The term "metaplasm," as previously employed by Hanstein, is applied in this paper to the fluid or semifluid contents of the nectary, which serve for specific physiological functions, and are subject to transformations, sometimes of a very deep-seated character. The metaplasmic substances vary greatly in chemical and physical properties, dependent on the relative proportion of carbohydrates and of albuminous substances.

Connection between the Arrangements of the Floral Organs and the Visits of Insects to Flowers.*—In continuation of his investigations of the physiological functions of the nectaries of flowers,† M. Bonnier gives the following as his general conclusions as to the connection of the arrangements of the floral organs with the visits of insects:—

1. The form of the corolla may be materially modified without offering any obstacle to the visits of insects.

2. Very different insects may visit the same species. The nature of the visiting insects varies with the locality, just as the amount of nectar produced varies with the latitude and altitude. A nectariferous plant which is visited by insects in one region may be destitute of nectar and unvisited in another region.

3. The development of hairs in the interior of the corolla, as in the Labiatæ, or of scales or internal spurs, as in the Borragineæ, is not correlated to that of nectar.

4. Insects very often visit flowers without effecting cross-fertilization, and even without producing any fecundation. They frequently collect a saccharine fluid outside the flowers.

5. Visiting insects go where the nectar is most abundant and most easy to obtain; their visits have frequently no relation to the floral arrangements which facilitate cross-fertilization.

Arum crinitum as an Insectivorous Plant.‡—The spathe of this plant, when in flower, exudes a powerful odour of putrid flesh, attracting to it quantities of flies which lay their eggs at the bottom of the spathe. The similar visits of insects to the spathe of *Arum maculatum* are described by Sir John Lubbock as having for their object the transference of the pollen to the female flowers; but M. B. Schnetzler believes that in the case of *A. crinitum* this is, at all events, only a secondary purpose. On the spadix of this species are a number of

* 'Bull. Soc. Bot. France,' xxvii. (1879) p. 68.
† See this Journal, vol. ii. (1879) p. 748.
‡ 'Comptes Rendus,' lxxxix. (1879) p. 508.

hairs resulting from the abortion of male flowers, and on the inside of the spathe are others in such a position that, while presenting no obstacle to the entry of insects, they effectually prevent their escape. Not only do the insects which have entered the spathe thus perish, but this is also the case with the larvæ which proceed from the eggs, these latter perishing from hunger. The glandular hairs which clothe the inner face of the spathe exude a viscid juice which has an obvious effect on the dead bodies of the insects, causing their rapid decay, and it is probable that the primary object gained is the absorption of the resulting substances for the nutrition of the plant.

New Insectivorous Pinguicula.*—Von Heldreich has detected, in the Korax mountains of northern Greece, at the height of 5500 to 7000 feet, a small *Pinguicula* with white flowers and very thick, white, yellow-green leaves, which he believes to be *P. crystallina* Sibth. On the upper side of the leaves were a large number of bodies of insects in an earlier or later stage of digestion by the glands plentifully sprinkled over its surface. This is the first insectivorous plant hitherto recognized in Greece; the genera *Drosera*, *Utricularia*, and *Aldrovanda* being apparently not represented in its flora.

Carnivorous Habits of Drosera rotundifolia and longifolia.†—Professor E. Regel has carried out a series of experiments on the power of the leaves of these plants to absorb nutriment from small pieces of flesh, which have led him to a contrary conclusion to that arrived at by C. and F. Darwin. Comparing a number of plants that were fed in this way with another series that were not, he found that while the average weight of the seeds was greater in the former case, this was more than compensated by their much smaller number, the gross weight being considerably less. He found also that the leaves were obviously injured by the flesh-food, and that the power of the plants to resist the winter was diminished. Professor Regel considers the epithet "carnivorous" applied to these plants to be inappropriate.

Nature of the Tubercles on the Roots of Leguminosæ.‡—M. Prillieux has subjected these structures to a fresh examination, in order to decide between the conflicting explanations offered as to their nature, viz. galls (Malpighi); diseased tumours (De Candolle); hypertrophy of the rootlets (Clos); abortive rootlets (Gasparrini); swollen, rudimentary, adventitious buds (Treviranus); and as to their cause, viz. injurious influences in the soil (Clos); animal parasites (Malpighi); fungus hyphæ (Eriksson); bacteria (Woronine); *Plasmodiophora* (Woronine and Kny). After a full description of the phenomena presented by these structures, Prillieux concludes that they are, without doubt, caused by a vegetable parasite of the nature of a plasmodium. He states that they are produced in water, as in the soil, provided that the parasites which induce them are able to reach the young roots.

* 'Oesterr. Bot. Zeitschr.' xxix. (1879) p. 291.
† 'Bot. Zeit.,' xxxvii. (1879) p. 645.
‡ 'Bull. Soc. Bot. France,' xxvi. (1879) p. 98.

Formation of Albumen in the Plant.*—A careful series of experiments has been carried on by A. Emmerling, in the "Versuchs-station" at Kiel, for the purpose of determining the place and mode of formation of the nitrogenous constituents of plants. The plant selected was the common bean, *Vicia Faba*, the different parts of which were examined at various stages of growth.

With regard to the presence of nitric acid, the results arrived at were that this substance is at no period of development present in any considerable quantity in the leaves; nor is it present in the flowers, fruits, seeds, or pericarp, while the stems and roots contain it in different proportions. The conclusion is hence derived that the leaves are especially the part where the nitric acid absorbed from the soil undergoes transformation.

The very extended researches on the presence of amide in the various parts of plants gave the following results:—In the mature leaves the amides remain nearly constant during the entire later period of development of the plant; younger leaves are richer in these substances than older leaves. The proportion of amide in flowers, branches, and buds is relatively large, considerably exceeding that in older, and two or three times the amount in younger leaves. The flowers contain a larger proportion in an early stage than after they are fully unfolded. The amide not only accumulates in the ovules, but the petals and sepals also contain a considerable quantity. Fruits and seeds are, in their early stages of development, comparatively very rich in amides; but the proportion decreases with the growth of the seeds. The stem is at all times comparatively poor in this substance, and the lower woody leafless portion is the poorest, the amount increasing both towards the summit and in the root. The quantity in the root is, however, but small; there is more in the lateral roots than in the tap-root.

The explanation suggested of these facts is as follows:—It is seen how quickly the nitric acid which is absorbed out of the soil into all parts of the stem and root disappears in the leaves or other green parts, or those which are growing rapidly; so that it is rare that even traces of it are to be detected in these spots. It is therefore scarcely questionable that it is chiefly in the green leaves that the nitrates are transformed into nitrogenous organic compounds, the final result of these transformations being the production of albumen. Even if the small quantities of ammonium salts absorbed through the roots take part in this result, the part they play is very subordinate to that of the nitrates. The final change to which the nitrates are subjected in the leaves is probably their decomposition by vegetable acids. The distribution of the amides follows a simple law, which may be thus stated:—Those parts of the plant which are in active growth and increase of mass are richer in amide than the older mature parts.

Composition of Chlorophyll.†—From the fact that chlorophyll loses its power of decomposing carbonic acid with the death of the part

* 'Landwirthschaftliche Versuchs-stationen,' xxiv. (1879) p. 113; see 'Naturforscher,' xii. (1879) p. 418.

† 'Zeitschr. für physiol. Chemie,' iii. (1879) p. 339; see 'Naturforscher,' xii. (1879) p. 391.

of the plant that contains it, while its spectroscopic properties are unchanged, Hoppe-Seyler came to the conclusion that on the death of the plant the chlorophyll undergoes a chemical change which is not accompanied by any change in its relation towards light.

After first removing the wax from grass leaves by ether, and then soaking in hot alcohol, a solution is obtained of two distinct colouring matters. The first, soluble with difficulty in alcohol and ether, and easily precipitated as greenish, silver-white, four-sided crystalline plates, is evidently identical with Bougard's crystals of erythrophyll. The second substance is more soluble in alcohol and ether, from which it crystallizes out in microscopical needles and plates of a dark green colour, brown in transmitted light, and of the consistency of soft wax. They are soluble with difficulty in cold alcohol, more easily when hot, very easily in ether or chloroform. To this substance Hoppe-Seyler gives the name *chlorophyllan*; and to it is due the well-known fluorescence of chlorophyll in light of a refrangibility between the lines B and C in the red. It is this constituent of chlorophyll which he believes to possess the power of decomposing the carbonic acid of the atmosphere.

Function of Chlorophyll, and Action of Light upon it.* — Dr. Pringsheim has recently directed a fresh series of experiments to the elucidation of the function of chlorophyll in the life of the plant, and the connection of its production and destruction with the intensity of light. His method of examination was to expose the structure under observation to the plane of a solar image projected in the focus of an achromatic lens of 60 mm. diameter.

When, by means of such a lens and a heliostat, an object containing chlorophyll, such as a moss-leaf, fern-prothallium, chara, conferva, or section of a leaf of a flowering plant, is exposed to concentrated sunlight, rapid and energetic changes are seen to take place in it, in a period varying from three to six minutes or more. The first striking effect is the complete decomposition of the chlorophyll, the result in a few minutes being the same as if the object had lain for twenty-four hours in strong alcohol. The green colouring matter of the grains has entirely disappeared, while the ground-substance of the chlorophyll has undergone but little change. The destructive change then advances to the other cell-contents, ending, if the action of the intense light is continued sufficiently long, in the complete destruction of the cell itself. The circulation of the protoplasm is arrested; the protoplasm-threads are ruptured; the nucleus is displaced; the primordial utricle (ectoplasm) contracts and loses its impermeability to colouring matters; the turgidity of the cell ceases; in short, the cell exhibits all the phenomena of rapid and irreparable destruction.

Pringsheim next proceeds to show that these phenomena are not the direct effects of a high temperature produced in the cell by radiation. A similar effect is produced whether the rays have previously passed through a red solution of iodine in carbon bisulphide, a green solution of cupric chloride, or a blue ammoniacal solution of cupric sulphate, provided only that the light transmitted is of sufficient

* 'MB. Akad. Wiss. Berlin,' July 1879, p. 532; see 'Ann. and Mag. Nat. Hist.' v. (1879) p. 62.

intensity. Blue light, however, exerts a more powerful influence than red, and the experiments clearly proved that the result was entirely independent of the degree of diathermancy possessed by the screen.

The next point established was that the phenomena of destruction of the cell and its contents in the light are altogether dependent on the presence of oxygen in the surrounding atmosphere, the phenomena not being presented in media free from oxygen, as in a mixture of hydrogen and carbonic acid; while the removal of the free carbonic acid of the atmosphere in no way interferes with the phenomena.

The conclusion arrived at is that the destruction of chlorophyll by light in the living cell is influenced and promoted by the light, and that it is in no way dependent on respiration, or the decomposition of carbonic acid by the plant. When the colouring matter has once been destroyed by light, the chlorophyll-grains have no power to reproduce it. Hence it follows that the phenomena in question cannot be a normal physiological act in the life of the plant, but are a pathological process. The ultimate fate of the decomposed colouring matter was not accurately determined; but Dr. Pringsheim is disposed to think that it passes away in the form of various gaseous products. That the injurious influences on the other contents of the cell are not the result of any unknown poisonous product from the decomposition of the chlorophyll-grains is proved by the fact that they occur also in cells which contain no chlorophyll, as in the hairs on the filaments of *Tradescantia*, the stinging hairs of the nettle, &c. It is possible also to stop the experiment immediately after the destruction of the colouring matter of the chlorophyll-grains, and to prevent its extending to the remaining contents of the cell.

By these results Dr. Pringsheim was led to the important and interesting conclusion that the chlorophyll, as long as it lasts, acts as a protective covering, moderating the injurious influence of light on the protoplasm; and that, by its strong absorption of the so-called chemical rays, it acts as a regulator of the respiration.

The author claims to have discovered, in all green chlorophyll-grains without exception, the presence of a hitherto unknown substance, the immediate product of assimilation, from which the starch and other secondary products are then formed. To this substance, which is either a hydrocarbon, or, at all events, contains less oxygen than the carbohydrates, he gives the name *hypochlorin* or *hypochromyl*. It may be separated by heating the parts of the plant which contain chlorophyll for from twelve to twenty-four hours with dilute hydrochloric acid, when it appears in the form of small glutinous drops, which rapidly increase, and in which finally long, reddish-brown, obscurely crystalline needles are formed. It is the oily ground-substance of the chlorophyll-grains, soluble in alcohol, ether, oil of turpentine, and benzol, but insoluble in water; and after separation solidifies sooner or later into an obscurely crystalline substance, having all the properties of a resin or wax. It is never absent from any chlorophyll-green plant, and is more universally distributed in the chlorophyll-grains than starch or oil; but has not yet been detected in those plants which contain no true green chlorophyll, as the Phycochromaceæ, Diatomaceæ, Fucaceæ, and Florideæ.

This hypochlorin is the most readily combustible of all the constituents of the cell. Its occurrence in every chlorophyll-grain is subject to continual increase and decrease; and comparative investigations between younger and older states of the grains show that the accumulation of starch advances *pari passu* with the decrease of hypochlorin. A number of substances belonging to the class of essential oils and their immediate derivatives, hitherto regarded exclusively as products of a retrograde metamorphosis, can be proved to originate directly within the ground-substance of the chlorophyll-grains.

The result of these investigations is to show that the most important function of the green colouring matter of chlorophyll depends on its relation to respiration, since it acts as a regulator of this process. By the powerful absorption of light of the chemically active rays the intensity of respiration in the green parts of the plant is reduced in the light below that of assimilation, and thus the production of the carbonaceous constituents of plants is rendered possible. This Dr. Pringsheim considers to be the only function of chlorophyll that has up to the present time been proved, and to furnish the explanation of the well-known fact that the elimination of oxygen takes place only in the green parts of plants, and only in the light.

Chemical and Physical Properties of "Intercellular Substance."*—Understanding by this term what is called by most writers the "central lamella" or common wall of two neighbouring cells, R. F. Solla has undertaken a series of investigations to determine the mode in which this disappears or becomes absorbed in the production of intercellular spaces, resin-passages, &c. The general results arrived at are as follows:—

1. The intercellular substance or central lamella of plants undergoes a variety of chemical and physical changes in the course of development of the tissues.

2. Its molecular constitution differs from that of the adjoining cell-wall layers.

3. The origin of the intercellular substance is either pure cellulose, as in cambium, or, as in the apex of the stem, a substance in which cellulose can be detected only later, in the young permanent tissue.

4. The intercellular substance of young permanent tissue consists usually of cellulose, but in mature permanent tissue, such as often in the bast, it can only be rarely detected directly; usually the cellulose undergoes a variety of chemical changes, and the intercellular substance hence varies greatly in its behaviour with different reagents.

5. These chemical changes frequently lead to the partial or entire separation of cells previously closely united, as, for example, in mealy fruits. The organic separation of cells is often merely a mechanical process. Even when the cells are artificially separated, as, for example, in boiled potatoes, the breaking up of the tissue depends on a splitting of the intercellular substance, and therefore on a purely mechanical cause.

* 'Oesterr. Bot. Zeitsch.,' xxix. (1879) p. 311.

Effects of Anæsthetics on the Sensitive Plant.*—M. Arloing has pursued a novel series of experiments on the effects on the sensitive plant of various anæsthetics, especially chloroform, ether, and chloral, by causing the plant to absorb them through the root from the soil. In the case of chloroform and ether he found that all the phenomena of irritation began to be exhibited after watering the soil with the solution; the leaf-stalks began to decline and the leaflets to fold up, the effects first manifesting themselves at the base of the leaf, and advancing to the apex. After a period of from thirty to sixty minutes these changes were however reversed, the parts resumed their normal position, but were then no longer sensitive. This condition of anæsthesia lasted for 1½ to 2 hours, when sensitiveness was again manifested. The rate of ascent of the fluid in the plant was determined to be from 15 to 46 mm. per minute. From the base to the apex of the stem the rapidity increased in the ratio of from 1 to 1·25 and 1·5, and was 1½ or 2 times as great in the leaf-stalk as in the stem. While, however, chloroform and ether acted on the sensitive plant as on animals in producing first irritation and then complete anæsthesia, the results with chloral offered a marked contrast, differing altogether from the effects of this anæsthetic upon animals. In small quantities no effect whatever was produced on the sensitive plant, while in larger quantities it was completely killed.

Vegetable Albinism.†—In a paper read before the Chemical Society, Professor Church has given the result of a series of experiments on this subject carried on in the botanical laboratory at Kew. He finds that white foliage does not possess the power, even in sunshine, of decomposing the carbonic acid of the air, but adds largely to the normal amount of that gas in the air, thus resembling the petals of flowers and the action of green leaves during darkness. The proportion of CO_2 in the atmosphere was found to be 3·21 parts in 10,000; and the following results were obtained with various plants:—

1000 sq. cm. of the white foliage of the American maple, *Acer Negundo*, evolved in twenty-four hours 16·69 parts of CO_2 per 10,000 of air; while 1000 sq. cm. of green foliage evolved 0·44 parts CO_2. Similarly, 1000 sq. cm. of white holly leaves evolved 18·82 parts CO_2 per 10,000; of green, 4·49 parts. 1000 sq. cm. of white leaves of *Alocasia macrorhiza* evolved, in two experiments, 15·06 and 38·96 parts CO_2; of green, 1·14 parts. When placed in water, white holly sprays gained in two hours 0·29 per cent. in weight; under similar conditions green holly gained 1·55 per cent.; when no water was supplied the white holly lost 0·54 per cent., the green holly 10·26 per cent. There was more starch in the green than in the white leaves. The above results are of great interest in connection with the hypothesis of Pringsheim, to which we have already called attention,‡ respecting the function of chlorophyll in checking respiration.

* 'Comptes Rendus,' lxxxix. (1879) p. 442.
† 'Pharmaceutical Journal,' 1879, p. 436.
‡ See this Journal, *ante*, p. 117.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Influence of Light on the Bilateral Structure of the Prothallium of Ferns.*—The cause of the bilateralness of the prothallia of ferns has already been much discussed by Bauke, Leitgeb, and others.† To the literature of the subject Prantl now adds another important contribution. The mode of experiment adopted by him was as follows. Two cover-glasses of different sizes are fixed together by a minute drop of Canada balsam, in such a way that at one edge the two glasses lie exactly one on the other, while at the opposite edge one projects slightly beyond the other. Upon the edge of the smaller glass, which forms a narrow step on the larger one, the spores were sown suspended in water, and the whole arrangement placed in moist sand, from which the water, containing a small quantity of a suitable nutrient substance, rises between the two glasses by capillary attraction. The light was only allowed to reach the spores in a nearly horizontal direction in some experiments, in a vertical direction from above in others, and in a vertical direction from below in others.

Without entering into details, it may be stated that the general results obtained were as follows:—

1. The rhizoids of all prothallia are negatively heliotropic, but not positively geotropic.

2. The germinating filament is orthotropic, positively heliotropic, and negatively geotropic.

3. The increase in breadth of the germinating filament is dependent on the intensity of the light, but its direction is not determined by light.

4. The surface of the cell is plagiotropic and dorsiventral; it places itself at right angles to the direction of the light, and develops an illuminated side, and a shaded side characterized by the presence of rhizoids.

5. In all prothallia of ferns the archegonia are produced only on the shaded side.

This character of the appearance of archegonia on the shaded side only of the prothallium is characteristic of ferns alone among vascular cryptogams; in Equisetaceæ the case is different.

Development of the Prothallium of Scolopendrium.‡—As the main result of a series of observations G. Beck states that when the spore of *Scolopendrium* germinates the exospore is not ruptured, but becomes softened in such a way that the germinating filament can emerge at any spot. The prothallium has in addition bristle-like trichomes. In no other essential point does the development of the prothallium of *Scolopendrium* differ from that of other Polypodiaceæ.

* 'Bot. Zeit.,' xxxvii. (1879) pp. 697, 713.

† See this Journal, ii. (1879) pp. 451, 917.

‡ 'Verh. k.-k. zool.-bot. Gesell. Wien,' 1879; see 'Bot. Zeit.,' xxxvii. (1879) p. 694.

Muscineæ.

Dicranum and Dicranella.*—M. E. Heckel directs attention to an abnormal organization in certain species of *Dicranum*, especially *D. scoparium.*

The two genera *Leucobryum* and *Sphagnum* have in the leaves and tegumentary tissue of the stem and branches perforated cells constituting a true capillary apparatus, through which the water of the marshes where they grow spreads to the terminal parts; differences of degree only separating the organization of the two genera.

Between the normal cell-structure of the great majority of mosses and that of *Sphagnum* comes the structure peculiar to *Dicranum.*

The leaves in this genus are formed of elongated cells, whose thickened lateral walls, having from three to six readily recognizable layers of cellulose, are attenuated at several (four to seven) places through loss of substance, only the median layer of cellulose being left intact. These attenuations resemble true canals at the points where the external membrane is sufficiently thin. This cellular structure is only found in the leaves, insensibly giving place to the normal structure at the points of their insertion on the stem. The other species examined by M. Heckel also presented this arrangement, the explanation of which is to be found in the rigidity of the leaves, and the necessity for the penetration of water to the interior of the hard tissue.

None of the *Dicranellæ*, except *D. heteromalla*, showed this structure, a fact which, taken with others, leads the author to consider this species to be a *Dicranum.* On the other hand the absence of the structure in *Dicranum crispum* Hedw. supports the conclusion of Lamy de Lachapelle that the latter is a *Dicranella.*

The similarity which exists between the cells typical of *Dicranum* and those figured by Solms-Laubach in the leaves of *Libocedrus Doniana* and in the epidermis of the leaves of *Biota orientalis* shows another point of connection between gymnosperms and cryptogams; and it is probable, M. Heckel says, that the areolated cells of conifers are "only a deeper accentuation of the anatomical fact which is the basis of this note."

Development of the Sporogonium of Andreæa and Sphagnum.†—The following are the main results arrived at by M. Waldner in a series of experiments carried on mainly to determine the answer to Kuhn's question, Does the spore-layer of *Andreæa* owe its origin to the basal square (Grundquadrat), or to the layer of the wall?

I. As to *Andreæa* :—

1. The number of segments formed by apical growth by means of a two-edged apical cell varies between narrow limits, viz. from 11 to 13.

2. The spore-layer originates in the third oldest segment, and to this purpose are applied not more than three, or at most four, segments. The two oldest segments form, with the basal part of the

* 'Comptes Rendus,' lxxxix. (1879) p. 790.
† 'Bot. Zeit.,' xxxvii. (1879) p. 595.

rudiment of the theca, the foot of the sporogonium, the remainder (6–8) the sterile apex of the capsule.

3. The spore-layer belongs to the basal square (endothecium of Kienitz-Gerloff), and is separated from it by the first tangential division.

4. The outer and inner spore-sac are formed by secondary division in the wall of the capsule or columella.

II. As to *Sphagnum* :—

1. The fertilized oosphere divides into two halves by a septum; in the lower basal half only a few more irregular divisions follow; the sporogonium originates from the upper half.

2. The apical growth is effected by transverse walls; the number of transverse disks thus formed is only from six to eight; the entire remaining longitudinal growth takes place by intercalary division within the basal part.

3. Each basal part, including that of the apical cell, breaks up, in succession from the oldest to the youngest, by cross division into four squares; the divisions of any two basal parts that lie immediately one above another cut one another at an angle of 45°.

4. In each square the division follows into inner and outer cells (the basal square and peripheral layer of the wall of Kuhn), either by two successive divisions, or by only one, as in *Ephemerum* and most mosses.

5. The inner cells or basal square are the origin of the columella; the outer cells, or peripheral layer of the wall, form the spore-layer and the wall of the capsule.

6. The separation of the spore-layer from the layer of the wall is effected by the first tangential division.

7. The outer and inner spore-sac are formed by secondary division from the wall of the capsule or the columella.

8. Only the three uppermost basal parts, including that of the apical cell, take part in the formation of the spores, while the remainder, with the basal part of the rudiment of the theca, form the bulbous foot and the neck of the sporogonium.

9. In the ripe capsules of all the species examined (*Sphagnum acutifolium*, *cuspidatum*, *cuspidatum* var. *plumosum*, and *rigidum*) only one kind of spore was invariably found.

10. In both *Andreæa* and *Sphagnum*, the fertilized oosphere, as well as the moderately developed embryo, are always surrounded by a hyaline coagulated mass of mucilage, which exhibits protein-reactions, and is drawn out into an appendage, which reaches so far into the neck of the archegonium as the latter has not assumed a brown colour; one or more antherozoids are always found embedded in this mucilage.

Stomata of Marchantiaceæ.*—The comparative anatomy of the Marchantiaceæ, especially in relation to their stomata, has been made a subject of study for several years by W. E. Alwin Voigt, who first lays down the terminology of the subject as follows:—

The term *pore* he applies exclusively to the actual opening to the stoma through the epidermis (or the entire opening where there is a border). The differentiated epidermal cells which enclose the pore are the *guard cells*. The structure equivalent to them which results from

* 'Bot. Zeit.,' xxxvii. (1879) pp. 729, 745.

the division of the cells parallel to the surface is the *border*. The term stoma (Spaltöffnung) itself he avoids using, because the structure in Marchantiaceæ is equivalent only in a physiological sense to the stomata of higher plants. Even without examining the history of their development, it is obvious that, while in ordinary stomata with their guard-cells a bilateral type of structure prevails, all the cell-divisions in the guard-cells of the Marchantiaceæ take place radially or in concentric circles.

The author describes in detail the varieties of structure observed in different genera, the description being accompanied by a plate, and thus classifies the variations in the genera observed by him :—

A. The guard-cells form a border to the stoma.

a. The border consists of five rings of cells: the inner pore is broad, and usually square :—*Marchantia* (*polymorpha*).

b. The border consists of four rings of cells; the inner pore is a long cruciform crevice:—*Preissia* (*commutata*).

B. The guard-cells do not form a border to the stoma.

a. Upper layer of green cells in the stoma with a hyaline rostrum destitute of chlorophyll :—*Fegatella* (*conica*).

b. Upper layer of green cells without such a rostrum.

α. Guard-cells sharply differentiated, arranged in one or more concentric circles or polygons.

* Three or more circles of guard-cells.

† Walls of epidermal cells angularly thickened; three or four more or less elongated polygons of guard-cells, usually consisting each of seven or eight cells, the whole with well-marked radii, and considerably larger than in *Marchantia polymorpha* :—*Reboulia* (*hemisphærica*).

†† Wall of epidermal cell not thickened or annularly.

‡ Three regular polygons of guard-cells, with seven or eight radii; the whole about as large as in *M. polymorpha* (*F. pilosa* has only two, often indistinct polygons) :—*Fimbriaria*.

‡‡ Four rings of guard-cells ; the whole mass usually twice as large as in *M. polymorpha* :—*Lunularia* (*vulgaris*).

** One or two circles of guard-cells.

† Walls of epidermal cells, with the exception of the guard-cells, annularly or angularly thickened.

‡ Walls of epidermal cells angularly thickened; pore larger than in *M. polymorpha* :—*Targionia* (*Michelii*).

‡‡ Walls of epidermal cells annularly thickened; pore as large or larger than in *M. polymorpha* :—*Grimaldia* (*barbifrons*).

†† Walls of epidermal cells, with the exception of the guard-cells, not thickened; environment of pore clear :—*Sauteria* (*alpina*).

β. No sharply differentiated ring of guard-cells; the pores appear only as perforations of the epidermis caused by resorption; stomata broad, enclosed by layers of a loose green tissue :—*Duvalia* (*rupestris*).

Structure and Systematic Position of Ricciaceæ.* — Professor Leitgeb's recent researches on this small group induce him to consider them as forming a connecting link between the Jungermanniaceæ and the Marchantiaceæ. To the former belongs the section Rielleæ, including the genera *Riella* and *Sphærocarpus*, coming near the Codonieæ; while the two remaining sections, the Corsinieæ, including *Boschia* and *Corsinia*, and the true Riccieæ, *Riccia*, *Oxymitra*, and *Ricciocarpus*, must be classed under Marchantiaceæ. The transition is a gradual one, from the Riccieæ, through the Corsinieæ, to the Marchantieæ.

As regards the alleged want of elaters, which has been supposed to mark a clear distinction between the Riccieæ and Marchantiaceæ; with the exception of the lowest genera, *Riccia* and *Oxymitra*, all the rest have sterile cells among the mother-cells of the spores, as has long been known in the case of *Sphærocarpus* and *Riella*. The thickening of the wall of the capsule is also no good differential character for the Marchantiaceæ, there being genera in that family which do not possess it. *Corsinia* and *Boschia* are evident transitional forms to the Marchantiaceæ, the former with unthickened, the latter with characteristically thickened elaters; both genera approach that family in the development of the archegonial receptacle, and in the anatomy of the leaves.

The three genera which make up the true Riccieæ, *Riccia*, *Oxymitra*, and *Ricciocarpus*, are characterized by the whole of the fertilized oosphere becoming transformed into the capsule, without any formation of a foot, and by the resorption of the wall of the capsule before maturity. *Ricciocarpus* (*Riccia natans*) is distinguished by the antheridia being united into groups; the ventral scales and the anatomy of the thallus indicate an affinity to *Corsinia*. *Riccia* is distinguished by its archegonia being buried in the thallus; *Oxymitra* by their being raised above its surface.

The Corsinieæ form rudiments of a foot even in the small-celled embryo; the wall of the capsule remains till maturity.

Sphærocarpus agrees with *Corsinia* in the formation of a foot, in the persistent capsule-wall consisting of unthickened cells, and in the occurrence of sterile cells among the mother-cells of the spores; but the antheridial receptacle is wanting, and the development of the embryo deviates greatly from that genus, and indicates an affinity with the Jungermanniaceæ through *Fossombronia*. It is on the other hand allied to *Riella*, in the identity of the earlier stages of development of the embryo. *Riella* exhibits a special affinity to Jungermanniaceæ in the structure and habit of the vegetative organs. The "wing" of *Riella* is not equivalent to a longitudinal half of a shoot of *Marchantia*, but is a "dorsal comb" or luxuriant growth of the dorsal side of the stem.

The question whether the sterile cells of the Rielleæ must be regarded as rudimentary elater-cells of the Marchantiaceæ, or as aborted reversions, Leitgeb considers to be still unsettled.

* 'Untersuchungen über die Lebermoose, von H. Leitgeb. Heft 4, Die Riccieen. Graz, 1879; see 'Bot. Zeit.,' xxxvii. (1879) p. 629.

The air-chambers are not formed by a separation of cells, nor by a splitting advancing from without inwards, but represent depressions of the surface, formed by particular portions becoming overgrown by the more rapid growth of the adjoining parts. They become subsequently completely covered in, though usually with a small opening outwards.

The ventral scales are entirely wanting only in *Riccia crystallina*. The origin and development of these scales is, according to the author, very different from that of the organs of Marchantieæ called by the same name.

Fungi.

Propagation of Sphæria (Gnomonia) fimbriata (Pers.).* — In December, 1878, Mr. C. B. Plowright planted two small specimens of hornbeam (*Carpinus Betulus*), which had still attached to their branches the withered leaves plentifully attacked by the *Sphæria*. Owing to the removal, the old leaves fell off, and were blown away long before the green leaves burst their buds at the end of May.

On the 1st June, he tied four fragments of a leaf, each of which contained a cluster of perithecia with mature sporidia in them, upon four places of one of the hornbeams—between the leaves of a terminal bud. On 12th July, numerous minute black specks were visible upon the leaves, and the infecting fragments were removed. In due course the black spots developed into typical specimens of *Sphæria fimbriata*. Up to November no further development of the *Sphæria* took place. This is the more noteworthy because the shrub which was not subject to experiment had, when first planted, the greater number of affected leaves upon it, but the parasite has not shown itself on a single leaf this year (1879); nor on the other hornbeam has a single perithecium developed itself save at the points inoculated.

This confirms Dr. Max Cornu's conclusion, that these ascigerous parasites are confined to the deciduous foliaceous organs, a conclusion arrived at in experimenting with *Rhytisma acerinum*.†

These observations are not without interest in showing the connection which exists between the *Phacidiacei* and the *Sphæriaceæ*, physiologically as well as structurally, and afford an explanation of the abundance of *Sphæria fimbriata* where it occurs, as compared with the allied species, *S. Coryli*, the hornbeam being a tree in which the dead leaves remain attached to the twigs, as a general rule, well through the winter and into the spring, until the sporidia arrive at their most perfect state of maturity.

Sclerotium of Claviceps.‡—A. Renner has afresh investigated the development and histology of the sclerotium of *Claviceps*, of which the following is a summary :—The sclerotium consists, for the larger part, of large polygonal cells, filled with drops of oil, and firmly united in their growth, constituting the so-called pseudo-parenchyma.

* 'Grevillea,' viii. (1879) p. 68.

† See this Journal, i. (1878) p. 265.

‡ 'Wandersammlung ungarischer Aerzte u. Naturforscher zu Budapest; naturwissenschaftliche Section, Aug. 30, 1879'; see 'Bot. Zeit.,' xxxvii. (1879) p. 677.

Within this, in the middle of the sclerotium, is a bundle of a loose, small-celled tissue, composed of very distinct hyphæ interwoven in an irregular manner. The cells of these hyphæ are elongated and cylindrical, and also contain drops of oil. This bundle passes through the ergot in the direction of its longer axis, and upwards into the so-called cap. From it proceed several lamellæ, which pass through the sclerotium radially towards the periphery through its whole length. The large-celled and small-celled tissues may together be treated as a medullary tissue, which is surrounded on the outside by two or three layers of cells with dark-brown cell-wall, constituting the so-called cortex. This is transparent only when the section is extremely thin.

Vine-rot (Pourridié de la vigne).*—The results of recent investigations of this disease have been communicated by M. Millardet to the Société des Sciences of Bordeaux. It is well known to viticulturists under the names "pourridié," "champignon blanc," and "blanquet"; and in the department of Lot-et-Garonne makes its appearance regularly in vineyards planted on oak-clearings after about twenty years. It presents the appearance of whitish strings, irregularly and often elegantly ramifying, exposed on the removal of the bark of the stem, and especially of the root.

The organism has usually been assigned to the fungoid form known as *Rhizomorpha*, an opinion in which M. Millardet agrees. The effects on the plant affected are very similar to those of the phylloxera. The author disputes the assertion of M. Boutin that the presence of phylloxera is marked by the inversion of the normal cane-sugar of the plant. He states that both these diseases are accompanied at first by a notable diminution in the proportion of sugar contained in the part affected, subsequently by its complete disappearance. The diminution of the sugar is proportional to the degree of alteration in the part affected, and its disappearance is always complete when the tissue is penetrated by the mycelium of the parasite, these being the necessary conditions in the cane both of the phylloxera and of the vine-rot.

Asci in a Polyporus.†—The Rev. M. J. Berkeley explained at the last conversazione of the Woolhope Club, at Hereford, the circumstances under which he found the pores of a *Polyporus* fringed at the margin with asci containing spores. The specimens had been forwarded also to Mr. C. E. Broome, and he confirmed the observation in all essential particulars. The asci were perfectly naked, and there is not the slightest reason for the assumption that they bore any relationship to *Hypomyces*, or even that they were parasitic in any other manner. There was every appearance of their being a development of an abnormal character, of the *Polyporus* itself. The explanation was offered in the hope of inducing further research in the same direction, so as to obtain some clue to the cause of a phenomenon so unusual and unexpected.

* 'Rev. Internat. Sci.,' iv. (1879) p. 373.

† 'Gardeners' Chronicle,' Nov. 16, 1879; 'Grevillea,' viii. (1879) p. 78.

Agaric with Green Spores.*—Dr. Cooke has recently received from Ohio, U.S., a dried specimen of an agaric, with all the external features of a large *Lepiota*, with a pileus 9 inches in diameter, which has spores when first thrown down, of a bright green colour, but upon drying these become of a duller verdigris green. This fungus has been named *Agaricus Morgani* Peck, and is interesting as being unique in the colour of the spores. It is not an accidental circumstance which has affected a single specimen, but one which is characteristic of the species. The individual spores, in the dried state, exhibit no colour when the light is thrown through them on the stage of the Microscope. Probably this may not be the case with fresh spores.

Development of the Maize-rust, Ustilago Maydis.†—A. Renner thus describes the germination of the spores of this fungus. In moist air they germinate in from twenty-four to forty-eight hours. The promycelium protrudes through a small, scarcely visible spot in the exospore, and generally forms a tube equalling the spore in length, but scarcely one-third or one-half its diameter. On this are produced laterally and terminally by budding minute ellipsoidal sporidia. But sometimes the promycelium develops into a longer tube, which divides by septa into several cells, the sporidia originating from these. The sporidia are numerous, and are arranged in branching rows, which break up on contact with a drop of water, a slender, germinating filament, which is frequently branched, proceeding from each sporidium. At the spot where the spores are to be formed, a number of branches of the mycelium become massed into a larger or smaller ball. The cell-walls of these branches swell up strongly and form a gelatinous mass, in which are a number of lumps consisting of granular protoplasm, produced by contraction at particular spots of the hyphæ. Each lump is surrounded by a hyaline layer of protoplasm. These lumps increase in size while they become invested with a homogeneous cell-wall, on which can soon be detected the brown spiny exospore and a thin endospore.

History of Development of the Uredineæ.‡—Dr. J. Schröter gives an important paper on this subject, which is, however, too full of the detailed description of species and of the mutual relationship of different forms to admit of a satisfactory abstract. *Uredo Ledi* or *Æcidium Ledi* is the conidial form of a *Coleosporium*, of which the author has discovered the teleuto-form. The uredo of the rhododendron also, in all probability, belongs to a *Coleosporium*. The æcidia and teleuto-forms of Ranunculaceæ are many of them connected with uredo-forms which have their home on grasses. *Æcidium Rumicis* is a stage in the development of *Puccinia Magnusiana*, parasitic on *Phragmites*. A large number of *Pucciniæ* grow on species of *Carex*;

* 'Grevillea,' viii. (1879) p. 53.

† 'Wandersammlung ungarischer Aerzte u. Naturforscher zu Budapest; naturwissenschaftliche Section, Aug. 30, 1879'; see 'Bot. Zeit.,' xxxvii. (1879) p. 676.

‡ Cohn, 'Beiträge zur Biol. der Pflanzen,' iii.; see 'Hedwigia,' xviii. (1879) p. 134.

the æcidia are found on *Taraxacum*, *Urtica*, and other plants. Numerous other genetic relationships are established in the paper.

Vine-mildew or False Oidium.*—This disease makes its appearance from time to time in vineyards in the United States, and has recently, according to J. E. Planchon, been detected in France on stocks imported from America. It is frequently confounded with the true *Oïdium*, but has in reality more resemblance to the potato-disease, being caused by a very similar fungus, *Peronospora viticola*. It attacks chiefly the herbaceous parts of the vine, especially the leaves of the second summer-shoots, more rarely the stems or berries. M. Planchon does not regard its attacks as a danger so great as to counterbalance the advantages to be derived from the importation into Europe of American vine-stocks free from the phylloxera.

Cherry-laurel Disease.†—A. Bertolini has had his attention called to a hitherto undescribed parasitic fungus which attacks the ripe fruit of the *Prunus laurocerasus* and for which he proposes the name *Oidium Passerinii*. It makes its appearance as irregular white spots, composed of filaments which invest the epicarp of the fruit, and from which rises a delicate down, perceptible by the aid of a lens. The former compose the ordinary hyphæ of the *Erysipheæ*; the latter is the conidia, consisting of ovoid cells placed one on another. In an early stage of development they constitute a tube undivided internally, but exhibiting constrictions on the outside; at the period of maturity this becomes separated by division-walls into the separate conidia at the constrictions, producing a necklace-like structure. At the final stage the conidia detach themselves in succession. Observed at this period under the Microscope, the fungus appears to consist of two layers, one inferior of tubes or elongated cells, the upper layer composed of the ovoid conidia reunited irregularly and containing granules of ovoid form and varying in number.

New Hyphomycete.‡—Professor W. Voss describes, under the name *Scolicotrichum Ungeri*, a new fungus belonging to the Hyphomycetes which he found, in Upper Carinthia, on the fallen radical leaves of *Polygonum viviparum*. In the same paper he gives a list of the subterranean fungi found by him in Carinthia, and of the epiphytal fungi from the "Cerna prst" or "black earth," a mountain range in the same district. This latter includes the rare *Puccinia Gentianæ* on *Gentiana cruciata*, *Exoascus Alni* var. *strobilinus* on the cones of *Alnus incana*, and many others, numbering in all upwards of thirty species growing on twenty-eight different hosts.

Classification of the Discomycetes.§—Mr. E. Boudier suggests the separation of the Discomycetes into two very natural sections, according as the mode of dehiscence of the asci is with or without an operculum, calling the first section *Operculate Discomycetes*, or simply

* 'Comptes Rendus,' lxxxix. (1879) p. 600.
† 'Nuov. Giorn. Bot. Ital.,' xi. (1879) p. 389.
‡ 'Oesterr. Bot. Zeitschr.,' xxix. (1879) p. 313.
§ 'Grevillea,' viii. (1879) p. 45.

Operculæ, the opening of the asci taking place by the elevation of a little lid at the summit, and the second *Inoperculate Discomycetes*, or *Inoperculæ*, the exit of the sporidia taking place by a small hole, formed at the extreme summit of the ascus, with its margin more or less elevated, but without any appearance of an operculum.

The Operculæ include the Morels, the Helvellas, the Verpas, the Pezizæ of the sections *Aleuria*, *Humaria*, many of the *Lachneæ*, *Ascobolus*, and the greater part of the genera which are derived from this section; and the Inoperculæ include *Geoglossum*, *Mitrula*, *Leotia*, *Phialea*, *Helotium*, *Lachnella*, *Mollisia*, and all the genera belonging to them.

There is no great difficulty in observing the mode of dehiscence, although few authors mention it. A very little attention soon renders it quite familiar, and M. Boudier considers its careful observation indispensable to a good classification of genera and species. A magnifying power of 300 diameters is sufficient, but it is necessary to examine the upper extremity of the open asci. These asci are always to be recognized by the absence of protoplasm, by which they differ from the young plants which have not yet formed their sporidia. Tincture of iodine may be employed, which colours the membrane and renders the operculum more visible. This tincture should, indeed, always be employed in the examination of species, because it often gives a deep-blue colour at the extremity of the ascus, as in *Aleuria* proper, *Peziza cochleata*, *P. badia*, *P. vesiculosa*, and others, and the character has a certain value; in other cases the colour is fainter, as in *P. firma*, *P. echinophila*, &c.; in other cases again, only the extreme margin of the opening is tinted, as in *Mitrula*, or it appears as a blue point, while more frequently the iodine does not produce any other coloration than a yellowish tint.

It must be pointed out, with regard to this suggestion of M. Boudier, that all our knowledge of exotic species, and of the earlier British ones, must be derived only from dried specimens. As according to the proposed system the distinctive characters are those which cannot be discerned in dried specimens, these could never be determined and no species described.

Vinegar-Plant and similar Fungi.* — The vinegar-plant or mother-of-vinegar (*Mycoderma aceti*), consisting of pellicles built up of elliptical cells, has been observed by M. Schnetzler to produce a series of cup-shaped masses in a bottle of white wine, which, falling in succession to the bottom, produced a cylinder of more than 4 inches in length; each cup as it fell left behind it a train of gelatinous bacterium-matter, which, passing from an actively mobile to a passive zooglœa state, reproduced the film. The exclusion of air by a cork did not hinder the growth.

The gelatinous material which envelopes the bacteria agrees in chemical characters with the cellulose of most fungi, in being insoluble in ammonio-sulphate of copper and in not being coloured blue or violet by iodine and zinc chloride,—the former imparting

* 'Bull. Soc. Vaud. Nat. Sci.,' xvi. (1879) p. 441.

a *yellow* tint to it. It may be considered as a specially modified cellulose and be called *Fungus-cellulose.* It is rendered more opaque and firm by boiling.

This *Mycoderma* forms, like the common *Nostoc*, with the same material, masses of great cohesion. It has the property of absorbing tannin in quantities; the colour of the vinegar is thus perhaps due to tannin derived from the wine in presence of some salt of iron.

The fungus formed in wine in presence of a large amount of air is *Mycoderma vini* or flower-of-wine, a thin pellicle of a greyish colour and with delicate surface-folds. It belongs to the *Saccharomycetes.* It is composed of cells 2 to 3 μ in diameter, which are reproduced by budding, and under certain conditions by ascospores. The alcoholic fermentation which it causes may be demonstrated on samples of pure grape-juice kept in corked bottles at a moderate temperature, when alcohol is produced, with development of *Saccharomyces ellipsoideus* and of a precipitate and surface-accumulation. Exposed to the air and shaken, the liquid now produces a pellicle formed of *Saccharomyces mycoderma* Reess; while it contains also *S. ellipsoideus* and all stages of transition between the two. Exposure to light increases the films, and absence of light causes cessation of their development. Ascospores are produced from any part of the pellicle which becomes dry. Although the wine in this state contains bacteria, yet the *Saccharomyces* appears to have the property of hindering their acetic fermentation.

The development of the alcoholic ferment, on the other hand, is checked by a previous fermentation, or by the presence of borax. From observations such as those already given, it is probable that the two species of *Saccharomyces* are but different forms of one species; they have the same fermenting power in saccharine as in grape-juice solutions.

A third phenomenon exhibited by wine is that of "ropiness." In this case, wine becomes thick and gelatinous, and, when examined microscopically, shows the presence of immense numbers of bacteria of 1 μ or less diameter, in strings. It occurs in white wines, especially when the grapes have not been strongly pressed—seldom in red wines: this is probably due, as François and Pasteur have observed, to the larger amount of tannin present in the red wines, and hence the evil may be checked by addition of tannin to wines thus attacked. A specimen of ropy wine contained a quantity of *Mucor racemosus* in mycelium or isolated; this fungus has the property of producing alcoholic fermentation in a saccharine liquid.

Cause of the Coloration of Pink Grains of Corn.*—M. Prillieux has been investigating the cause of the singular pink colour which grains of corn sometimes present. The conclusion at which he has arrived is that it is due to the permeation of the grains by a *Micrococcus*, which multiplies within the tissues and destroys them, attacking first of all the starch, then the proteinaceous substances, and finally the cellulose of the cell-walls. The mode of destruction of the

* 'Ann. Sci. Nat. (Bot.),' viii. (1879) p. 248.

starch-grains is, however, different from that which diastase produces, and which has been frequently described and figured in germinating grains of corn.

Relation of Oxygen to the Life of the Microzoa.*—It is stated by Gunning,† as the result of a long series of experiments, that, in the case of putrescible liquids contained in sealed glass vessels, putrefaction either never sets in, or, if it does, is speedily suspended. This appears to be directly contrary to a statement of Nencki, based on the experiments of Jeanneret, viz. that living organisms can, in the absence of oxygen, both induce and bring to completion the decomposition of relatively large quantities of organic matters. Nencki, in criticizing this objection, shows (1) that the exclusion of air by hermetically closing the vessel introduces the condition of the prevention of the escape of volatile products, which, by consequent accumulation, may end or prejudice the life of *bacteria*, &c.; and (2) that the liquids used to induce putrefaction did not contain those special ferment organisms whose life is independent of a supply of oxygen. The methods by which he subjected the point to a further investigation are described, and as the result he considers that his original statement is justified.

On the other hand, he corroborates the observation of Gunning that the putrefaction of liquids contained in sealed vessels takes place only up to a certain point, the attainment of this limit being evidenced by the liquid becoming clear, the organisms losing their activity and sinking to the bottom. The explanation of this lies in the poisonous action on an organism of its own excreta, which is probably true for the lower as for the higher forms of life.

In reference to the probable cause of the non-occurrence of fermentation in several of Gunning's experiments, viz. the absence of "anaërobic" organisms, the microscopic examination of fluids putrefying under exposure to the air demonstrated the following points:—The scum which forms on the surface contains Microbacteria and Bacillariæ only, whereas in the deeper parts of the fluid, protected by this scum from access of oxygen, different forms of Coccus are found, together with the knobbed form of *bacteria*, these latter being essentially anaërobic organisms. The same definite localization of the "organized ferments" is observed in liquids putrefying under the influence of pancreas-extract, whether at the ordinary temperature or at 40°. In the latter case, in which the process is more rapid, the localization is most sharply defined from the second to the fourth day. Further light is thrown on the conditions of life of these anaërobic organisms by an experiment of Kaufmann's. To a boiling solution (10 per cent.) of 230 grains gelatin, 10 c. c. of pancreas-extract were added, and the whole was cooled to 40°, at which temperature it was maintained in an apparatus similar to that described by Jeanneret.‡

Putrefaction set in on the third day; and on the seventeenth day

* 'Journ. Prakt. Chem.,' xix. (1879) p. 337; see 'Journ. Chem. Soc.,' 1879. Abstr., p. 953.

† Ibid., p. 266.

‡ 'Journ. Prakt. Chem.,' xix. (1879) p. 353.

33 c. c. of gas had been evolved; on the twelfth the evolution underwent a sudden increase. The gas was now collected daily and analyzed as far as regards the percentage absorption by potash; the unabsorbed portion consisted of nearly pure hydrogen.* To select a mean result:—The evolution ceased on the twenty-first day, and the liquid contained ammonia, acetic acid, and glycocine, in addition to peptones. From the above it appears that not only are the anaërobic organisms in question capable of inducing the putrefactive decomposition of large quantities of organic matter, but they do so after having been exposed to the boiling temperature.

It may therefore be stated, generally, that proteids are brought into putrefaction by anaërobic organisms, and are through their agency resolved into products, such as glycocine, indole, phenol, acetic and butyric acid (together with a certain quantity of carbonic acid and ammonia) and that of these, the fatty and amido-acids are susceptible of complete oxidation to carbonic anhydride and water (and ammonia), under the influence of other forms of microzoa whose life depends on a supply of oxygen. The relation of the functions of these two groups of microzoa is in close analogy with that of *Torula* to *Mucor* and *Mucedo* in the fermentation of sugar.

The digestive process which occurs in the large intestine is a putrefactive decomposition which must be referred to anaërobic organisms, and one which occurs under the favourable condition of the absorption of the products by the mucosa. There are also certain pathological conditions of the body which are attended by putrefaction in absence of atmospheric oxygen. The author gives full details of the chemical and microscopical examination of pus taken from two subjects, shortly after death in one case from acute cystitis, in the other from pleuritis. From both he succeeded in isolating phenol and indole, and he also observed the identity of the organisms present with the anaërobic microzoa previously described. The pus-corpuscles had for the most part undergone no change of form, whence it must be concluded that the putrefaction, which had been going on for months, was extremely tardy in character; this is probably in consequence of the prevention of the escape of the products.

In conclusion, the author states that he is satisfied that these microzoa are present in normal tissues and glands.

New pathogenous Bacillus.†—Professor C. J. Eberth describes a new form of *Bacillus*, found by him in the liver of a badger. The examination was conducted about half an hour after the animal's death.

The method adopted was to place thin sections of liver into a tolerably strong aqueous solution of methyl violet (quality BBBBB) for one to six hours; then to wash the sections carefully in water containing two to three drops of strong acetic acid to the ounce, allowing them to remain in it for one to four hours, until no more colouring

* The occurrence of hydrogen as a product of this decomposition stands in opposition to the observation of Jeanneret.

† 'Arch. pathol. Anat. und Phys.' (Virchow), lxxvii. (1879) p. 29.

matter was dissolved out. The sections were then placed in alcohol, which removed a further quantity of the colour, clarified with oil of cloves, and mounted in balsam. By this treatment the liver-cells were hardly at all stained, the colouring matter being taken up by their nuclei, by the pus-corpuscles, and by the *Bacilli.* Bismarck brown was also used as a staining material.

The *Bacilli* were found amongst the pus-corpuscles, in small abscesses about the size of a pin's head, in the substance of the liver. They also occurred in the apparently normal portions of the glands in the capillaries. Very few were found in other organs, such as the spleen, kidney, and lung. The abscesses in the liver were due to the *Bacilli* penetrating through the capillary walls and producing necrosis of the hepatic tissue.

The *Bacilli* are cylindrical rods, rarely composed of two segments, and somewhat larger than *B. anthracis* of splenic fever (6 μ as against 5 μ). In some cases, after treatment with dilute iodine solution or Bismarck brown, one or two dark-brown granules came into view, occupying the whole width of the *Bacillus.* It was not decided whether these were spores or only strongly stained portions of protoplasm. No free spores were seen amongst the *Bacilli.*

Spores of Bacteria.*—Until recently detected by Van Tieghem in *Spirillum* and *Leuconostoc*,† spores had been observed in bacteria only in some species of *Bacillus.* The same observer now adds to the list a large number of species of the last-named genus, together with the genera *Bacterium*, *Vibrio*, and *Spirochæte.*

On the surface of a variety of liquids Van Tieghem has recently observed a bacterium remarkable for its bright, shining appearance, to which he gives the name *B. lucens.* When transplanted into pure water it gradually becomes paler, and finally develops its spores. Each segment, constricted in the middle, usually forms a spore in one half, while the other half becomes empty; occasionally the two halves appear to be separated by a septum, and then a spore is formed in each.

In liquids in which certain molluscs, especially oysters, were putrefying, a *Spirochæte*, probably S. *plicatilis*, appeared in great quantities. The number of coils varies from five to eight: in the latter case the coils measure about 0·1 mm. in length, and 4 μ in breadth, the diameter of the individual not being more than 0·8 μ. As it elongates, no septa make their appearance until the formation of the spores. Each coil then divides into about four segments, in each of which is formed a spherical spore of about 0·8 μ diameter.

A *Vibrio*, probably *V. serpens*, growing in the same liquids, also produced spores as soon as it was transplanted into pure water. The spores were spherical, from four to six in each individual, formed each in a spherical segment.

A large motionless *Bacillus*, named by Van Tieghem *B. crassus*, also produces spores. Before completing its growth, the filament attains a diameter of 4 μ, which is increased to 5 μ or 6 μ, when

* 'Bull. Soc. Bot. France,' xxvi. (1879) p. 141.

† See this Journal, ii. (1879) p. 928.

about to form spores, which are cylindrical, and produced one in each cylindrical segment. They are spherical, 5 μ in diameter, and the largest hitherto known in the family.

Spirillum amyliferum, a new Bacterium.*—In investigating the *Bacillus Amylobacter* produced in the process of sugar-refining,† Van Tieghem has discovered, growing side by side with it under the same conditions of nutrition, a new *Spirillum*. The filament, curved to the right in a rigid helix, is from 12 to 15 μ in diameter; when isolated, it makes from two to four turns of the spiral. After ceasing to increase in length, it becomes considerably thicker, and develops starch in two distinct places. At each of these places is then formed a bright spore, oval in form, and measuring from 25 to 30 μ in length, and about 15 in breadth. The protoplasm and the starch then disappear, and give place to a hyaline fluid, and each spore is enclosed in a thin cell-wall, and ultimately set at liberty from the filament. On germinating it protrudes a tube through the exospore, which at once begins to curve. It then forms a septum in its middle, and subsequently two others, then dividing in the middle into two, and finally into four independent filaments. Like *B. Amylobacter*, *Spirillum amyliferum* can live without free oxygen, and may become an energetic ferment.

Existence of Bacteria or their Germs in the Healthy Organs of Animals.‡—Chiene and Ewart stated § that neither bacteria nor their germs exist in the healthy organs of animals. Nencki and Giacosa, however, find by experimenting, first, with slices of organs of a rabbit extracted with great care under a spray of carbolic acid and dipped into a bath of molten Wood's metal (m. p. 75°) until the metal solidified round the fibre, and secondly, with the organs collected in tubes filled with mercury and placed in a bath of this metal at 120° and then allowed to stand some days at 40°, that in both instances putrefaction set in after a few days. The temperature to which the metals were heated before experiment was sufficiently high to destroy all germs, and to prevent the entrance of the latter from the air, as the baths were covered with a layer of carbolic acid solution.

Absorption of Bacteria into the Air.‖—J. Soyka has contrived an apparatus by which he is able to measure the power of currents of air of different velocity to raise bacteria-spores produced in putrescent fluids. He found that a velocity of 3 cm. in the second was sufficient for this purpose, when accompanied by evaporation from the surface of the fluid. From this he concludes that bacteria may be taken up into the air in great quantities, even when there is hardly sufficient motion to produce a perceptible current.

* 'Bull. Soc. Bot. France,' xxvii. (1879) p. 65.

† See this Journal, ii. (1879) p. 928.

‡ 'Journ. Prakt. Chem.,' xx. (1879) p. 34; see 'Journ. Chem. Soc.,' 1879. Abstr., p. 1016.

§ 'Journ. Anat. and Physiol.,' 1878, p. 418.

‖ 'SB. math.-phys. Klasse der Münchener Akad.,' 1879, p. 140; see 'Naturforscher,' xii. (1879) p. 386.

Cause of the Movements of Bacteria.*—Some of the bacteria, such as most species of *Micrococcus*, *Bacillus anthracis*, &c., are known only in a stationary condition; other allied species, as *Bacterium Termo* and *Spirillum volutans*, are ordinarily in a condition of movement; while others, e. g. *Bacillus Amylobacter*, are known in both conditions. The cause of all organic movements is no doubt ultimately the contractility of protoplasm. But this may take two forms. The contractility may reside in the protoplasm, which is entirely enclosed within a cell-wall, although this cell-wall may be prolonged in places to filiform structures, to which the term *appendages* may be given. Or, secondly, a portion of the protoplasm may protrude through the cell-wall in the form of fine threads or *vibratile cilia*. To which of these modes the bacteria owe their power of movement has been a subject of controversy; and Van Tieghem believes he has now established that it is always the former, and that the supposed vibratile cilia alleged to have been detected by some observers were really appendages invested with a cell-wall. His observations were made chiefly on *B. Amylobacter*; neither iodine nor any of the aniline pigments produced on the appendages the characteristic colouring of protoplasm. This is considered by Van Tieghem to re-establish the affinity held by Cohn to exist between the bacteria and the Phycochromaceæ.

Action of Dry Heat and of Sulphurous Acid on the Bacteria which accompany Putrefaction.†—A. Wernich has carried out a series of experiments on the influence of these disinfecting agents on the production of bacteria in Pasteur's solution, in which were dipped pieces of cotton-wool, wadding, and linen which had been steeped in putrefying flesh liquid, and then slowly dried. Exposure to a temperature of 140°–150° C. for a period of from one to two minutes delayed the bacteria-turbidity two to three days, while it commenced in twenty-four hours after the substance had been exposed 10–60 minutes to a temperature of 110°–118° C. Exposure to 125°–150° C. for five minutes prevented all bacteria-infection, even for a period of eleven days.

When volume-percentages of 1·5, 2·2, and 3·3 of sulphurous acid were produced in a glass vessel, to which the materials were exposed, even if continued for twenty-two hours, no effect ensued on the production of the bacteria-turbidity in the solution. When exposed to 4, 6·6 or 7·15 per cent. (in volume) of sulphurous acid for six hours, the production of bacteria was entirely prevented; but this was not the case when the exposure lasted only twenty, forty, sixty, or two hundred minutes. The different substances named were freed with different degrees of facility from the infection-germs; cotton-wool the easiest, linen next, and wadding with the most difficulty.

Microscopic Mycological Preparations.‡—A series of mycological preparations for the Microscope by Dr. O. E. R. Zimmermann, of Chemnitz, in Saxony, is described by von Thümen as being of great value as an aid to instruction in mycology. The preparations are

* 'Bull. Soc. Bot. France,' xxvi. (1879) p. 37.

† 'Centralblatt med. Wiss.,' xvii. p. 227; see 'Naturforscher,' xii. (1879) p. 311.

‡ 'Oesterr. Bot Zeitschr.,' xxix. (1879) p. 330.

made with great care and skill, and are arranged in four series. The first consists entirely of parasites belonging to the families Uredineæ, Ustilagineæ, and Peronosporeæ; the second of representatives of the most interesting families of the Ascomycetes; the third of Mucorini and other conidial fungi; the fourth of Bacteria, all well coloured in order to be more easily recognized, and of a few yeast-fungi. Von Thümen urges microscopists and mycologists to send commissions for the series already executed to Dr. Zimmermann, in order that he may be encouraged to continue and extend his labours.

Lichenes.

Lichens collected during the English Polar Expedition of 1875-76.*—Professor T. M. Fries, of Upsala, has examined these lichens, and in a paper reporting the result he says that in Dr. Hayes's Arctic journey lichens were probably not brought away from a more northerly position than 78° N. lat.; but Mr. J. Payer in the German expedition with certainty obtained specimens at Cape Fligely, 82° 5′ N. lat. With the exception of these last, but three specimens of lichens have hitherto been published as found beyond 81° N. lat. Thus considerable interest is attached to those obtained under Captain Sir G. Nares, by Captain Fielden of the 'Alert,' and Mr. Hart of the 'Discovery.' As these vessels wintered in different quarters, the localities where the lichens were obtained are more numerous, thus adding to their value as indicative of vegetable life in the frozen regions. Mr. Hart obtained his at thirteen stations, Discovery Harbour, 81° 42′ N. lat., being the most northern. Captain Fielden records twelve stations, Westward Ho Valley, 82° 41′ N. lat. being the limit, whilst Lieutenant Aldrich gathered *Gyrophora cylindrica* β on the shore of the "Palæocrystic Sea," the northernmost spot trodden by man, viz. Cape Columbia, 83° 6′ 30″ N. lat.

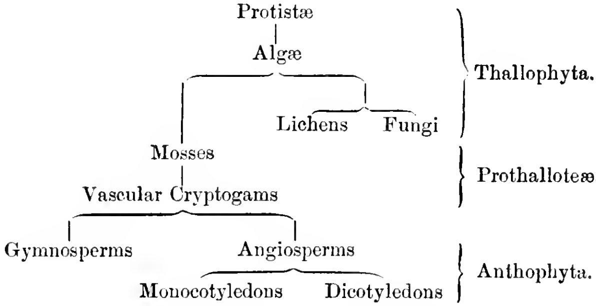
Professor Fries notes that the higher fruticulose and foliaceous lichens are feebly represented, doubtless owing to the severe climate; but this absence is apparently at variance with the presence of musk oxen; added to which the reindeer moss is absent. This anomalous circumstance of the presence of large ruminants and deficiency of their usual lichen food, Captain Fielden explains by stating that the musk ox in Grinnell Land does not feed on lichens, but on mosses and grasses. The same officer has also pointed out that the lichen growth, curiously enough, increased in size of species with increase of altitude. Professor Fries concludes that "without the least credit being given to an open polar sea (existing no doubt only in fancy) lichen vegetation may exist at the very pole, if there is land or only rocks free from snow and ice for only a short period of the year."

The list includes 102 species, and they are mostly such as are already known from the Arctic regions, although there are some which were previously known only from much more southern regions. Seven species are, however, entirely new, viz. *Parmelia separata*, *Caloplaca celata*, *Lecidea despecta*, *L. ultima*, *Microglena sordidula*, *Verrucaria phæothelena*, and *Microthelia melanostigma*.

* 'Journ. Linn. Soc. (Bot.),' xvii. (1879) p. 346.

Algæ.

Relationship of Algæ to Phanerogams.*—Haeckel recently proposed the following phylogenetic scheme for the vegetable kingdom :—



Dr. O. Kuntze points out the close resemblance, in many points of structure, with Algæ, of a small order of flowering plants, the Podostemonaceæ, consisting of 23 genera and 103 species of tropical water-plants, which he considers may have a very close genetic affinity with Algæ, similar to the suggested relationship of Cytineæ and Balanophoraceæ with Fungi. The Podostemonaceæ are often very small plants, mostly grow immersed in running water, and the smaller species are composed entirely of parenchymatous tissue without any fibro-vascular bundles ; the stem is often entirely wanting, when present, dichotomous or moss-like, or even resembling the thallus of hepaticæ or lichens; there is often no true root, and the vernation is frequently circinate. These resemblances seem, however, nearly all to relate to those points of structure which depend on habit rather than to those which would indicate the line of descent, such as the structure of the reproductive organs. Dr. Kuntze does not believe in the derivation of the Gymnosperms from the Angiosperms; but traces the former from the Oosporeæ through Vascular Cryptogams, the latter directly from the Carposporeæ.

Endogenous formation of Normal Lateral Shoots in Rytiphlœa, Vidalia, and Amansia.†—P. Falkenberg has carefully investigated this anomalous structure in the above-named three genera of Rhodomelaceæ, growing in the Bay of Naples. Although the whole of the vegetative branching of the thallus of these algæ depends on these endogenous shoots, their origin can be detected only with difficulty in the mature thallus. They are not properly designated adventitious shoots, as is shown by their strictly acropetal order of development immediately beneath the growing apex of the thallus, and by their regular position on the main stem. In *Vidalia volubilis* the formation of tetraspores is limited to the endogenous branches. In

* 'Flora,' lxii. (1879) pp. 401, 417.
† 'Nachr. K. Ges. Wiss. Göttingen,' 1879, No. 11; see 'Bot. Zeit.,' xxxvii. (1879) p. 601.

the same species true adventitious branches sometimes arise on old parts of the thallus, which, however, do not materially affect the habit of the plant, and are always clearly distinguished, by their position on the midrib of the thallus, from the normal endogenous branches, which are always marginal in their origin.

Revivification of Diatoms.* —Professor Hamilton L. Smith, referring to the observations of Mr. F. Habirshaw and Captain Mortimer,† as to the revivification of some diatoms after six years, says that while there can be no doubt that living diatoms were found as stated, proof is yet needed that they were really *revivified*. It is contrary to experience hitherto; indeed, it is well known, and one of the means employed to procure purer gatherings, that oftentimes apparently pure water will, if allowed to stand quietly, show an abundant crop of diatoms. In many cases that he has noted of the appearance of living diatoms after wetting long-dried material, they have been, *not the forms originally in the gathering*, but those evidently derived from the water. At present, while we may, and perhaps must, admit that up to a certain limit diatoms, like the rotifers, may be dried, with power of revivification or reproduction, there is yet lacking sufficient evidence that their drying may extend over a series of years.

Classification of Desmidieæ.‡ — In his investigation of the desmids of Eastern Prussia, Klebs has redescribed and reclassified the species belonging to the important genera *Closterium*, *Penium*, and *Cosmarium*.

It may be stated that the general result of his researches has been to render much less distinct than has heretofore been supposed the boundary-lines of both species and genera. In a large number of cases he shows how well-known species hitherto considered distinct pass imperceptibly one into another. Even as regards the genera, *Penium* is so closely allied to *Closterium* as hardly to admit of satisfactory discrimination; *P. margaritaceum* furnishing a direct transition to the striped or banded closteria like *C. intermedium*. *Cosmarium Thwaitesii* is again closely allied to *Penium* through *P. closterioides*. *Pleurotenium cosmarioides* de By., the author considers to be a form of *Cosmarium de Baryi*. A similar review of the remaining genera of Desmidieæ will probably follow.

Parthenogenesis in a Spirogyra.§—In a quantity of a *Spirogyra* (probably *S. arcta* Ktz.), from spring water with a rocky bottom, H. Zukal observed an abundant formation of spores (like zygospores) without any previous conjugation. The spores were formed, in some instances, in two, three, or even six adjoining cells, without the least trace of the formation of projection from the cells, or other prelude to conjugation, and they resembled in every respect those formed in the ordinary manner. They also escaped in the same manner from the

* Baird's 'Annual Record of Science and Industry' for 1878 (1879) p. 370.

† This Journal, i. (1878) pp. 150 and 314.

‡ 'Ueber die Formen einiger Gattungen der Desmidiaceen Ostpreussens,' von G. Klebs, Königsberg, 1879; see 'Hedwigia,' xviii. (1879) p. 150.

§ 'Oesterr. Bot. Zeitschr.,' xxix (1879) p. 291.

cells in which they were formed, becoming normal resting-spores; but all attempts to induce them to germinate failed.

Sub-aerial Alga.*—The form *Chroölepus jolithus* Hg. has been submitted to a careful examination by Professor Schnetzler. His specimen grew on the surface of gneiss in the Chamounix valley: it has also been noticed in the Harz, on a siliceous rock, which owes its name, "Violet Stone," to the odour of violets which the alga exhales when damp.

It consists of simple or ramified series of thick-walled cells, whose terminal members develop biciliated zoospores within them. By the side of the cells a quantity of yellow oil-drops occur, which are derived from the cells, as is shown by the treatment of these last by borax; when the protoplasm contracts and the red investing liquid —which is coloured blue by iodine—escapes as red oil-drops: alcohol also produces the yellow oil from the cells.

The chlorophyll appears to be masked by the oil which becomes manifest in the protoplasm after the action of borax. Oil thus appears here to replace the starch of other plants; it also occurs in the chlorophyll-grains of *Strelitzia* and *Musa*.

Development of Sphærotilus natans and its Relationship to Crenothrix and to Bacteria.†—At a weir near Breslau, E. Eidam observed great quantities of mucilaginous and slimy light-brown patches of an alga which he identified as *Sphærotilus natans* Ktz. In its vegetative condition the filaments are remarkably long, colourless, and not club-shaped at the extremity like *Crenothrix*, but of a uniform diameter throughout. Each filament is divided into a large number of long cells filled with a homogeneous protoplasm. The entire filament is inserted in a colourless sheath. It is never endowed with motion, but often breaks up into fragments, and multiplies, like all leptothrix forms, by the development of the separate fragments into new filaments. No incrustation with iron has been observed, like in *Crenothrix*. But another very remarkable mode of reproduction was observed in the filaments of *Sphærotilus*, accompanied by a striking change in colour. The cells become opaque, and the whole mass of a milky appearance; the protoplasm collects into a large number of extremely small and strongly refractive balls. Each cell becomes thus transformed into a sporangium, and the protoplasmic balls are spores, each of which may develop into a new filament. In mass the spores are of a brick-red and finally a brown-yellow colour. When a number of spores fail to germinate, the mass has the structure of a zooglœa-colony, and resembles the palmella condition of *Crenothrix*.‡

The writer does not, however, agree with the conclusion of Cienkowski that the groups of bacteria distinguished by Cohn are generically identical. He believes, on the contrary, that there may be a very large number of distinct organisms, each of which may have its bacterium- and its leptothrix-condition, although the cycle of development of many is at present but very imperfectly known.

* 'Bull. Soc. Vaud. Sci. Nat.,' xvi. p. 247.

† 'SB. bot. Ver. Prov. Brandenburg,' April 25, 1879; see 'Bot Zeit.,' xxxvii. (1879) p. 724.

‡ See this Journal, ii. (1879) p. 925.

Volvox minor.*—One point left undecided in Cohn's otherwise exhaustive researches on the life-history of *Volvox* was the mode of germination of the oospores. This has now been observed by O. Kirchner in the case of *V. minor*. In February the contents of the oospore escape from the ruptured exospore in the form of a sphere, the endospore at the same time swelling up greatly; and are first divided by two walls at right angles to one another. The four cells thus formed separate from one another in such a way that they maintain their connection only at the posterior end. This forms one pole of the subsequently spherical cell-family, the other end closes up only after a large number of cells have been formed. A new family is thus directly derived from each oospore by the division, and the subsequent peculiar mode of displacement of the cells. The distinction does not appear to hold good which was previously considered to obtain between *V. globator* and *V. minor*, that the latter is diœcious; the families go through first of all a female and later a male condition, and are therefore proterogynous.

MICROSCOPY.

Professor Huxley on Work for Microscopists.†—In his presidential address to the Quekett Microscopical Club, Professor Huxley said that having been asked to indicate those courses of inquiry which might best be commended to members of such a Society, he thought that what was desirable was "the following up of details, tracing out minutiæ of structure, and such questions as are only to be solved by long and patient devotion of time and dexterity, and a thorough knowledge of instrumental manipulation—it is exactly there that men of science find their difficulties, because the amount of time consumed is so great.

"Take, for example, the application of persistent watching to the unravelment of the life-history of a vast number of low organisms; that is a process which has been adopted in respect to certain fungi in order to ascertain whether they are parasites or variations. In such a case the plan pursued is that of taking the spores and watching them step by step, and there is no other way of doing it; it involves enormous expenditure of time and great instrumental dexterity, but those who can follow it obtain results which are to be obtained in no other way. The work of Mr. Dallinger and Dr. Drysdale, for instance, affords us a very remarkable example of this kind of observation. These two gentlemen mounted guard alternately over a Microscope for days and days, and watched one identical monad through all its stages; and they succeeded in tracing out its entire life-history, and made an epoch in our knowledge of these lowest forms. Now suppose this kind of observation was to be directed to the Infusoria in general, what an opportunity there is for some of you! There is not a single genus or species of which we may say that we know the whole history. The common *Paramecium*, for

* Cohn, 'Beitr. Biol. Pflanzen,' iii.; see 'Bot. Zeit.,' xxxvii. (1879) p. 693.
† 'Journ. Quek. Micr. Club,' v. (1879) p. 250.

instance, is one of the commonest things that exist, yet nobody certainly knows whether it has any other mode of reproduction except by fission. The skill which I have seen displayed here is of immense value in such kind of work, and if only applied to it must very soon bring some good results. The like is true also of the *Acinetæ;* we know something about them, but nothing like a complete history: and it is a perfect opprobrium to science that nobody knows what an *Amœba* is. I do not mean to say that we do not know the things we call by that name when we see them, but that we are unable to say with certainty what are their modes of reproduction, what are their various states, which are animal and which are vegetable.

"Turn to the study of development, the whole of which is in a progressive state. We are now carrying it so far that we can trace back a single group of organs to a particular portion of the dividing yolk mass, and the ultimate result will probably be to trace out each group of organs to the blastomeres from which it has proceeded. . . . . This is the kind of service which those members of the Club may perform who feel inclined for it; it is work which may be of very great value, and which certainly cannot be undertaken by those who have to occupy themselves with science as a whole."

Curiosities of Microscopical Literature.—The increase of cheap periodicals, and the demand for "popular" articles on scientific subjects, has unfortunately been the ready means of disseminating a vast amount of error, which it will be far more difficult to eradicate. The turn of the Microscope appears now to have come, judging from a series of articles * which have recently appeared, and from which we extract the two following paragraphs out of many more of a similar character.

"Turning from the practical and useful applications of the Microscope to the human subject, we find that among the scientific questions settled by its means it has correctly defined the line between the vegetable and animal kingdoms. This was a matter of some moment; it had occasioned endless discourse, contradiction and arguments, and, although now put conclusively at rest, some people would consider it erroneous to class a moving isolated body as a vegetable."

"In the lower forms of life, found in ponds and ditches, so deep have the researches into every available form been carried by studious observation, that the minute animals and vegetables more generally distributed throughout the country have been classified, named, and their natural history as correctly related as those of the mammalia. These minute organisms, before invisible and unknown, have been observed by indefatigable and acute observers as closely as we can observe the larger animals. The result of this has been that the information respecting them is as complete, perfect, interesting, and almost as useful as that of any other department of nature."

Kossman's Glass Photograms.—Professor Kossman, of Heidelberg, has superintended the preparation of a series of 250 "photograms," on glass, intended for exhibition by the sciopticon, and to

* 'Design and Work,' vi. (1879) p. 68, &c.

save the cost and inconvenience of wall charts. From the list, which is all that we have seen, it appears that the photographs have been taken from the works of the various standard authors on the particular subject represented. Thus for the 17 protozoa, Claparède and Lachmann, Ehrenberg, Haeckel, Schulze, and Stein have been referred to. There are 20 representations of cœlenterates, 20 of echinoderms, 43 of worms, 21 of crustacea, 20 of insects, myriapods, and arachnids, 22 of mollusca, and 17 of vertebrata.

Bachmann's Guide for making Microscopical Preparations.—This book (in German, 196 pp., with 87 woodcuts), after a description of the necessary instruments and reagents, explains the methods of preparing slides of plants, insects and spiders, mollusca, blood-corpuscles, microscopical inhabitants of water, hard substances, trichinæ, entozoa, bacteria, and preparations of vertebrate normal histology.

The author enforces the importance of keeping a "Preparation Journal," and gives an extract from his own, which is arranged as follows:—

No.	Description of the Object. General.	Description of the Object. Special.	Date Found.	Where Found.	Preliminary Treatment.	Further Treatment.	Preserved in	Observations.
34	*Gryllus campestris*, L.	Transverse Section of Gizzard	12th Nov., 1878.	München.	Hardened in Müller's fluid for 10 days.	Stained with picro-carmine and cut in paraffin.	Canada balsam.	Not sufficiently stained.

Beauregard and Galippe's Practical Micrography.—This is a book (in French) of 900 pages, with 570 woodcuts. Besides the usual preliminary chapter on "Microscopes and their Employment," it consists of two parts, "Vegetable Histology," and "Animal Histology." In the former are included (in separate chapters) the anatomical elements, tissues, structure of stems, roots, and leaves, and the organs of reproduction of Cryptogams and Phanerogams. The latter deals with blood, pus, sediments of urine, milk, semen, fæcal matters, parasites, mucus, vomited matters, stains of various kinds, and the examination of water and the atmosphere and of hairs from a medico-legal point of view.

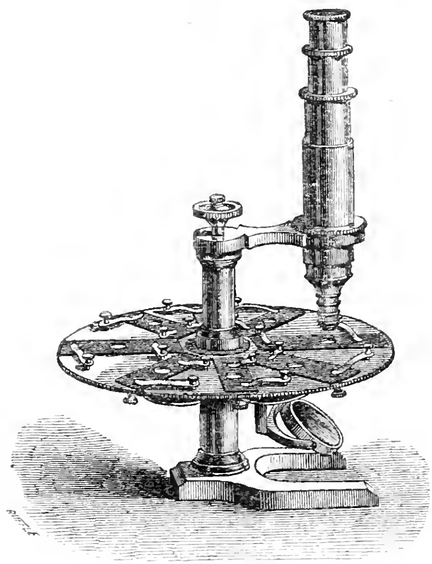
Microscopical Journals.—We have received no parts for a long time of the German 'Zeitschrift für Mikroskopie,' or of 'Brebissonia, a Journal of Algology and Microscopical Botany.' The last number of the French 'Journal de Micrographie' is August, and of the 'American Journal of Microscopy' September. The 'American Quarterly Microscopical Journal' ceased to appear on the completion of its first volume, but we are glad to hear that Professor Romyn Hitchcock (one of the Fellows of this Society), who so ably edited it, is about to issue a new monthly microscopical journal.

We are also pleased to welcome the 'Quarterly Journal of the Microscopical Society of Victoria' (of which Society Mr. T. S. Ralph, A.L.S., is the President). The contents of the first number were noticed in our last Bibliography, and included papers on new species of Polyzoa by Messrs. Maplestone and Goldstein, and by the Rev. J. E. Tenison-Woods on the Radula of Australian Mollusca.

Klönne and Müller's Demonstration Microscope.—This instrument is represented in Fig. 9. Its speciality consists in the addition of a circular stage revolving round the pillar of the Microscope as a centre, and arranged so that eight objects can be examined.

This contrivance does not appear to us to be by any means so con-

Fig. 9.



venient as that of the late Mr. Lobb, who constructed a revolving stage nearly identical with that shown in the figure, not, however, attached to the Microscope, but on a separate stand, so that it could be brought into operation at any time, and when not required, the Microscope was available for use in the ordinary way.

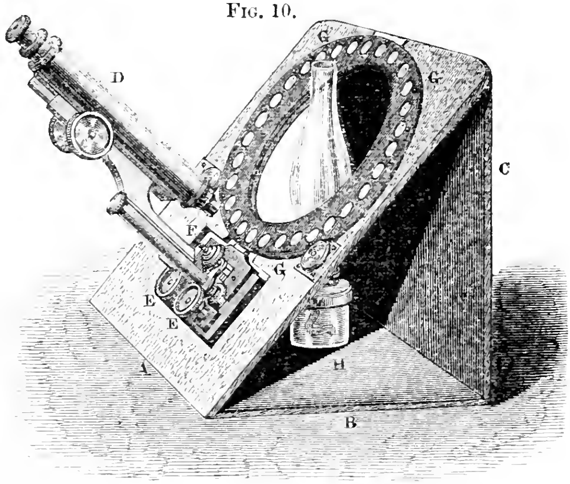
Microscope with revolving Object-holder.—This instrument, for showing transparent objects, which was exhibited at the December meeting (from Mr. Crisp's collection), is a modification of the Hett Microscope, described by Professor Quekett,* the latter being, however, available for opaque objects only.

It consists of an inclined frame A, supported by an upright and base-piece B, C, as shown in Fig. 10. The frame carries a brass

* 'A Practical Treatise on the Use of the Microscope,' 3rd ed., 1855, p. 538.

ring G, in which thirty objects are placed, the ring being rotated by means of catches fixed to its outer margin, and each object can thus be brought successively into the field of view.

Fig. 10.



The Microscope tube D can be focussed by the ordinary rack and pinion movement, and also (for fine adjustment) by the milled head F. It is moved in two rectangular directions by other milled heads, E E, so as to adjust the object in the field. A lamp H can be used if desired.

New Binocular Microscope and Achromatic Objectives.—A preliminary announcement has been made of a binocular Microscope "which is entirely new and original in its application of optical principles as well as in its mechanical construction, and entirely overcomes the difficulties and defects of the Wenham plan." Also a "globe lens," made on a "newly discovered optical principle, which enables the highest corrections to be obtained by an adaptation of the relative thicknesses only of the materials used."

Steinheil's "Aplanatische Loupen."—These achromatic triplet lenses are constructed so as to be used at a greater focal distance from the object than most of the existing high-power lenses. They are "Aplanatic," as their name implies, and it is claimed that they give excellent definition over the whole field, even to such an extent that they may be tilted to almost any angle without distortion, so that the highest powers may be readily used. The different focal lengths of the lenses mounted for the pocket are $1\frac{5}{8}$, $1\frac{1}{16}$, $\frac{11}{16}$, $\frac{1}{2}$ and $\frac{3}{8}$, magnifying from $5\frac{1}{2}$ to 24 times.

They can be fitted in bronzed brass cupped mounts with holder, for dissecting purposes, with magnifying powers from $3\frac{1}{2}$ to 24.

Improved Illuminator for Diatoms and other Test Objects.*—Mr. Wenham describes this contrivance as simple, easy to construct,

* 'English Mechanic,' xxx. (1879) p. 279.

and effectually answering its purpose, without any difficulty in use. The idea has long been exploded that it is necessary to use as illuminators achromatic lenses having but little spherical aberration; lenticular arrangements uncorrected for chromatism act quite as well—in fact, some of the best effects are by the chromatic bands of ordinary lenses—and for the purpose of intensity mere condensation, irrespective of any image-forming focus, is quite sufficient.

In March 1856, Mr. Wenham described several forms of immersion illuminators. The first was a right-angled prism connected with the slide by an intermedium of oil, turpentine, or oil of cloves, which, however, had the fault of requiring the addition of some extraneous means of condensing and intensifying the light; for this reason a nearly hemispherical lens was used, connected with the slide, in the same way as the prism. This lens gave more light, and was in every way preferable. A cylinder and a cone of glass were also tried, and found to be a great improvement, but there still remained a difficulty in concentrating the most light towards the object above the centre of the base. A narrow line of light thrown across the object is very efficient for the purpose of developing striæ, and to obtain this line the form was finally adopted, shown full size in the annexed woodcuts, Fig. 11 being a side view, and Fig. 12 an edge view. It consists of a semicircular disk of glass of $\frac{1}{4}$ inch radius; the edge is rounded and well polished to a transverse radius of $\frac{1}{10}$ inch, for the reason that the focus of a spherical surface on crown glass falls within its substance to nearly three times the radius, consequently the line of light will be in the most concentrated position at $\frac{1}{20}$ inch above the centre of the semi-disk, which distance is sufficient to reach objects mounted on slides of the usual thickness, to the under side of which it is connected with water or more refractive oil. The sides of the semi-disk are grasped by a simple kind of open clip attached to the substage. This illuminator is complete in itself, and requires no supplementary condensing lens; the obliquity is simply obtained by swinging the ordinary mirror sideways, and by this means the *Amphipleura* mounted in balsam can be at once resolved.

FIG. 11.

FIG. 12.

The disk illuminator is very easy to make. The polished edges of two suitable pieces of glass are cemented together with shell-lac. One face is then ground flat and attached to a brass chuck with sealing-wax, seeing that the line of junction falls in the centre; the disk is then turned or ground down to a circle $\frac{1}{2}$ inch in diameter. The edge is next rounded and ground true by means of a piece of brass having a channel cut in it of $\frac{1}{16}$th radius, then smooth with the finest emery, rocking the brass grinder and reversing it frequently to equalize the curve. The polisher is a stick of wood with a $\frac{1}{10}$th radius notch cut in the end; this is held on the T rest, and pressed on the edge of the glass with a rocking motion from side to side, occasionally turning it over, using crocus and water, and as it is important that there should be no rings visible in the polish, the last finish must be given by melting some hard pitch or polishing-wax into the groove in the stick, and finish with this and fine rouge. The half-disks, when separated, produce two illuminators of equal form.

Mr. Wenham says,* that while he was never successful in the patient manipulation required to bring out the striæ of *Amphipleura*, yet with the new illuminator he succeeded at once, and on every subsequent occasion. This simple piece of glass, that looks something like the half of a broken button, collects and concentrates a surprising amount of light, and is in a great measure a substitute for the costly achromatic condenser, and can be used either in fluid contact with the slide or not.

The disk should be set in an independent rotating fitting, so that if the object is turned by the rotation of the stage the disk may be moved round to meet it, which movement also serves to modify or cut off light.

Powell and Lealand's Immersion Condenser.—Messrs. Powell and Lealand exhibited, at the Scientific Evening on 3rd December, their new immersion condenser. It is non-achromatic, and by means of a large back lens an angle of light of about 130°, measured in crown glass, can be utilized. Diaphragm slots are fitted beneath, by which two beams of light at right angles can be used either together or separately. The makers claim for it, that the most difficult known test objects requiring oblique illumination can be resolved with the mirror in the optic axis, the required obliquity of incidence being produced by refraction through the condenser.

Mr. Bolton's Tubes of Living Organisms.†—Mr. Bolton recommends that as soon as the tubes (which are mostly $\frac{1}{3}$ inch in diameter, and $1\frac{1}{2}$ inch long, holding $\frac{1}{2}$ drachm of water) are received by post they should be opened, uncorked, and, if they cannot be examined at once in the Microscope, a hole should be bored by a cork borer in a bung cork, and the tube passed into the hole so that the top is level with the top of the cork, and the tube and its contents thus floated on the surface of some water in a tumbler, basin, or still better, in an aquarium. In this way much danger to the life of the more delicate animal organisms will be avoided from variations of temperature, which are not unlikely to occur in so small a body of water as the tubes themselves contain. Many of the advantages of a large body of water are thus obtained without any danger of the objects being lost, or diffused over too large a field to be readily found again.

In the examination of the tubes under the compound Microscope they are awkward to fix, and the aberration of the light is so great as to prevent the possibility of seeing anything with fair clearness except through the centre of the tube. This difficulty may be in great measure overcome by having a *trough* in which the tubes will just lie diagonally. A tube being placed in such a trough filled with filtered water, the aberration arising from its cylindrical form is approximately counteracted, and it is surprising how easily its contents can be examined to the very sides and bottom.

As a *dipping tube* for the transfer of objects under the Microscope he uses a short curved capillary glass tube, the upper end of which is blown out into a little funnel, and the mouth covered with a piece of stretched sheet indiarubber. A small orifice is pierced in the tube

* 'English Mechanic,' xxx. (1879) p. 360.

† Ibid., pp. 262, 288.

just below the funnel. The advantage of this over the ordinary dipping tube is that by first pressing the indiarubber with the finger (when the orifice is closed with the thumb), and thus forcing out air, small quantities of water together with minute objects will, when the finger is withdrawn, be taken up out of shallow vessels, such as watch-glasses, &c. In addition there is perfect control over the water, and it can be expelled by the mere touch of the finger on the indiarubber; whereas in the old form of tube the water has to be blown out with the mouth, entailing the removal of the eye from the Microscope, which sometimes is very inconvenient.

Mr. Bolton in writing to us says that he wishes to add that by the aid of this tube a larger quantity of water can be drawn out of a small bottle or tube than could be accomplished with the old form; in fact, it can be used as a kind of syringe, but for this purpose he now prefers a small tube with a capillary point to which an india-rubber teat is attached.

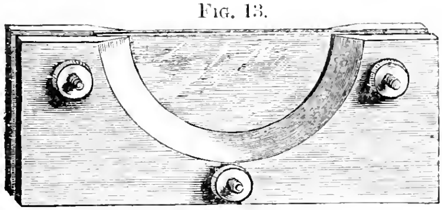
Wills' Compressorium.—In the same paper Mr. Bolton describes a simple form of compressorium that we do not remember having seen previously described. Two pieces of thin glass are cemented to a glass slip in the shape of the letter L, but with the two strokes of the letter about equal in length, and another thinner and longer one is fixed longitudinally, thus L——. The L serves to retain in position a square slip of cover-glass placed, not on the L, but inside it; the horizontal piece, which should be ground to a bevel on its top edge before fixing it, serves to carry a fine needle, the point of which is inserted beneath the edge of the cover-glass. This point being tapered, it is easy to increase or diminish the thickness of a film of water carried between the cover and the slip by pushing the needle further in or out, and so to form a cheap and effective compressorium. Those who try it will be surprised at its efficiency.

Graham Compressorium.—This consists of a brass plate somewhat larger than the ordinary slide, but about the same thickness, with a central hole $\frac{3}{4}$ inch in diameter, slightly recessed on the upper side so as to admit of a $\frac{7}{8}$-inch circle of thin glass being cemented in. Near one end a stout screwed pillar is riveted inside a small brass cylinder, containing a spiral spring. A brass cap fits over the cylinder, having at its lower end an arm carrying the upper ($\frac{7}{8}$-inch) circle of thin glass. A milled head working on the fixed screw presses down the arm while the spiral spring raises it, when the milled head is turned the reverse way. The glasses are perfectly parallel, and can be turned quite clear of each other for cleaning, and if broken can be very readily replaced. The thinness of the bottom plate allows the paraboloid or achromatic condenser to be used.

Botterill's Live Trough.—The advantages claimed for this form of trough, which is shown in Fig. 13, are the facilities it affords (1) for being cleaned, (2) for replacement of broken glass, (3) for arranging the objects in the best position for examination, (4) for reversal, and, lastly, the minor one that it will stand upright without support.

It consists of two brass plates, which can be separated and screwed together again at pleasure, and hold between them two plates of glass, which are kept apart to any desired distance by indiarubber. The plates—say $3'' \times 1\frac{1}{4}''$, and about $\frac{3}{32}$ inch thick—should be of *hard* brass, so as to bear screwing up without bending, and so causing leakage. The curve of the trough may vary, but the semicircular—say $1\frac{1}{2}'' \times \frac{3}{4}''$ —is the most economical, as the two plates can be turned in the lathe at once, and this shape is also a convenient one for use. The bevel should be wide, so as to allow objectives to work close to the curve. The screws should be of equal length, that the trough may be level

FIG. 13.



and steady when reversed, and be long enough to allow the plates to be set about $\frac{3}{16}$ inch apart. The nuts should be milled, and as small as can be conveniently handled. The glasses may be semicircular, but oblong ones $2'' \times 1''$ seem to answer equally well. It might be an advantage to cement the lower one to the plate, but this is not essential. The edge of the bottom glass should be even with the edge of the plate, and the upper one about $\frac{1}{16}$ inch from edge of plate, which will be found convenient when filling troughs from a dipping tube, &c.

The best thing to separate the glasses is half of a circular flat indiarubber band of the thickness which will give the required distance between the glasses. These bands, notwithstanding the sulphur, &c., contained in them, have not been found to act injuriously on living organisms.

The trough may be put together, and then used in the usual way, or, as is generally better, the following plan may be adopted:—The lower glass and rubber band being in their place on the lower plate, the object is arranged on the glass with needles in a little water, so that it may be best examined, and the upper glass and plate being put on, the whole should be screwed up, care being taken that the pressure (which need not be excessive) is equal, and the plates kept parallel; the trough can then be filled up with water.

Teasdale's Test Slide for Dark-Ground Illumination.—This consists of ten or more parallel lines, 2000 to the inch, disposed as a symmetrical pattern of eccentric radials. The lines are ruled under perfect equality of circumstance, and with a conchoidal fracture and not a "cut," so as to give a maximum of brilliancy.

On applying this test, if the field be equally illuminated by the spot lens or centrally-stopped condenser, the bands will appear all equally bright; but if the illumination be in any way faulty or one-sided the eye instantly detects it, the bands being so ruled that those which lie at right angles to incident unilateral light are best seen.

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SCHULTZE, A.—An Easy and Simple Method of Resolving the Finest-lined Dry Diatomaceous Tests mounted on Cover with special reference to *Amphipleura pellucida*. *Journ. Quek. Micr. Club*, V., pp. 209–12.

SEILER, C.—Photography as an aid to Microscopical Investigations. *Am. Journ. Micr.*, IV., pp. 159–62.

SMITH, H. L.—Measuring Aperture: a word for Mr. John Mayall, jun., and Prof. R. Hitchcock. *Am. Journ. Micr.*, IV., p. 177.

SMITH, S. L.—*See* Edmunds, J.

SPENGEL, J. W.—Some new Improvements in the Slide (Rivet-Leiser) Microtome. 4 figs. *Zool. Anzeig.*, II., pp. 641–8.

STEPHENSON, J. W.—On a Table of Numerical Apertures, showing the Equivalent Angles of Aperture of Dry, Water-Immersion, and Homogeneous-Immersion Objectives with their respective Resolving Powers, &c. *Journ. R. Micr. Soc.*, II., pp. 839–41.

STRASBURGER, E.—On an Object suitable for the demonstration of Cell-division. 12 pp. [Sep. reprint] *SB. Jen. Gesell. Med. & Naturwiss.*, 1879.

(WARD, R. H.)—Improvements in Cell-cutting. 5 figs. *Am. Nat.*, XIV., pp. 65–7.

WENHAM, F. H.—*See* Edmunds, J.

„ „ On Dark Field Illumination for the Microscope by means of the Parabolic Condenser. [*Engl. Mechanic*, XXX., p. 419.]

„ „ On an improved Microscope Illuminator for Diatoms and other Test Objects. 4 figs. *Engl. Mechanic*, XXX., p. 279.

WICKERSHEIM'S Preserving Method. *Zool. Anzeig.*, II., pp. 669–70.

WILLIS, L. M.—In re Apertometers. *Am. Journ. Micr.*, IV., pp. 155–7.

PROCEEDINGS OF THE SOCIETY.

Meeting of 10th December, 1879, at King's College, Strand, W.C.
The President (Dr. Beale, F.R.S.) in the Chair.

The Minutes of the meeting of 12th November last were read and confirmed, and were signed by the President.

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

	From
Balbiani, Prof. G.—Leçons sur la Génération des Vertébrés. Recueillies par le Dr. F. Henneguy (revues par le Professeur), and twelve other previously published papers, including his 'Recherches sur les Phénomènes sexuels des Infusoires,' 1861 ..	*The Author.*
Gibbes, Heneage.—On the Structure of the Vertebrate Spermatozoon (reprinted from the 'Quart. Jour. Micr. Sci.,' vol. xix.) and two slides to illustrate the paper	*The Author.*
Thümen, F. de.—Verzeichniss der um Bayreuth in Oberfranken beobachteten Pilze. (8vo. Landshut, 1879), and separate copies of 21 of the author's articles, and list of his publications	*The Author.*
Warming, Dr. E.—Om nogle ved Danmarks Kyster levende Bakterier. 116 pp., 4 plates. (8vo. Copenhagen, 1876) ..	*The Author.*
,, ,, De l'Ovule. 190 pp., 7 plates, and three other previously published papers	*Ditto.*
Weismann, Prof. Dr. A.—Beiträge zur Naturgeschichte der Daphnoiden. Parts I.-VII. 486 pp., 15 plates. (8vo. Leipzig, 1876-9)	*The Author.*
,, ,, Das Thierleben im Bodensee. 31 pp., 1 plate. (8vo. Lindau, 1877)	*Ditto.*
Cabinet for the old Microscopes of the Society	*Mr. Crisp.*

A special vote of thanks to Mr. Crisp, for the Cabinet, was carried by acclamation.

Mr. West described a form of tilting and rotating slide, which he exhibited to the Meeting, designed so that the object was placed in the centre of a sphere, and remained in the centre of the field and unchanged as to focus, in whatever direction the bed of the slide was moved.

Mr. Crisp read some announcements of forthcoming optical novelties from America, including a new Binocular Microscope and a "globe lens," by Mr. Gundlach.

Mr. G. J. Hinde, in exhibiting jaws of Annelides and Conodonts, said that up to within a recent date the knowledge of the Annelide jaws had been confined to that of their markings, but lately the hard parts of the jaws had been discovered in a fossil state, both in this country and also in America. They resembled closely the jaws of existing Annelides, but their form was extremely variable; there could be no doubt that they were really what they were called. The Conodonts were found in the Silurian and Carboniferous strata, and appeared as small round or curved dots, each consisting of a single tooth. They were formed of carbonate of lime. A great deal of discussion had arisen concerning them, and they had been thought by some to belong to fishes, but owing to the great age of the rocks in which they occurred this had been disputed, though he thought it possible that it might yet turn out that they did. Professor Owen had thought that they might belong to Annelides or Crustaceans, but the discovery of the real Annelide jaws showed that they did not belong to that class. In size they varied from $\frac{1}{6}$ to $\frac{1}{24}$ in., the jaws of the Annelides ranging from $\frac{1}{3}$ to $\frac{1}{24}$ in.*

Mr. Gulliver's paper, "On the Classificatory Significance of Raphides in *Hydrangea*," was read by the President (see p. 44).

Professor Martin Duncan's paper, "On a part of the Life-cycle of *Clathrocystis æruginosa*," was read by Mr. Stewart (see p. 17).

The Rev. W. H. Dallinger's paper, "On a Series of Experiments made to determine the Thermal Death-point of known Monad Germs when the Heat is endured in a Fluid," was read by Mr. Crisp (see p. 1). The figures in illustration of the apparatus used were drawn on the board by Mr. Stewart.

Dr. Matthews thought that the investigations would be of importance in regard to the destruction of such parasites as *Trichinæ* and others. They were at present not at all aware at what point the life of their germs was destroyed.

Mr. Stewart said that strong evidence would soon be placed before the public to show that *Trichinæ* would survive conditions which it had not previously been thought possible that they could do; for instance, they had been detected alive after two months' burial of the flesh in which they were found.

Mr. Teasdale's paper, "On a simple Revolving Object-holder," was read by Mr. Crisp (see p. 45), the figures in illustration being drawn upon the board by Mr. Stewart.

Mr. Beck said that he had lately been surprised at the things brought out as new which were really very old, and it seemed to him not out of place to mention that the system of showing objects on a disk like that now described was quite an old one, as in the Exhibition of 1851 some opaque injections by Mr. Rainey were shown on that plan, and the method was illustrated in Professor Quekett's book.† A modification of it was also made by his brother, the late Mr. Richard Beck, which was exhibited by Mr. Crisp that evening. The Microscope on the table ‡ was also a modification of the plan devised by

* See also 'Journal,' vol. ii. (1879) p. 884.

† 'A Practical Treatise on the Microscope,' 3rd ed., London, 1855, p. 538.

‡ See *ante*, p. 144.

Hett, and was made originally to show some diatoms mounted by Professor Smith. It differed from Hett's original plan, which was only intended for showing opaque objects. He referred to these matters not to impeach the perfect bona fides of anyone, but simply to recall what many were already aware of, that in the course of thirty years a new race of microscopists seemed to rise up who did not know what had been done years before.

Mr. Curties said that so far as Mr. Teasdale's particular apparatus was concerned, he had by no means brought the matter forward as a new invention, but simply because it carried out the plan that had been discussed in a way which was not only cheap but efficient.

Professor Hamilton Smith's letter, criticising some remarks in the October number of the Journal (p. 781), was read by Mr. Crisp, together with Mr. Mayall's reply, and Mr. Mayall further explained his contention by means of a drawing upon the board.*

Professor Kellicott's letter, as to *Anuræa longispina* recently found in this country by Mr. Levick, and described in the 'Midland Naturalist,' was read by Mr. Crisp.†

Mr. Crisp referred to the supposed demise of the French, German, and American Microscopical Journals, and also announced that a new American Monthly Microscopical Journal was about to be started by Professor Romyn Hitchcock, one of the Fellows of the Society.

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

Mr. Crisp :—(1) R. Beck's revolving object-stage. (2) Microscope on a modification of Hett's plan, with revolving object-holder for transparent objects (see p. 144). (3) Various nosepieces, including new triple and quadruple (aluminium) of Messrs. Beck. (4) Schmidt and Haensch's Trichina-Microscope. (5) Ward's microspectroscope.‡

Mr. H. Gibbes :—Spermatozoa of newt in glycerine.

Mr. G. J. Hinde :—Annelide jaws and conodonts from the Silurian and Devonian, N. America.§

Mr. F. H. Ward :—Section of stem of *Crescentia Cujete*—double stained.

Mr. West :—Tilting or rotating slide.

* Professor Hamilton Smith points out that in line 12 of p. 781 "ink" should be substituted for "instrument."

† See 'Journal,' ii. (1879) p. 879.

‡ Ibid., i. (1878) p. 326.

§ Ibid., ii. (1879) p. 881.

MEETING OF 14TH JANUARY, 1880, AT KING'S COLLEGE, STRAND, W.C. THE PRESIDENT (DR. BEALE, F.R.S.) IN THE CHAIR.

The Minutes of the meeting of 10th December last were read and confirmed, and were signed by the President.

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

	From
Davis, G. E., C. Dreyfus, and P. Holland.—Sizing and Mildew in Cotton Goods. 306 pp., 9 plates, and 10 figs. (8vo. Manchester, 1880)	*The Authors.*
Dodel-Port, Dr. A. and C.—Anatomisch-physiologischer Atlas der Botanik. 18 plates, folio. Text 56 pp. (4to. Esslingen, 1878)	*The Authors.*
Medical and Surgical History of the War of the Rebellion. Part ii. vol. i. Medical History. 869 pp., 41 plates, 42 figs. (4to. Washington, 1879)	*The Surgeon-General's Office.*
Ord, W. M., M.D. On the Influence of Colloids upon Crystalline Form and Cohesion. 179 pp., 8 plates, and 25 figs. (8vo. London, 1879)	*The Author.*
University College.—Catalogue of Books in the General Library and in the South Library, with an Appendix. Vol. iii. O—Z. 524 pp. (8vo. London, 1879)	*The College.*
Four slides of Human Nodose Hairs	*B. Wills Richardson, Esq.*

Mr. Crisp called special attention to the excellent botanical diagrams presented by Professor Dodel-Port, of Zurich, in acknowledgment of his election as an Honorary Fellow of the Society.

Dr. Beale described the four slides, sent by Mr. B. Wills Richardson, of nodose hairs from the heads of a girl and a boy.*

Mr. Charles Botterill's "Improved Live Trough" (see p. 148) and "Life Slide" were described and exhibited by Mr. Crouch.

Mr. Alfred Hume's new form of frog-plate was also described and exhibited by Mr. Crouch, the advantages claimed for it being greater cleanliness in use, and increased convenience both to the observer and the subject of his observations.

Mr. Stewart called attention to a preparation he exhibited, showing very clearly the terminal end-plates of striped muscle in the common Snake.

Mr. Wenham's "Disk Illuminator" was described and exhibited by Mr. Crisp (see p. 145).

* See 'Quart. Journ. Micr. Sci.,' xx. (1880) p. 116.

Professor Abbe's paper, "Some Remarks on the Apertometer" (see p. 20) was laid before the meeting by Mr. Crisp, who gave some demonstrations of the advantages of the expression of numerical over that of angular aperture.

Mr. A. D. Michael read a paper, "A Further Contribution to the Knowledge of British Oribatidæ" (see p. 32), which was illustrated by diagrams and by numerous specimens exhibited under Microscopes on the table.

Dr. Braithwaite desired to express the pleasure he felt at seeing such original work in a much neglected branch of natural history, and hoped it would be followed by many more such communications.

Mr. Stewart asked what plan Mr. Michael suggested as being the best to transmit to him creatures of that kind for examination. It was most likely that they might in the course of their rambles find many of them, and it would be very desirable to know the best means of forwarding them.

Mr. Michael said if the distance was not more than one or two days' post, they would come very well in a glass minim tube with some damp moss; if, however, the journey was one of longer duration, it would be better to put them into dilute acetic acid or glycerine.

Dr. Fripp's paper "On Daylight Illumination with the Plane Mirror" was taken as read.

Mr. J. W. Groves read a paper "On a Means of obviating the Reflection from the inside of the Body-tubes of Microscopes, with Suggestions for Standard Gauges for the same and for Substage Fittings, &c."

Mr. Ingpen said that Messrs. Powell and Lealand had obtained the result proposed by Mr. Groves by slipping a short piece of tube over the A eye-piece, so that it did not enter the body for its whole length. By this plan they also secured the same distance between the objective and the diaphragm in each eye-piece; this was a matter of some importance, as many objectives would not perform so well with either a longer or shorter body than ten inches, and this arrangement also brought each eye-piece into focus on its insertion into the body, and saved the trouble of focussing each one separately. With respect to the question of uniformity of gauge, this was doubtless very desirable. The $1\frac{1}{2}$-inch gauge for the substage fittings originally suggested by the late Mr. Richard Beck was now very generally adopted, but it seemed unlikely that the various opticians would extend that uniformity to bodies or eye-pieces.

Mr. T. Jeffery Parker called attention to a slide of *Bacillus subtilis* taken from a zooglœa film on the surface of hay infusion fifteen days old. The *Bacilli* exhibited the spore-forming condition described by Ewart, the rods having elongated into long boldly-curved interlacing filaments, the protoplasm in which had collected here and there into the characteristic refringent spores.

The List of Fellows to be recommended to the Society for election as members of the Council at the ensuing Annual Meeting was read in accordance with the 44th Bye-law.

Mr. J. W. Goodinge and **Mr. S. J. McIntire** were appointed Auditors to audit the Treasurer's accounts.

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

Mr. Crisp:—(1) Stephenson's binocular Microscope with very short bodies. (2) Wenham's disk illuminator.

Mr. Crouch:—(1) Botterill's live trough. (2) do. life slide. (3) Hume's frog-plate.

Mr. T. Jeffery Parker:—*Bacillus subtilis*—spore-forming condition.

Mr. B. Wills Richardson:—Four slides of human nodose hairs.

Mr. Stewart:—Terminal end-plates of striped muscle in common Snake.

Mr. Ward: —*Gnemon gneton.*

New Fellows.—W. Clowes, jun.; G. E. Davis; H. E. Forrest; R. Mintern; H. Nesbitt; D. H. Scott; W. Teasdale; J. Vernon; and B. Whitworth, M.P.

Walter W. Reeves,
Assist.-Secretary.

Vol. III. No. 2.] BI-MONTHLY. APRIL, 1880. [To Non-Fellows, Price 4s.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A RECORD OF CURRENT RESEARCHES RELATING TO

INVERTEBRATA, CRYPTOGAMIA, MICROSCOPY, &c.

Edited, under the direction of the Publication Committee, by

FRANK CRISP, LL.B., B.A., F.L.S.,
One of the Secretaries of the Society;

WITH THE ASSISTANCE OF

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Lecturer on Biology at Bedford College, London,

A. W. BENNETT, M.A., B.Sc.,
Lecturer on Botany at St. Thomas's Hospital,

AND

F. JEFFREY BELL, B.A.,
Professor of Comparative Anatomy in King's College,

FELLOWS OF THE SOCIETY.

WILLIAMS & NORGATE,

LONDON AND EDINBURGH.

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NTED BY WILLIAM CLOWES AND SONS,] [STAMFORD STREET AND CHARING CROSS.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

VOL. III. No. 2.

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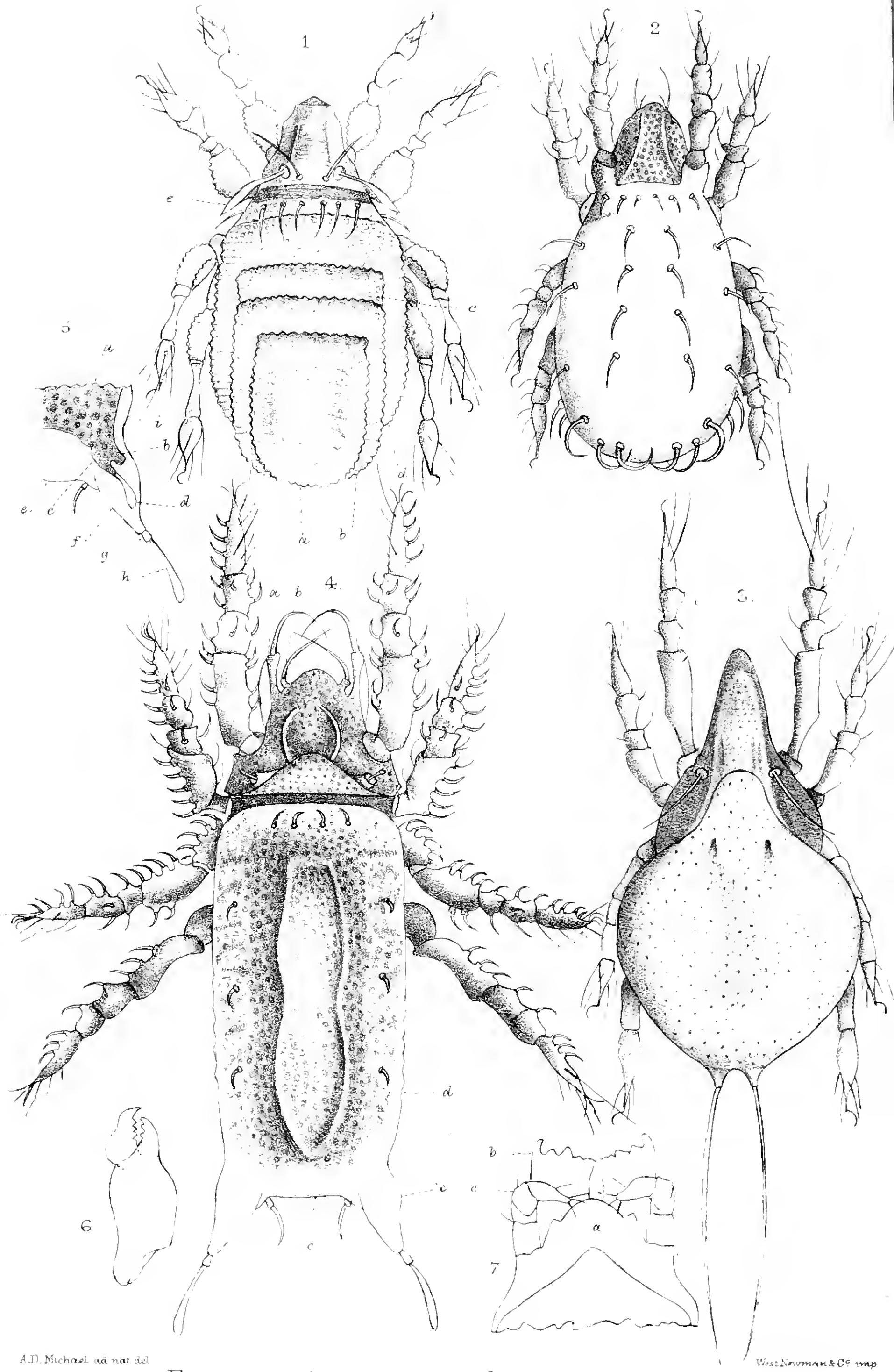
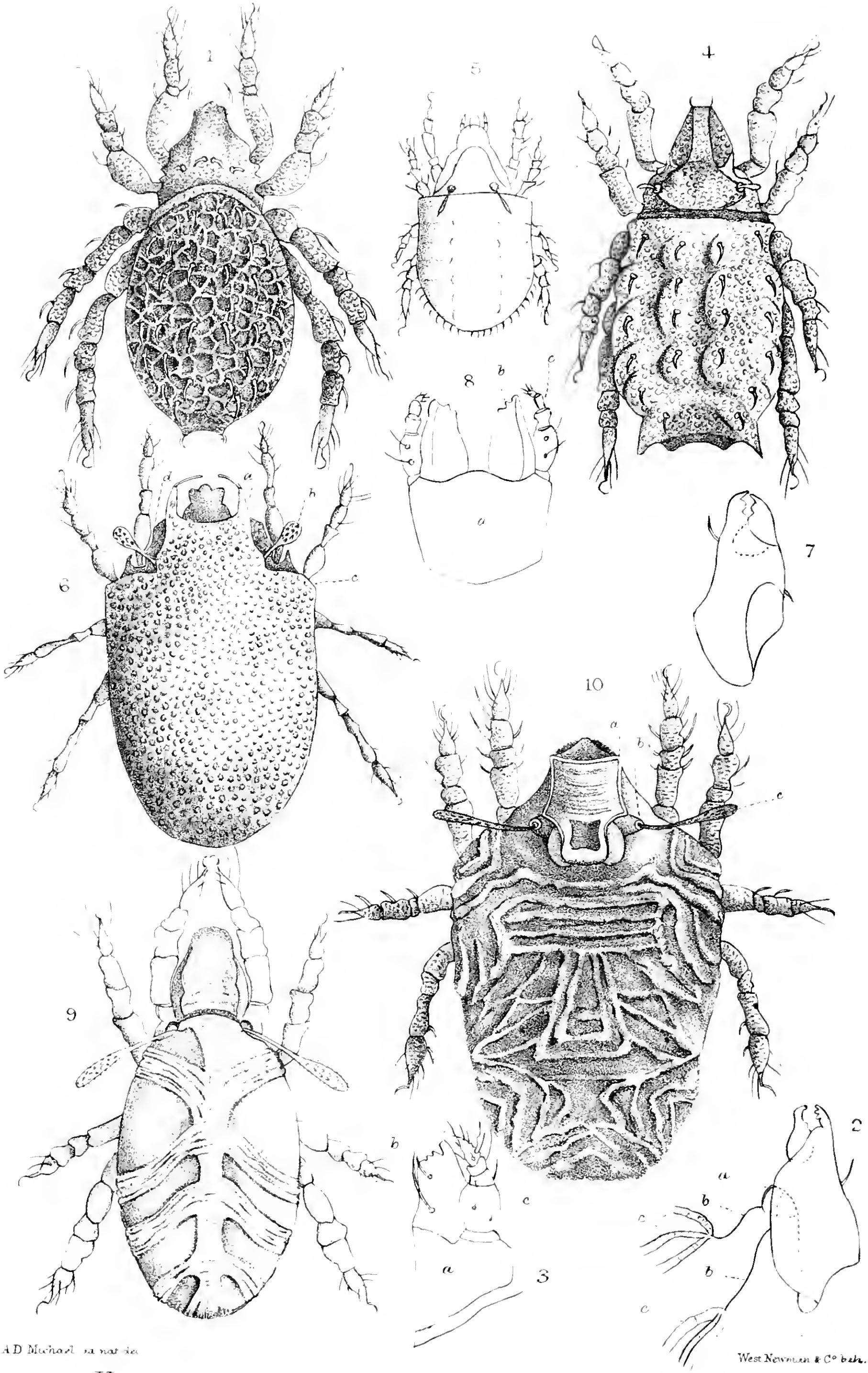


A.D. Michael ad nat del.

West, Newman & Co. imp.

Eremeus oblongus 1. Notaspis bipilis 3
Hermannia bistriatus 2. Nothrus segnis 4-7.



A. D. Michael ad nat. del.

West Newman & Co. lith.

Hermannia reticulata 1–4 Tegeocranus velatus 6–9.
Tegeocranus coriaceus 5 Scutovertex sculptus 10

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

APRIL, 1880.

TRANSACTIONS OF THE SOCIETY.

VII.—*A Further Contribution to the Knowledge of British Oribatidæ.* (Part II.) By A. D. Michael, F.L.S., F.R.M.S. (with the assistance of C. F. George, M.R.C.S.E.).

(*Read 14th January*, 1880.)

Plates V. and VI.

The general rules at the head of Part II. of my former paper have been strictly followed, except those which relate to the drawings.

I have numbered the species consecutively with those in the former paper in order to facilitate reference.

All the figures are drawn from nature.

EXPLANATION OF PLATES V. AND VI.

Plate V.

Fig. 1.—*Eremœus oblongus.* Adult nymph, × about 100. *a*, cast notogastral skin of larva; *b*, cast notogastral skin of nymph, first ecdysis; *c*, cast notogastral skin of nymph, second ecdysis; *d*, cast notogastral skin of nymph, third ecdysis; *e*, stigmatic hair.

Fig. 2.—*Hermannia bistriatus.* Adult amphibious nymph (*Nothrus palliatus* of Koch), × about 50.

Fig. 3.—*Notaspis bipilis.* Adult nymph, × about 70 (*Murcia acuminata* of Koch), drawn in the inert stage. The dark marking in the middle of the abdomen arises from the liver, excretory organs, &c., showing through the skin.

Fig. 4.—*Nothrus segnis* (Herm.). Perfect creature, × about 85. *a*, outer apophysis of the rostrum; *b*, inner ditto; *c*, skin of posterior projection of nymph carried by perfect creature; *d*, strip of same skin along lateral margin of perfect creature.

Fig. 5.—The same. Half of posterior margin as seen by transmitted light, same amplification. *a*, body of adult seen through nymphal skin; *b*, apophysis at latero-posterial angle; *c*, small branch from inner side of ditto, carrying. *d*, a large spatulate hair; *e*, cast skin of posterior margin of nymph; *f*, skin of the great prolonged angle of the body of the nymph; *g*, apophysis of same; *h*, spatulate hair carried thereby; *i*, same as *d*, Fig. 4.

Fig. 6.—The same. Mandible, × about 200.

Fig. 7.—The same. Other mouth organs × about 300. *a*, labium; *b*, maxilla; *c*, palpus.

[Plate VI.

Descriptions of Nymphs.

All the nymphs described are monodactyle.

The descriptions all refer to the appearance of the full-grown nymph.

All the nymphs have the abdomen more or less soft.

The full-grown nymph is always a little smaller than the adult, except in the inert stage, when it is sometimes a trifle larger.

Unless stated to the contrary the larva resembles the nymph, except in its smaller size, and in having only six legs instead of eight.

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45. Pelops acromios. Herm.

Notaspis acromios. Herm. 'Mem. Aptérol.,' p. 91.
Pelops acromios. Nic, 425.
„ „ Koch, fasc. 30, pls. 9 and 10.
„ *fuligineus* „ „ „
Celæno spinosa „ „ 3 „ 17. Nymph.

I found a few specimens at Epping Forest, and bred it from the singular nymph, as to which I can confirm the correctness of Nicolet's plate and description, except that I think the former rather too red.

46. Oribata femoralis. Nic.

Nic. 432.

I found a few specimens of this creature at Epping Forest. The stigmatic hairs are a little longer and more pointed, and the interstigmatic are further apart than in Nicolet's drawings.

Plate VI.

Fig. 1.—*Hermannia reticulata.* Adult, × about 55.

Fig. 2.—The same. Mandible seen from median line, × about 200. *a*, one of the projections for the attachment of the retractor muscles; *b*, tendonous attachment; *c*, remains of muscular tissue.

Fig. 3. — The same. Other mouth organs, × about 200. *a*, labium; *b*, maxilla; *c*, palpus.

Fig. 4.—The same. Full-grown nymph, × about 75.

Fig. 5.—*Tegeocranus coriaceus.* Very young nymph showing traces of segmentation.

Fig. 6.—*Tegeocranus velatus.* Adult, × about 140. *a*, projecting end of wing of shield of the cephalothorax; *b*, stigmatic hair; *c*, wing-like projection of the corner of the abdomen; *d*, chitinous projection indented for insertion of first pair of legs.

Fig. 7.—The same. Mandible, × about 400.

Fig. 8.—The same. Other mouth organs, × about 400 (same lettering as Fig. 3).

Fig. 9.—The same. Adult nymph, × about 190.

Fig. 10.—*Scutovertex sculptus.* Adult nymph, × about 100. *a*, plate on cephalothorax; *b*, stigmata; *c*, stigmatic hair.

It must be remembered, regarding the name, that what Nicolet calls the femur is what most modern authorities call the trochanter: the latter name is used in this paper.

47. Oribata setosa. Koch.

Oribates setosus. Koch, fasc. 30, pl. 19.
Oribata setosa. Nic. p. 436.

Nicolet describes the stigmatic hair as being cylindrical, but he draws it as spatulate; my specimens are even more spatulate than his drawing.

Found at Epping Forest.

48. Oribata sphagni. Mihi, *nov. sp.*, Pl. IV. Fig. 6.

Average length about ·32 mm.
„ greatest breadth ·20 „

Colour yellow brown. Texture nearly uniform, smooth and polished.

Cephalothorax, a long-shaped cone, furnished with a tectum attached only by the base, but slightly raised above the dorsal surface of the cephalothorax, and on the same level as the abdomen, from which it is not divided by any depression. The tectum covers about three-quarters of the length, and the greater part of the width of the cephalothorax; it has the lateral edges raised in blade-like ridges, which project beyond the rest of the tectum and terminate in a stout spine with a blunt tip projecting slightly beyond the point of the rostrum.

Stigmata hidden beneath the wing-like expansions of the abdomen. A large, curved, chitinous plate projects from the side of the cephalothorax, and encloses a space limited in front by a less projecting ridge, and receives the first two joints of the first pair of legs; the space is open above and below. The last three pairs of coxæ are very close together; the second joints of the first two pairs of legs are greatly enlarged; the coxæ are hidden; the second joints are also the largest in the hind pairs of legs, but not as large as in the front pairs. The greater part of the tarsal joints of the first pair of legs projects beyond the rostrum, the second pair do not reach the point of the rostrum, and the fourth pair do not quite reach the posterior extremity of the body. The third joint is very short in all the legs, and bears a short, stout, blunt spine on the first pair, and smaller hairs on the other pairs. The fourth joints bear a long, straight hair in the first and fourth pairs, and two shorter curved hairs on all legs. All the tarsi bear numerous hairs. The claws are large.

The *abdomen* is oval, with a sinuated anterior margin, almost confounded with the tectum; it is quite smooth and hairless. The lateral wing-like expansions (*a*) are broader than long, that is to say, the measurement is greater in a line drawn transversely across the body than in a line parallel to the median line from rostrum to anus; the wing-like expansions do not extend further back than the coxæ of the fourth pair of legs.

Found near Epping, in *Sphagnum*, usually under water. Common.

Nymph, Pl. IV. Fig. 7.

Semi-transparent white, some of the raised lines on the cephalothorax chitinous brown, legs yellowish. *Rostrum* short, bluntly conical for a short distance, thence almost parallel-sided, overlapped in the middle by the point of a roughly triangular marking or shield, which forms the upper surface of the remainder of the cephalothorax, its base resting on the anterior margin of the abdomen. A few irregular raised lines or ridges are found on the upper surface of the cephalothorax. A pair of strong spines stand erect near the point of the rostrum. The interstigmatic hairs are similar, and the stigmatic hairs are filiform. *Legs* rather thick, armed with short, stout spines on the tarsi, the usual long hair on each fourth joint; each leg of the first two pairs is set on a rounded protuberance of the body. A red spot near each of the stigmata, probably some internal organ, shows through by transparency.

Abdomen about twice as long as broad, attaining its full width immediately behind the anterior margin, which is straight and bordered by two or three almost straight ridges. The abdomen is shield shaped, the anterior part being almost parallel-sided flat, with the edges raised, and divided into broad, irregular, shallow ridges or wrinkles, which become more curved as they get farther back, and enclose two concentric. nearly elliptical ridges near the posterior margin. All the ridges have large raised dots irregularly scattered over them. On each anterior angle of the abdomen is a stout straight spike, and there are about ten others, slightly curved, along the margin of each side, pointing backwards, and set into papillæ. Abdomen convex below, anus set far forward.

The nymphs are generally found rolled up in a subaqueous *Sphagnum* leaf.

49. Oribata ovalis. Nic.

Nic. 438.

I found two specimens of what seems to be this species at Epping Forest; the wing of the tectum, however, is prolonged to a point instead of being cut short as in Nicolet's drawing. Nicolet says that perhaps this is the *calcaratus* of Koch; this seems to me doubtful.

It is very inconvenient that Nicolet should have used the name of *ovalis*, as Koch used it before him for one of this genus which Nicolet says is his *punctata*. Koch's description hardly seems to me sufficient to distinguish; the species are allied.

50. Oribata quadricornuta. Mihi, *nov. sp.*, Pl. IV. Fig. 1.

Average length about ·58 mm.
„ breadth „ ·37 „
„ length of legs of all pairs about ·30 mm.

This most complex species has in some respects considerable resemblance to *O. setosa*, but is different from, and cannot be confounded with it; indeed the peculiar form of the tectum alone would distinguish this species at a glance from all that I am acquainted with. It is difficult to give an idea of the elaborate arrangements of the cephalothorax by description.

The whole form is a pear-shape, which, omitting the wing-like expansions, is broadest not far from the posterior extremity; the broadest part of the wing-like expansions is about the middle of the abdomen. The colour is chestnut-brown, with a vague lighter patch at the extreme anterior portion of the abdomen, the legs also are lighter. The chitinous hood of the forepart of the rostrum (Pl. IV. Fig. 3) is rather narrow and arched, but with a flattened, depressed anterior margin (*b*), bearing a minute median point; from thence the cephalothorax becomes broadly conical, but it is almost concealed by the numerous projections or pieces of apparatus (so to speak) which overshadow or surround it. By far the most important of these is, as usual, the tectum (Fig. 1, *a*, *b*); this, instead of appearing a single piece attached transversely below or a little in front of the anterior margin of the abdomen, looks as if it consisted of two symmetrical halves, or apparently separate pieces, one on each side, only touching at a single point; in reality, however, they are joined near the base close to the line of attachment to the cephalothorax, with which they here coalesce. This line of coalescence, seen through the surface by the transparency of the latter, is oblique, extending from within the commencement of the wing-like expansions of the abdomen to about a fifth of the distance along, and not far from the middle of, the cephalothorax; thence starts the free inner edge of the half-tectum, almost at right angles to the line of coalescence, and sweeps forward until it reaches about the middle of the cephalothorax, where the two halves of the tectum touch and then separate again. The lines of attachment and lateral edges of the tectum are not straight, but form sweeping curves. From the line of coalescence a thin, short ridge extends inwards from each side, the two meeting. The result of all this is, that the portion of the cephalothorax enclosed between the tectum, the line of coalescence, and the convex anterior margin of the abdomen resembles one of the trefoils found in Gothic ecclesiastical windows. Each half of the tectum slopes upward from the cephalothorax, so as to stand very clear, and is prolonged into two great, chitinous, curved horns, or rather pointed blades, which extend as far as the tip of the rostrum, the outer (Fig. 1, *a*) being slightly the longest; between the two is a deep, wide indentation, concave posteriorly, so that each half of the tectum reminds one of an old-fashioned bootjack; from the centre of each concavity proceeds a strong, rough spine (Fig. 1, *c*), extending horizontally forward far beyond the rostrum. The usual interstigmatic hairs (Fig. 1, *e*) are in this species, two similar spines, even longer and stronger than those of the tectum, extending from the margin of the abdomen nearly as far as, and lying just inside, the tectum spines. Below the tectum, on each side, a broad, blade-like ridge (Fig. 1, *f*), standing on edge, is attached by its lower edge along the cephalothorax, its anterior portion being free and cut into three serrations. From the hood of the cephalothorax, immediately under the last-named blade-like ridge, so that it seems to spring from the ridge itself, arises a long curved spine (Fig. 3, *c*), at a lower level than the tectum and interstigmatic spines; the two curved spines cross under the others nearly at a right angle and almost meet; these curved spines are very strongly pectinated on the outer edge, but nearly smooth on the inner edge.

Two great curved partitions (Fig. 1, *g*), attached to the cephalothorax below, enclose spaces, open in front and above, closed posteriorly and below, which receive the front pair of legs, and appear as though they were unnecessarily large and long for the purpose; the partitions have a curious horseshoe-shaped mark on the under side; the stigmata are sunk in the posterior angles of these spaces, and the stigmatic hairs, which are long, falciform, and rough, extend horizontally above them. The legs are thin, the two front ones have the coxæ turned almost at right angles, those of the two hind pairs and the trochanters of the fourth pair are broad and flattened. The third and fourth joints of the first two pairs of legs, and the fourth joints of the fourth pair, bear short, stout, rough spines, all the tarsi are clothed with long, fine hairs, and the fourth joint of the first pair bears the usual long, fine hair.

The abdomen has the wing-like expansions (Fig. 1, *b*) large and extending far back, deeply sinuated on the anterior margin to give play to the second pair of legs; this margin is marked with several fine lines or wrinkles. From the angle of the lateral and anterior margins of the abdomen, immediately outside the stigma, a strong, chitinous apophysis curves inward round the air-sac, and showing through, in consequence of the transparency of the dorsal plate in this place, looks like an expansion of the ridge of the anterior margin of the abdomen. Along each side of the abdomen is a row of four hairs, and there are two more at the junction of the wing-like expansions, also three pairs on the posterior margin at different levels.

The only specimens of this species which I have found were in the decayed wood of an old tub which had been lying for a long time in a garden near Tamworth, in Warwickshire; in this wood the creature was in considerable numbers and in all stages, the perfect form chiefly on the surface, and the nymphs and larvæ mostly in the substance of the wood. Mr. George has, however, found the perfect creature at Kirton Lindsey.

Nymph, Plate IV. Fig. 2.

Average length of adult nymph, about		·42 mm.	
„ breadth in widest part	„	·25	„
„ length of first pair of legs	„	·22	„
„ second and third „	„	·15	„

Colour of body very pale red-brown or flesh-colour, darker towards apex of rostrum; legs a darker shade of same colour. Body shiny and transparent.

Cephalothorax conical, slightly longer than broad, anterior half having a somewhat convex, and posterior half a decidedly concave lateral margin. The stigmata are slightly projecting tubes on the upper surface, almost below the anterior margin of the abdomen. Stigmatic hairs long, rough, slightly curved, and gradually thickened towards the end. The interstigmatic hairs are strong spines, rough with points, standing up, and curving forward, considerably longer than cephalothorax; there is a similar spine, but shorter, and pointing more sideways, on each side, in the same transverse line outside the stigma; two pairs of similar spines on the vertex, in front of the interstigmatic spines, each pair being shorter and closer together than those behind it. The first and second pairs of legs are of nearly equal thickness throughout; third and fourth pairs with coxæ and trochanters enlarged. Tarsal joints thickest near proximal ends, and longest, except in fourth pair of legs, where the fourth joints are of equal length. There are the following curved spines on the legs, like those on body, but shorter, viz. two on each trochanter of first and third, and three on each of second pairs of legs, two on each femur and fourth joint of first and second pairs, and one on each similar joint of third and fourth pairs of legs, two much smaller on each tarsus of second and third pairs of legs. There is a strong conical projection near distal end of fourth joint of each leg of first pair, bearing a long, fine hair at the apex of the projection. All tarsi furnished with numerous fine, short hairs, and there are a few similar on the other joints.

Abdomen shield-shaped, vaulted, with a short, truncated, conical projection at the anal end, immediately at each side of which is a rough spine directed backward and inward. Along the margin of each side are seven nearly equidistant curved spines, more than half as long as the abdomen is wide at its greatest width; a similar one on each side of the anterior margin of the abdomen, and a shorter pair more central on same; two pairs on notogaster behind last-named pair, and one pair further back and further apart. Under surface bowed, legs set far in, anal plates large and set far forward.

The nymph appears to be social, and to form a sort of web in the wood.

51. Leiosoma palmicincta.* Mihi, *nov. sp.* (Pl. III. Fig. 4).

Average length	.. .. ..	about	1·02	mm.
„ breadth	.. .. ..	„	·72	„
„ length of legs,	first pair	„	·50	„
„ „	second	„	·42	„
„ „	third	„	·58	„
„ „	fourth	„	·66	„

The adult of this species offers so much resemblance to the *Leiosoma nitens* of Gervais, that I think it best to commence by pointing out the differences; these, however, are in such important characters that it would be impossible to treat this species as a variety of *nitens*, even from the adult, without reference to its remarkable larval and nymphal stages.

The most remarkable differences in the adult are, first, that the abdomen is much shorter and rounder than in *nitens*, and is slightly truncated posteriorly; secondly, the prolonged central point which terminates the tectum nearly reaching the tip of the rostrum, and is eminently characteristic of *nitens*, is entirely absent in this species; thirdly, that the stigmatic hairs are very thin where they emerge from the stigmata, and have lanceolate heads, instead of being setiform as in *nitens*. There are many less important differences.

Colour very dark brown; whole creature polished; cephalothorax brown, short, and obtusely pointed; tectum broad, and covering about two-thirds of the length of the cephalothorax, almost straight on the anterior margin. Wings of the tectum standing on edge, rather narrow, and marked with a few wavy lines, each wing ending in a short, blunt projection bearing a hair, which extends beyond the rostrum. There are two hairs rather closer together on the lower edge of the rostrum. A ridge, resembling the wing of the

* *Palma*, a palm (tree); *cinctus*, girdled.

tectum, surrounds the depression that receives the coxa of the first leg. Interstigmatic hairs long and setiform, stigmata hidden below the tectum.

Legs with a whorl of fine hairs on the distal end of each joint, except the tarsus, which is sparsely clothed with similar hairs.

Abdomen rounded on the anterior margin, uniformly polished, and bearing two extremely fine hairs on the ventral edge of the hind margin.

Larva and Nymph, Pl. III. Figs. 1, 2, 3.

If the perfect form be a somewhat ordinary looking creature, this cannot be said of the larva and nymph, which are amongst the most marvellous in the whole range of *Acarina*. A description of the nymph will serve for both, because it carries the cast notogastral skins, which, in the immature stages of the species, is the whole of the creature that can be seen on the dorsal view.

Cephalothorax short, broadly conical, and plain; it carries two pairs of fine hairs, one near the point of the rostrum, and the other on the anterior edge of the vertex.

Legs rather short, of nearly uniform thickness throughout; tarsi densely clothed with hairs; each hair springs from a short apophysis; similar hairs, but thicker and fewer, are found on the other joints of the legs. As far as the dorsal aspect is concerned, both cephalothorax and legs may be neglected altogether, the former being completely hidden, and of the latter only the tips of the tarsi of the first pair being visible, sometimes not even these.

Abdomen elliptical, major axis about half as long again as minor in the young larva, but the two almost the same length in full-grown nymph. The edge of the ellipse is not even, but is more or less concave or straight between each pair of the apophyses mentioned below. The cast notogastral skins are carried concentrically. The median portion of the back is strongly arched, and has waved transverse lines or wrinkles, very minutely dotted. The margin is slightly raised. The nymphal skins, where not covered by the larval one, are finely reticulated. Round the margin of the creature are twenty apophyses; eight of these are rather crowded together on the anterior portion, the others are more evenly distributed, but those at the sides are furthest apart. Sixteen of these apophyses are more or less expanded at the base, and in most instances have three points, the lateral ones thin, flat, sharp, and often abortive, the centre stout, cylindrical, truncated, and carrying a remarkably large palmate or spatulate hair or scale (Plate III. Fig. 3), standing quite free from the body; the shape of these scales is much like that of an ordinary scale of the lepidopterous species, *Lycæna Argus*, or one of *Lepisma saccarina*, but is broader; the apophysis is inserted like the petiole of a cordate leaf, and is expanded into a hammer-head within the scale; this head is colourless (the rest of the apophysis being brown), and from it radiate about sixteen black nervures joined by a transparent colourless membrane; the two centre nervures run nearly straight to the distal margin of the scale, those at the edge follow the cordate shape of the proximal margin and terminate near the distal end of the lateral margin. The longitudinal nervures are crossed by finer transverse nervures, which become gradually more delicate and closer together as they approach the distal margin; they are tolerably regular in the centre of the scale, but become broken and irregular towards the edges; their general effect is to divide the scale into reticulations, which are nearly triangular at the proximal margin, square in the centre, and oblong elsewhere. The scales all slope downward slightly from the edge of the skin, so as to touch the surface upon which the creature is standing; they overlap at their edges, and thus form a close margin, or band, round the animal; each scale is about a third of the width of the real body, thus the band of scales covers more ground than the whole of the rest of the creature. In addition to the lateral overlapping of scales on the same skin, the distal margins of the scales of each cast skin overlap the proximal margins of those on the skin beneath it, so that when the nymph has all the cast skins on (as it usually has), every part, except the cast larval skin, is utterly hidden by the scales, which, as before stated, extend beyond the head, cephalothorax, and legs. The scales are iridescent in daylight, like the wings of the *Sesiadæ*, and the nymph is then a blunt cone of scales showing prismatic colours, and would scarcely be taken for an animal at all.

The four apophyses which do not carry scales are longer than the others, especially the front pair; each terminates in an imbricated hair of singular size and length, the hind pair being sometimes as long as the whole body. These long hairs seem to break off from the cast skins; at least I have not ever seen them remaining, and therefore I have not drawn them. The under side of the creature is corrugated; the legs, which are set far in, and the cephalothorax of course show, bordered only by the edge row of scales.

I found both the immature and perfect forms on the lichen upon the granite rocks of the Land's End district and on the moss which grew with it. I only obtained five specimens in different stages as the result of long and careful searching, but possibly the time of year (autumn) was not favourable. Some of these specimens had to be sacrificed in order to trace the creature's history.

As far as I know, larva, nymph, and perfect form are unrecorded. I propose in that case to call the species *palmicincta*, from the girdle of palmate scales which form the conspicuous feature of the nymph.

I may mention that I brought home what I supposed to be several very young specimens found in the ordinary yellow lichens from rocks near the coast; on bringing them to London the use of higher powers disclosed that they are a different species, the shape being slightly longer and the nervures of the scales not being reticulated but irregularly furcate. I have them still, but they have not attained the adult form and I doubt their surviving the winter.

52. Leiosoma subterraneus. Koch.

Oribata subterraneus. Koch, fasc. 38, pl. 11.

Average length ♀ about 1·50 mm.
,, breadth ,, ·72 ,,

I have two or three specimens of what seems to be Koch's *Oribata subterraneus* (he does not make a separate genus of *Leiosoma*); it is clearly a Leiosoma, and equally clearly not any of Nicolet's species. It may be known by the following distinguishing marks: the cephalothorax is small, the wings of the tectum bifid at the anterior end, the interior point being longest, and a strong, rough hair springing between them, the two wings joined by a broad chitinous ridge; stigmatic hairs fusiform, ending in a fine hair as in *microcephala*, abdomen broad, rounded anteriorly and posteriorly, and arched.

Creature dark and polished.

Found in moss at Epping Forest.

53. Cepheus bifidatus. Nic.

Nic. 446.

Mr. George sent me a single specimen of a species which appears to belong to the genus *Cepheus* in all important points of structure, but has strongly heterodactyle claws, whereas Nicolet says homodactyle claws are a leading character of this genus. I confess I have not ever seen what seems to me a truly homodactyle claw on any of the family, but the difference between the claws is very great in this creature; if it be a *Cepheus* it seems to resemble *bifidatus*, although there are some differences, viz. the hairs on the abdomen are thicker than in Nicolet's drawing, and curved instead of straight, the cut in the front of the tectum is wider and not so deep as Nicolet's, and the raised margin of the abdomen does not run so far back. I myself should be inclined to think it the same species but varying somewhat from the French type. Mr. George, however, doubts its being so.

54. NOTHRUS SEGNIS. Herm. Pl. V. Fig. 4.

Notaspis segnis. Herm. 94.
Nothrus segnis. Koch, fasc. 30, pl 1.
" *furcatus* " Nymph, fasc. 30, pl. 3.
" *ventricosus.* " fasc. 29, pl. 17, 29 adult without cast skin?

Average length..	.. .. ..	about	·85	mm.
" breadth	.. .. ..	"	·32	"
" length of legs,	first pair	"	·45	"
" " "	second	"	·33	"
" " "	third	"	·38	"
" " "	fourth	"	·48	"

Colour yellow brown, legs a little darker, whole surface thickly covered with raised dots.

Cephalothorax flat and broadly conical, deeply notched for insertion of first pair of legs, depressed below the abdomen, central part near abdomen raised, and from the anterior lateral part of this elevation two vague irregular ridges run forward. Stigmata much raised, far apart, and set far forward. Stigmatic hairs very short, sloping forward, ends small and of a short pyriform shape. At each side of the rostrum is a long apophysis projecting forward, the outer edge bearing a blade-like expansion which does not reach the tip; from the end of the apophysis springs a large hooked spine, those from the two sides meeting or crossing. A pair of much smaller projections, nearer the median line, bear similar spines. The whole of these arrangements are generally so blocked up with dirt that they are difficult to make out.

Abdomen not vaulted either way, but slightly broadest in the middle; it is between three and four times as long as the cephalothorax and its sides are slightly curved; the anterior margin is markedly raised, and bears four very small hairs arising from tiny papillæ; it is straight and at right angles to the sides, the hind margin also runs nearly at right angles to the sides, but is slightly concave; at each hind corner is a triangular projection pointing a little outward, and about half-way from the tip of this, on the inner side, springs a smaller apophysis bearing a spatulate spine. The true form of the posterior margin is however entirely concealed in consequence of the adult carrying the posterior part of the last nymphal skin which only however covers a narrow strip of the hind margin of the body, but projects beyond it in a broad, semi-opaque, white band, with an irregularly conical tail at each corner which contains the triangular projection, apophyses, and spine of the real body, as though it were a bag drawn over them, and a narrow strip of the same nymphal skin usually forms a lateral margin to the body. There are three fine, short hairs, like those on the anterior margin down each side of the abdomen. The legs are broad and flat; the coxæ of the first three pairs set almost at right angles to the rest of the legs. Each leg diminishes regularly in width from near the insertion of the trochanter to the tip of the tarsus. All the legs except the coxæ and inner sides of the fourth pair, bear strong hooked spines along their edges at short intervals.

Behind the anterior margin of the abdomen is a wide depression; posterior to this the back is elevated so as to form a low ridge in the centre, occupying about a third of the width, and from the ends of this longitudinal ridges run back, in an irregularly sub-parallel direction to near the hind margin, where they approach each other and join. The space within these ridges is depressed, and a deepish but wide trench borders them on the outside; from the outer edge of this trench the body slopes up to the lateral margin, and this slope bears a number of oblique and irregular ridges, sometimes anastomosing, and becoming vague and confluent, towards the hind margin.

I have found the females so full of eggs that the abdomen was greatly distended by them.

I think it most probable that Koch's *Nothrus ventricosus* is the same species as this but without the strips of cast skin.

Found in moss in Epping Forest. Not common.

Nymph.

This nymph is figured by Koch as a separate species under the name of *Nothrus furcatus*, fasc. 30, pl. 3.

Average length of full-grown nymph in inert stage to insertion of tail hairs	·84 mm.
Average breadth of back	·21 ,,
,, length of legs, first pair ..	·31 ,,
,, ,, ,, second pair ..	·20 ,,

Colour semi-transparent white, the skin slightly granular. Creature four times as long as broad; of this length about three-eighths is the cephalothorax, over four-eighths the abdomen, and nearly one-eighth the projection at the posterior end. Legs and rostrum light brown.

Cephalothorax conical at the apex, thence nearly parallel over half its length, then widening out rapidly to the width of and nearly to the level of the back.

Abdomen quite flat with parallel sides about two-thirds of its length; thence curved slightly inwards, and terminated posteriorly by two conical projections with a depression between them and each terminated by a slightly curved spine. There are four lumps on the anterior margins each bearing a strongly curved spine, the two central ones crossing.

Legs thick and rather short.

55. Nothrus sylvestris. Nic.

Nic. 458.

Found by me at several places; common.

56. Tegeocranus velatus.* Mihi, *nov. sp.* (Pl. VI. Fig. 9).

Average length	about	·32 mm.
„ breadth	„	·17 „
„ length of legs, first three pairs	„	·12 „
„ „ „ fourth pair ..	„	·14 „

This, as may be seen from the measurement, is an extremely small species, which presents some little difference from others of the genus, but not enough I think to require the formation of a new one.

Colour a dull brown; surface roughened with large, irregular, raised dots; these dots are upon a sort of external membrane or skin, which often partly rubs off and shows a highly polished yellow-brown surface below, an arrangement which I have not seen in any other member of the family. I thought at first it must be the nymphal skin, but it is not, the nymph is quite different.

Cephalothorax and *rostrum* very long, about two-fifths of the entire length; the rostrum very blunt at the point, with large mandibles. The cephalothorax is narrow and almost entirely hidden by the tectum-like shield, which conceals all except the forepart of the rostrum, but does not hide the whole of it as is frequently the case with this genus; this shield seems to be simply a tectum attached to the cephalothorax by its whole surface, its lateral wings stand nearly on edge, and, beyond the side of the cephalothorax, they are terminated anteriorly by large curved projections reaching nearly to the tip of the rostrum, and each bearing a stout curved hair at its point. The stigmata are at the side, underneath the anterior part of the wing-like expansions mentioned below, which are deeply notched to admit the passage of the stigmatic hairs; the latter are of medium length, and consist of flat, broadly pyriform ends, much roughened with points, and carried on slender peduncles.

The legs are not half the length of the body, the coxæ and trochanters broad and rather flat, particularly in the fourth pair; the tarsi are clothed with fine hairs and a few are scattered on the other joints.

The *abdomen* and tectum present an even surface on about the same level; the former is nearly oval with the wide end foremost, and there is a deep constriction laterally between it and the

* *Velatus*, clothed (as with a skin or veil).

cephalothorax, but this is entirely hidden, in the dorsal view, by thin chitinous plates proceeding from the anterior angles of the notogaster, and which remind one a little of the wing-like expansions in *Oribata*, but are far less developed than in that genus; these plates end laterally in obtuse points projecting (on the dorsal level) between the second and third pair of legs. By transmitted light the real shape of the body is seen very clearly through these expansions.

This species lives in moss; Mr. George has found it at Kirton Lindsey, and I have met with it wherever I have searched.

Nymph, Pl. VI. Fig. 9.

The nymph is pale grey, and is a beautiful object when seen alive under a sufficient amplification.

The skin is slightly granular; the abdomen appears at first, from the dorsal view, to occupy nearly four-fifths of the entire length, but closer examination shows that the hinder portion of the cephalothorax is included in this measurement. The anterior part of the cephalothorax is narrow and truncated; it bears a ridge along each side, two lesser ones nearer the median line, and some small transverse wrinkles on the vertex. The stigmata are large and open, but not raised, the stigmatic hairs long, rough, gradually thickened towards the end, which is rounded.

Legs short and of equal thickness throughout; fourth joints of first pair overhanging the tarsi as in *Eremeus.* Trochanters longer than other joints, coxæ set near the edge of the body.

The *abdomen* almost coalesces with the hinder part of the cephalothorax, and the two together form an ellipse nearly twice as long as its greatest breadth; along the median line runs a raised band which widens where it touches the anterior and posterior margins and where it is crossed by the lateral bands; these are usually four in number, each composed of three or four parallel wrinkles; they are doubly curved, the most anterior curves forward and outward from the median line to near the lateral margin, the three posterior curve backward and outward.

Found in same places as the adult.

I believe the species to be unrecorded, and if so I propose to call it *Tegeocranus velatus,* from the spotted membrane which covers it.

57. Tegeocranus femoralis. Nic.

Nic. 166.

I have found three or four specimens of this singular species on moss at Epping Forest; Nicolet only found about the same number in the woods of Satory.

58. Hermannia reticulata. Thorell. Pl. VI. Fig. 1.

Average length	.. ..	about	·85 mm.
„ breadth	.. ..	„	·42 „
„ length of legs, first and second pairs		„	·37 „
„ „ „ fourth pair	..	„	·55 „

I have a species which seems in most particulars to agree with Thorell's *reticulata* from Bell's Sound, Spitzbergen; he describes his as yellow-brown, mine is black, but he probably had his specimens sent in spirit, after which they would very likely be yellow-brown. What is more important, he describes his as reticulated with black; mine is reticulated, but it is with raised ridges of the same colour, which ridges no doubt cast a shadow by oblique light. It is therefore impossible to say for certain, without comparing specimens, that it is the same species. I think it best to follow my ordinary rule of giving the foreign author credit for the species where there is a doubt; meanwhile the description of mine is as follows:—

Colour in life almost jet black all over.

Cephalothorax nearly half as long as abdomen, but being partly overhung by the latter does not look so long as it is; broadly conical until insertion of first pair of legs, thence nearly straight; tip of rostrum obtuse and blunt, the whole surface covered with reticulations so fine that except under a considerable amplification each reticulation appears to be a raised dot. A power of about 200 diameters shows each to be composed of a number of very minute granules. There is a slight transverse mark about a third of the distance from the tip of the rostrum like the edge of an obsolete tectum. Near the abdomen the cephalothorax rises in two rounded elevations, pressed together at the median line, but divided by a sharp cut; these bear the stigmata in the anterior part of their lateral margin. The stigmatic hairs are very short and small, they are almost triangular, the base of the triangle being outward and the point prolonged to form a very short peduncle. The interstigmatic hairs are short and thick, and curve inwards horizontally so as nearly to meet. There are two fine curved hairs on the rostrum. The coxæ of the first two pairs of legs are hidden below the body. The trochanters are very thin where they are inserted, then they turn suddenly at an angle and become greatly enlarged; third and fourth joints square, about equal in length, and together as long as the second; tarsus nearly as long as second joint, straight, truncated at the distal end. Third and fourth pairs of legs tapering gradually, trochanters not enlarged. The second, third, and fourth joints of each leg bear two or three short, thick, curved hairs on each joint. All the tarsi are sparsely provided with fine hairs. Labium very narrow and pointed. Maxillæ long.

The *abdomen* is rounded in front and projects over part of the cephalothorax; it is truncated posteriorly, allowing a short, slightly bifid projection at a lower level, to be seen; this bears two thick hairs curving inward. The whole abdomen is conspicuously reticulated by ridges which under a high amplification are resolved into chains of raised granulations; these ridges divide the abdomen into irregular spaces, of very varying shapes and sizes, but all angular, not curved; the reticulations have a tendency to be largest and of the most regular forms in the centre, longest in the median line towards the hind margin, and smallest towards the lateral margin. There are four rows, each consisting of four thick, curved hairs on the notogaster (dorsal surface of the abdomen), and two extra ones on its anterior margin.

Found at the Land's End, usually in moss.

Nymph, Pl. VI. Fig. 4.

Rostrum and remainder of *cephalothorax* about equal in length. Abdomen about twice the length of the two together. Rostrum a cone, truncated anteriorly, and having four very small projections on the truncated edge, the outer pair bearing short, curved hairs; remainder of the cephalothorax oblong and much broader than long. Abdomen sharply divided from cephalothorax, and raised above it. The *rostrum* and central part of the cephalothorax covered by a hard, dark brown, chitinous plate, rough with raised dots; the anterior part of this plate bears two slightly raised ridges, joined by a cross ridge posteriorly where they are widest apart; the angles formed by the longitudinal and transverse ridges are prolonged backward so as to reach the stigmata, which are raised, and surrounded by similar ridges. The remainder of the cephalothorax and the whole of the abdomen are light brown or yellowish white. The legs are like the chitinous plate on the cephalothorax.

The stigmatic hairs are rather short, and increase regularly but slightly towards the tip. The legs are thick and strong, the two front pairs the thickest, the hind ones the longest, the fourth pair when extended reach considerably beyond the hind margin of the abdomen.

The *abdomen* is oblong but sharply narrowed a short distance from the posterior margin, the angles of which are prolonged into short, blunt points; a narrower hind margin, lower in level, projects beyond the central part of the upper margin and also has produced angles. The general effect of the abdomen is of being almost flat with indented markings: this arises from the edges being nearly as high as the centre, but the edge, which is broad and convex and cut into a series of undulations or lumps, has an irregular, depressed, concave channel, bordering it on the inside, and within this again the dorsal surface is raised so as to form three pairs of irregular, flattened lumps, with depressed spaces between the pairs; the two lumps of each pair almost touch on their inner edges; these lumps bear two longitudinal rows of short spatulate hairs of the same colour as the abdomen. All the lines of the abdomen and indeed of the whole creature are wavy and irregular, chiefly from the roughness of the surface.

Found in moss.

In my former paper I have mentioned the possibility of Thorell's species being a nymph of *H. piceus;* his description would agree with that nymph nearly as well as with this species, but I think this is his creature.

59. Hoplophora ardua. Koch.

Koch, fasc. 32, pl. 15.

Average length about ·7 mm.

This species may be known by the abdomen being pointed posteriorly instead of round, and the stigmatic hairs being long and filiform, very slightly thickened at the ends, the interstigmatic long and setiform, abdomen polished but marked with very fine dark wavy lines.

A few specimens found at Epping Forest.

Descriptions of Nymphs, the perfect Forms of which have been described or recorded in the Paper of 1879.

Oribata lapidaria. Lucas.

Nymph.

This nymph is figured and described by Koch as a separate species under the name of *Murcia rubra*, fasc. 31, pl. 20.

General effect of colour orange red, varying to dark pink; this, however, is produced, not by the integument, which is colourless, transparent and shiny, but by minute specks of the colour thickly scattered through the internal tissues underlying the skin. The creature is diamond-shaped, the anterior portion of the diamond being the longest. *Cephalothorax* not above one-fifth of the length of the whole body, and with a constriction immediately in front of the stigmata; anterior to this the cephalothorax is small and narrow. Stigmata far apart, small and red, with short stigmatic hairs, having small, almost globular clubs, a pair of fine hairs on the rostrum pointing forward, and a similar pair, but stronger, a little in front of the middle of the cephalothorax. Interstigmatic hairs long and curving upwards and outward. Legs thin and short; no enlarged joints; the penultimate joints of front pair bearing long hairs. Tarsi clothed with hairs, and a few others scattered on the legs. *Abdomen* flat in young specimens, becoming more convex as the creature gets older; the diamond more angular when young; its points become rounded off when the nymph is older. The abdomen has two dark red spots on its anterior margin, and a rather white space between them; the spots are joined by a red line. There is a band of six black hairs pointing backward about a fifth of the distance behind the anterior margin; a little behind this is a transverse mark, like a scratch on the skin, probably where some part of a cast skin has been attached; posterior to this is a somewhat flask-shaped patch, the largest part being anterior and the smaller extending to the anal margin; this patch is doubtless a portion of a cast skin; it is strongly dotted. In the constriction answering to the commencement of the neck in the flask are two large crimson spots, which seem to be subglobular organs showing through the skin; in the centre of each of these is a small black ring, which seems to surround a minute opening; a separate patch of cast skin covers each spot; the extreme transparency of the integument and the colour of the internal parts allow every motion of the latter to be distinctly seen; whilst the creature is active, the cells of the probably adipose tissue underlying the skin are plainly visible, the pigment lying round what may be called the cell-wall, without entering on the question whether it be a true cell. During the inert stage these cells seem to break up. They are no longer visible, and the pigment is mixed vaguely in the substance of the creature.

Notaspis bipilis. Herm.

Nymph, Pl. V. Fig. 3.

Taken from inert specimen.

This nymph is figured and described by Koch as a separate species under the name of *Murcia acuminata*, fasc. 31, pl. 24.

Average length	about	·80	mm.
,, greatest breadth	,,	·45	,,
,, length of first pair of legs ..	,,	·50	,,
,, ,, ,, second and third ditto	,,	·30	,,
,, ,, ,, fourth ditto	,,	·40	,,

Whole creature flask-shaped.

Colour clear white, very transparent, polished, but dotted all over with fine punctures, internal parts showing through and producing two dark brown spots a little behind the anterior margin of the abdomen, joined by a lighter brown band, which is extended posteriorly into a somewhat saddle-shaped marking, often found in *Acarina*, and said by Claparède to be the liver and excretory organs. *Rostrum* in front of the stigmata, about one-fourth of whole length, conical, with curved sides; thence the cephalothorax widens rapidly and is excavated for the insertion of the two anterior pairs of legs. Stigmatic hairs longish, filiform, and rather thick.

Abdomen with a large rounded projection in front, extending over the cephalothorax and confluent with it; thence making two strong, rounded shoulders, and then tapering with a rather more gradual curve to the posterior end, where it terminates in two strong, conical papillæ of a dark brown colour, each bearing a hair nearly as long as the creature.

Tarsi of first pair of legs, each bearing two long hairs arising from a papilla and a good many shorter ones: most of the other joints bear two or three shorter hairs. This is one of the best species in which to observe the pulsation during the latter part of the inert stage alluded to above.

Found in moss near the roots.

Notaspis lucorum. Koch.

Nymph.

General shape oval; the rostrum forming the smaller end, the widest part being about one-third of the length from the posterior extremity; two deepish indentations in the anterior portion of the lateral margin, one behind the rostrum, and the other at the junction of the cephalothorax and abdomen, are formed by depressed lines in these places. The line dividing the cephalothorax and abdomen is not a sharp one, but only a vague depression. The rostrum and cephalothorax are very small, and they and the legs are chitinous brown, not dark. The abdomen is yellowish white and polished, but with a few irregular depressions and with scattered dots and vermiform lines. About central in this portion of the body is an irregularly oblong, dark, red-brown mark, prolonged anteriorly, so as to form two lighter horns, each ending in a black spot, and also prolonged posteriorly by two wider projections of vague and varying form; the whole of this marking (which forms a conspicuous feature) is caused by the liver and other internal organs showing through, in consequence of the transparency of the creature.

The *stigmata* are small and point sideways; the stigmatic hairs very short, and bearing a blunt, pear-shaped club, which often looks almost globular. There are a pair of hairs near the point of the rostrum curving forwards, a longer pair on the vertex standing nearly upright; a long hair at the angle formed by the juncture of cephalothorax and abdomen; two longitudinal rows of hairs on the abdomen, and a row round the same part a little within the margin; in this row the posterior ones are the largest and nearest to the margin. All these hairs are whitish, but usually look nearly black in consequence of the whiteness of the creature and their being in shadow on one side.

The *legs* are rather short; the fourth pair, which are the longest, being considerably less than half the length of the body.

The first and second pairs are rather shorter and thicker than the third and fourth pairs. Each tarsus bears one long hair as long as the whole leg, and there are several shorter curved hairs down each leg, and two or three pairs on each tarsus.

The creature at first has much the appearance of a cheese mite; it seems to be social and to form a kind of loose web under lichen. On this web it may be found in great numbers, and in all stages of growth, from the larva to the inert nymph. The perfect creature is common on the lichen. Amongst the nymphs I found the predatory mite, *Cheyletus flabellifer*, which I first found in a cellar feeding upon *Glyciphagus palmifer*.

SCUTOVERTEX SCULPTUS. Mihi.

Nymph, Pl. VI. Fig. 10.

(Perfect creature, vol. ii., Pl. XI. Fig. 4.)

Colour light umber brown, darker on the rostrum.

The *cephalothorax* is more than a third of the entire length, very broad at the base, being the full width of the anterior margin of the abdomen, and the line where they join being the widest part of the body; it is conical, much shorter than its greatest width, the apex slightly truncated or rounded, with a small point in the centre of the truncated line. An almost square chitinous plate, with projecting anterior angles, marks the place of the tectum in the adult, and is evidently an early stage or analogue of that part; it has transverse markings. This plate has a smaller, less chitinous, square plate behind it, which almost reaches the abdomen. The stigmata are small and near together on the dorsal surface; stigmatic hairs rather long and stout, thicker towards the end, which is lanceolate. The legs are set at the edge of the body, and much resemble those of the adult, but are shorter, and armed with a few stout spikes in addition to the hairs.

The *abdomen* has a slightly concave anterior margin, and narrows gradually from thence until near the posterior one, which is rounded. The whole abdomen is deeply corrugated by folds of the soft skin; two or three of these folds run on to the corner of the cephalothorax, cutting off a small triangle on each side; six or seven folds are parallel to the anterior margin, but become shorter as they get further back. Behind these the folds enclose a trapeze-shaped space, and behind this they have a tendency to a reversed direction, but over the anus they again point forward, and along the sides they are crowded and irregular, and give a broken outline to the creature. The corrugations do not quite agree in different individuals nor in the same one at different ages, nor, indeed, on the two sides of a specimen. The under surface of the abdomen is also corrugated. The anal plates are very large, convex, and diamond shaped.

EREMEUS OBLONGUS. Koch.

Nymph, Pl. V. Fig. 1.

This is probably what is described and figured by Koch as a separate species under the name of *Murcia obsoleta*, fasc. 31, pl. 23, but his description and drawing do not admit of certainty.

Colour light ochre brown; the creature in life has rather a metallic look.

The visible part of the *cephalothorax* is not above a fourth of the whole length of the creature, but the hind part is sunk and hidden beneath the anterior margin of the abdomen. The *rostrum* rather narrow, bluntly pointed, and bearing two fine curved hairs on its front margin. There is a sharp indentation above the insertion of the first pair of legs; thence the cephalothorax widens suddenly, but is again sharply indented above the second pair of legs. The vertex bears the two longitudinal ridges so conspicuous in the perfect creature, and there are a few cross markings between them. Stigmata projecting, rather wide apart, and pointing upward and backward. Stigmatic hairs long, very fine where they emerge from the stigmata, but gradually thickening, and ending in lanceolate clubs with pointed ends. Interstigmatic hairs shorter than stigmatic, straight, and inserted close to the abdomen.

Legs: fourth pair about reaching the posterior margin; the two front pairs thicker than the others, with the coxæ very small, the trochanters conspicuously large, flat on the inside and bowed on the outside. The femurs are small in all the legs; in the two hind pairs the coxæ are large and flattened, and the trochanters proportionately diminished. The fourth joints of these hind pairs are thin, especially at the proximal ends. All the trochanters bear a remarkable knifeblade-like chitinous ridge on their upper and lower inner edges, most of the upper ones being serrated. There is a similar deeply serrated ridge on the upper edge of each coxa of the fourth pair of legs. The claws are long and thin, the curves open. A rough hair springs from inside the proximal end of the ridge on each trochanter, and another further forward on the first two pairs. There are some fine hairs on the lower joints of the legs, those on the tarsi being as usual most numerous.

The *abdomen* shield-shaped, but sharply narrowed at the anterior margin, where it bears a row of hairs curving backward. The cast notogastral skins are carried not concentrically, but the centre of each nymphal skin a little further back than the centre of the one that underlies it; thus each upper shield projects a little beyond that below it at the posterior margin; the larval skin, however, is placed centrally upon the first nymphal skin. The skins are all rough and spotted on the anterior margin, and corrugated at the lateral ones; the larval skin bears six or seven transverse markings, which may possibly be traces of segmentation.

Lives in moss like the perfect creature, and is common in spring and autumn.

Damæus verticillipes. Nic.

Nymph.

This is probably what is described and figured by Koch as a separate species under the name of *Nothrus pollinosus*, fasc. 29, pl. 12; it is possible, however, that *pollinosus* may be the nymph of Nicolet's allied species *Damæus papillipes*, which he considers to be identical with Koch's *pulverulentus*, fasc. 29, pl. 3.

Very like perfect creature, but legs shorter in proportion. No projections to cephalothorax; colour shiny, semitransparent white, powdered with opaque white dust. It carries the cast skins, the pile being somewhat flatter on the back than in the adult. Each cast skin is edged at the anterior margin and round the sides with long black hairs, sharply bent backwards so as to form hooks; these hairs are so coated with dust as to look white. Stigmata light brown; stigmatic hairs like adult, but with a fine point prolonging the rounded distal end. Legs with hairs like adult. The line of the cast skins prolonging the line of the back horizontally so as to appear like a flat back. The four spikes found on the anterior margin of the abdomen in the adult are not present in the nymph.

Tegeocranus coriaceus. Pl. VI. Fig. 5.

(Perfect form, vol. ii., Pl. XI. Fig. 1.)

Colour semitransparent yellowish white. *Cephalothorax* a blunt cone with curved sides; when very young this part occupies a third, but when full grown not above a fifth of the entire length, as seen from above. It is raised along the median line for about two-thirds of its length from the margin of the abdomen. Stigmatic hairs short, lanceolate, and pointing backward; hairs on the rostrum setiform. Legs not reaching beyond the body behind, and of about equal thickness throughout. *Abdomen* shield-shaped, rather flat when young, but becoming very arched when full grown; anterior margin markedly wider than the base of the cephalothorax, nearly straight in the young, but curved in the full-grown nymph; whole notogaster finely but irregularly punctured, the punctures being frequently prolonged as short striæ. Two rows of setiform hairs on the notogaster and a row round the margin; these are all short when young, but longish when full grown. It is one of the species in which the traces of segmentation can be most clearly seen in the young nymph; it is figured in this stage: when fully grown, it is fatter and rounder looking.

Tegeocranus labyrinthicus.

Nymph, Pl. IV. Fig. 10.

(Perfect creature, vol. ii., Pl. XI. Fig. 2.)

Colour very nearly white, slightly brownish about the rostrum and legs, skin semitransparent and granular, but the granulations very fine and difficult to see; in general effect it is a fat-looking little creature, something like an inflated bladder. On examination it is seen that the cephalothorax is divided from the abdomen by a large raised fold, which forms the anterior margin of the latter, and the cephalothorax itself has a depressed margin, whence it rises in an arched central elevation, rounded anteriorly, and marked with one or two obscure folds; another small fold gives a truncated appearance at the junction with the rostrum, which is depressed, and has the filiform palpi very plainly visible from above lying along the sides of the labium. The stigmatic hairs are long and filiform, and appear as though inserted under the fold of the abdomen; the hairs of the vertex are set rather far forward, and are also long and filiform, but not nearly so long as those of the stigmata; there are a pair of short hairs near the point of the rostrum. The legs are short and thick, diminishing gradually to the point of the tarsus; each tarsus of the front pair bears the usual long hair at its proximal end, but it is not so long as in most other species, and is absent from the other legs.

The *abdomen* is slightly rounded anteriorly, and obtusely pointed posteriorly; it is much arched, but has an irregular, somewhat triangular depression at each side, commencing near the anterior margin, and extending about half-way back on the dorsal surface, but coming to a rounded point as it approaches the ventral; this depression is not bordered by angles anywhere, but looks more like the sinking in of a viscid material. There are four pairs of longish hairs round the hind margin, two or three pairs on the back, and two pairs of much shorter curved ones at the sides.

I have found it in short moss growing on walls, &c., and in lichen.

Hermannia bistriatus. Nic.

Nymph, Pl. V. Fig. 2.

This nymph is described and figured by Koch as a separate species under the name of *Nothrus palliatus*, fasc. 30, pl. 4.

The perfect creature is figured and described by Nicolet, page 457, and called *Nothrus bistriatus*, because he supposed it to be the same as Koch's *Nothrus bistriatus*, fasc. 29, pl. 21, in which I am unable to agree with him. Nicolet states the species to be the nymph of *Nothrus palustris*; in this, as before explained, Nicolet seems to me to be in error. As Koch's name has priority, and I do not think the species identical, I should have been forced to rename this, but for the fact that it does not really belong to the genus *Nothrus* at all, but is I think a Hermannia.

Colour white, except a plate covering the rostrum, and the legs and epimera, all of which are dark brown. *Rostrum* rather small, truncated, and armed with two strong, blunt, curved spines directed forward. The chitinous plate which covers it is granular and bears two ridges, parallel anteriorly, but diverging at the rear; the plate is continued a little further back on the cephalothorax than the rostrum, but it is only as wide as the latter, thus leaving a soft, white, part at the side; under this the first pair of legs are inserted, and work in the angle where it meets the rostrum. There is a transverse line of curved spines on the hinder part of the cephalothorax, pointing backward, but probably capable of being erected. Legs hard, thick, gradually tapering towards the distal end; each tarsus is armed with three or four short, strong spikes on its under side, and numerous hairs of varying size on its upper and lateral surfaces. There is one similar spike under each fourth joint; each joint bears one or two strong, curved spines on its outer edge, and the trochanters of the first pair a similar one on the inner edge. The fourth joints of this pair have each two long hairs arising from the centre of their distal ends, and there are other hairs and spines of less importance; these all collect such a quantity of dirt and vegetable matter about them that it is often difficult to see them. The claws are short, thick, and strongly curved.

There is not any clear line of demarcation between cephalothorax and abdomen; the latter is arched and really is not much longer than broad; it is nearly its full width at the posterior margin, which is slightly rounded; both the lateral and posterior margins are bordered with short, curved spines or hairs, the latter margin also having a second row lower in level, and there are two rows of about four such hairs on the notogaster.

There are two rounded openings on each side of the abdomen, near the hind margin, which appear to be stigmata, and I have not been able to discover any stigmata or stigmatic hairs in the usual place.

This singular nymph, as before stated, appears to be amphibious, living equally well in *Sphagnum* under water, or in other mosses on dry land.

Found near Epping; not uncommon.

VIII.—*The President's Address.* By Lionel S. Beale, F.R.S.

(*Annual Meeting*, 11*th February*, 1880.)

My first duty this evening, Gentlemen, is to notice with regret the losses we have sustained during the past year, in consequence of resignations and deaths. Of our number seven Fellows have resigned and ten have been removed by death. Among the latter are some of our oldest friends, who have passed away full of years and honours, and some who have died in the prime of life, while they were at work.

Samuel Charles Whitbread, F.R.S., was elected a Fellow of this Society in 1851, and for many years took great interest in its proceedings and welfare. He was very active in forwarding the interests of the Society, was in years gone by generally present at our meetings, and was many times a member of the Council.

Charles Brooke, M.A. Cantab., F.R.S., was also elected in 1851, and to the last was one of the most earnest and enthusiastic members of our body. Many times on the Council, President on two occasions, for the years 1862–64 and 1873–74, Mr. Brooke was present at almost every one of our meetings till a short time before his death, and frequently took part in the debates. He contributed many memoirs on microscopical subjects, and had a natural aptitude for scientific investigation. In designing, constructing, and arranging apparatus he was most ingenious. If I mistake not, Mr. Brooke was the inventor of the first automatic instruments for permanently registering variations in the thermometer and barometer, and he constructed many pieces of apparatus for the Microscope. He edited and greatly enlarged Golding Bird's 'Natural Philosophy,' and was, I believe, the author of some scientific articles in Encyclopædias. Mr. Brooke was for many years surgeon to the Westminster Hospital, but, partly perhaps in consequence of his modest and retiring disposition, and partly from lack of self-confidence, though much beloved by all who knew him intimately, he never gained a very large private practice. For the interests of science this was fortunate. Mr. Brooke was strong and active, and when a young man was a very distinguished skater. Through life he was opposed to materialist doctrines, and took a very active part in the proceedings of the Victoria Institute. In him we lose a zealous microscopist, a faithful friend, and one of the most uniformly amiable and kindly of associates.

Thomas Brand was elected a Fellow in 1856. *John Curphy Forsyth* became a Fellow in 1860, and *P. S. Mitchell*, of St. Leonard's-on-Sea, in the same year.

F. T. Griffiths, M.D., who was elected a Fellow of the Society in 1861, a Bachelor of Letters of the University of France, was

Lecturer on Physiology and Pathological Anatomy in the Sheffield School of Medicine. He was a physician, but at the same time was much interested in many departments of science. For some years he was Health Officer of Sheffield, and was the author of several works, among which are 'The History of Sanitary Science,' many reports on 'The Sanitary Condition of Sheffield,' and 'On Healthy Dwellings.'

John Waterhouse, F.R.S., F.G.S., F.R.A.S., of Halifax, Yorkshire, elected in 1861, was remarkable for his love of scientific work. He was a good observer, skilled in mathematics and physics, besides being well versed in botany and other departments of natural science. An excellent obituary notice of Mr. Waterhouse will be found in the 'Proceedings of the Royal Society,' No. 198, November 20th, 1879, from which I copy the following extract:—"His favourite studies were astronomy, geology, electricity, and light. He took part in the early progress of photography, and in the discovery by the Rev. J. B. Reade, M.A., F.R.S. (a very active Fellow and President of our Society in 1869), of the method of taking portraits, first upon leather, and afterwards upon paper, instead of silver plates or glass; and also with the chemical means of giving permanence to such images. He was an adept in working with the Microscope, was extremely fond of music, and a good player on the violoncello, while in practical applications few men could handle their tools better than he, for in addition to his scientific acquirements, he was a good mechanician, and many of his turnings in ivory were almost Chinese in their beauty and skilful execution."

W. Whitaker Collins was elected a Fellow in 1861. The next name on the list of deceased Fellows is that of *Peter Matthews*, who was elected in 1867; and the last of those whose loss we have to regret is—

Edward Dowson, M.D., who was elected in 1868. Dr. Dowson from the time when he came to London, in 1850, had been an intimate friend of my own, in fact we were fellow-students together in King's College. From boyhood he was much attached to scientific pursuits, and particularly to various departments of Natural History. As a student he devoted much of his time to Botany, took honours in that subject at Apothecaries' Hall, and soon attained sufficient eminence in botanical science to qualify himself as a teacher. For some years Dr. Dowson lectured on this subject at Charing Cross Hospital, but, owing to an attack of rheumatic fever, he was obliged for a time to relinquish work, when his friend, Dr. Braithwaite, lectured for him. For four years Dr. Dowson discharged the duties of Physiological Instructor under Dr. Acland, at that time Lee's Reader of Anatomy in the Anatomical Museum of Christchurch, Oxford, and at the same time was engaged in preparing specimens, and adding to the collections of zoology and comparative anatomy, afterwards removed to the University Museum. He was much interested in these and kindred inquiries, and took an active part in conducting interesting experiments on cross-breeding, carried out some years ago by Mr. S. Bouverie Pusey.

Had Dr. Dowson's health been good, he would probably have contributed to the scientific work of the day. As it was, he belonged to a class which in England is happily a large one, and comprises thoughtful and highly intelligent persons who, from various circumstances, are prevented from adding much to the science of their time. Doing little in the way of writing books or memoirs, and perhaps little known beyond the circle of their immediate acquaintance, such men nevertheless often possess extensive information and sound judgment, and exert considerable influence upon scientific thought and progress. Though not deeming their own work of sufficient importance for publication, many are themselves thorough scientific workers and good observers, and always take a deep interest in the communications and researches of others. Edward Dowson was of a highly sensitive sympathetic nature, and one of the pleasantest of companions. Every one who knew him loved him.

By resignation, the Society loses a zealous and able coadjutor, for few have been more active during the past thirty years than Mr. F. J. Wenham, C.E., who was elected in 1850. Every year since, I think, he has contributed to our 'Transactions' one or more memoirs, besides notes and other communications. Not a few of these are characterized by great originality, and contain evidence of most careful and thoughtful inquiry. I trust I may be permitted to indulge the hope that Mr. Wenham may add yet more to the vast amount of useful work he has already done, and for which every one interested in the advance of microscopical inquiry already feels deeply indebted to him.

The Report of the Council has already conveyed to you most gratifying information as regards the present state and future prospects of our Society. Our numbers have considerably increased, seventy-nine new Fellows having been elected or nominated since the beginning of last year. The Society now comprises more than four hundred and fifty Fellows. Eighty-six societies are associated with us in work, and their Presidents are ex-officio Fellows of this Society. Great and highly advantageous changes have taken place since our last anniversary. Our new meeting-room has been furnished, our stock of instruments considerably increased, important additions have been made to the library, and many new slides added to our collection. Amongst the latter must be specially noticed the gift of upwards of one hundred and seventy, collected by our former President, the late Charles Brooke, and presented to the Society by his representatives. Cabinets, a clock, a revolving Microscope table, and many valuable things too numerous to particularize, have been given by generous Fellows, who have received our hearty thanks, and whose excellent example is for every reason worthy of imitation.

Notwithstanding our increased expenditure, and the necessary outlay in fitting up the new meeting-room, our excellent Treasurer informs us that we are financially more prosperous than at any previous time, and that he has been able to add a good sum to our investments.

Lastly, many Fellows, and especially our distinguished Secretaries, have most generously presented us with that which is of inestimable value—their time—and by doing so have greatly contributed to the progress and success of the Society. We owe a deep debt of gratitude to Messrs. Frank Crisp, T. Jeffery Parker, A. W. Bennett, and Professor Jeffrey Bell, and others, who have so zealously devoted themselves to the arduous work of extending and improving our Journal, of which in its present shape I am sure every Fellow feels justly proud. The bi-monthly numbers already have a large general circulation, and I am convinced that investigators, teachers, and students in every department of Zoology and Comparative Anatomy, all who study Cryptogamia, or devote themselves to Embryology, as well as those interested in general microscopical investigation, will highly appreciate the excellent 'Record of Current Researches' which has been during the past year so considerably and so advantageously enlarged. The second volume of the Society's Journal, just published, contains more than one thousand pages, twenty-six plates, and nearly one hundred engravings on wood. There is an excellent index of forty closely printed columns, for which our thanks are due to the careful editor. There is no more useful or valuable labour than index-making, and in these days of active scientific research we ought to do our utmost to encourage this too often neglected and ill-remunerated literary work.

The real work of a scientific society is, I think, to be estimated partly by the merits of its published memoirs, and partly by its educational work. In every department of Microscope inquiry original memoirs of great interest and value have been read at our meetings and published in our Journal. Not only have we had under our notice new methods of research, new Microscopes, and great improvements in the structure of instruments used by microscopical observers, but new principles for the construction of object-glasses have been laid down, new media for immersion observation have been pointed out, and several new forms of life have been discovered, shown, and described for the first time at our meetings.

Of late years a change has, so to say, been wrought in the spirit of many scientific societies, and as this change, be it for better or for worse, is progressing, and seems likely to extend, it may be well for us to take note of it, more particularly as the change in question has been much fostered, if indeed it did not actually originate, in societies like our own, whose *raison d'être,* it may almost be said, is the promotion and encouragement of observation. In former days, when the study of natural knowledge was practically restricted to a select few, it was natural that they should meet and converse from time to time concerning their achievements and encourage one another to prosecute their several studies. But now, when, instead of a select few, we have thousands, even in London alone, the prosecution of research has of necessity been much divided and subdivided. Where at one time the scientific workers of England in all departments of science might have sat round a good large table, those interested in a subsection of a department of scientific investigation require in these days a large room for their accommodation.

As the zeal for science spread and the desire for scientific investigation increased, there arose a demand for instruction in technical scientific processes, and I believe that the great success of most of our learned societies at this very time is due as much to their value for teaching purposes as to the advantages they afford as associations for publishing and recording the results of new scientific discoveries. It seems to me that a microscopical society is and ought to be, above all things, a teaching, demonstrating, observation-encouraging body, and as time goes on we shall probably find that the demand for this part of our work will increase, while its advantage to students will be appreciated and acknowledged more and more.

It is especially in the manner I have indicated that a large number of societies in different parts of the world, many of which are associated with us, are doing such very useful work. It may seem paradoxical to say so, but the true way to encourage new original inquiry is to explain and repeat to others old observations, and to demonstrate over and over again what has already been proved. The difficulty of ascertaining and exactly appreciating what has been already done, destroys the hopes of many a would-be observer and investigator. Now this repeated showing of specimens and illustrating delicate and difficult methods of investigation appears to me to be the very work which a society like our own is able and eminently qualified to perform well. Technical skill is required for the successful prosecution of any department of microscopical inquiry, and it often happens that what appears at first sight to be a somewhat roundabout or rule-of-thumb method is successful in enabling us to bring out peculiarities of structure and to demonstrate certain arrangements which are not to be otherwise made out. The authority who tries to persuade you that the best way of making out the structure of an organism, or its tissues, is to examine it alive or immediately after its death by immersion in the simplest fluids, such as water, salt and water, serum, vitreous humour, and the like, shows that his training has been imperfect, and proves thereby that he has not tried experiments in investigation and is not acquainted with many things he ought to have learnt, and is probably ignorant of many structures and arrangements which exist and have been seen by others, and are all-essential; while it follows that his ideas concerning many of the phenomena which occur during the development and growth will be more or less narrow, cramped, and incorrect. There is some danger of such a person convincing himself that he is able to discern things far beyond the limit of microscopic investigation, because he happens to be totally ignorant of so many things within the microscopic limit, which are well known, but which would, however, be found to be altogether out of accord with his discernments beyond it. Infallibility seems to be an endowment of authorities who insist that they are able to discern what other mortals cannot see; but in fifty or more years common folk are to enjoy the privileges now restricted to these seers of science. While asseverating much about fact and law, observation and experiment, demonstration and truth, scientific speculators carry the public from fiction to fiction. Some teachers of this class underrate the value of technical skill, and have no taste for the slow, sure steps of repeated observation.

We may see a scientific authority, eminently successful in one department, bursting the bounds of science, and lapsing, by an easy and gradual process of descent, into the condition of an over-confident boasting pretender. There is no branch of human knowledge in which facts of observation establishing important principles have been so lightly thrust aside, or the results of patient work so ruthlessly discarded, as in some departments of microscopic inquiry. There would be less danger of such conduct being successful if there were more to defend our methods, and a greater number qualified to test statements which are made, by the repetition and confirmation of the facts and observations impugned. We have amongst us men eminently skilled in every department of microscopical inquiry, and well qualified to instruct others in practical investigation and to detect errors or confirm facts of observation. Continually joining us are men who desire to follow in our footsteps, and to outstrip us as soon as possible. In order to expedite this much-desired end, it seems to me we should do what we can to help them on the road, wide enough for all, along which so many have journeyed towards a goal that may be approached, though perhaps never to be reached.

The Nature of the Changes in Living Matter.

For consideration in my address this evening I have ventured to choose a subject which I hope will not prove altogether without interest. It seemed to me that every one who can use the Microscope and study the countless living forms frequently presented to his view, as, for example, in a few drops of water, must often long to know more concerning the nature of the forces or powers which determine their origin, their growth, multiplication, and actions than has been thus far conclusively determined. The question has been considered again and again, but the conclusions with regard to important principles are at variance and often incompatible or contradictory, and certainly need more full consideration and free discussion than they have yet received. As the general views in question affect almost every department of human thought, and must continue to exercise an important influence upon considerations connected with religious and even political opinion, as well as our views concerning the principles upon which the training and education of the young should be based, no apology is needed for bringing them under your notice.

Observers in these days, in a discussion like the present, have some advantage over their predecessors, inasmuch as the actual matter of any given living organism which was in a living state at the time of the examination can with certainty be distinguished from that which was not actually living. Few, I imagine, who have considered the facts would now venture to affirm that *all* the matter of any living organism was at any one time really in a living state. The body of every living man or animal at all periods of time consists only in part of matter that is living, the greater proportion of the matter of the body being in a non-living state. But by calling much of the tissue "living" which does not manifest any characteristics of life, and really contrasts in every important particular with that which lives, those who support the materialistic argument manage to lead a few persons imbued with a large share of faith to believe that they have reason on their side.

The general purport of my remarks will be to show, contrary to the teachings which are now most popular, that the living state and the non-living state belong to different categories, and that these two states are distinct and irreconcilable. Between the living matter of a living body and its non-living matter there is a sharp contrast, and the changes going on in the one are in their essential nature altogether distinct from those occurring in the other. In those situations where the living seems to shade into the non-living, the gradation is apparent, not real, and the continuity between them is only apparent. The seeming gradational passage of one into the other is due to the varying proportion of the living matter to that which is non-living in a given bulk. But between the particles actually living and the matter around them, which is non-living, there is no gradation whatever. Living particles may be very near to the non-living, nay, they may touch them, but the actual state of the one is totally different from the actual state of the other. The change is really sudden and abrupt, and the differences between the particles are not of degree, but of kind, and are essential, irreconcilable, absolute.

But the very contrary of all this is taught far and wide at this very time. It is maintained by many writers and thinkers that between the living and the non-living there is no clearly marked demarcation, that the one passes by insensible gradations into the other, that the phenomena of living matter are of the same order as those of non-living matter. It has been recently laid down by Dr. Allman, at the last meeting of the British Association for the Advancement of Science, that an analogy between the phenomena of living matter and the phenomena of lifeless matter is to be recognized, although he neither mention sthe particular phenomena to which he refers, nor points out any particular forms of living matter and lifeless matter which exhibit the analogy he declares. Is it too much to ask that Dr. Allman and those who think with him upon this important question of the nature of life, and the supposed analogy between the vital and non-vital phenomena, should explain themselves more clearly, and point out the facts to which they appeal, and upon which they profess to rely, in support of the view they entertain? For my own part, I shall be grateful to any one who will bring to any of our meetings any specimen of living matter which illustrates the supposed transition from the non-living to the living, or of non-living matter which is supposed to manifest phenomena exhibiting analogies to those of living matter. Up to this time I cannot admit that any one holding the views I controvert has advanced facts which in any way justify that doctrine, and I maintain that the conclusions generally entertained and taught with regard to the actions of living matter and non-living matter are not to be justified and are really incorrect.

Living Matter.—Dead Matter.—Protoplasm.

Every one here is familiar with the appearance of living matter under the Microscope, as seen, for instance, in the colourless, transparent, moving substance of a living *Amœba*; but as some confusion has resulted from the careless use of terms, I shall be obliged, in order to make myself clear, to trouble you with a little criticism as regards the plan adopted by many of naming the things they are describing, and the ingenious device of calling matter in absolutely different and irreconcilable states by the same name. We want to know what life is, and we are told that living matter is only *matter*, and that the same matter in the dead state is also only matter, and this is the only reply from the materialist standpoint vouchsafed to the question " What is life ? "

Now the matter that moves is clear and transparent and structureless, and, as I long ago showed elsewhere, the conclusion is justified that such-like clear transparent structureless moving matter exists in all living organisms from the lowest to the highest at every period of life, in health and in every form of disease. I have, therefore, called it living matter, and have pointed out that every form of it yet discovered differs entirely and absolutely from any form of non-living matter hitherto met with. But again and again this inference has been contradicted, although the arguments long ago advanced in its support remain unanswered and ignored. From time to time slight concessions are made, but it is still maintained, contrary to evidence, that there is a transition from the non-living to the living, and that the chasm separating them, infinite as it is, has in fact been already bridged.

" Living matter " has been called *protoplasm*, but that word has been applied to matter which does not " live," to matter which "grows," and to matter that does not " grow," to matter that produces matter like itself out of that which is unlike, and to matter which cannot do this, to coloured as well as to colourless matter, to matter which is structureless and to matter that has very distinct, definite, and remarkable structure, to matter in which many granules can be seen, and to matter which is destitute of granules, to the apparently homogeneous living matter seen under the eye to be moving in a manner not to be explained, and the unquestionably very heterogeneous magma dredged from the deep, and artificially preserved, as well as to structures so absolutely dead as roasted mutton and boiled lobster.

The colourless moving matter of the amœba is protoplasm. The active part of a nerve-fibre is protoplasm. Contracting muscle is protoplasm. Dead muscle is protoplasm. Roast and boiled muscle is protoplasm. The green colouring matter of plants is protoplasm. Chlorophyll is a " living substance," says Dr. Allman, and then remarks that chlorophyll contains starch. I conclude, therefore, other colouring matters found in plants must also, according to this view, be regarded as protoplasm. Is starch as well as chlorophyll protoplasm ? Protoplasm is the basis of physical life and the physical basis of life, and the physical basis of mind. *Bathybius* is protoplasm. Protoplasm, says Dr. Allman, is essentially *a combination of albuminoid bodies.* Others have maintained that protoplasm has been made directly from non-living matter, nay, is being so formed daily and hourly at this very time. Many sanguine persons think that some day protoplasm will be made artificially by the chemist, and if this can only be achieved there will then remain but the discovery of the "conditions" under which this artificial protoplasm will manifest its vital properties, and the "living thing" made by man will be ready for examination in our Microscopes.

The President of the British Association, in his address last August, gives his cordial support to Huxley's assumptions concerning protoplasm, the "physical basis of life," and remarks that "wherever there is life there is protoplasm; wherever there is protoplasm, there too is life," forgetting that he himself in more than one place speaks of *lifeless matter* as *protoplasm*, and nowhere distinguishes between the *living substance* and the *lifeless matter* which remains after its death,—forgetting, too, that roast and boiled muscle and many other forms of non-living matter have been called protoplasm by Huxley and others. Further, we are told that protoplasm is to the biologist what the ether is to the physicist, "*only*" one is a "tangible reality," and the other is a "hypothetical conception." Possibly some scientific men may have of late years dealt too freely in hypothetical conceptions, but the analogy between the latter and tangible realities remains to be discovered.

Bathybius.

I am sure many here will be interested to learn anything that can be added to our knowledge concerning *Bathybius* which may help them to decide whether it is a tangible reality like protoplasm or a hypothetical conception like the ether. Dr. Allman decides for *Bathybius*, and remarks "that further arguments against its reality will be needed before a doctrine founded on observations so carefully conducted shall be relegated to the region of confuted hypotheses." Professor Huxley spoke on this matter, but his words were not reassuring. He expressed his sorrow that "his young friend, *Bathybius*, had not verified the promise of his youth (laughter)," and his only confidence in August, 1879, in his "young friend," originally evolved in 1867, appeared to be expressed in suggestions concerning the possibility of his being a "blunder" and the probability of its exposure. Professor Huxley seems to forget the effects which this possible blunder produced upon D. F. Strauss and many more who seriously believed in *Bathybius*, and have since been influenced by Strauss' teachings, founded upon the existence of *Bathybius*. Professor Huxley asserts *Bathybius* has not been proved to be a "blunder," but he does not say what in his opinion *Bathybius* has been proved to be, or whether anything at all has been proved concerning his *Bathybius*. Dr. Allman, however, solemnly asserts *Bathybius*, and, paying the highest compliments to Huxley and Haeckel for their "very elaborate investigations," affirms this slime to be "living matter," in which "no law of Morphology has as yet exerted itself." Now upon what Dr. Allman bases his statements is by no means clear. He tells us:—1. That slimy matter dredged up from the Atlantic was *preserved in spirits*. 2. That specimens of this slimy matter were examined and declared to consist of protoplasm. 3. That this protoplasm *must in a living state* extend over wide areas of sea bottom! The matter has been further examined, he says, by Haeckel, who has confirmed all that had been advanced by Huxley, and who is convinced:—1. That the bottom of the open ocean at depths below 5000 feet is *covered with an enormous mass of living protoplasm*. 2. That this enormous mass of living protoplasm "lingers there in *the simplest and most primitive condition*, having as yet acquired *no definite form*." 3. Haeckel suggests that "this enormous mass of living protoplasm *may have originated by spontaneous generation*."

We see then that this very wonderful slime, by the exhaustive examination of Haeckel, has been made much more wonderful. Not only is it living protoplasm which "lingers in the simplest and most primitive condition," but it lives upon the inorganic, and "*probably*" originated from it by spontaneous generation. Now, Gentlemen, please consider the sort of facts adduced, and the inferences deduced from them. Professor Huxley, speaking upon Dr. Allman's address, remarks "that *Bathybius* could not be found when he was wanted, and when he was found, all sorts of things were said about him." I shall leave it for your consideration and determination whether *Bathybius* was not "wanted" before he was found; whether he has actually been found although he has long been "wanted" and has been diligently searched for during many years; whether many of the things said concerning his origin, existence, properties, and composition, should be accepted as being correct, and based upon actual observation; and, lastly, whether Huxley's "*Bathybius Haeckelii*" ought or ought not, after a conjectural existence of several years, to be allowed to rest among confuted hypotheses and discarded myths.

Physical Basis—Protoplasm.

It is now generally assumed that all Life is somehow dependent upon the properties of the actual matter that lives; indeed, life is referred to the properties possessed by the particles before they acquired the living state. In short, it is asserted that life is physical or material. Moreover, it is maintained by many physicists and others, that *all* the phenomena peculiar to living things will some day be adequately accounted for by properties of the atoms or of the matters compounded of them, which properties will be discovered. So that, knowing the properties of the material particles in any special case, we, or rather our successors, or those among them having the right amount of intelligence, are to be able to premise what sort of living power is to be evolved from any given piece of living matter. Living matter, it is said, consists of a *basis*, a *physical basis*, the changes in which somehow result in life—in fact, a physical basis of physical life. But it is very remarkable that the difference between the physical basis of a living thing and the physical basis of the same thing in the dead state has not been pointed out, or even the possibility of there being any difference at all hinted at.

The physical-basis-of-life argument being accepted, some may perhaps be able to show that a ship is the result of the properties of the particles of iron which constitute her physical basis; and that the house is a consequence of the interaction of the forces of the particles of clay, wood, iron, &c., of which it has been built. The act of construction or building, as well as the designer, the constructer, and the working artificers being of no consequence, are entirely left out of account. In the living thing, it is denied that any force or power exists which directs, or changes, or controls the relation to one another of the material particles, but it is asserted that from these the life is evolved; and though, no doubt, the statement that iron evolved the ship, or that clay, &c., evolved the house, would not be readily accepted as true, it would not be in any degree more absurd or less tenable than the assertion that man is evolved from the matter of which his body is constituted, or that a living particle results from the interaction of the forces of the matter of which it consists.

Properties of Protoplasm.

From the chair of the British Association it was declared only last autumn, that "Life is a property of protoplasm,"—and, that there may be no ambiguity as to the sense in which the word *property* is used, we are further assured that the properties of living matter may be compared with those of lifeless matter, and that there are unmistakable analogies between vital actions and phenomena purely physical.

Among the "properties" of protoplasm is often mentioned "irritability." What is meant by irritability has, however, never been fully explained by any one. Dr. Allman speaks of it as the "one grand character of all living beings," so that growth, multiplication, movement, nutrition, in short, "life," is considered to be due to this "irritability." But muscular contraction is also said to depend upon the irritability of the "protoplasm" of the muscle. But the protoplasm of muscle is certainly not *living* in the sense that the protoplasm of an amœba, for instance, is living. The last can grow and multiply by division. The muscle cannot do so. "Irritability" in one case accounts for movements limited as regards direction, and in the other for movements which may occur in any direction whatever. Dr. Allman agrees with those who assert that contractility is a *property* of protoplasm just as attraction is a *property* of the magnet. But here evidently is a radical confusion of various properties, for the "properties" referred to in the two cases are so distinct in their very nature as not to be comparable with one another. Who will point out the analogy said to exist between contractility and attraction, or between things so diverse as protoplasm and steel? You can demagnetize and remagnetize the same piece of steel. But the cosmic dust has not yet been evolved out of which the material philosopher is to be constructed who will restore to the same piece of matter its "irritability" after its death.

As the phenomena of living things as generally known and understood appear to be so very different from anything observed in connection with non-living matter, it is incumbent upon those who see or say that they discover an analogy between living and non-living, to clearly point out the precise facts which according to them establish the analogy. It is not just either to science or to the public or to those who differ from them to repeat over and over again that analogies exist between living things and things that do not live, if the precise points of analogy cannot be pointed out. It is obvious that people generally cannot investigate for themselves the several minute points which may establish a scientific proposition. The public must take much upon trust, and are apt to infer that if a man holding a recognized scientific position asserts that an animal is a machine, and that all its actions are mechanical, he must have very good reasons for laying before them a proposition which seems to be so preposterous that no one would venture to propound it unless he had actually proved it to be true. So, unlearned persons having much faith go their ways, and announce to their friends and neighbours that they, as well as all other animals, are machines. Their own conviction that all machines are made in pieces which are afterwards put together, and that no animal is so made, does not disturb their faith. Authority has spoken. They must believe and not inquire, accept upon trust, but not criticize.

The supposed "Structure" of Living Matter.

The investigation of what may be termed the minute anatomy of non-living matter has been carried to a point far beyond the powers of the Microscope, I may say immeasurably beyond, but with what result as regards the nature of the changes occurring in living matter? Instead of confirming the doctrines now forced upon us with such pertinacity, every discovery connected with the forces and properties of matter and the behaviour and arrangement of its molecules show how utterly groundless is the supposition that the phenomena of the living world are in any way to be accounted for by material properties. Even in those cases in which substances of the same composition as those which are formed in a living organism, can be produced artificially, the extraordinary difference as regards the conditions existing in the two cases will be sufficient to convince any unbiassed person of the totally distinct nature of the processes concerned, and of the utter incompatibility of the principles and laws by which they are governed. Professor Dewar has recently succeeded in producing hydrocyanic acid by the direct union of its elements, but the temperature at which combination occurs is *far above that of a white heat.* How, therefore, can an analogy obtain between a process in which a substance is formed at such a very high temperature, and one in which the same thing is produced at or below 70° F.?

The argument has, however, been often advanced, that as our present magnifying powers reveal such and such structural characters, if we possessed much higher powers of amplification we should be able to discover structures still more delicate and intricate than anyone has yet seen, and should demonstrate structure in that which now appears destitute of it. But the argument is fallacious, and for the reason that when we reach a point well within our present range of observation we find in living matter a structurelessness, the appearance of which is not in any way altered by submitting it to the highest resolving power we possess. And not only so, but within a very moderate range of amplifying power, the matter in question may be proved to be a more or less viscid or semifluid substance, portions of which move from, and towards, now separating from, now intermingling with—other portions of the mass. Unless, therefore, the term structure be used in two different senses, it is actually at this moment certain that living matter is structureless. Of any approach to that which is known as structure, as seen in any tissue animal or vegetable, there is not only no vestige, but the constitution of the matter, as far as has been proved up to this time, justifies the conclusion that there can be none.

Still the idea of structure being the cause of the phenomena of living matter lingers in the mind, and the observations of recent investigators seem to indicate certain structural peculiarities in the nucleus. Networks, filaments, frameworks of delicate fibres, rodlets, and granules have all been seen in certain cases, but it has by no means been made clear whether the appearances in question are real structural peculiarities, developed for a purpose and destined to discharge some special office or function, or whether they are but the result of accidental changes in the matter of which the nucleus consists, consequent upon its death and the coagulation of some of its constituents, or perhaps occasioned by the action of reagents, or by the media in which the specimen is immersed. However this may be, it is quite certain that nuclei in numberless instances in the living state are devoid of filaments, granules, and every other indication of structure. Not only so, but nuclei undoubtedly originate in living matter, which itself affords no indication whatever of structure.

Hidden Molecular Structure.

As protoplasm is the matter out of which all cells are formed, it cannot, it has been asserted, be destitute of structure. It is already organized, but our Microscopes, it is said, are not perfect enough to enable us to see any evidence of organization. Some authorities, however, discard such ingenious hypotheses, and frankly admit the absence of any definite structure which is demonstrable. But then, say they, there must be some hidden molecular structure or mechanism to account for the phenomena manifested by the matter in its living state. But in favour of this assertion no facts or arguments are adduced. Not one word as to the nature of the supposed invisible undemonstrable molecular structure. Not one word concerning the way in which any of the hypothetical molecules might be supposed to account for the observed facts. No suggestion of the reason why the structure affirmed to exist, should exist. In this and in many other instances, men claiming to have authority come before the public and assert that things are so and so, without giving any grounds for their assertion.

Imagined molecular differences between two given masses of protoplasm are held to be sufficient to account for wide differences in the results. Whether a given mass is to develop into a man or a monkey, depends upon its "hidden molecular constitution." The President of the British Association remarks, that "between two masses of protoplasm indistinguishable from one another, there *may be* as much molecular difference as there is between the form and arrangement of organs in the most widely separated animals or plants."—There "*may be*,"—but the facts already known render it much more probable that there *are* mighty differences which *are not molecular*, and that there are none which are "*molecular*."

Structurelessness of Living Matter—Its Power.

Let us, however, grant the existence of molecular structure which cannot be demonstrated, but which may, perhaps, be discovered at some future time. What will its advocates do with it? How will they explain by its aid the phenomena of movement, of growth, of multiplication, of formation, exhibited by any living thing, or a part of any living thing, in nature? I challenge any one to give an adequate explanation of vital movements proceeding in many different directions, and at the same moment, in a living mass as clear as water, during a few seconds of time. If the hypothesis of some hidden and unknown molecular machinery is admitted, we get no nearer to the explanation of the fact, unless the arrangement and mode of action of the supposed "machinery" can be pointed out. That such assertions concerning what *may be*, and the speculations thereupon, may postpone for a little while the crash of materialistic philosophy that impends, is possible; but even this is doubtful. People have but to look, and they will find structure gradually appearing out of the structureless, and becoming more distinct as development advances. The earlier phenomena being universally characterized by absence of structure—structure being seen to develop in the formless—why should it be assumed that invisible structure existed from the first?

In the next place, let me ask you to notice the attempts made to show the varying degrees of simplicity and complexity in what is called undifferentiated protoplasm. Some, it is said, exhibit the "extremest simplification." This is simple protoplasm; other kinds are supposed to have a more complex organization. But all this is purely gratuitous speculation, and is not based upon any facts whatever, for the lowest form of protoplasm is neither more nor less simple in composition or molecular arrangement or constitution, as far as can be ascertained by any investigation to which it can be subjected, than that of man himself. *All* is structureless; and, so far, no one has succeeded in ascertaining, by any method of examination to which protoplasm can be submitted, whether a given mass has emanated from a very low and simple organism or from a high and complex one. Neither have we any means of judging whether any given piece of protoplasm is capable of evolving a low or a high form of life. There is no reason for the conclusion that the form of life to be evolved is in any way determined by the physical constitution of the living matter. The cause of the result, whatever its nature may be, is associated with, and operates upon, structureless matter only. Nor is there any evidence of any quantitative relation between structure-forming *power* and the *matter* by which this is transmitted from particle to particle; seeing that a particle of living matter, which probably weighs considerably less than the one hundred-millionth of a grain, by transmitting its peculiar power from material particle to particle, is capable, during a period extending over many years after its own formation, of imposing upon many pounds of matter structural, and not only structural, peculiarities of the most striking kind. Let the advocates of the molecular machinery of living matter, and the believers in hidden molecular mechanism and molecular constitution, consider the peculiarities of form and structure determined by the matter of a spermatozoon. What do they discover concerning this matter? It seems to be a minute speck of commonplace "albuminoid" material, not very different from that out of which ordinary epithelial cells are formed.—But only think of its power!

Chemical Composition and Analysis of Living Matter.

The phenomena which characterize life have been referred by many to the mere chemical properties of the substance or substances of which the living matter is composed, or to the properties of the original atoms of which the matter consists. In many addresses and memoirs on this question, we meet with statements concerning the chemical composition of protoplasm which are most misleading. Dr. Allman adds the weight of his authority to the assertion, that you can analyze protoplasm. But is it not obvious that, if by protoplasm "living matter" is meant, and the context shows that this is really so, you cannot do anything of the kind? The only matter that can be analyzed is that which is found after the death of living matter—not the actual living matter itself. Is it not misleading people if you tell them you are really showing them what living matter is made of when you are only able to show them some of the characters and properties of the substances which remain after the matter has ceased to live? Of course dead matter can be broken up into its elements, and these may be arranged and re-arranged in a thousand ways without our learning how they were arranged when the matter was alive. While, on the other hand, we are able to prove most conclusively that the substances discovered after death certainly did not exist as such while the matter lived. The things we handle and name only came into being when life ceased. The elements of which they are compounded of course were there, but that is all. What we desire to learn is how they were related to one another, how they were arranged during the living state, and this remains absolutely unknown.

How can any properties of matter that can be even thought of, or any structural molecular arrangement, pull apart and re-arrange atoms of Oxygen, Hydrogen, Nitrogen, Carbon, and at varying degrees of temperature in different cases? By what process of analysis or synthesis of which we can form any conception can these changes, which we know do occur in the case of one living thing at a temperature of 100° F., of another at 50°, of another at 32°, be accounted for? Nay, there are instances in which complex chemical compounds, as well as highly complex structures, are formed in living beings at temperatures below, and indeed considerably below, the point at which water becomes solid.

Will any material properties of "undifferentiated protoplasm" account for similar chemical changes at different temperatures, or different chemical changes at or near the same temperature? Many things are asserted about compounds and molecules which possess diverse properties, but which are destitute of the "property" of life, of the nature of which we desire to learn something, but this *life* "property" is gone before the investigation is commenced. It is the old story. People ask to be informed concerning their nature, as they are living, and they are told all sorts of things about dead bodies, as if man and man's body were identical. Did not Socrates point out that his dead body was not and could not be Socrates? We want to know about living matter, and a number of dogmas are authoritatively laid down for our instruction about matter which has ceased to live. Dr. Allman does not hint at the possibility of a difference between the albuminoid bodies obtained by the analysis of protoplasm and the protoplasm itself in the living state.

The craving after molecular structure which is invisible, and the anxious longing to discover material properties to account for phenomena which are totally different from any physical phenomena of which we have any cognizance, have been now observable for many years, and indicate a strong desire upon the part of restless advocates to gain a cause which has appeared to many well qualified to judge to be a perfectly hopeless one from the first. In order to make the speculations and assertions which have been offered appear plausible, all sorts of suggestions have to be made as to what may be possible, or what may be discernible by the imaginations of gifted individuals. Speculation is added to speculation, and error is piled upon error, until it becomes almost impossible to present the pith of the matter for consideration in moderate compass. Is the modern philosopher who proceeds to smash, and dissolve, and analyze living matter, with the object of discovering the mechanism which works, and the forces which act, control, and guide, very much in advance, as regards the reasonableness of the proceeding, of the savage who pounds up a watch in order to see what is inside? Nay, the watch, by the pounding to which it has been subjected, will have actually undergone *less* change than the living matter, which shall have been submitted only to the preliminary steps of chemical analysis.

The "Cell Soul."—Consciousness.—Identity.

Probably every one here is aware that those who teach that there is a close relationship between the living and the non-living, differ from one another in some points which are of fundamental importance. 1. Some hold that all the actions of animals, vegetables, and non-living matter belong to the same category, and are in their essential nature the same. 2. Some think that while the phenomena of living matter generally belong to the same class as the phenomena of the non-living, mental phenomena and consciousness as manifested by man belong to a totally different category. They maintain that while the movement of living matter is physical, consciousness is altogether and absolutely distinct, and must be placed in a separate class. But those who entertain this idea ought surely to point out exactly what they mean by "consciousness," and the particular phenomena to which they propose to restrict the term "psychical" as opposed to physical. Yet this consciousness, which is held to be quite distinct from irritability and other supposed properties of ordinary matter, some of which are manifested by living matter, is intimately associated with living matter only—nay, we can even point out the living matter which is concerned in the manifestation of consciousness. The extreme divergence of opinion existing in connection with this part of the subject is very remarkable. Thus Virchow confers upon cells a power of influencing neighbouring cells, in virtue of which they seem, according to him, to be cognizant of what is going on around them, nay, almost capable of acting in sympathy with the actions of neighbouring cells. Haeckel ironically retorts "that we must ascribe an independent soul-life to each organic cell." We must distinguish, says Haeckel, "between the central soul of the total polycellular organism, or the 'personal soul,' and the separate elementary souls of the single cells, or 'cell souls.'" But Haeckel's "soul" is evidently so very vague in its nature and so uncertain in its manifestation, that it is at present impossible to predicate anything more definite concerning it, than that in all probability, like the *Bathybius Haeckelii*, it originated by spontaneous generation from some form of the inorganic flourishing at unfathomable depths. The discussion is rendered still more difficult by the perplexing views of many concerning the likeness of things which, to all ordinary minds, seem to be very unlike one another. Particularly as regards the words "identical" and "identity" is there much confusion.

It would, indeed, be difficult in any other department of human knowledge to find anything to equal the extravagance of the hypotheses recently advanced concerning living matter and its properties. We are told that particles of matter out of which are evolved things utterly unlike one another are nevertheless identical.

The stuff which develops an oak, that which becomes a cabbage, that which gives origin to a dog, and the living matter which represents a man at an early stage, are all said to be "identical." Because forsooth two portions of matter resemble one another closely in appearance, in the elements which enter into their composition, in the way in which they increase, divide, and so forth, they are "identical." We may actually see matter developing into a man, and matter developing into a dog, and because we cannot distinguish one from the other by physical investigation, we are expected to assent to the dictum that they are identical. It is difficult to argue with those who so terribly abuse the use of the language they employ. At every step one is puzzled to determine in what sense a word is used. This word identity is ingeniously applied to things which differ from one another *toto cœlo*, by philosophers who seem to be unconscious of, or at any rate do not hesitate to ignore, any differences which are not to be made evident by chemical or other mode of analysis. One might as well assert the identity of reason and dogma because the difference cannot be expressed in ounces or pounds. As we cannot distinguish the germ of a man from that of a dog by microscopic observation or by chemical analysis, we are told that the germs are identical, in face of the fact that a man results from the one, and a dog from the other. In spite of the obvious diversity as to form and variety of structure we see around us, all living forms were at one time identical. Identity produces diversity. This assumed identity results in extraordinary diversity of property, structure, and the like. And when we inquire how this comes about, we are assured that it is to be accounted for by the laws of molecular change.

Many who repudiate materialism really accept the so-called basis upon which it rests, as if it were true. A considerable number of intelligent persons go so far with the materialists as to argue that the characteristic phenomena of living protoplasm may be due to the physical properties of the matter which enters into its composition, but consciousness is, according to them, in another category altogether. Polarity is the property of the magnet, irritability the property of protoplasm, but the idea of consciousness being the property of brain protoplasm not only shocks their tender consciences, but outrages their traditional beliefs, so they discover that the argument "breaks down," without, however, showing precisely where, why, or how.

The President of the British Association affirms that "the chasm between unconscious life and thought is impassable," while he holds that the chasm between unconscious life and the phenomena of non-living matter has already been bridged over, and many scientific men seem to have accepted the same idea. Life is a property of protoplasm, but consciousness is not a property of protoplasm. What consciousness is we are not told, but it is intimated that in the far-off future perhaps some higher faculties may be evolved which may enable our successors to understand what we do not. But where among living beings this consciousness abruptly begins, and when in the development of man it is grafted upon or superadded to the life, is not suggested. Whence comes consciousness, and what is it according to this hypothesis? What category shall be invented for this wonderful property, consciousness?

Now, I should like to know how mystery and prophecy and the speculations about the evolution of new faculties in a far-distant future advance our knowledge. All that can be learnt by observation is conclusive in favour of a very close relationship between life and consciousness, and the sudden acquisition of the latter characteristic is not conceivable. On the other hand, to assert that life is a property of protoplasm, just as polarity is a property of a magnet, is utterly unreasonable. You cannot devitalize and revitalize the same matter, but you can magnetize and demagnetize the same piece of steel many times. The "impassable chasm" is between the non-living matter and that which lives, not between the latter and consciousness.

Consciousness, it is asserted by Dr. Allman, is as "absolutely distinct" from unconscious life as it is "from any of the ordinary phenomena of matter." To this statement I entirely demur, and maintain, on the contrary, that consciousness and unconscious life are intimately related, and that both are so very far removed from any of the phenomena of ordinary matter, that it is doubtful whether one should be considered nearer to or farther from them than the other. The further statement, that "the chasm between unconscious life and thought is deep and impassable," I therefore regard as altogether incorrect, and opposed to the fact of development where life is certainly at first unconscious, but where consciousness is slowly and gradually, but not suddenly manifested. It seems much more in accord with what is known of nature to infer that out of the unconscious state the conscious gradually emerges, than to assume that consciousness is something that is somehow suddenly superadded or evolved, in some manner that cannot be suggested.

Psychical Phenomena.

If the term psychical is extended to animals, it must undoubtedly be extended to plants, and to every form of living matter. And certainly every form of living matter manifests actions which cannot be included in physics or chemistry, and might be termed psychical, though not the same form of psychical action as thought. In the simplest forms of living matter the vital action seems to emanate from the centre of the living particle, and to influence matter in a direction from centre to circumference. In nutrition and growth the non-living matter pursues the very opposite direction, from circumference to centre. The precise part of a living particle where the matter is changed from the non-living into the living state is the centre. The change is *psychical* (?). Instead of vital actions depending upon the influence of external agencies acting from without and exciting a response, they always tend to act from within, and the degree of their activity depends upon the extent to which the external restrictions under which the living matter is placed, are removed. I believe that, in the same way, mental action (psychical), influences the particles of mind living matter, and bears the same sort of relation to these particles as the vital power (psychical) of any form of living matter bears to the matter of which it is composed.

There is, then (psychically), some intimate bond between all life, but absolute separation between all living and non-living. However great the difference between the lowest and highest life, this difference is as nothing to that psychical difference which separates the lowest simplest living from any kind of non-living matter. To regard consciousness as something *per se* is gratuitous. Of course, if the "irritability" which distinguishes living matter from non-living matter is a physical property, this doctrine might be tenable; but I have shown that it is as unreasonable to regard this so-called irritability as a physical phenomenon, as it is to consider thought itself to be a mere property of matter.

In conclusion, I ask you to consider whether it is not more reasonable to place all life in one category, and all non-living in another, than to seek to include nearly all life in the physical class, and man only, or man and the higher animals, in a separate psychical category. To include man and all life among the physical and material, to say that man is a machine and all his actions mechanical, is simply one of many preposterous assertions in the same direction, which are untrue. Depend upon it we must attack, sooner or later, the problem how life directly influences material particles, for we shall have to accept the proposition that material particles as soon as they "live" are governed and arranged and moved in a manner in which no physical forces whatever are able to govern, arrange, and move them.

I venture to throw the most important conclusions into the form of propositions.

The phenomena of living matter are not due to the properties of the matter. Vital actions are of an order absolutely distinct from any known physical actions.

Life force, or power, has not been, and cannot be, evolved in any way from matter only, nor is it a consequence of changes occurring in matter, but, on the contrary, life influences and determines changes in the matter, which changes are quite peculiar.

The vital phenomena of the lowest simplest forms of living matter are of the same general nature as those of the highest, and are as far removed as are the latter from any kind of physical change.

The assertion that any low forms of life are near to, or establish any transition towards, the inorganic, is not justified by any facts known to science.

The attempts made to make the public believe that the so-called properties of living matter belong to the same order or category as that in which known properties of known forms of non-living matter can be included, are not to be justified by an appeal to facts, and are therefore contrary to the principles of science.

Every vital phenomenon is absolutely different in its nature from every physical (mechanical or chemical) action. There is no analogy whatever between the two sets of phenomena.

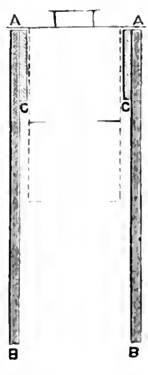
The present state of knowledge justifies the conclusion that no form of living matter existing at present, nor any one which existed in the past, directly originated from non-living matter, or in any way derived its powers or properties from the non-living.

IX.—*On a Means of obviating the Reflection from the inside of the Body-tubes of Microscopes, with Suggestions for Standard Gauges for the same and for Substage Fittings, &c.* By J. W. GROVES, F.R.M.S., Demonstrator of Physiology in King's College, London.

(*Read 14th January*, 1880.)

I WISH to draw the attention of the Society to a defect common to all Microscopes, but which attains its worst development in the instruments made on the Continent. I refer to the fact of the inner surface of the body-tube acting as a reflector, due to the black lining being either imperfectly put on or subsequently rubbed off. In instruments of Continental manufacture the former cause prevails as a rule, while in English stands, even the best, it will be found that the inside of the tube, soon after, if not at the time of purchase, is more or less bright for a certain distance from the top, corresponding to the length of the lowest or A eye-piece. When the latter is used the best performance of the Microscope is obtained, all the bright reflecting surface being covered; but when higher oculars are required, then, as their tubes are shorter, there remains an exposed bright surface, which reflects the light to the eye, producing more or less blurr, which is sometimes so marked that the higher eye-pieces become useless. I therefore propose a very simple alteration in the body-tube, which would entirely do away with the defect.

FIG. 14.



The body-tube A B, Fig. 14, should have inserted in it a short piece of tube, A C, of the same diameter as the eye-piece, but only as long as the one of highest power. The other eye-pieces would then be in contact only with this short tube, as shown in the figure, and the black lining of the body-tube would not be rubbed, and would therefore remain uninjured.

While suggesting an alteration in the tube, I should like to bring forward a subject in regard to which opticians could confer an immense boon on workers with the Microscope, viz. by adopting certain standard sizes for the lengths and diameters of the body-tubes, substage fittings, &c. At present the eye-pieces, condensers, &c., of one maker will not fit the Microscopes of other makers without special adapters; whereas, if certain standard gauges, say A, B, and C, were adopted, it would only be necessary to order whatever might be required for an A, B, or C stand, and there would be a certainty of it fitting.

How many gauges and of what sizes they should be are questions which could be settled by a committee consisting of some of the English and foreign makers, together with two or three competent workers. By the deliberations of such a committee, under the auspices of this Society some years since, we obtained the Society or universal screw, which, as well as the Hartnack or Continental, are still the usual gauges both here and abroad. I think that the time has arrived when this, as the parent Microscopical Society, should offer facilities for determining the standards for such other parts of the instrument as would enable the apparatus of one maker to be used with the stand of another.

X.—*On a Petrographical Microscope.**

By A. Nachet, F.R.M.S.

(*Read* 10*th March*, 1880.)

A Microscope intended for petrographic investigations should have a quality somewhat difficult to obtain, that is, the perfect centering of the stage beneath the objective so that a crystal examined by polarized light is always in contact with the crossed threads placed at the focus of the eye-piece.

If the stage is made to revolve under the objective the latter must be perfectly centered, that is to say, it must be placed in absolute coincidence with the axis of rotation of the stage. Several methods have been proposed to accomplish this, but they have all a grave inconvenience, viz. that when the objectives are changed it is necessary again to find the axis of rotation, to which the axis of the new objective no longer corresponds, thus causing considerable loss of time.

If, however, the objective is turned with the object there is no longer any displacement of the image. To accomplish this it is only necessary to arrange the optical part so that it is divided into two sections, the objective forming part of the stage and turning with it, and the *eye-piece remaining fixed* with the crossed threads and the analyzer.

A Microscope designed on this principle is shown in Fig. 15. The column A carrying the fine and coarse movements, only supports in reality the objective, and the whole turns with the stage and the object, the upper tube containing the eye-piece and the analyzer remaining immovable. The latter tube slides into a collar at the end of the arm fixed to the column B, so that it is not affected by the rotation of the body nor by the focal adjustment which acts only on the objective.

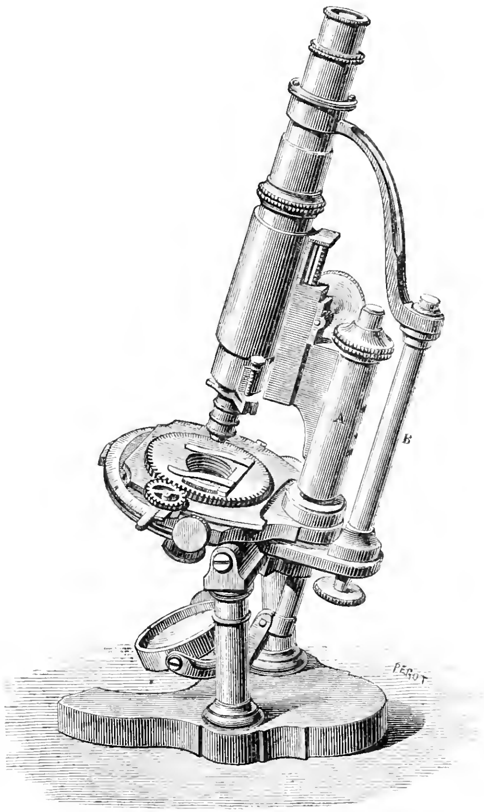
The advantage of this instrument is shown by the fact that the greater the amplification the more precise the centering is, contrary to what is the case when the stage alone turns beneath the objective. In fact the sole cause of deviation which can exist in the new system arises from a small alteration of coincidence between the axis of the eye-piece and objective, but this want of coincidence is almost imperceptible.

In examining rocks it is necessary to change the objectives very frequently—a revolving nose-piece can scarcely be employed in consequence of the flexion which exists in those for three or four objectives, notwithstanding every care in construction. I

* The original paper is in French.

have therefore adopted the system of spring pincers of Professor Thury—the adjusting ring allows an exact centering and the application of the objective is effected instantaneously.

Fig. 15.



The stage of the instrument has a circular division with a vernier for the exact determination of the point of extinction in the plane of polarization. It also has two transverse divisions serving as a finder as well as a second rotating plate, the utility of which is not absolute and is only suitable for special mineralogical observations.

RECORD

OF CURRENT RESEARCHES RELATING TO

INVERTEBRATA, CRYPTOGAMIA, MICROSCOPY, &c.*

ZOOLOGY.

A. GENERAL, including Embryology and Histology of the Vertebrata.

Norris's Third Corpuscular Element in Blood.†—Dr. Norris has recently propounded a new view as to the histology and growth of blood-corpuscles, concluding that in normal mammalian blood there are a large number of colourless, invisible, biconcave disks similar in every respect except colour to the red corpuscles, and that they are in fact an earlier stage of the latter, in which they have not yet obtained hæmoglobin.

Dr. Norris first suspected the existence of these corpuscles whilst studying microphotography, when he observed that exceedingly faint outlines of corpuscles were represented on the photographic plate, which could not be discovered in the original preparations. On further examination he also observed that in very thin layers of fresh blood the red corpuscles were often seen to impinge upon some invisible body similar in form to themselves, which body might not unfrequently be observed to make an indentation in the plastic stroma of the red corpuscle. Dr. Norris was led by these appearances to infer that there existed in the blood bodies which are invisible to the eye by reason of possessing the same refractive index as the liquor sanguinis in which they are immersed. He concluded, therefore, that if the serum could be withdrawn they would be rendered visible.

With this object he designed two very ingenious methods of withdrawing the serum. One process, which he calls "packing," consists in taking a slightly convex cover-glass, and strapping it by means of strips of adhesive plaster to a microscopic slide. When so arranged Newton's rings should be produced across the centre of the cover-glass, the surfaces being then separated by a space not greater than $\frac{1}{10000}$ of an inch. If a drop of blood be placed at one edge of the cover-glass it will penetrate by the force of capillarity, but the glass surfaces are in such close contact that the corpuscles can only enter flatways and in single layer. At the spot where the rings are formed the space is too narrow to allow the corpuscles to pass; they therefore

* ☞ It should be understood that the Society do not hold themselves responsible for the views of the authors of the papers, &c., referred to, nor for the manner in which those views may be expressed, the object of the Record being to present a summary of the papers *as actually published*. Objections and corrections should therefore, for the most part, be addressed to the authors.

† 'On the Origin and Mode of Development of the Morphological Elements of Mammalian Blood,' by Richard Norris, M.D., Prof. of Physiology,—Birmingham, 1879; abstract by Mrs. Ernest Hart in 'London Medical Record,' Jan. 15, 1880.

become "packed," forming a close mosaic on one side of the rings, while the serum is drawn off by capillary attraction on the other side.

The second method Dr. Norris calls "isolation." The slide used is drilled with a hole, in which a metal eyelet is inserted; a square cover-glass is strapped to the slide by one edge only, so that the opposite free edge overlaps the aperture; a small screw working in the eyelet is used to carefully raise the hinge-like cover-glass. The blood is introduced at one edge, and as soon as it has by capillarity spread itself in a thin layer between the glasses, their two surfaces are gently separated by inserting the screw and raising the cover-glass. At this moment the whole bulk of the fluid passes away towards the edge of the glass attached by the plaster, leaving a few corpuscles adhering to each of the two glass surfaces with which the blood was in contact. If this operation be performed over a strong solution of osmic acid, the vapour immediately fixes the corpuscles in the condition in which they were at the moment of the withdrawal of the serum. By this method, either with or without the action of the vapour, transparent colourless corpuscles as well as normal red corpuscles are found adhering to the glass.

His third method is to change the refractive index of the serum by the addition of a saturated solution of chloride of sodium. When thus treated the blood is found to teem with corpuscles, previously invisible, of every shade of tint.

As to the origin of these colourless corpuscles Dr. Norris considers them to be a simple transformation of the lymph-corpuscles. He states that he has examined the latter in a fresh state, and that he has failed to discover a nucleus; in fact, he considers them to be simply discoid non-nucleated cells, consisting of an external pellicle and semifluid contents, and the appearance of nucleation he believes to be always due to the action of reagents. This lymph-disk becomes biconcave by a rapid process on its introduction into the blood circulation, and can then be recognized (by the methods described) as a young colourless corpuscle. Dr. Norris states that he has been able to observe the conversion of the discoid lymph-cell into a biconcave corpuscle. He is entirely opposed to the current view that the white corpuscle of the blood is a nucleated cell; he considers it to be a mere "accidental aggregate of adhesive lymph-corpuscles," the false appearance of nucleation being caused by the same *post-mortem* changes already described as taking place in the lymph-cell.

Mrs. Ernest Hart,* who has undertaken a careful investigation of the author's experiments, considers that his conclusions are vitiated by sources of fallacy arising from the methods employed, which appear to produce the appearances which he describes as normally existing. In his third method it is demonstrable that the influence of a saturated solution of chloride of sodium on the blood-corpuscles in the fresh state is to cause about one-third of the number to lose their hæmoglobin, and become transparent and colourless. The longer the blood is left in contact with the salt, the greater the number of corpuscles that become transparent. Mrs. Hart has found

* Loc. cit.

that, if the refractive index of the serum be changed by means which are conservative and not destructive of the integrity of the red corpuscles, the transparent or third corpuscle cannot be found by any of the ordinary methods of observation.

Regarding the method of "packing," the corpuscles are here subjected to an extreme degree of pressure. They are drawn by the force of capillary attraction between two glass surfaces bound firmly together, until they reach a spot which they cannot pass by reason of the close contact of the two glasses. They therefore become wedged in and are subjected to the action of two forces, the capillary attraction which is drawing the liquor sanguinis from around them, and the pressure of the glasses between which they are tightly wedged. This pressure causes certain of the corpuscles to discharge their hæmoglobin and to become transparent. Some of the corpuscles are acted on in this way much more rapidly than others; but in course of time a great number of the corpuscles become quite colourless, and all of them as they pass towards the centre of the glass, where the pressure is greatest, become paler. Moreover it may be observed that at the same time the serum becomes distinctly tinted on the further side of the Newton rings, and in one instance Mrs. Hart determined by the micro-spectroscope the presence of the discharged hæmoglobin in the serum.

While the "isolation" method is the one least open to objection, Mrs. Hart thinks that the capillary attraction of two glass surfaces with a thin layer of fluid between them, and the amount of force necessary to overcome this attraction and raise the cover-glass, have not been sufficiently considered, nor the probable effect of violence done to the delicate structure of the red blood-corpuscles by the antagonistic forces here brought into play. Many of the corpuscles have the appearance of being ruptured, and of having lost their contents. On repeating the same experiments with frog's blood it was found that either the corpuscles were ruptured, setting their nuclei free, or were rendered transparent by the loss of hæmoglobin; in fact, the appearances produced by isolation are identical with those effected by the well-known experiment of pressure on the cover-glass over a fresh preparation of frog's blood. It may be noticed, however, as a point in favour of this method, that the small metal eyelet prevents the glasses from being in such close apposition as might be supposed, and hence the capillary attraction is not as powerful as it would be if the glasses were in close contact. In this method also, the possible effect of the sudden withdrawal of the liquor sanguinis on the more unstable of the corpuscles is a point not to be lost sight of.

Finally, regarding Dr. Norris's theory as to the alleged false appearance of nucleation in the lymph-corpuscles and the white blood-corpuscles, M. Ranvier's observations * concerning the division of the nucleus of the living white blood-corpuscle in the Mexican axolotl may be referred to. Owing to the transparency of the protoplasm, the nucleus and the nucleolus are distinctly visible in the living

* 'Recherches sur les Elements du Sang.' Bibl. hautes Études. Labor. d Histologie.

state, and the amœboid movements and the process of fissiparous division of the nucleus can be watched. Moreover, Dr. Norris's theory that the white corpuscle is merely an accidental collection of two or three non-nucleated, vesicular, colourless corpuscles, leaves unexplained the amœboid movements observed in the living state in the leucocytes both of Mammalia and Amphibia.

After going with care through a series of observations on this subject, Mrs. Hart is disposed to believe that the colourless corpuscles which (without the addition of a saturated solution of common salt) are still undoubtedly seen when the blood is examined by the method of "isolation," are red corpuscles that have undergone *post-mortem* changes prior to taking part in the formation of the fibrine, and promises shortly the publication of some further observations.

Remarkable Phenomena presented by the Coloured Blood-corpuscles of the Frog.*—Repeated observations tend to show that the structure of the coloured blood-corpuscle is by no means so simple as is usually assumed: and from this point of view the observations made by J. Gaule in Professor Ludwig's laboratory at Leipzig are of singular interest.

On diluting the fresh blood from a vigorous frog with 0·6 salt solution, and exposing it after rapid defibrination to a temperature of 32°–36° C. on the hot stage of the Microscope, the escape of a peculiar body may be observed in many of the corpuscles. The bodies thus evolved simulate worms so closely by their form and wriggling movements, that Gaule styles them "Würmchen," which may be translated *vermicles*. He concludes from several reasons that they are simply protoplasmic portions of the corpuscles, which, under these special conditions, separate for a short independent life. No reference is made to previous workers in the same field; but it would seem not improbable that the "Würmchen" correspond with the maculæ which Professor Roberts of Manchester revealed seventeen years ago by treating the corpuscles with tannin or magenta, reagents which would of course prevent any further signs of life in the objects.

The "vermicles" are about half the length of the red corpuscle, pointed at either end, but more in front, and containing one or two vesicles or droplets. Their singular movements deserve a rather full description. After wriggling out of the corpuscle, in which it makes its appearance as a rod-like body beside the nucleus, the "vermicle" moves on, trailing the corpuscle behind by a long thread. On meeting a second corpuscle it bores into it, withdraws, pushes it aside, and goes on carrying this too in its train; and though the threads finally give way, "vermicles" may be seen dragging three, four, or more corpuscles after them. The corpuscles, quitted or attacked in this way, undergo in a short time changes of form and colour leading to complete disorganization, which otherwise, under similar conditions, require hours for their accomplishment. Finally the "vermicle" also undergoes disorganization. While the conditions given above

* 'Arch. Physiol.' (Du Bois-Reymond), 1880; see 'Nature,' xxi. (1880) p. 453.

are found on the whole most successful in bringing about these results, Gaule indicates limits of temperature and dilution within which they often occur, usually with slight modifications. It is this variation with the conditions of the experiment that supplies one of his strongest arguments against the previous individual existence of these bodies.

Cartilage-cells of Salamandra maculata.*—Professor Frommann, using for his investigation the sternal and scapular cartilages, finds that the ground-substance is almost completely homogeneous, great magnification giving no indication of any granular or fibrillar properties; at the boundary of the cells it passes into a delicate homogeneous capsule which almost always completely encloses the cavity. Here and there in the ground-substance it is possible to make out closely packed granules, which do not seem to be connected with the cells. When the cells are not completely enclosed by the capsule there is present a single or double row of granules, which vary somewhat in arrangement. In fresh cells the protoplasm completely fills the space enclosed by the ground-substance; in hardened specimens there is often a small intermediate space due to the shrinking of the contents.

The nuclei of the cells are rounded and their coat varies in thickness; the filamentous network of the nucleus consists of extremely fine and short fibres which unite to form radiating knots and very narrow meshworks of a rounded, or more or less oval form. The nucleoli are round, oval, or irregularly angular, and there is nothing to indicate that they are formed by the thickening of the network of the cells.

Diffusion of Copper in the Animal Kingdom.†—The fact of the normal presence of minute quantities of copper in various members of the animal kingdom has been noticed within the past twenty-five years in a few isolated cases, and to these Dr. M. Giunti ‡ adds a number of interesting and diversified instances.

His attention was first directed to the subject accidentally by finding over one-third of 1 per cent. of copper in the guano deposits from bats occurring in certain Italian caves. This led to an analytical examination of the bat, the results of which showed that about four ten-thousandths of the weight of the ashes of this animal consist of cupric oxide. Bent upon finding an ultimate source for the metal, Giunti subjected to analysis the insects which form the food of the bat, and in all cases found copper present in a greater or less amount. The quantity would seem to vary in the different orders, families, and species. Aquatic insects contain less than those found on land, and the Coleoptera appear to yield the highest percentage. Thus the ashes of *Anomala vitis* contain 0·1 per cent. of cupric oxide, and those of *Blatta orientalis* 0·826 per cent. High as this percentage seems, the amount of copper in an individual insect is infinitesimal, being, in

* 'SB. Jen. Gesell. Med. u. Naturw.,' 1879, p. 46.
† Mr. T. H. Norton, in 'Nature,' xxi. (1880) p. 305.
‡ 'Gazetta Chimica Italiana,' ix. p. 541.

the case of *Anomala vitis*, less than four-millionths of a gramme. Copper was also detected amongst other Coleoptera (notably the larva of *Gryllotalpa*), and amongst Diptera (*Musca domestica*), Lepidoptera, Hymenoptera, &c.

Giunti next sought to ascertain whether other insectivorous animals besides the bat are wont to assimilate the copper present in their insect prey. This was found to be the case with all members of this class subjected to examination, such as snakes, lizards, hedgehogs, &c. The ashes of the latter contain from one to two ten-thousandths of copper, while the ashes of lizards contain over fifteen thousandths. In their case most of the copper is to be found in the skin of the animal.

The experiments were likewise extended amongst the Invertebrates. Various varieties of spiders; of myriapods, such as *Iulus terrestris*; of isopods, such as *Armadillidium vulgare*; and of snails, have all given affirmative responses to his tests. Amongst these *Iulus terrestris* contains the largest amount of copper, its ashes showing a percentage of 0·18.

B. INVERTEBRATA.

Comparative Value of Monochromatic Impressions in Invertebrates.*—The influence of the different rays of the spectrum on the eyes of the principal types of animals has a special interest in comparative physiology; but only recently has it made sufficient progress to admit of experimental research. M. Chatin points out that there are two principal means of investigation. The first originates in the discoveries of Boll, who showed that the retina of many animals contains a so-called visual purple which is effaced in light and gives place to fresh tints whose gradation often indicates the relative lengths of the incident waves. Unfortunately these facts are by no means capable of general application, the substance being wanting in some groups.

The second and more practical method is that of Dewar, who has shown that the impact of light on the retina gives rise to a special current which disappears directly the visual organ ceases to be in the circuit. "Dewar's Current" thus constituting a criterion of the retinal agitation, it is easy to estimate its intensity by the measure of its dynamic manifestation, the expression of which remains identical in the most varied types of animals.

In the Arthropoda, and especially in the Decapodous Crustacea and some insects (locusts, &c.), the current asserts itself with absolute constancy, and nowhere are the effects of luminous action more easy to observe, which is explained by the essentially bacillar structure of the eye of these animals. Certain differences in the intensity of the current may be observed to be produced by the different rays, and it is in the yellow-green region that the maximum is reached.

This tendency is still more marked in the Mollusca, and especially in the Pulmoniferous Gasteropoda: in the yellow rays the current acquires its greatest intensity; it gradually becomes weaker

* 'Comptes Rendus,' xc. (1880) p. 41.

in the green zone, decreasing rapidly with blue-violet, and reaching its minimum in the red region of the spectrum.

These facts establish the principle of the method, whilst they explain the indifference which some invertebrates show to certain rays (as red, &c.). The author is engaged on several points which require further study: as to determine the rapidity with which the retinal excitation disappears, and to estimate precisely the degree of monochromatism of the incident light; this last condition would only be incompletely realized by employing media—coloured glass, absorbent solutions, &c.—of which use has been made in the generality of experiments, and it seems rather as if it ought to be obtained by the application of new processes, such as polarized light, &c.

Mollusca.

Development of Pulmonata.*—A long paper on this subject, dealing chiefly with the ontogeny of *Planorbis marginatus* and *P. carinatus*, is contributed by Carl Rabl.

First period.—The formative or animal half of the egg contains small yolk-granules, the nutritive or vegetative half large ones. The first and second cleavage planes are meridional, including both animal and vegetative poles; the third is equatorial, at right angles to the other two, and divides the egg into four small animal cells (micromeres), and four large vegetative cells (macromeres). A second equatorial furrow then separates off from the latter four more micromeres; the embryo being now 12-celled. Next, each cell divides into two; the products of division of the eight micromeres have all the character of "animal" cells, that is, are finely granular: of the eight cells formed by the division of the four macromeres, four, situated near the equator, are also animal cells, the remaining four, alone of the twenty-four, retaining the character of vegetative cells, that is, being bright yellow in colour and coarsely granular. At this stage there is a large cleavage cavity.

Thus cleavage proceeds according to the numbers 4 . . . 8 . . . 12 . . . 24, or first in arithmetical, afterwards in geometrical progression. This Rabl states is the case in Gasteropods with a comparatively small amount of food material in the egg (Dermatobranchiata, Pulmonata), while it takes place entirely by arithmetical progression (4 . . . 8 . . . 12 . . . 16 . . . 20 . . . 24) in those with a great amount of food material (Pteropoda, Pleurobranchiata, Heteropoda, and most Prosobranchiata).

The next important change is the division of the four large vegetative cells, by which at last twelve cells, all having a macromeral character, are produced. Two of these become grown over, and pushed into the cleavage cavity; they are the primary mesoderm cells. The remaining ten macromeres form the endoderm, the micromeres, now increased to about forty, the ectoderm. So that in the 52-celled stage, the three primary germ-layers are already constituted. Moreover, the embryo exhibits true bilateral symmetry, the two

* 'Morphol. Jahrb.,' v. (1879) p. 562.

mesoderm cells and ten endoderm cells being disposed evenly half on each side of a median plane.

Second period.—After the three germ-layers are established, the mesoderm undergoes further multiplication, small daughter-cells being divided off from the large primary mesoderm cells, and the endoderm is invaginated, forming the archenteron. A special accumulation of ectoderm cells (Scheitelplatte) on either side of the anterior end forms the rudiment of the cerebral ganglion. At the same time the embryo begins to rotate in the egg, cilia being developed, chiefly in the neighbourhood of the future velum, but at first showing no regular arrangement.

Rabl thinks it probable that the blastopore, although diminishing greatly in size, never actually closes up: its anterior end corresponds exactly in position with the future mouth.*

On the dorsal side of the velum, the embryo grows out into a sort of hump, the head-vesicle (Kopfblase). On the ventral side a smaller prominence is formed, the rudiment of the foot. The shell-gland appears as a slight depression in the ectoderm, almost immediately opposite the mouth.

The endoderm cells take in nutriment from the surrounding albumen, and soon undergo differentiation into small cylindrical cells lining the permanent digestive cavity, and large cells (albumen-cells), external to the latter. The radula-sheath appears as an outpushing of the ventral wall of the foregut; a somewhat similar process from the midgut, passing backwards and downwards, and ending blindly close under the ectoderm, is the rudiment of the hindgut. At the place where it terminates the ectoderm is raised up into a slight anal elevation.

The shell-gland increases considerably, extending inwards until it nearly reaches the wall of the alimentary canal. Soon, over it and the surrounding ectodermal area a delicate cuticular pellicle appears—the rudiment of the shell.

Up to a comparatively late period, the mesoderm consists of two symmetrical rows of cells. Most of these cells—the number of which remains small—are of moderate and equal size, but one in about the middle of each row is conspicuous by being several times larger than the others. This cell undergoes remarkable changes: a cavity appears in its protoplasm behind the nucleus, and the cell sends out two long processes, containing a continuation of the cavity, one towards the "Scheitelplatte," the other towards the foot. The body thus formed is the primitive kidney; it is ciliated internally, and both its ducts, the anterior of which ends in a funnel-like aperture, appear to open into the body-cavity.

The velum has by this time become thoroughly differentiated; it consists of large, vacuolated, ciliated cells.

Third period.—The embryo has now begun to lose its bilateral symmetry: during the period all the more important organs take their origin.

* See, on this and other points, Prof. Lankester's remarks in the 'Quart. Journ. Micr. Sci.,' xx. (1880) p. 103.

The whole area on which the shell is formed probably has its origin in the shell-gland, the depression of the latter becoming less and less marked, and its cells spreading out, as it were, over the mantle area.

As already mentioned, the supra-œsophageal ganglia arise from the "Scheitelplatten"; probably the infra-œsophageal ganglia are formed, indirectly, from the same groups of cells. The eyes and otocysts are shown to be ectodermal structures; the tentacles also arise as offshoots of ectoderm, into which, at a later period, a mesodermal core extends.

The most anterior section of the alimentary canal, with the odontophore, arises from the ectoderm; the midgut, and its product the hindgut, from the endoderm. The dorsal and ventral walls of the midgut are formed of small cylinder cells, the lateral walls by large globular "albumen-cells"—endoderm cells immensely enlarged by the absorption of albumen. Towards the close of embryonic development, these latter undergo extensive subdivision, group themselves into larger or smaller lobules, acquire a yellowish brown colour, and form the rudiment of the liver.

The permanent kidney is formed from a group of mesoblast cells at the hinder end of the embryo; these cells soon arrange themselves into a curved tube consisting of three portions:—a ciliated segment, probably opening into the pericardium; a secreting segment containing concretions; and a discharging segment opening on the surface of the body.

The heart also, in all probability, arises from the mesoderm; in the earliest stages observed, it already consists of auricle and ventricle.

The fate of a group of mesoderm cells, situated in the same region, just posterior to the tentacles, was not made out. Rabl considers that they are probably identical with the structure which is considered by Ray Lankester, in *Limnæus*, as the foundation of the supra-œsophageal ganglia, by Fol as that of the connective tissue.

Space will not allow us to give an abstract of the general remarks on the above observations with which Dr. Rabl concludes his paper.

Methods.—Up to the 24-cell stage, no treatment of any sort is necessary, except for the purpose of observing the division of the nuclei. For later stages, the albumin is removed, and the eggs treated with 1 per cent. osmic acid until they acquire a brown colour, then with carmine or picrocarmine, and then with a mixture of glycerine 1 part), absolute alcohol (1 part), and water (3 parts). They are then examined in glycerine. With advanced embryos it is best to harden with alcohol of very gradually increasing strength, before staining. For sections, the embryos (which are about $\frac{1}{5}$ mm. in length), were embedded in a mixture of wax and oil on a slide.

Molluscoida.

New Fossil Polyzoa.*—The Rev. J. E. Tenison-Woods describes a new genus allied to *Gemellaria*—where the cells are joined back to back and all the pairs face the same way. In the new form, however, the

* 'Journ. and Proc. Roy. Soc. N. S. Wales,' xii. (1879), p. 57 (2 figs. of a plate).

faces alternate in two ways, that is, the faces are on all four sides of the almost cylindrical branches, and they alternate in each of the opposing cells arising on the side of the centre of its alternate neighbour. *Tetraplaria* (*australis*) is the name proposed.

Embryology of Bowerbankia.*—Herr Repiachoff follows up his previous important papers† on the development of the Polyzoa by now showing the agreement which subsists between the earlier stages of *Bowerbankia* (two species) and the Chilostomatous *Tendra* and *Lepralia pallasiana*.

The polar corpuscle marks the future posterior side; after its exit the cleavage of the egg-cell begins; the third cleavage divides the embryo into a dorsal and a ventral portion, enclosing a cleavage cavity. After two stages like the corresponding ones in *Tendra*, the smaller dorsal cells divide, and then the four median ventral cells are pushed into the cavity and form the endoderm. After the closing up of the ectoderm it acquires a thickening on the dorsal side above mentioned; the true position of this thickening with regard to the "primitive mouth," and therefore to the body of the larva, was difficult to decide, and this interpretation of the relations of the parts leads to the unexpected conclusion that this "mouth" is on the opposite side of the body in *Bowerbankia* to that which it occupies in the Chilostomatous larva, and that the thickening does *not* represent in position the sucker of the Chilostomata.

The second special feature of the larva is a *zone of cilia*, carried by a single row of very large cells which present a fusiform aspect when viewed from above the embryo. Of the two spaces at the sides of the zone, the larger is rather thin-walled, the smaller is remarkably thick at its centre—which constitutes the dorsal thickening abovementioned—but becomes thinner towards the zone; at a later stage these parts become less sharply defined from their surroundings, the ciliary zone takes an oblique position with regard to the long axis of the embryo, the thickening becomes extended in the direction of that axis, and now consists of two or three successive divisions. At later stages this extension is continued, and the ciliary zone takes the form of two practically parallel rows of cells, connected with each other above and below, and lying chiefly right and left of the thickening; they take a turn round the ventral side of the anterior end of the embryo, and here form a border to the anterior end of the thickening.

At this stage the *mantle* is indicated by a ventral invagination at the hinder end of the body. The cells (probably all) of the ciliary zone now divide so as to create two parallel rows in it; they also appear to divide longitudinally, and the zone, or most of it, becomes now indistinguishably fused with the thickening, forming the structure called by the author elsewhere the "ventral ring." The mantle now assumes its special characters. The endoderm—whose characters differ somewhat in different individuals of the same stage, consisting sometimes of a single layer of cells enclosing other cells scattered or aggregated, sometimes of an apparently compact mass of cells

* 'Zool. Anzeiger,' ii. (1879) p. 660. † Ibid., i. (1878) No. 10., &c.

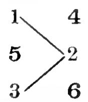
—projects a narrow strip of its tissue into the mantle fold. The origin of the mouth was not observed.

It seems reasonable to conclude that the ciliated zone is homologous with that of Chilostomatous larvæ, to whose "hood," also, the ectodermal thickening seems comparable.

Arthropoda.

Locomotion of Insects and Arachnida.*—The mode of progression of Insects and Arachnida is, according to M. G. Carlet, much more regular than is generally supposed. The only rule laid down by authors is that two legs of the same pair never move simultaneously.

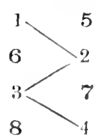
Insects whose movements are slow and whose legs are equidistant (as *Oryctes nasicornis* and *Timarcha tenebricosa*), move their limbs as indicated in the following table, where the legs are arranged in their natural position, the figures indicating the order in which they are raised:—



While the legs 1, 2, 3 are raised almost together, 4, 5, 6 remain as the support, to be raised in their turn when the first have resumed the office of supporters. In other words, the insect rests on a triangle of support formed by the two extreme feet on one side and the middle one on the other side, whilst the other three feet are carried forward.

This mode of progression equally obtains in the other orders.

In arachnids the order in which the feet are raised was clearly followed in the female of *Epeira diadema*. It is almost impossible to trace it out in the males on account of their rapid motion; but the more voluminous abdomen of the females hinders their progress and renders it possible to construct the following table:—



Here the polygon of support is a quadrilateral formed on the one side by the feet of even numbers, and on the other by those of odd numbers.

a. Insecta.

Beetle with Proboscis of Butterfly.†—Herr Hermann Müller, in contrasting the different states of development which the parts of the mouth attain in the groups Apidæ and Rhopalocera (Bees and Butterflies), points out that the limitation of these parts to little more than a long tube in the latter, and their extension in the former to a complicated

* 'Comptes Rendus,' lxxxix. (1879) p. 1121.
† 'Kosmos,' iii. (1880) p. 302.

set of variously shaped organs, including a short tube, are the natural consequences of the modes of life in the two groups respectively. The bees, and more markedly their ancestors, the fossorial wasps, having to conduct digging and scooping operations in the preparation of their nests and the care of their young, only devote a small portion of their time to the use of their essentially sucking organs; hence these are less and more slowly developed than in the butterflies, whose existence is entirely occupied by the functions of reproduction and feeding. In the one case the insect's energy is spread over the various organs, in the other it is mainly concentrated upon one, so that evolution has had free scope to work out the development of the very specialized organ of the butterfly.

While, however, it is easy to trace out the different stages by which the bee's mouth-apparatus has been attained, owing to their embodiment in still living types, there remains a wide gap between the butterfly and its ancestors the Phryganidæ. This may be explained by the comparatively short period which may be supposed to have been occupied by the evolution of the butterfly's proboscis, of which a hint seems to be supplied by the development, in a genus (*Nemognatha*) of the essentially gnawing group Coleoptera, of a *trunk*, similar both in structure and mode of use to that of Lepidoptera. This fact was noticed by Dr. Fritz Müller in Brazil, in the case of a dark, glistening blue species of that genus. The European species, *N. chrysomelina*, has the maxillæ considerably prolonged, but of the normal Coleopteran structure, while in the other case they are distinguished from the component halves of the Lepidopteran trunk only by their inability to be coiled up. Thus within the limits of a single *genus* the transition is made from a biting to a sucking mouth; a transition which, to fill up the gap between the Phryganidæ and butterflies, we have had to assume to have been made by the ancestors of the latter group of insects.

Sexual Colours of certain Butterflies.*—Mr. Charles Darwin points out that the males of several butterflies display beautiful colours on their wings when viewed in front, in which position the male would be seen by the female when approaching her. In *Diadema bolina* the two sexes differ widely in colour. The wings of the male, viewed from behind, are black with six marks of pure white; but when viewed in front the white marks are surrounded by a halo of beautiful blue. The males of another genus, *Apatura*, exhibit most magnificent green and blue tints only when viewed in front, and also in several species of Ornithoptera the hind wings of the males are of of a fine golden yellow when so seen only. Butterflies when at rest close their wings, and their lower surfaces, which are often obscurely tinted, can then alone be seen; and this, it is generally admitted, serves as a protection. But the males when courting the females alternately depress and raise their wings, thus displaying the brilliantly coloured upper surface; and it seems the natural inference that they act in this manner in order to charm or excite the females.

* 'Nature,' xxi. (1880) p. 237.

In the cases above described this inference is rendered much more probable, as the full beauty of the male can be seen by the female only when he advances towards her. In a similar manner the males of many birds, as the peacock, &c., display their wonderful plumage to the greatest advantage before their unadorned friends.

The consideration of these cases leads Mr. Darwin to add a few remarks as to how far *consciousness* necessarily comes into play in the first acquirement of certain instincts, including sexual display; for as all the males of the same species behave in the same manner whilst courting the female, we may infer that the display is at least now instinctive. Most naturalists appear to believe that every instinct was at first consciously performed; but this seems to him an erroneous conclusion in many cases, though true in others. Birds, when variously excited, assume strange attitudes and ruffle their feathers; and if this were advantageous to a male whilst courting the female, there does not seem to be any improbability in the offspring which inherited this action being favoured; and we know that odd tricks and new gestures performed unconsciously are often inherited by man.

In the case of young ground birds which squat and hide themselves when in danger directly after hatching, it seems hardly possible that the habit could have been consciously acquired without any experience. But if those young birds which remained motionless when frightened were oftener preserved from beasts of prey than those which tried to escape, the habit of squatting might have been unconsciously acquired. Again, a hen partridge when there is danger flies a short distance from her young ones and leaves them closely squatted: she then flutters along the ground as if crippled; but, differently from a really wounded bird, she makes herself conspicuous. Now it is more than doubtful whether any bird ever existed with sufficient intellect to think that if she imitated the actions of an injured bird she would draw away an enemy from her young ones; for this presupposes that she had observed such actions in an injured comrade and knew that they would tempt an enemy to pursuit. Many now admit that, for instance, the hinge of a shell has been formed by the preservation and inheritance of successive useful variations, the individuals with a somewhat better constructed shell being preserved in greater numbers than those with a less well-constructed one; and why should not beneficial variations in the inherited actions of a partridge be preserved in like manner, without any thought or conscious intention on her part any more than on the part of the mollusc, the hinge of whose shell has been modified and improved independently of consciousness?

Bees eating Entrapped Moths.*—Mr. Packard, jun., says that a flowering stalk of an asclepiad (*Physianthus* [*Araujá*] *albens*) was brought to him last September, with the bodies of several moths (*Plusia precationis*) hanging dead from the flowers, being caught by their tongues or maxillæ. These moths had, in endeavouring to

* 'Am. Nat.,' xiv. (1880) p. 48; see 'Nature,' xxi. (1880) p. 308.

reach the pollen-pockets of the flowers, been caught as if in a vice by one of the opposing edges of the five sets of hard, horny contrivances covering the pollinia.

A very short time afterwards the Rev. L. Thompson, a careful observer, sent Mr. Packard the following details of the behaviour of bees (*Apis mellifica*) also frequenting the flowers of the same asclepiad:—"My attention was attracted by two or three bees buzzing immediately around as many entrapped moths that were alive and struggling to get away. Every moment or two a bee suddenly and furiously darted upon a prisoner and seemed to me to sting it, despite its desperate efforts to escape. This onset was generally instantaneous, but was repeated again and again; and after a moth became still and apparently lifeless the bee settled upon and, if my eyes did not greatly deceive me, began to devour it." Mr. Thompson previously noticed tongues of the same species of moth caught in the flowers, the bodies to which they belonged having disappeared. At the time he fancied these were probably eaten by birds, but on further examination he came to the conclusion that the bees had really feasted on animal food, as well as upon the nectar of the surrounding flowers.

On this fact being communicated to Mr. Darwin, he wrote that he "never heard of bees being in any way carnivorous, and the fact is to me incredible. Is it possible that the bees opened the bodies of the *Plusia* to suck the nectar contained in their stomachs? Such a degree of reason would require confirmation, and would be very wonderful." Hermann Müller wrote "that his brother Fritz in South Brazil has observed that honey-bees (species doubtful) licked eagerly the juice dropping from pieces of meat which had been suspended in the open air to dry; but he thinks nothing has been published on the carnivorous habits of bees." The well-known apiarian, Prof. A. J. Cook, however, reminds Mr. Packard, "that honey-bee workers within the hive, on killing off the drones, tear them in pieces with their mandibles rather than sting them, and that he has seen them thus kill a humble-bee that had entered the hive." Huber, if we mistake not, also tells us that under certain circumstances the common hive-bee will devour the eggs laid by the queen bee.

Honey Ant—Myrmecocystus Mexicanus.*—The Rev. H. C. McCook recently exhibited to the Philadelphia Academy formicaries containing living specimens of the honey ant, *Myrmecocystus Mexicanus* Wesmael. These embraced three worker castes, major, minor, and dwarf, the honey bearer and the fertile queen. The artificial nests had been brought from the Garden of the Gods, Colorado, where the honey ant had been discovered by Mr. McCook. They had previously been supposed to be confined to a more southern latitude. The nests are found on the tops or southern slopes of ridges. In exterior architecture they are small gravel-covered moundlets, truncated cones, pierced in the centre by a gate or perpendicular opening from 3 to 6 inches deep. The interior architecture was illustrated by numerous specimens brought from excavated nests. It consists of a series of

* 'Proc. Acad. Nat. Sci. Phila.,' 1879, p. 197.

underground galleries and chambers, cut through the gravel and sandstone to a distance of nearly 8 feet in length, 2 to 4 feet beneath the surface, and about 10 to 12 inches in width at the widest part.

The honey bearers were found hanging in groups to the roofs of the honey chambers by their feet; their large globular abdomens looking like bunches of small Delaware grapes. About eight to ten chambers, containing each an average of about thirty honey bearers, were found. The workers cared for the honey bearers when the chambers were opened, and dragged them into the unopened parts.

The ants proved to be nocturnal in their habits, remaining within doors until after sunset, about 7.30 P.M. each evening, when the workers issued forth in column, and dispersed among the clumps of scrub oak, *Quercus undulata*. Here they sought the galls made by a species of *Cynips* which grows abundantly on the bushes, and licked therefrom a sweet exudation which issued in small transparent beads from the surface. From 11.30 P.M. to about 3.30 A.M., when the first streakings of dawn began to appear, the workers returned home, laden with the honey. This appears to be fed to the sedentary honey bearers by disgorging it in the usual way, and remains within the globular abdomens as a store for future use. The economy of this habit appears to resemble that of the bee; the exception being that the bee's honey is stored within the inorganic substance of a waxen cell, while the ant's is lodged within the organic tissue of the living insect.

Phosphorescence of the Glowworm.*—M. Jousset de Bellesme has been led to make fresh experiments on the light of the glowworm, as neither Matteucci nor any other observer has taken into account the will of the animal, or attempted to eliminate this cause of uncertainty, so that when, for example, a glowworm was placed in carbonic acid, they could not decide whether the phosphorescence ceased because the surrounding medium did not allow of its production, or because the animal voluntarily refused to shine.

The author therefore deprived the insects of control over the light by removing the cephalic ganglia and replaced the voluntary excitation by the passage of a moderate electric current in the trunk or luminous organ. This produced unfailingly a brilliant phosphorescence. In this way he confirmed Matteucci's view as to oxygen being essential to the production of the light. The insects prepared as above described, when plunged into carbonic acid, nitrogen, or hydrogen, and excited by electricity, never became luminous.

It may therefore be regarded as certain that the large cells with granular protoplasm constituting the parenchyma of the phosphorescent apparatus, produce a substance which becomes luminous in contact with the air introduced through the numerous tracheæ intersecting that apparatus.

To ascertain what this material is, it is necessary to isolate and analyze it. The resemblance of the light to that of phosphorus has led several chemists to seek for that substance in the luminous appa-

* 'Comptes Rendus,' xc. (1880) p. 318.

ratus, but in vain. When a glowworm is crushed luminous traces are seen on the ground, and it has been concluded that, as in lucifer matches, these were nothing else than a phosphorescent material collected in the apparatus for the ulterior wants of the insect. This experiment is, however, very defective. If a phosphorescent glowworm be dissected with needles, the fragments will remain luminous for several hours at least. If on the other hand it is rapidly crushed in a mortar so as to destroy the very cells, the phosphorescence immediately disappears; the pulp collected, exposed to the contact of pure oxygen or submitted to the influence of electrical excitation, remains absolutely dark. A partial crushing, therefore, allows the phosphorescence to be still produced, complete crushing abolishes it. On the hypothesis of a reserve of phosphorescent material, excessive crushing ought evidently to favour the production of the light, by spreading the material over a wide surface in contact with the air; but the contrary takes place. The phosphorescence only takes place if the apparatus is divided into fragments, so that groups of cells being intact continue to act. Dissection and the abnormal contact of air excites the cells, and their protoplasm under these influences produces the phosphorescent material at the expense of the materials which it contains. If the cells be killed by crushing, life no longer intervenes to set those materials to work and give them the chemical form under which the phosphorescence shows itself.

The phenomenon is therefore of a chemical nature, but only produced under biological conditions. This can be proved in another manner. By submitting a glowworm to the action of sulphuretted hydrogen it is immediately killed, and no light can be obtained from it by electrical excitement. The cells are intact in form, but being physiologically destroyed by the gas they no longer perform their functions. The organ can then be pulled to pieces, acted on by oxygen or electricity, without provoking phosphorescence. It is certain, however, that the protoplasm contains all the materials chemically necessary for the production of the phosphorescent substance, but this substance is not ready-made. It is only produced in proportion to the consumption under the influence of the will, and by the aid of the nervous system, which excites the cells and causes them to act.

The phosphorescence is therefore a phenomenon of the same order as muscular movement, or the discharge of electricity in the apparatus of the torpedo, which are without doubt the result of chemical combinations taking place in the protoplasmic matter.

The author considers it very probable that the phosphorescent substance is a gaseous product, for the structure of the organ does not give the idea of one secreting liquid. On account of the close resemblance which the phosphorescence bears to that of decomposing substances he thinks the gas is most likely phosphuretted hydrogen. As the result therefore of his observations on the glowworm and *Noctiluca*, he considers phosphorescence to be a general property of protoplasm, consisting in a disengagement of phosphuretted hydrogen. It can thus be understood how it is that many of the lower animals which are without a nervous system are phosphorescent.

Moreover, it enables us to connect the phenomena of phosphorescence observed in living organisms with those of organic matters in course of decomposition. It is another example of a phenomenon of a biological order very clearly reduced to an exclusively chemical cause.

Rhynchopsyllus—a New Genus of Pulicida.*—This ectoparasite, which has for its nearest allies *Pulex*, *Rhynchoprion*, and *Ceratopsyllus*, was found on a Brazilian species of *Molossus;* some thirty-three specimens were obtained, all of which were females, and of these twenty-five were taken from behind the ear; the creature is described by Professor G. Haller as being the size of a grain of rice. Although the materials were so numerous, only two of the females were in the completely normal condition. There are therefore two states in which the female may be found, one the normal, and the other the mite-like condition in which the abdomen is filled with ova.

The various parts of the mouth organs are described, and their functions explained: the well-developed proboscis pushes its way into the body of the host by the aid of the saw-like movement of the labrum; the mandibles anchor themselves into the skin by the aid of their backwardly directed hooks; the pincer-like maxillæ are then directed inwards and towards one another and so pinch up the skin into a fold and produce a congestion of the blood; the labial palpi open out and the wound is increased in size. The blood is now greedily taken up by the trough-like labrum and sucked into the narrow œsophagus; the œsophagus is very narrow, long, and angulated in its median portion; this is succeeded by a small hemispherical vesicle which has the function of a crop; internally it is lined by a chitinous layer which is not invested by epithelium, and externally there is a strong muscular layer composed of a large number of circularly disposed muscular fibres. As the chitinous layer really consists of a number of rows of toothed plates, it follows that in this insect we have the comminuting apparatus of the Mandibulata connected with the vesicular sucking organ of the Diptera. In the modified females there is a special modification of the hinder portion of the tracheal system; instead of having, as has the normal female, eight pairs of stigmata, it has no stigma on the last abdominal segment; the tracheal tube ends blindly and in a large vesicle, the size of which is increased by the diverticula which are connected with it. The function of this modification is not far to seek; the terminal segment is almost completely tucked into the preceding one, so that a stigma would be superfluous while an air-reservoir can be easily developed from the tracheal tubes anterior to it.

Resistance of Aphides to severe Cold.†—M. J. Lichtenstein has shown that the Phylloxera of the vine (*Phylloxera vastatrix*) can be reproduced, either by the fecundated egg or by subterranean budding colonies, on condition of having *necessary nourishment and heat.* The latter condition appears indispensable for the agamic

* 'Arch. Naturg.,' xlvi. (1880) p. 72.
† 'Comptes Rendus,' xc. (1880) p. 80.

reproduction of the *Aphis*, but it does not appear to be necessary to the life of the insect.

During December, 1879, the temperature reached $-11°$ to $-12°$ C., and not only did not the subterranean Phylloxera in any way suffer, but on the plants and trees in the garden were gathered various species of *Aphis*, all stiffened by the cold, and often covered with snow or hoar-frost, but alive.

When these were taken into a temperature of 8° to 10°, in two or three days all began to produce young. Suspended only by the cold, the generative faculty, or rather the *gemmation*, was by no means extinct.

The author therefore concludes that the hibernating *Pseudogynes* of those species of *Aphis* which reproduce indefinitely, suffer very little from the cold, and are capable of resisting very low temperatures.

Destruction of Insect Pests by means of Fungi.*—Professor E. R. Lankester, in a summary of two recent papers on this subject, says that insect pests such as the Phylloxera and the Colorado beetle, are about to receive a check at the hands of the same class of scientific students as have already reformed surgery by the knowledge obtained of *Bacteria*, as well as improved the silk, beer, wine, and other manufactures. The application of knowledge of natural facts is in this case a very remarkable one; for it is proposed to make use of our recently acquired knowledge of diseases due to *Bacteria*—not that we may arrest such diseases, but that we may promote them. Insect pests are to be destroyed by poisoning them not with acrid mineral poisons which damage plants as well as the insects, but by encouraging the spread of the disease-producing *Bacteria* which are known to be fatal to such insects.

Professor Hagen, of Cambridge, Mass., has called attention† to the old practice of destroying greenhouse pests by the application of yeast. He conceives that this method may be applied to other insect pests. He imagines that the yeast-fungus enters the body of the insect on which it is sprinkled and there produces a growth which is fatal to the insect's life. It is a well-known fact that insects are very subject to fungoid diseases, and it is also ascertained that the application of yeast to the plants frequented by such insects favours their acquisition of such disease.

Professor Elias Metschnikoff, the celebrated embryologist, has however made some investigations on this subject and given an explanation of the possible value of yeast application,‡ different and more satisfactory than that which Professor Hagen appears to adopt.

The general result of the most accurate investigations of the beer-yeast fungus (*Saccharomyces cerevisiæ*), is entirely opposed to the notion that it can enter an insect's body and produce a disease. Beer-yeast is beer-yeast and appears always (or within experimental limits) to

* 'Nature,' xxi. (1880) p. 447.

† 'Destruction of Obnoxious Insects—Phylloxera, Potato-beetle, Cotton-worm, Colorado Grasshopper, and Greenhouse Pests—by application of the Yeast Fungus,' Cambridge, 1879.

‡ 'Zool. Anzeiger,' iii. (1880) p. 44.

remain so. On the other hand De Bary has made known the life-history of some simple fungi which destroy insects, and from Pasteur, Cohn, and others we know of diseases due to those simplest of fungi, the *Bacteria*, which produce the most deadly ravages amongst insects. Professor Metschnikoff has examined some of these minute parasitic fungi and cultivated them by passing them from one insect to another, and has experimentally proved their very deadly character to the insects exposed to infection. The "green muscardine" (*Isaria destructor*) is the name given by Metschnikoff to one of the minute fungi the effects of which he most successfully traced. Now it is perfectly evident that if green muscardine spores could be produced in large quantity, or spores of similar disease-producing fungi, and applied to the ground and shrubs infested by insect pests liable to harbour those fungi, we should have the best of all means for effecting the destruction of the insects, viz. a poison which once set at work would spontaneously multiply and spread its destroying agents around.

Accordingly Professor Metschnikoff endeavoured to cultivate the "green muscardine" apart from insects, so as to obtain its spores if possible in great quantity, in a liquid which might be applied to places attacked by injurious insects. He at last succeeded in effecting this cultivation by the use of beer-mash: in this decoction the green muscardine produced a rich mycelium and finally spores.

It is exceedingly probable that we have here the true explanation of the value of the application of yeast to plants, &c., affected by insect pests. If there are a few spores only of such parasites as the "green muscardine" about, the fluids of the yeast will serve them for nourishment and so cause the muscardine to spread until it comes into contact with the insects. There is no reason to suppose that the beer-yeast plant itself is capable of generating a disease in any insects, at the same time we must remember that yeast as ordinarily used by the brewer is by no means pure; it contains in small quantities other minute fungi besides the *Saccharomyces cerevisiæ*, and it is quite possible that a given quantity of it, say a pint, *may*, if the brewery from which it came were not conducted on the most perfect system (such as that lately introduced by Pasteur), contain a few spores of such a disease-producing parasite as muscardine. A diseased insect once in a way falling into the mash-tub would sufficiently keep up the supply, and thus it is possible that yeast may carry infection to insect pests and destroy them.

At the same time Professor Metschnikoff's suggestion of a deliberate cultivation of an insects'-disease-producing fungus, and the application of the cultivated fungus in quantity to places infested by these insects, is in the highest degree ingenious and likely to give results the value of which will be estimated in thousands of pounds, and so do something to persuade "practical" men that all science (biology as much as chemistry, geology, or electricity) is deserving of their respect and encouragement.

MM. Brongniart and Cornu have also presented a note * to the

* 'Comptes Rendus,' xc (1880) p. 249.

French Academy describing an epidemic of Diptera (*Syrphus mellinus*), thousands of which they had found killed by species of *Entomophthora*, and in some observations on this paper one of the Perpetual Secretaries recalled the recommendation made some years previously by M. Pasteur to the Phylloxera Commission, viz. to find a means of destroying the Phylloxera by inoculation with a microscopic fungus, and urged the subject on the attention of naturalists.

γ. Arachnida.

New Arachnid.*—Under the name of *Sphærobothria* Dr. Karsch describes a new Avicularid, which appears to be allied to *Eurypelma* (Koch). This genus, from Costa Rica, is remarkable for the presence of a circular dorsal pit on the cephalothorax, from which there arises a hemispherical or less markedly conical and larger body. The specimens are grey on their dorsal, and more brown on their ventral surface. Only females are in the possession of the Berlin Museum, and of these there are three examples. The specific name of *Hoffmanii* is proposed for it.

Poison Glands of Solpuga.† — Herr Croneberg describes the structure of these debated organs, which appear to form a pair of thoracic glands placed at the sides of the stomach. They are connected by a groove-like process with a depression, infundibular in form, and developed from the integument; at the bottom of this funnel there is a chitinous conical process, which is traversed by a narrow canal leading directly into the glandular tube. Surrounding the chitinous process, but not connected with the gland, are a number of muscular fibres. The gland itself forms a greatly coiled tube, has a wide lumen, and a *membrana propria* formed of cells of cylindrical epithelium. Closely attached in its anterior portion to the walls of the stomach, the gland divides at this point into two branches, which are each beset with a number of saccules; there is no opening into the stomach, and the secretion of the gland seems to be pressed out by the contraction of the muscles, and to be carried outwards by the funnels in the integument.

Generative Organs of the Phalangida.‡—M. de Graaf finds that the male is sometimes converted into a hermaphrodite by the conversion of the testes into an ovary, when the ovarian cells are developed on the surface of the testis; the spermatozooids are flattened corpuscles, ovate in form, with a dark oval nucleus. The female is not provided with receptacula seminis; the ovipositor is made up of a large number of chitinous rings, and is bifurcated at its termination; it is surrounded by three distinct sheaths; the innermost of these is chitinous, and its free surface is covered by a large number of fine undulating folds, each of which has a sharp spinule. The second is similar in structure, but has no spinules; the third is muscular in character. The penis has only one sheath of chitin, and this invests

* 'Zeitschr. gesammt. Naturwiss.' (Giebel), lii. (1879) p. 534.
† 'Zool. Anzeiger,' ii. (1879) p. 450.
‡ Ibid., iii. (1880) p. 42.

it very loosely. Two small glands open into the vagina at the end of the oviduct, and their secretion serves to agglutinate the ova together.

Further results are promised shortly; the subject was undertaken as being that for which a prize was offered by the University of Leiden.

Post-embryonal Development of Glyciphagus.* —Herr Kramer, in opposition to Mégnin, comes to the conclusion that the generative orifice is developed at a proportionately early, that is the second, stage; and that it is impossible rigidly to distinguish between a larva- and a nymph-stage. He points out that, at any rate, in the form which he has examined there is no nymph-stage in the sense of Dugès or Mégnin, for the first eight-footed stage is characterized also by the presence of a genital orifice, even though that orifice have only two suckers. With regard, further, to the mode of copulation amongst these mites, Kramer thinks what was taken by Mégnin for the copulatory act is only something introductory to it; in copulation the male has its ventral surface closely appressed to the female, and itself lies upon its back.

δ. Crustacea.

New Crustacea.†—Mr. Thomson describes two new Isopods from New Zealand, which seem to be of rare occurrence; the first, for which he suggests the specific name of *tuberculatus*, belongs to the genus *Arcturus*, and is most like, apparently, the *A. corniger* of Stebbing; the materials for the description of *Tanais Novæ-Zealandiæ* consisted of a single specimen; it appears to be the southern representative of *T. vittatus* of Lilljeborg, but it differs from it in some striking specific characters.

Mr. Thomson also describes a new species of *Nebalia*, which from the length of its antennæ he proposes to call *longicornis*, and takes this opportunity of expressing the opinion that the proposition of Packard to make a new order *Phyllocarida* for the Nebaliads is a better plan than that of the late Willemoes-Suhm, who would have enlarged the group Schizopoda for their reception.

Mr. H. N. Ridley also describes a new Copepod (*Doridicola antheæ*) which he found in the tentacles of a dark purplish-slate colour variety of *Anthea cereus*.

New Fossil Decapod.‡—Mr. R. P. Whitfield describes (from the Upper Devonian rocks of Ohio) the remains of a Macrouran Decapod which appears to differ so much from any described genus as to make it undesirable to refer it to any of them. One of its peculiarities consists in the possession of a pair of very strong antennal appendages which project from beneath the anterior end of the thoracic carapace, of such size and strength as to raise considerable doubt as to their true nature. The existence of five thoracic limbs, exclusive of these, projecting from beneath the carapace on one side would seem to place their pedal nature out of the question, while their great development would indicate that they had served some purpose other

* 'Arch. Naturg.,' xlvi. (1880) p. 102.
† 'Ann. and Mag. Nat. Hist.,' iv. (1879) pp. 115, 118, and 458.
‡ 'Am. Journ. Sci.,' xix. (1880) p. 33.

than simple antennæ, and to raise the question as to the possibility of their having been chelate at their extremities. As only the basal portions of these organs are, however, represented, this question cannot be satisfactorily determined.

The name of *Palæopalæmon* is proposed for it. It is characterized by a shrimp-like body, with a thoracic carapace narrowed but not rostrate in front, and keeled on the back and sides. Abdomen of six segments terminated by an elongated, triangular and pointed telson; segments arched; pleura smooth, not expanded nor lobed; their extremities rounded. Sixth segment bearing caudal flaps, one on each side, composed of five visible elements, the outer four apparently anchylosed to form a single large triangular plate on each side of the telson. Thoracic ambulatory appendages elongated, smooth and filiform, except the upper (second) joint, which is laterally compressed. Abdominal appendages short, the upper joints flattened or convex anteriorly, as if for the attachment of plates or fimbria. Antennæ with the basal joints strong and well developed, of large size, much exceeding in strength any of the thoracic limbs. Eye-peduncles short. Type *P. Newberryi* Whitf.

This the author believes to be the most ancient Decapod crustacean yet recognized, and on that account alone is of great interest.

The earliest form previously described is Mr. Salter's * *Palæocrangon socialis*, said to be from the lower carboniferous limestone of Fifeshire. There is another supposed Decapod, *Gitocrangon*, noticed by Richter † from the Upper Devonian, which is mentioned by Salter, but of which he says he is doubtful if it be a crustacean at all.

Blind Amphipoda of the Caspian Sea.‡—Dr. O. Grimm is led by the discovery of some of these forms in the Caspian Sea, to make some interesting remarks on the extent of the blindness of blind animals and of the modifications undergone by other sense-organs in connection with the loss or impairment of sight.

The problem of the origin and evolution of blind animals has, as he points out, occupied much attention of late, and two opposite opinions prevail which cannot be reconciled. Twenty years ago one might have been contented with the view that creatures were created blind because they were intended to live in the dark, so that the faculty of sight was unnecessary. Nowadays, however, this notion is supported by few; the great majority of naturalists recognize in the absence of eyes the result of a residence in darkness by which the visual organ must certainly retrograde, as it is not made use of. Besides Fries' experiment with *Gammarus pulex*, it is well known that persons who have lived for years in dark prisons have lost the pigment of their eyes, as also that in many blind people the optic nerve has disappeared, i. e. is transformed into a mass which contains no visual nerve-fibres.§ Thus it appears very natural that animals which

* 'Quart. Journ. Geol. Soc. London,' xxii. (1861) p. 531.

† 'Beitr. Paleont. Thüring.'

‡ 'Arch. Naturg.,' xlvi. p. 117. Transl. in 'Ann. and Mag. Nat. Hist.,' v. (1880) p. 85.

§ Stricker, 'Studien über das Bewusstsein,' p. 54.

live in dark caves and depths of the sea, or in the earth itself, should lose their power of vision, their eyes being reduced to almost nothing.

But we know that in the depths of the sea where some eyeless animals occur, whose deprivation of eyes is explained by the darkness prevailing, there also exist forms which have not merely ordinary eyes, but unusually developed, large, prominent, and deeply pigmented eyes. The *Gnathophausia* of the 'Challenger' expedition, from 1830 to 4020 metres, actually possesses pedunculate eyes, and, besides these, ocelli on the maxillæ; the *Memida*, from 1000 to 1200 metres, has well-developed and exceedingly sensitive eyes; while *Gammaracanthus caspius* from 108 fathoms, *Boeckia spinosa*, *nasuta* and *hystrix* from 70 to 150 fathoms in the Caspian, and various species of *Mysis* from the same sea and from depths down to 500 fathoms, all have well-developed, large, prominent, and black pigmented eyes. This sufficiently proves that at these depths the visual organ is made use of, as here absolute darkness does not prevail, but more properly only a dark night. We have only to remember that nocturnal animals such as owls, predaceous mammals, &c., possess very large and well-developed visual organs (in fact, eyes adapted to the darkness), to explain the established fact that the depths of the sea are inhabited by Crustaceans in which the visual faculty is enormously increased. But seeing that, as has been said, forms of animals also exist in the same abysses whose eyes are but slightly developed or unpigmented, or even appear completely reduced to a rudimentary condition, it is evident that the explanation that the retrogression of the eyes is produced by living in the depths of the sea is not sufficient.

In the Caspian Sea, Dr. Grimm obtained fifteen new species of Gammaridæ (*Gammarus pauxillus*, *G. crassus*, *G. Gregrokowii*, *G. portentosus*, *G. coronifer*, *G. thaumops*, *Pandora cæca*, *Iphigeneia abyssorum*, *Gammaracanthus caspius*, and *Amathilinella cristata*), all of which are furnished with eyes, but in very different degrees of development: thus *G. caspius* has very large round eyes, *G. coronifer* and *Amathilinella cristata* long but narrow eyes, *G. thaumops* triangular unpigmented eyes, and *Pandora cæca* small unpigmented eyes, which can hardly be endowed with the faculty of sight.

Five other species (*Onesimus caspius*, *O. pomposus*, *O. platyuros*, *Pantoporeia microphthalma*, and *Niphargus caspius*) furnish even a still better illustration that eyed and eyeless may live together. Thus *Pantoporeia macrophthalma* and *Niphargus caspius* have pigmented but small eyes. Of the species of *Onesimus*, some have red, others (*O. caspius*) perfectly unpigmented eyes, which in the latter species at least are altogether deprived of the power of sight; with these more or less blind forms, there live a number of Mysidæ, the large, well-developed eyes of which certainly absorb sufficient light even in the darkness of the depths.

It having been shown that deep-sea existence alone does not of necessity cause the retrogression of the visual organs, the author proceeds to show by what the disappearance of the eyes is essentially brought about and by what they are replaced. Whilst admittedly the quantity of light is very small, at a certain distance from the surface it never falls to zero, so that the possibility of vision is not excluded, and the eyes of animals need only to be adapted to the comparative darkness. This appears to be the case with the Caspian Mysidæ, *G. caspius*, *Boeckia*, &c. It is, however, conceivable that in many animals the eyes do not become developed in the persistent darkness, and are replaced by other organs of sense. In the latter case the eyes may even become degenerated, and the more rapidly and completely the less they are used, the less the service they are capable of rendering to their possessor.

Niphargus caspius, for example, has comparatively very highly developed organs of smell and touch on its antennæ, and these are more numerous in the male, in which the eyes are smaller than in the female. These organs may enable the animal to dispense with eyes in the dark depths it inhabits, and they are thus in course of degeneration, although they have not yet completely disappeared—in part perhaps to be made use of in ascending to 35 fathoms. *Onesimus caspius* has highly developed though concealed gustatory and tactile cylinders developed on the maxillipedes; but no sense-organs on the antennæ and other external parts of the body as in *Niphargus*.

Thus we see that in these two genera the defective faculty of sight is replaced by the augmented functions of other organs, and even brought about thereby in so far as these render the eyes not indispensable and their retrograde metamorphosis therefore possible. How it happens that in the different genera different organs come to greater development depends on the external conditions and mode of life of the animal, which are to be looked upon as the *primum movens* in the process of the degeneration of the one and development of the other organ. Thus whilst *Niphargus* swims freely in the water and not in the mud, *Onesimus* burrows about in the muddy bottom. Antennæ with sensitive organs are of no use, therefore, and the more concealed parts of the body had to be provided with such organs.

Systematic Arrangement of the Platyscelida.*—Professor Claus proposes the following arrangement of these aberrant Amphipods, in the study of which he has been engaged for some time:—

A. Body broad and compressed; abdomen narrowed and folded under the thorax. Femoral plates of the fifth and sixth thoracic appendages form broad plates.	1. Abdomen much shortened, and completely folded. Mouth organs broad and compressed. *Typhidæ.* 2. Abdomen not so short and less completely folded under the thorax. Mouth organs elongated. *Scelidæ.*
B. Body elongated, and more or less compressed. Abdomen elongated and never more than incompletely folded under the thorax. Femoral plates smaller and more elongated.	3. Body more or less compressed, abdomen greatly developed and half folded. Femoral plates of the fifth pair of legs large, of the sixth pair greatly broadened. *Pronoidæ.* 4. Body hyperioid in form, abdomen as in 3. Femoral plates of fifth and sixth pair of legs triangular and similar. *Lycæidæ.* 5. Body elongated, abdomen large not folded. Femoral plates of fifth, sixth, and seventh pair of legs triangular, thin, but of some size. *Oxycephalidæ.*

* 'Arbeit. Zool.-Zoot. Inst. Würzburg,' ii. (1879) p. 147.

The families are defined, and the genera and species described in order; of forms new to science are *Eutyphis armatus* (very common in the Atlantic and Indian oceans); *E. serratus* (Zanzibar and Messina); *E. globosus* (Messina); *Hemityphis terminanus* (Atlantic Ocean, Cape of Good Hope); *H. crustulum* (Zanzibar); *Paratyphis maculatus* (Atlantic); *Tetrathyrus forcipatus* (do.); *Amphithyrus bispinosus* (Atlantic); *A. sculpturatus* (do.); *A. similis* (Messina); *Tanyscelus spheroma* (Zanzibar); *Parascelus Edwardsi* (Atlantic); *P. typhoides* (Messina and Naples); *P. parvus* (Atlantic); *Schizoscelus ornatus* (Atlantic); *Euscelus robustus* (Zanzibar); *Eupronoë maculata* (Zanzibar); *E. armata* (Atlantic, Zanzibar); *E. minuta* (Southern Seas); *Parapronoë constulum* (Atlantic, Zanzibar); *P. parva* (Zanzibar); *Thamyris globiceps* (Zanzibar); *Lycæa nasuta* (do.); *L. similis* (Lagos); *L. serrata* (Bengal); *L. robusta* (Mediterranean); *Paralycæa gracilis* (Hab. ?); *Pseudolycæa pachypoda* (Messina, Zanzibar); *Lycæopsis themistoides* (Mediterranean); *Oxycephalus similis* (Messina); *O. latirostris* (Lagos); *O. longiceps* (Zanzibar); *O. typhoides* (Zanzibar, Messina). As will be observed, many of the later genera are also new.

The forms contained in this group appear to exhibit a very considerable degree of variation in the characters of many of their organs, and in their external forms there are all stages between the broad and rounded Typhidæ, and the elongated, rod-shaped Oxycephalidæ (e. g. *Rhabdosoma*—a name well suited to describe the creature's form).

Anatomy of Caprellidæ.*—Dr. Hoek, in an article on the anatomy and classification of the Caprellidæ (a subject to which Gamroth† has been lately directing his attention), points out what no previous observer seems to have noted—the presence of concentrically striated plates of small size, which are to be found in *Caprella linearis*, between the chitinogenous tissue and the chitinous investment; varying in form and size, they are best seen in adult specimens. Nor does any mention seem yet to have been made of the canaliculi which are to be found at the ends of the second pair of thoracic appendages. With regard to these, the author is of opinion that they are the canals of integumentary glands; but the glands themselves he was never able to find in *C. linearis*.

Dr. Hoek then deals with various points on which more or less different reports have been made; among these, perhaps the most interesting is the relations of the generative orifice. Berzelius, Sars, and Huxley state that it is found on the ventral surface of the last ring of the thorax; and the latter has directed attention to the fact that in the Decapoda (lobsters, crabs, &c.) the orifice is to be found on the first (or basal) joint of the appendage. Now, in *C. linearis* Hoek finds lateral processes on these basal joints, which meet in the middle line of the body. He is not absolutely certain that these processes belong to these joints ("coxæ"), and he comes to the conclusion, further, that the copulatory pouches of the female are appended to the ventral surface.

Into the systematic points with which the author carefully deals

* 'Tijdschr. Nederland. Dierk. Vereen,' iv. (1879) p. 97.
† See this Journal, ii. (1879) p. 715.

we have no space to follow him. Nor can we say much as to his account of the Corophida; a new genus, belonging to the subfamily Podocerinæ, is described—*Orthopalame* (*Terschellingi*)—which was found at the island from which it takes its specific name; and the following species are stated to be members of the Netherland fauna—*Corophium longicorne*, *C. crassicorne*, *Cerapus difformis*, *Orthopalame Terschellingi*, *Amphithoë littorina*, and *Podocerus falcatus*.

In the basal joints of the third and fourth pairs of thoracic feet the author has found glands which may, perhaps, like somewhat similar glands in the Phronimida,* be poisonous in function; they do not seem to have been hitherto noticed by any observer.

Cyclops.†—According to Mr. M. M. Hartog, the nervous cord of *Cyclops* is essentially Copepodan in type; it is not distinctly dilated into special ganglia containing cells evenly distributed up to the third thoracic segment, which is here continued by a fibrous commissure to a ganglion in the next segment. Beyond this are no cellular elements in the cord, which bifurcates in the second abdominal segment, and the branches terminate in the furca. The sensory and motor nerves appear to be wholly distinct, the latter coming off at a higher or deeper level. All the sensory nerve-fibres pass through a bipolar ganglion-cell near their distal termination. Minute, rounded spaces in the hypoderm, especially one at the base of the last thoracic limb, and a pair on either side of the upper face of the front of the head, appear to be auditory organs (containing one or more minute, irregular, highly-refractive corpuscles in the male). Respiration in Cyclops is entirely anal.

Lernanthropus—one of the Copepoda.‡—A paper on this subject, by Carl Heider, took its origin in the discovery by Professor Claus of the male of *L. trigonocephalus*, which was hitherto unknown, and of a remarkable form of receptaculum seminis in the female of *L. Gisleri*. The latter species is very commonly to be found on the gills of various fishes, and especially of *Labrax lupus*, *Umbrina cirrosa*, and others. The males are but rarely found, and are always attached to the females.

The genus appears to afford support in a very interesting manner to the views of Professor Claus on the genealogy of the Copepoda. A phylum of the Entomostraca, they became adapted to locomotor habits and a pelagic life; but while some exhibited a higher development of the nervous system and of the sensory organs, others took to commensal or parasitic habits, and underwent the degradation with which these are accompanied. In *Cyclops* we find the second pair of antennæ converted into anchoring organs by which the creature fixes itself to plants. In the Corycæida parasitism is not obscurely indicated by the changes in organization, and we are, through them, led to the true parasitic Copepoda, in which the body has undergone so remarkable a change; the segments of the abdomen disappear,

* Mayer; see this Journal, ii. (1879) p. 719.
† 'Rep. Brit. Assoc. Adv. Sci.', 1879, p. 376.
‡ 'Arb. Zool. Inst.' (Claus), ii. (1879) p. 269. (5 plates.)

the abdomen forms a mere appendage to the end of the body; the thorax too ceases to present distinct segments, though the thoracic appendages are still retained. In *Lernanthropus*, though retained, they are considerably metamorphosed; the first two pairs only present the characteristic Copepod form, the other two (or three) are converted into merely tubular appendages or lobes; the cephalothoracic region is divided by a deep groove which separates the antennary from the post-antennary portion, and which is probably due to the mode by which these parasites attach themselves to their hosts.

The *body* has an elongated, ellipsoidal form, and all indications of regular segmentation are lost, though it is still divided into a number of parts by transverse grooves; of these the most anterior carries the two pairs of antennæ, together with a pair of processes with broad bases, but rapidly narrowing, and of some length. Behind the base of the first pair of antennæ and in the middle line there are four dots arranged in trapezial form, which are the seats of four tactile setæ. This division of the body is connected with the succeeding one by a rod-shaped thickening of the carapace (articular rod), which is so placed as to hinder considerably any lateral movement of the parts on one another or any bending upwards of the anterior one. The next division of the body consists of the fused remaining cephalic and the first thoracic ring; to this the mouth organs and the first pair of rudder-feet are attached. Now follow the fused segments of the thorax, and to them is attached the small abdomen. This region is longer than either of those in front of it, and carries the second pair of rudder-feet, and the two or three metamorphosed thoracic appendages already mentioned; the anus opens at the hinder end between the two processes of the characteristic Copepod furca. The colour of the animal varies between a dark reddish yellow and a deep reddish brown; but there are individual as well as specific differences in coloration.

Owing to their habits the creatures exhibit not only atrophy in the segmentation of the separate appendages, but a loss of all hairs and setæ, while the mouth organs are converted into sucking and stabbing organs. The second pair of antennæ are seizing parts, and consist only of two joints each, the second being a hook-shaped claw. The mandibles are enclosed in the proboscis formed by the paragnathi, which are elongated and considerably thinner at their extremities than at their base. We have not the space to follow the author through the details of the succeeding appendages, nor through his account of the chitinous carapace, which appears to be endowed with a very fair degree of elasticity.

Notwithstanding their parasitism the *nervous system* is very well developed; and it is possible to distinguish the supra- from the sub-œsophageal ganglionic mass. From the former there are given off nerves for the antennæ and for the anterior portions of the head; the latter supplies the mouth organs and limbs; but it is scarcely possible to speak of a ventral ganglionic cord, and it seems to be more appropriate to give the name of ventral *nerve* cord to the two nerves which pass backwards in the middle line from the sub-œsophageal ganglion. With the superior mass a trifid eye is connected, which is placed in a depression of the body and is unpaired; the three constituent parts (simple eyes) are placed one on either side of a median one; in each of these it is possible to distinguish a crystalline lens and an internal portion filled with a very dark colouring matter; each "optic cell" is surrounded by a pretty firm integument; but it is still impossible to say how it is innervated, for as it lies directly on the tip of the most anterior portion of the supra-œsophageal ganglion, it seems impossible to speak of any proper optic nerve. The nerve-relations of the first pair of antennæ are, however, sufficient to demonstrate their sensory function; nerve-fibres pass into the tactile processes with which these structures are supplied, and just before they so enter, the fibre is connected with an ovate or spindle-shaped cell. The caudal furca has a very similar nerve supply. Another set of sensory organs are to be found in the tactile setæ which are scattered over the whole of the body; these are solid hairs, generally provided with a number of processes, and connected by a duct running through the carapace into the subjacent tissues; this duct is filled with a granular protoplasm, in which a rounded or somewhat oval nucleus may be distinguished, and there is supplied to it a delicate filament which is apparently a nerve-fibre.

Other organs of less evident function remain to be considered. On the inner side of the basal joint of the second pair of maxillipedes there is a small elevation, which is covered with small, closely-set hooks. Careful observation is necessary before one can detect in the midst of these a delicate, sharply-ending process. The author compares their arrangement with what was seen by Vejdovsky in *Tracheliastes*, and taken by that observer for a sensory organ; but in neither case was it possible to detect the entrance of any nerve-fibre. On the ventral surface of the cephalothoracic region there are two pairs of processes; one set are elongated and are covered by a fine and delicate integument, while they contain the same granular ground-substance as the other processes already described; the second set are irregularly knob-shaped or pyriform, their investment is no thinner than that of the surrounding parts, and there are no definite ducts; their whole surface is merely covered with closely-packed, fine hairs, altogether similar to those found over the whole of the carapace. The cavity of the process is filled with a number of small, spindle-shaped cells not unlike those found in the first pair of antennæ, and continued into processes which are more distinctly seen in the stalk of the pyriform enlargement; it can only be said that they are apparently nerve-fibres.

The most striking portions of the *muscular system* are the dorsal and ventral longitudinal cords, some of which extend along the whole length of the body, while others are attached to different regions; the muscles for the limbs, which are often very well developed, arise from the sides or back of the carapace, while the separate joints are moved on one another by special muscles; other bundles are connected with the digestive tract, and serve to compress or enlarge its lumen.

The *enteron* runs straight from the mouth to the anus, and is not provided with any appendages or cæca; the œsophagus, which traverses the ganglionic mass, is narrow; the succeeding portion is widened out, while the rectal region is diminished in size; the walls are bright yellow, owing to the colour of the epithelial cells; the contents are of course fluid, and their reddish coloration is probably due to the blood they have sucked; the enteric tract exhibits movements which, almost rhythmical in order, have the character of waves of contraction, and pass from before backwards, and then from behind forwards. The anus has the form of a cleft set along the longitudinal axis of the body.

With regard to the *vascular system*, which can only be properly studied in the living animal, little is yet known, though Professor van Beneden has made a number of observations on the subject.* It differs from any arrangement yet described as obtaining among the Copepoda, inasmuch as there is a widely distributed system of closed vessels, which have no direct connection with the spaces of the cœlom. There is no heart, but below the enteron there are two longitudinal vascular trunks, and above it a single one, which runs between the paired generative glands: the bright red fluid in these vessels is driven forwards, in the ventral trunks, by the movements of the intestine, every contraction of which propels a fresh wave of blood; while it takes a backward course in the dorsal vessel after having supplied the various appendages. The contained fluid is not provided with any kind of corpuscle, but only fine granules, and here and there a small spherule; many of the smaller vessels end blindly, and the blood must therefore return by the same course as that by which it went to the peripheral portions of the body. The blood supply is especially rich in the lobate processes of the body, which are formed by the metamorphoses of some of the hinder appendages, which appear therefore to have taken on the function of respiratory organs.

The *generative organs* are always paired, and consist of two glands lying above the anterior portion of the enteric tract; their ducts and the orifices of the ducts are likewise paired; the ovaries are closely approximated to one another, and consist of a much-coiled tube on either side, which passes at its anterior extremity into the oviduct; this is very wide, and is as a rule found to be filled with large ova; it is a good deal coiled, and towards its hinder end gives off a large cæcal branch; at the end of the duct, the duct of the cement-gland, the seminal vesicle, and the connection with the spermatophore open into it. Not rarely a viscid secretion is found in the cement-gland. The seminal vesicle (receptaculum seminis) is unpaired, and extends some way forwards, but its neck divides into two passages, one for either oviduct. This last is narrowed near its orifice, which is placed on a small brown projection at the side of the abdomen. The organs of the male were carefully described by Professor Claus in 1858; the testes, like the ovaries, lie in the anterior portions of the thorax, are elongated and pyriform, and so

* Cf. next note.

closely placed to one another that they almost seem to be fused. The seminal duct after passing some way backwards returns upon itself, and then bending outwards passes into a looped outer portion; at the lowest part of its course it has connected with it the so-called pouch of the spermatophore; it then narrows, and opens by an elongated cleft at the side of the abdomen.

As to *histological details:* there are three kinds of gland-cells in the unicellular glands which are so common in this creature; the first, which are found in the matrix of the whole body, and are especially numerous in its lobes and projections, are of a considerable size, invested by a strong membrane, while the distinct nucleus is surrounded by a highly granular plasma, in which a mass, apparently the result of secretion, may frequently be found; the duct of the gland has a funnel-shaped orifice through which it passes to the delicate duct which traverses the carapace. These are the *tegumentary glands.* The second set is not so numerously represented or so widely distributed as the first; they are found on the lateral margin of the dorsal lobes of the female, either singly or in pairs; the cells have clear, highly refractive contents, and the nucleus is small. The third set of glands are found in the cephalothoracic region, and are of great size; the granulated contents are not all similar, for large granules may be seen in the finer ground substance, and the nucleus, which is very large, is especially remarkable for being broken up into a number of pyramidal pieces, which are set in the fashion of a rosette. Although the author was enabled to detect the efferent duct, he did not succeed in tracing it through the whole of its course. The lobes already referred to contain a distinctive form of tissue; in addition to the ordinary connective tissue, there are supporting fibres which appear to add to the consistency, and to increase the elasticity of the structures in question; further investigations require to be made before their essential characters can be said to be known.

The young larvæ escape from the egg in the Nauplius stage. The genus is remarkable for the fusion of the first thoracic ring with the cephalothorax, for the fusion of the remaining thoracic segments into one piece, and for the diminished size of the posterior locomotor feet and of the abdomen. The species differ from one another in the characters of the lobate appendages of the body, and in the relation of the various parts of the body to one another; the greatest differences in form are to be found in the females. Nineteen species are known; in eighteen cases the female, and in ten the male has been observed; the author gives a key to these, which is followed by an account of each; his own researches do not appear to have resulted in the discovery of any new forms.

Red-Blood Vascular System of certain Crustacea.*—In connection with the preceding note, Professor E. van Beneden states that he first made some observations on this subject so long ago as 1868; he then found that when the foliaceous organs (lobes of Heider) are carefully

* 'Zool. Anzeiger,' iii. (1880) p. 35.

examined, they will be found to be coloured brightly red, to contract rhythmically, and to lose their colour at each contraction; the cause of this coloration was the presence of a system of vessels containing a red liquid. When more carefully examined and subjected to a higher magnification, it was found that under the integument of these organs there was a wide-spaced network, and immediately below this there were the vessels; these latter have thin, but distinct, walls, in which here and there a fusiform nucleus can be distinguished; the liquid contents of the vessels are, in thin layers, coloured reddish yellow, and when seen in mass, bright red. In the "perivascular spaces" there is a colourless liquid which contains amœboid cells and granular bodies of various sizes. Both these liquids are expelled when the organs contract, and the movement is so rapid that it is impossible to detect how it is accomplished. As the organs recover their former size, the lacunar fluid is the first to return. We have, then, in these Crustacea, just as in most Annelids, a lacunar hæmal system and a red-blood system; the differences between the contents of the two are alone sufficient to show that there is no connection between them.

In the succeeding year Prof. van Beneden found similar, but more simple, arrangements in *Congericola* and *Clavella;* in the former there are four longitudinal ventral trunks, and the two on either side present numerous transverse anastomoses; in this creature the only vessels found were relatively very large; the lumen of their tubes was observed to be, for a brief period, effaced, as if a kind of peristaltic contraction was being effected. The observations made by the author in Brazil, on some undetermined species of *Lernanthropus*, appear to confirm M. Heider's results; in active specimens the foliaceous appendages were observed to contract rhythmically from six to ten times a minute, and the elasticity of the cuticle was seen to aid in restoring the organ to its original condition of extension. Previous, however, to his visit to Brazil, M. van Beneden made the highly important observation that the colouring matter of the vascular fluid was identical with the hæmoglobin of vertebrate animals.

No similar circulating system is to be observed in any other Arthropod, so that while we are debarred from regarding the arrangement found in *Lernanthropus* as being derived from the vascular system of the annulate worms, we have afforded to us a very interesting example of morphological independence, notwithstanding the marked similarity of histological details and physiological duties. Nor can the red blood of the annelid be regarded as the strict homologue of the blood of the Vertebrata; it can only be compared to the red blood-corpuscles of the latter, inasmuch as it never passes out of the vessels in the way in which the corpuscles of the Vertebrata do; M. van Beneden proposes, therefore, the following nomenclature; the whole vascular system of the annelid should be known as the *hæmatic system*, the fluid of the body-cavity as the *plasmatic fluid*, while the cavities in which it circulates make up the *plasmatic system*. The presence or absence of this system either in Crustacea or in Annulata is regarded as due merely to differences in histological differentiation;

the vessels appear to be formed from the vasoformator cells of the connective tissue, some of which cells are converted into hæmoglobin. When such a cell loses its fusiform appearance and becomes free, it constitutes a red blood-corpuscle; if it gives up its hæmoglobin to the plasma it preserves its ordinary character, and the plasma becomes red.

Unobserved Organ in Sapphirina.*—Dr. Ficker describes an abdominal organ which, placed in an internal canal and invested by a protoplasmic coat, opens to the exterior by a vesicular enlargement at the hinder edge of the furca. Placed at the sides of the enteric tract and paired, it has the same character in both males and females. It generally commences in the third abdominal segment, and appears to have its canal enclosed in a syncytium containing clear nuclei and large nucleoli. The author is of opinion that these glands have a secreting function, but as he has no physiological evidence to offer, he follows the advice of Professor Leuckart, and applies to them the name of *furcal glands*. Further observations are necessary to show whether they are or are not confined to the *Sapphirina*, or are to be found in other Copepoda also.

Ostracoda in Tree-tops.†—Dr. Fritz Müller points out that it is not altogether to be wondered at that the Bromeliaceæ, considering the many hiding-places and the abundant supplies of food furnished by their leaves, should harbour a host of animals, including larvæ of insects, all stages of the beetles peculiar to them, and even tadpoles of tree-frogs which here pass through their transformations.

But a much more extraordinary fact is the occurrence in the tops of these plants of a minute crustacean, to be called *Elpidium Bromeliarum*, whose allies are chiefly marine forms. The species for which the author has established this genus—named after *Elpe pinguis* of Barrande, from the Silurian rocks, and resembling it entirely in form, though not in size—belongs to the Cytheridæ, essentially a marine group. In external appearance it differs remarkably from the other members of the family; the breadth of the shell is much greater than its height, and the ventral side is flat and the valves cleft on this side by a longitudinal furrow, the *tout ensemble* being that of a coffee bean: the length is about 1·5 mm. The shape of the shell adapts it for moving along the smooth broad leaves and for alighting on its lower surface after falling, a purpose served in the other Cytheridæ by the flattening of the lateral surfaces. *Elpidium* is found to as far as 60 miles inland, and its transmission from tree to tree must be due, not to its own efforts but to beetles (*Agabus*, *Hister*, &c.); which may well be, as the young on leaving the mother are only ·2 mm. long; but the fact of almost every *Bromelia* containing these animals is startling, seeing that they thus appear to owe their presence there to chance alone. It has hitherto been taken in no other position, although the neighbouring pools contain a variety of other Crustacea (as *Cyclops*, *Cypris*, *Chydorus*, &c.), so that the *Bromeliæ* seem to constitute its only locality.

* 'Zool. Anzeiger,' ii. (1879) p. 515. † 'Kosmos,' iii. (1880) p. 386.

New Family of the Lernæida.*—In his classical work on the Crustacea, M. Milne-Edwards divided the Lernæida into three families: Chondracanthida, Lernæopoda, and Lernæocera; M. Hesse finds as a result of his researches on a new form (*Stylophorus hippocephalus*, from the nasal cavity of *Raja rostrata*) that it is necessary to form a fourth, the Lernæopalmida. The male is not known, but the females are fixed to their prey by means of a pair of brachiform thoracic appendages which are very long and completely separate; their superior extremity is terminated by cartilaginous palmar membranes which are so united as to seize and hold fast a small cartilaginous band which is drawn into a point at the two lateral extremities. The brachiform appendages penetrate for their whole length; and the "hippocephalic" head has two large lateral eyes; the sucking organs are retained within the mouth. The body is pyriform in shape, large, and flat; it is terminated by a central boss, on either side of which there projects a long cylindrical and recurved tube. The ovigerous tubes are long and large.

The animal is 5 cm. long, and this great size M. Hesse associates with the length (2 metres) and weight (100 kilogrammes) of its host; it is probable that it penetrates the resistant muscles of the nasal cavity by so using the "osselet" or band between its brachiform appendages as to give to it a gyratory movement, and so to bring into use the points at either end. The first specimens which came into the author's hands were mutilated, and at first he only observed that the appendages were so arranged at their terminations that they seemed to be adapted to hold something firmly; a careful examination revealed a small "osselet" of cartilaginous substance and rectangular in form, placed within the narrow rounded hole which these creatures form in the nasal muscles of their host. More perfect examples revealed the relations of this body which had its ends so disposed as easily to recall to the mind the arrangements of an anchor, and M. Hesse found that the creature attached its arms to this band of cartilage, but that when it was touched it quickly leaves go of it, and contracting itself very rapidly withdraws its body from the cavity it has itself formed.

The head appears to be even more like that of the horse than is the anterior end of *Hippocampus*, and this resemblance is not a little aided by the two large lateral eyes; the presence of these eyes is sufficiently remarkable inasmuch as in allied forms the females are ordinarily eyeless, and when such organs are present they always occupy a median position. The ova are not extruded until they have been provided with three pairs of appendages, and it is only after they become free that the rotatory organs take on the characters peculiar to the parasite.

Vermes.

Optic Organs of Free-living Polychætous Worms.†—Professor Gruber finds as a result of his comparative investigations that in all the Chætopoda which he examined the eye, howsoever much it may

* 'Ann. Sci. Nat.,' viii. (1879) Art. No. 15.
† 'Archiv. Mikr. Anat.,' xvii. (1879) p. 243.

vary in size and in external characters, is always formed on a common type; it generally has a spherical form and consists of two principal portions—an outer, which is nothing more than a modification of the general cuticular investment, and which forms the dioptric organ, and an inner part, which is directly connected with the nervous system and forms the perceptive organ or retina. There is no proper sclerotic, but the retina is invested by a thin cuticle which is a continuation of the cerebral capsule. The first or tegumentary portion may be cuticular or hypodermal: the former is relatively highly homogeneous and pellucid; not only is there no cuticular cornea developed but in *Nereis* the cornea is even thinner than the surrounding integument. The hypodermal portion, which the author proposes to call the *dioptric intermediate body*, is distinguished by its great transparency and its considerable power of refracting light; further than this we can make out two different forms, inasmuch as the body may be (as in *Nereis*, *Aphroditis*, *Polynoë*, &c.), a portion of the hypodermis which consists of radially arranged tubular cells which increase in length from the periphery towards the axis, and have their nuclei placed at the basal or retinal end; in the others the central portion of the body is occupied by a homogeneous cuticular structure which appears to form the lens proper; the cells set around it and investing it are the corneo-epithelial cells, while the lens itself is either plano-corneal (*Eunice*) or convex-corneal (*Alciope*). It consists of a homogeneous mass which appears to be gelatinous rather than chitinous in character. In *Alciope* the lens consists of three concentric layers, of which the outermost is granular and appears to be the softest; on the other hand, in *Nephthys* the granular matter occupies the central portion.

The *retina* has the form of a goblet hollowed out in the middle; merely the terminal outspreading of the optic nerve, it consists of two parts continuous one with the other; internally there is a layer, generally very thin, of optic fibres, and an outer, thicker, palisade layer. The elements of this last are tubes which are generally prismatic in form, and are continuous internally with the optic fibres, while externally they are attached to the limiting membrane. That the constituent bodies are not histologically elementary organs is shown by the fact that they contain two nuclei at least; in some, e. g. *Eunice* and *Alciope*, there is, further, a median retinal nucleus, and the wall of the tube between this and the outer nucleus is considerably thickened, is highly refractive, and is composed of alternating lamellæ with different refractive indices; this portion, which may well be known by Greef's name of "tube-rod," always contains a granular pigment which is black when present in considerable quantity.

When we compare the parts here described with the arrangements that are found among the Tracheata we see that we have to do with *homotypical structures;* the only difference, and this is not constant, is that in the Tracheata the rod forms an axial, while in the Chætopoda it is a parietal portion of the retinal tube. At the same time it is to be noted that, notwithstanding this homotypy, the eyes of these two groups can only be regarded as highly analogous structures, for the great variations in the number and disposition of these organs lead us to question how far it is possible to demonstrate their homologous nature, even within the limits of each separate phylum; there is, for example, no evidence which justifies us in regarding the eyes of spiders and of imaginal insects as strictly homologous. The author concludes by pointing out that the eyes of the Cephalopoda present analogous arrangements.

Chætopoda of the Virginian Coast.*—Mr. Webster gives an account of the Chætopod Annelids collected by the zoological expeditions sent out in 1874 and 1876 by Union College; fifty-nine species were obtained, which belonged to forty-nine genera and twenty-three families. The following forms new to science were obtained:—*Lepidonotus variabilis*; *Antinoë parasitica*; *Lepidametria commensalis* (this is a new genus allied to *Halosydria* and to *Lepidasthenia*); *Phyllodoce fragilis*; *Eumida maculosa*; *Syllis fragilis*; *Sphærosyllis fortuita*; *Pædophylax dispar*; *Procerœa tardigrada*; *P.?* (*? Autolytus*) *cærulea*; *Nereis irritabilis*; *Drilonereis longa*; *Staurocephalus sociabilis*; *Spiochætopterus oculatus*; *Nerine heteropoda*; *Polydora hamata*; *P. cæca*; *Aricia rubra*; *Aricidea fragilis* (nov. gen. et nov. spec.); *Labellaria varians*; *Pectinaria* (*Lagis*) *dubia*; *Melunia maculata*; *Lysilla alba*; *Potamilla tortuosa*. Two new genera *incertæ sedis* are also formed; one for a specimen in which the sides of the head are produced into thin plates, which are covered with papillæ, *Cabria incerta*; in the other the head is divided into palpi, and the elongate body is flattened and composed of a number of segments, *Phronia tardigrada*.

Adaptation and Mimicry in the Turbellaria.†—M. Paul Hallez states that *Leptoplana tremellaris* is able so to contract itself when the stone that hides it is turned, and is so capable of taking on the character of surrounding bodies, that while he, with an educated eye, has in a day taken twenty specimens, some of his friends have only found two or three. *Hyphostomum viride* and other forms which contain chlorophyll-granules in their integument live among fresh-water confervæ. At Wimereux there are two species of *Vorticeros*, one of which is yellow, and lies among Bugulæ or Campanulariæ, and the other red and a dweller among red algæ. *Planaria nigra* is best found where deposits are black and putrid, and the same is the case with *Mesostomum personatum*. The more or less transparent species, such as *M. lacteum*, live on stones or plants, but are protected by the colour of the object which supports them shining through their bodies.

It very ordinarily happens that the change in colour is accompanied by other modifications; taking the case of *Vorticeros*, we find that *V. pulchellum*, which lives at greater depths than *V. Schmidtii* (nov. sp.) is provided, as is so frequently the case in pelagic as compared with littoral species, with two long tentacles. Among the *Planaria*, *P. nigra* and *P. fusca* have fresh-water varieties. The

* 'Trans. Albany Inst.,' ix. (1879) p. 202 (11 plates).
† 'Rev. Internat. Sci.,' iv. (1879) p. 362.

presence of tentacular organs in forms living in running water is regarded as an indubitable advantage, inasmuch as these parts are extremely sensitive, and it may well be said that the service they render is in direct relation to their length. The author is, further, of opinion that the food of these creatures is a factor in their protective arrangements, by exerting a direct influence on the colours of their integument, and he illustrates this by the case of *D. lacteum* which he fed largely on the larvæ of *Chironomus*, and in which he found that the gastric diverticula became red, and that this tint extended in time to the reticular tissue of the body. So too there is the case of *Dinophilus vorticoides*, which is coloured a bright red, but in which the colour is not regularly distributed, but is found best marked in the greatly sacculated stomach; this may be easily explained by a reference to the food of these creatures, which consists largely of diatoms and of the debris of red algæ.

Land Planarians of Germany.*—Dr. Kennel, after paying a well-deserved tribute to the labours of Mr. Moseley, discusses the grounds on which *Rhynchodesmus terrestris* O. F. M. and *Geodesmus bilineatus* Metschnikoff are regarded as part of the fauna of Germany. No one can have much doubt as to the habitat of the first, but it is possible that some naturalists would hesitate more than does our author in regarding the second as indigenous to Germany. These creatures appear to subsist on animal food principally. The author deals chiefly with anatomical details, inasmuch as Moseley's histological results are so complete; with regard, however, to the cilia with which these animals are ordinarily considered to be covered, he points out that Moseley's result in which sections only revealed cilia on the ventral surface, can be paralleled by other members of the same group in which cilia are most certainly distributed over the whole surface of the body; and he supposes that at death the strongly developed rods in these creatures, obscure the discrimination of the cilia. The epidermis on the ventral surface is different in character to that found in other parts, for it consists of regular low cylindrical cells between which there are no unicellular glands nor any rods; on either side of this ventral portion (*Sohle*), the epidermis becomes much thicker and consists apparently, in well-developed animals, of almost only rods; true ciliated cells may, however, be made out in thin sections from which the rods have dropped away. The structures which Mr. Moseley took for unicellular glands are regarded as being rather rods which have been altered in character by the use of reagents.

The *musculature* is best developed on the ventral surface, where it is separated into several distinct layers; like Mr. Minot, the author was unable to discover any circularly disposed fibres. He looks upon the inner layer of longitudinal muscles of the dorsal surface as dividing into two layers on the ventral, and as having the nerve-fibres between them. The digestive organs resemble in character the same parts in the fresh-water Planaria, and Kennel would not, he says, enter

* 'Arbeit. Zool.-Zoot. Inst. Würzburg,' v. (1879) p. 120.

into any description of them were it not that the results attained to are so divergent. He finds then that in both *Rhynchodesmus* and *Geodesmus* there is on the ventral side of the body and behind its central region a fine orifice, which can scarcely be seen in the living animal, but which leads into a wide space leading into a long bell-shaped pharynx; this pharynx is only protrusible in the same sense as is the human tongue, but the animal must push out its pharynx to be able to eat; whether the pore referred to should be correctly denominated the mouth, embryological investigations can alone determine. A transverse section through this pharynx reveals the presence of a fine homogeneous layer provided with numerous but short cilia; below this, there is a thin but compact layer of longitudinal muscles, and then there comes a circular layer; in the subjacent connective tissue unicellular glands, and indications of nerves are to be discovered. Nor is this all; next there is a layer of longitudinal muscular fibres, which are more distinctly separated into bundles, then there is more connective tissue, and then a thick layer of circular muscles, whence muscle fibres radiate out to the periphery; the arrangement is much the same, though not altogether similar, in the fresh-water Planarians. The enteric tract is throughout provided with a simple and high cylindrical epithelium, the cells of which are closely appressed and are set obliquely to the axis of the enteron; these cells are directly connected with the surrounding connective tissue.

As to the structure of the *generative organs* proper the author finds himself in complete agreement with Mr. Moseley; the generative products seem, in these hermaphrodites, to be developed at different times, and this is the cause of Kennel's earlier statement that *Geodesmus* had only one pair of testes; he now corrects this in saying that there are in it six pairs. The character of the yolk-glands and their different ducts required careful investigation: the results of Dr. Kennel show that in the fresh-water Planaria, with one pair of ovaries, there are to be found, in all the sections almost from the anterior end of the body as far as the generative organs, packets of large cells which may be finely or coarsely granular; these cells make up the yolk-glands; the ducts are numerous and short, and open at the point where the oviduct joins the vagina. In *Rhynchodesmus*, *Geodesmus*, and *Planaria lugubris* the yolk-glands only open into the outer side of the oviducts, but in *Dendrocœlum* the arrangement is much more complicated; where the duct of the yolk-gland opens, the oviduct is connected with a large vesicle. The author then gives a careful account of the arrangement of the various parts of the generative organs, which is beyond an abstract.

Passing on to the *nervous system*, the cerebral ganglion of the land Planaria is described as lying in the most anterior region of the body, and as forming a rounded mass consisting of two symmetrical halves; the mass of the brain is made up of a very finely granular dotted substance and of small cells, which are most numerous where the two halves approximate. Although they have not the character of "typical" ganglionic cells, they must be regarded as nerve-cells, and as completely similar to the smaller cells which are found interspersed among the larger ones in the marine Planaria. As, however, the brain in the terrestrial forms is not surrounded by a firm capsule, it is difficult always to distinguish between the cells of the brain and those of the surrounding connective tissue. When the longitudinal nerves are carefully prepared, they may be seen to be made up of a fine dotted substance, altogether similar to that of the cerebral ganglia, together with a network of fibrils such as may be found in the transverse section of the lateral nerve of any Nemertine. The two longitudinal nerve-trunks of all Planarians give off a number of branches to the skin and to the organs of the body; moreover, it is quite easy in *Rhynchodesmus*, though less easy in *Geodesmus*, to show that the two trunks are continually united to one another by transverse commissures. In the former of these two there are two small pigment goblets, which are filled with small cells, while the pigment is black; in the latter the eyes are larger, the pigment is dark brown, and the cells are elongated and hexagonal; the mode of connection of these eyes with the spots has not been completely worked out. In some forms it is also possible to distinguish two bright spots near the eyes, which are destitute of pigment and rods, and in which the epidermis takes on the character of small cylindrical cells with fine, short cilia. To these spots a very strong nerve is given off from the brain, and this swells out in such a way that we may almost say that a ganglion is developed; it is possible that these organs belong to the same category as the "lateral organs" of the Nemertine worms, as do also the granular aggregations found by Keferstein in the marine Planaria.

Nothing is definitely known as to the development of their nervous system, but it may be presumed that it commences from an unpaired rudiment; the commissures would then be indications of this primitive unity, and while in some (*Rhabdocœla*, *Bipalium*) the two longitudinal cords finally become distinct, it is possible that the "step-ladder" nervous system of higher worms will find here its explanation. We know, indeed, that in *Tomopteris* the longitudinal nerve-cords have a very close resemblance to what is found in the Planaria. The œsophageal ring may be explained by the characters of the mouth and pharynx, just as in *Planaria limuli* the sucker gives rise to the union of the longitudinal nerves. Among the Turbellaria, *Microstomum* has an œsophageal ring; and if the pharynx of the Planaria is, as Semper thinks, homologous with the proboscis of the Nemertinea, then the latter have a step-ladder nervous system.

As to the *water-vessels*, the author has not been able to detect any indication of any canals. This he thinks to be due to the absence of proper walls and a definite epithelial investment; but there seem to be canalicular spaces in the tissue of the body, which have openings, though not definite openings, to the exterior, and in which a clear fluid is driven along by cilia; the cells which develop these last are not aggregated into a distinct epithelium. These suggestions afford an explanation of the apparent absence of the water-vascular system when we reflect that on the contraction of the animal at death the lacunæ in the body would disappear.

Encysted Scolex of Tetrarhynchus.*—Dr. Hoek describes the characters of the Tænioid cysts found by him in the connective tissue of the mesentery and in the intestinal wall of a codfish. He finds that the description given by Van Beneden of the proboscis is very exact, and he was able to observe in the living example its intro- and eversion. When protruded the hooks with which it is provided were seen to vary greatly in form; except in the inferior region they are set in whorls, and of these whorls there are some hundred and fifty; in the inferior portion the hooks are long, delicate, and curved; they may become hooked, broadened, and flatter, or they may take on very remarkable forms. There are four chief water-vessels, but no indication of a vesicle was to be made out, and transverse commissures only exist in the region of the head; in the suckers there is a beautiful system of anastomosing vessels. The water-vessels open by pores on the anterior side of the head, and on the anterior lateral margins of the suckers.

On the interesting question of the nervous system, the author reminds his readers that Wagener in 1857 announced the presence of a large central cephalic ganglion with efferent nerves; but those observations have never been confirmed. What the author found was this—throughout the whole body there extend several longitudinal trunks, of which two on each side are the more distinct. They have no connection with one another, are placed directly below the integument, and give off small branches, which pass into the reticular connective tissue, and, if they are longitudinal trunks, innervate the water-vessels and the sheath of the proboscis. These structures have been followed into the head, whence their branches may be followed out to the margin of the head, to the suckers, and so on. As the author points out, they may be comparable to the spongy lateral cords of Steudinger, which seem to differ from them by forming an anastomosis in the head.

Dealing with the details of their histology, the author states that the wall of the cyst is a smooth structureless investment of considerable thickness, and composed of several easily separable layers. The only special point of histological structure appears to be the radial bands found in it. The worm itself can only be properly examined by means of transverse sections; thus seen it exhibits from without inwards a cuticle, a matrix from which the cuticle is developed, a layer of longitudinal and a layer of transverse muscles, and an extremely fine connective tissue, the so-called parenchyma. To see this last well it is necessary to remove the calcareous concretions.

The scolex, like the cystic worm, is provided with a cuticle, but it has appended to it delicate hair-like processes, which are not true cilia; no pore-canals could be seen. There is again a matrix, the cells of the contained connective tissue vary greatly in size; the supposed nerve-trunks are made up of elongated elementary parts, which are so far like ganglion cells that at one or both sides they are continued into processes; the efferent ramules are pale and finely granulated. So far as their structure is concerned, the author is

* 'Niederl. Arch. Zool.,' v. (1879) p. 1 (1 plate).

careful to point out that the longitudinal trunks might very well be muscular, and Schiefferdecker has described the muscular elements in these forms as consisting of long delicate spindles, which pass at either end into very fine processes. True epithelial cells were only observed on the sheath of the proboscis.

Natural History of the Orthonectida.—In connection with the last note on this subject,* it is necessary to observe that in a short communication † Metschnikoff says that his species *Rhopalura Giardii* must fall, as it is clearly identical with the *R. ophiocomæ* and *(Mac)Intoshia gigas* of that author. He bases his view of the generic and specific identity of the two forms just mentioned on the constancy of zoosperms in the smaller form, on their absence in the larger one, and on the complete similarity in character of these elements with the "ovarian cells" of *Rhopalura*. The sperm-clements are asserted to have a long flagellum, and not to be bacterioid, as stated by Giard, and the so-called muscular bands are never observed in the female, nor is there the difference in rapidity of movement between "*Rhopalura*" and "*Intoshia*" that should be expected from the absence in one and the presence in the other of such muscular structures.‡

Echinodermata.

The Elasmopoda—a New Order of Holothuridea.§—Sir C. Wyville Thomson, on looking over the Holothuridea of the 'Challenger' Expedition, recognized the resemblance of a large number of the deep-sea species to *Elpidia glacialis*, a form found by Dr. Hjalmar Théel at a depth of 150 fathoms in the Kara Sea in 1875, who was accordingly asked to undertake the description of the material belonging to the class. As the result of his examination, Dr. Théel recognized over 200 species, half of which are new to science, and of these the greater number from the deep-sea are related to *Elpidia*. The group, enlarged to such an extent and presenting so many marked peculiarities, quite revolutionized the *facies* of the Holothuridea, and asserted itself as an order of value equal at all events to that of the Pedata and Apoda, and for this order Dr. Théel proposes the name Elasmopoda.

Order: Elasmopoda (ἐλαύνω, to move). Body distinctly bilateral. Ambulacra well defined. The lateral ambulacra of the trivium bearing large, slightly retractile pedicels, disposed either in a single row, or sometimes in two rows, along each side of the ventral surface, and sometimes with another series of larger highly-elongated not retractile processes placed externally and above the pedicels; pedicels of the two lateral ambulacra symmetrically arranged, being more or less distinctly opposed across the ventral surface. The odd ambulacrum naked or very seldom with a few rudimental pedicels. Bivium provided with very long not retractile processes, often disposed in one or more rows along each of its ambulacra and more or less distinctly

* This Journal, *ante*, p. 86.

† 'Zool. Anzeiger,' ii. (1879) p. 618.

‡ This note should have been inserted after the third paragraph of p. 87.

§ 'Nature,' xxi. (1880) p. 470 (11 figs.).

opposed across the dorsal surface, or with only a few rudimental ones in its anterior part, or with a single very large one, resembling a broad, branched or unbranched lobe, and near to it some small papillæ. No respiratory trees. Integument naked, spiculous, or plated.

In the first part of a preliminary report on the 'Challenger' Holothuridea,* Dr. Théel defines seven new genera (with nine new species) of Elasmopoda, viz:—

Deima (δεῖμα, a fright), 2 sp.
Oneirophanta (ὀνειρόφαντα, a vision), 1 sp.
Orphnurgus (ὄρφνη, darkness), 1 sp.
Cryodora (κρύος, cold), 1 sp.
Lætmogone (λαῖτμα, depths of the sea), 2 sp.
Ilyodæmon (ἰλύς, ooze, δαίμων, spirit), 1 sp.
Achlyonice (ἀχλύς, darkness), 1 sp.

There are also described six new species of *Elpidia* (ἐλπίς, hope), one of *Irpa*, and one of *Kolga* (names from the Norse mythology), the two latter being new genera closely related to *Elpidia*, procured by the Norwegian North-Sea Expedition, and described by Koren and Danielssen.

These are all abyssal forms, eight of the seventeen species having been dredged from depths of more than 2000 fathoms. They are very extravagant in shape—the names which Dr. Théel has given them shows that their appearance suggests "such stuff as dreams are made of"—and they are of large size, some over a foot in length.

One group is very gelatinous, and of a rich purple colour; others are gelatinous, grey, and semi-transparent; while another series, and among these the most fantastic of the whole, are yellowish and have a test crustaceous with a thick layer of calcareous plates, often running out into strangely shaped processes. A peculiar little group from the Antarctic Sea are little more than a gelatinous membrane, covering an enormously distended intestine, filled with diatom ooze. From the number of species and individuals which came up in the scattered and infrequent hauls of the trawl, the *Elasmopoda* must form, Sir Wyville thinks, quite a prominent feature of the abyssal fauna.

Nervous System of Comatula.†—Mr. P. H. Carpenter points out that although there is a close histological resemblance between the ambulacral nerves of the Star-fishes and Crinoids, there is one important point of difference between them. The ambulacral nerves of the star-fishes—at any rate of the Ophiurids—send off branches to the muscular bundles which connect successive joints of the rays and effect the movements of the animal. The swimming movements of *Comatula* are far more active than the movements of any star-fish, and are also performed with a singular regularity, while they are effected by the combined contraction of several hundred pairs of

* 'Handl. K. Svensk. Vet.-Akad.,' v. No. 19.
† 'Rep. Brit. Assoc. Adv. Sci.,' 1879, p. 418.

muscles; but no branches are traceable from the ambulacral nerves on to these muscles such as are known in the Ophiurids.

Dr. Carpenter's experiments at Naples have shown that these muscles are under the influence of a governing centre, which not only regulates their contractions, but co-ordinates those contractions in the most remarkable manner; and that this centre is situated in the fibrillar envelope of the chambered organ, while the axial cords of the rays and arms are the channels by which the influence of the centre is communicated to the muscles.

This experimental evidence as to the nervous nature of the axial cords is further supported by the results of anatomical investigation. Sections show that these axial cords give off branches regularly in the centre of each segment of the arms and pinnules; and that while some of them ramify upon the ends of the muscular bundles, others are traceable into the small marginal leaflets bordering the ambulacral grooves, where they break up very minutely and become lost. It has also been discovered that in many tropical *Comatulæ* which have an excentric mouth, more or fewer, sometimes even more than half the arms which come off from the aboral side of the disk, have no ambulacral nerve at all, although the dorsal axial cord gives off its two pairs of branches in the usual way. In one large species from the Philippines with nearly two hundred arms this condition is not limited to the aboral arms only, but occurs on some of the arms on each radius, while the others have the usual groove and subjacent ambulacral nerve.

These facts are strongly indicative of the nervous nature of the axial cords, although Claus and Gegenbaur in their recently published text-books make no mention of this view at all, and described the nervous system of *Comatula* as essentially similar to that of the star-fishes. It would seem, however, that while the ambulacral nerve of the Ophiurids supplies the muscles as well as the tentacles, these functions are more differentiated in the far more active Crinoids. The axial cords of this group appear to be the principal motor nerves as far as the skeleton is concerned, while the ambulacral nerves supply the tentacles only, possibly having some influence on the slow, creeping movements which the isolated disk has been observed to perform. Why should we deny the nervous nature of the axial cords, simply because our doing so would clash with our preconceived notions as to what the Crinoids ought to be in order to agree with the views on Echinoderm morphology, which were adopted without a sufficient knowledge of the anatomy of this most interesting group?

Development of Asterias rubens.*—Dr. Greef finds that after the unimpregnated ovum of the Star-fish has been in fresh sea-water for five or ten minutes the germinal spot becomes granular. The granules are at first rare and small, and appear at the periphery and around the central vacuole; they increase rapidly in number, and the spot takes on a mulberry-like appearance. The small granules now increase rapidly in size, and as they grow they gradually fuse with

* 'Arch. Naturg.,' xlvi. (1880) p. 94.

one another till they form a small number of largish sarcode-bodies. When these granules have thus fused to some extent, the germinal vesicle begins to shrink as the yolk drives it towards the periphery of the egg; on reaching this it forms the first directive corpuscle, below which and evidently derived from the same vesicle there is an irregular clear space, in which the remains of the germ-spot may be made out; this represents the second directive corpuscle. But now, below these, there is an irregular and still smaller clear space; this is formed by the remains of the germinal vesicle, and in it there are a few very pale and delicate corpuscles, which would likewise seem to be derived from the germinal spot. The clear area now contracts and withdraws itself from the periphery; soon a clear round spot appears in its place, and around this the substance of the yolk is radially disposed. The rays elongate, and two pale bodies, altogether similar to those which remained when the germinal spot was broken up, appear in the central portion. Shortly there appears a second radial figure, which is only distinguished by having a clearer centre and only one nuclear body. These two figures approach one another slowly, touch, and finally completely fuse. The two or three nuclear bodies of the first star first unite with one another, and then fuse with that of the smaller figure. All this calls strongly to mind the fusion of the sperm-nucleus with the ovarian nucleus which has been observed by Hertwig, Fol, &c.; but the author directs attention to the fact that the whole process described by him in this paper may take place in an unimpregnated ovum.

Greef has already observed that in *A. rubens* the mesodermal cells begin to be developed from the ectoderm previously to the first invagination, and previously, therefore, to the formation ot the endoderm. He has now repeated that observation, and finds that the cells of the mesoderm may not only be developed at the point of the ectoderm at which the invagination afterwards commences, but that they may appear at any point on the ectoderm. The mesoderm is the seat of origin of the whole of the calcareous skeleton.

Cœlenterata.

Tactile Organs of Eucharis multicornis.*—Eimer gives an account of these organs in the above-mentioned Ctenophore, where the distal end of the tactile processes are beset with specially modified cells. These cells are rounded in form and are filled with granular contents; they are grouped in racemose fashion, and cover over the rounded end of the "tactile wart"; the most anterior or distal are some ten times larger than the outer or more proximally placed cells; their envelope is delicate. Between these bodies there project tufts of three or four distally diverging, apparently homogeneous setæ.

The gelatinous tissue composing the warts is traversed both longitudinally and transversely by numerous fibres, which appear to be nervous in character; they have not only a close resemblance to the nerves which, as the author has described, supply the epidermis

* 'Arch. Mikr. Anat.,' xvii. (1879) p. 342.

of *Beroë*, but they have likewise spindle-shaped bodies embedded here and there amongst them; so also, just as in *Beroë*, they repeatedly branch in a dichotomous fashion when they approach the tactile setæ, and these branches first arise from swellings, which have a tripolar or multipolar character, according to the number of filaments which arise from them. Owing to the repeated division the terminal filaments are very fine, and their final direction is lost; the author has, however, no doubt that they become connected with the setæ and with the terminal cells. The former are tactile setæ, and the latter have either an offensive secretion or one which enables them to attach to themselves nutrient matter; at the same time the possibility of their being capable of receiving tactile impressions must be borne in mind.

New Fossil Coral.*—The Rev. J. E. Tenison-Woods describes a coral—*Trematotrochus fenestratus*, nov. gen. et sp.—of most singular and interesting character, combining some of the leading characteristics of several families and subfamilies. It is a Turbinolidian coral, with pali, without a columella, and with a perforated wall. In exterior form it is very like a *Turbinolia*, and like some members of that genus it has what seem to be deep pores between the costæ. But in the true *Turbinolia* these pores go no further than the wall; they follow a groove between the costæ, and, though deep, never go through. In the new species they go through the wall; in fact, as the pores are very large, the portion of the wall which separates them becomes little more than a flat transverse bar.

Haeckel's 'System of the Medusæ.'†—This first instalment of Haeckel's greatest work since the appearance of his monographs on the Radiolaria and Calcispongiæ, is devoted solely to Gegenbaur's Craspedota (which are nearly equivalent to the naked-eyed Medusæ of Forbes or Cryptocarpæ of Eschscholtz). The author's treatment of his subject, though resting necessarily on anatomical characters, is purely systematic. Without any introduction, he at once enters on details. There is a table of contents, but no index or general list of synonyms; the synonyms of old species are cited in each case.

Revisions of orders and families occupy rather more than 100 pages, and about 250 pages treat of genera and species. The definitions of the genera and higher groups are further exhibited in analytical tables. The etymology of each genus is given, and notes are appended to the generic diagnoses. The name of each species is followed by a diagnosis, a special description (or in its place a commentary with reference to a description elsewhere), and short paragraphs under the heads of colour, size, and station. The development, when known, is indicated but not described.

In Haeckel's system the Craspedota constitute the first legion of

* 'Journ. and Proc. Roy. Soc. N. S. Wales,' xii. (1879) p. 57.

† "Das System der Medusen. Erster Theil einer Monographie der Medusen. —Erste Hälfte des ersten Theils: System der Craspedoten." 'Denkschr. Jen. Gesell. Med. und Naturwiss.,' i. (1879) 360 pp. 20 plates. [Analysis by Dr. J. Reay Greene.]

the Medusæ, with four orders and sixteen families. We here add to the names of these the numbers of genera (in brackets) and species referred to each.

ANTHOMEDUSÆ (50) 125 sp.
Codonidæ (14) 44 sp., Tiaridæ (13) 30 sp., Margelidæ (16) 40 sp., Cladonemidæ (7) 11 sp.
LEPTOMEDUSÆ (61) 140 sp.
Thaumantidæ (11) 20 sp., Cannotidæ (15) 25 sp., Eucopidæ (24) 60 sp., Æquoridæ (11) 35 sp.
TRACHOMEDUSÆ (26) 60 sp.
Petasidæ (7) 10 sp., Trachynemidæ (6) 14 sp., Aglauridæ (5) 13 sp., Geryonidæ (8) 23 sp.
NARCOMEDUSÆ (23) 75 sp.
Cunanthidæ (6) 22 sp., Peganthidæ (4) 16 sp., Æginidæ (8) 16 sp., Solmaridæ (5) 21 sp.

All the families except Cunanthidæ and Peganthidæ are divided into subfamilies, of which there are 40. Of the genera, 20 are broken up into (45) subgenera.

Of the 160 genera and 400 species of Craspedota which, as shown above, Haeckel defines, 83 genera and 148 species are new. Of the new species, 58 are placed in (42) quite new genera, 37 in (27) other new genera which also contain 45 old species, while 53 are left in (40) old genera together with 90 recognized species. There is a third category of (14) new genera for 21 old species exclusively. Lastly, 37 old genera include only 96 admitted species.

From his 'Prodromus,' dated 1877, Haeckel quotes his own names for 125 species. In fifty-seven cases he now substitutes the generic for the subgeneric name, changing also the specific name in three of these. Generic names only are changed in fifty-six instances, specific only in five, both in four. Only three of the species thus cited retain names quite unchanged. We do not refer to mere grammatical alterations, which are very numerous. From synonyms in the text it might be thought that five species * were wrongly named in the Atlas, but on consulting the latter we find the right names of these species in the copy before us.

The Atlas has 233 figures, on 20 plates, representing wholly or in part 104 species, of which 80 are new. The figures of old species include, among others, those of seven Medusæ, first described by the author in the Jena Journal for 1864. Most conspicuous of these is *Mitrocoma Annæ*, the only species to which an entire plate is devoted. Only six plates are coloured, to speak correctly, for the figures of fourteen others are either uniformly tinted or appear pale on a coloured ground. In the text, references are omitted to the figures of *Sarsia eximia*, *Thamnostoma macrostoma*, *Æquorea discus*, *Cunina rubiginosa*, and *Polyxenia cyanostylis*. *Ctenaria* is figured.†

As to the 68 new species not here figured, we are promised fuller

* *Melicertissa clavigera*, *Polycanna* (2 sp.), *Marmanema clavigerum*, and *Rhopalonema cæruleum*. There are a few other trifling errors of reference.

† See this Journal, ii. (1879), p. 890.

descriptions and illustrations of some in the "Deep-sea Medusæ of the 'Challenger' Expedition," and of others in the author's forthcoming 'Spicilegium Medusarum.'

Supposing Gegenbaur's families of Craspedota amended and extended, their equivalents in Haeckel's system may be thus shown. Oceanidæ correspond to Anthomedusæ; Thaumantidæ, Eucopidæ, and Æquoridæ to Leptomedusæ (with the free gonophores of the Campanularians); Geryonidæ with Trachynemidæ to Trachomedusæ; and Æginidæ to Narcomedusæ.

The first two of Haeckel's orders compose the collective group (sub-legion) of Leptolinæ in opposition to the Trachomedusæ and Narcomedusæ taken together, or Trachylinæ (see p. 233).

Since the Anthomedusæ include the free medusiform gonophores of the Tubulariæ of Agassiz, or Gymnoblastea of Allman, it may be well to cite the corresponding families from the last-named writer's monograph. His Syncorynidæ, Pennaridæ, Corymorphidæ, and Hybocodonidæ belong to Haeckel's *Codonidæ;* his Turridæ to *Tiaridæ;* his Bougainvillidæ, Podocorynidæ, and Nemopsidæ to *Margelidæ;* while his Clavatellidæ and Cladonemidæ constitute but one family in the systems of both Agassiz and Haeckel. The genus *Corynetes*, according to Haeckel, has its place among the Tiaridæ.

But the chief novelties in Haeckel's arrangement are his two families Petasidæ and Cannotidæ. The first includes *Olindias* of Fritz Müller and the subfamily Petachnidæ—made up of (*a*) the same writer's *Aglauropis*, (*b*) *Gossea* of Agassiz (founded on *Thaumantias corynetes* of Gosse), and (*c*) four new genera containing five species discovered by Haeckel, who here also describes a new species belonging to each of the three genera just mentioned. In Cannotidæ the radiating canals either branch or have pinnately disposed offsets. The types of its subfamilies are *Polyorchis*, *Berenice*, and *Willia*. The genitalia of the latter arise from the canal-system, the apparent origin of the ovaries from the manubrial wall being the result of secondary extension.

Notable in a high degree is Haeckel's determination of the affinities of *Favonia* and *Limnorea*, genera of Péron and Le Sueur, which have puzzled all succeeding systematists. Agassiz suggested for their reception a new family at the end of the Rhizostomi. Haeckel, having consulted the original manuscripts of Péron and examined some new Medusæ (*Thamnostoma* and *Thamnostylus*) which approach *Limnorea* in aspect, now assigns them places in his Margelidæ. The genus *Limnorea* is retained. *Favonia* is merged in *Nemopsis*.

The new account given of the Æginidæ contains much interesting matter, into which we cannot now enter. We have said enough to show that this book of Haeckel's is essentially to be valued as a work of reference.

New Hydroid Zoophytes.*—Dr. J. Armstrong describes and figures the following new species from the Indian coasts and seas:—

Lafoëa elongata, at Pigeon Island and Konkan coast, also at

* 'Journ. Asiat. Soc. Bengal,' xlviii. (1879) p. 98 (4 plates).

Diamond Island off the coast of Pegu; *Halicornaria setosa*, off Cape Negrais in 80 fathoms, Cheduba Island in 8 to 10 fathoms; *Halicornaria plumosa*, off Cape Comorin in 35 to 40 fathoms, and off Cheduba Island in 10 to 15 fathoms; *Himaria compressa*, in abundance off Diamond Island and on the Konkan coast, also off Cape Comorin; *Antennella Allmanni*, off Cape Comorin in 50 fathoms, and off Cheduba Island in 8 to 10 fathoms; *Sertularella rigosa*, off Cape Comorin in 40 fathoms, and off the Arakan coast in from 10 to 15 fathoms; *Desmoscyphus humilis*, on the coast of St. George's Island, West Coast of India; *Endendrium ramosum*, off Cape Comorin in 40 fathoms, and very sparingly along the coast of Arakan in from 10 to 70 fathoms.

With the exception of a single species, all the above hydroids are calyptoblastic. The one exception is *Endendrium ramosum*, which is a typical gymnoblastic zoophyte, and is especially remarkable in having the gonophores borne, not upon a true blastostyle, but upon atrophied hydranths from which the tentacles have disappeared.

Species of Hydra.—Dr. W. Haacke * promises a treatise upon this genus, which is to show that only two species are to be distinguished with certainty which are not green. In the first of these, to be named *H. Trembleyi*, the bud produces all its tentacles at one time; in the second, *H. Roeselii*, but two, opposite, tentacles appear at first, the rest appear singly. Some particulars of special interest in the development of the tentacles in *H. Roeselii* are also to appear.

Porifera.

Structure of Siliceous Sponges.†—In the eighth of his contributions to the structure and development of sponges, Professor F. E. Schulze gives an account of Nardo's *Hircinia*, and of his own new genus *Oligoceras*. Under the single genus *Hircinia* he includes, besides the forms usually grouped under that name, *Stematamenia*, *Filifera*, *Sarcotragus*, and *Polytherses*.

1. *Hircinia variabilis.*—Under this designation Schulze includes the six species of Oscar Schmidt's subgenus *Hircinia*, notwithstanding the great differences they exhibit in external form, colour, arrangement of spicules, &c. The oscula may be flush with the surface or sur rounded with a raised rim; they may or may not be provided with a sphincter.

The pores are sometimes connected with straight canals leading into the interior of the sponge; at other times these canals anastomose by cross branches, which may be dilated into large subdermal cavities. The thickness of the cortical layer above these cavities varies greatly even in the same sponge. The canals leading from the subdermal cavities to the ciliated chambers are irregularly branched and present transverse or oblique constrictions at frequent intervals. Their terminal branches communicate by small round pores with the hemispherical ciliated chambers, each of which may possess more than one pore. From each chamber proceeds a short funnel-like duct, which

* 'Zool. Anzeiger,' ii. (1879) p. 622.
† 'Zeitsch. wiss. Zool.,' xxxiii. (1879) p. 1.

either opens directly into an efferent canal, or first unites with the ducts from several contiguous chambers, a racemose arrangement being thus produced.

A layer of flat epithelial cells can be made out, by the employment of silver nitrate, lining both afferent and efferent canals. On the surface of the sponge such a layer is more difficult to demonstrate, and here its cells are often covered with a delicate cuticle, as in *Euspongia* and *Cacospongia*.*

The connective layer has also, in all essential respects, the same characters as in *Euspongia*; the contractile fibre cells are also similar. A special accumulation of connective tissue takes place round the developing egg, producing a capsular investment.

The skeleton resembles that of *Cacospongia scalaris*. The primary radial fibres include foreign bodies, are usually terete, and are frequently perforated so as to present the appearance of an irregular network. The secondary connecting fibres may or may not contain sand-grains, siliceous spicules, &c. Although no definite layer of spongoblasts could be made out, Schulze has no doubt that the fibres are cuticular structures. The collar cells differ in no respect from those of *Euspongia* and *Cacospongia*.

Eggs were found in all stages of development, from irregular rounded cells resembling the amœboid corpuscles of the connective layer, to large ripe eggs, quite opaque from the great number of highly refracting yolk-granules contained in them. All stages of cleavage were also observed, but no sperm aggregations were met with in this species. Probably they are found only in a small number of individuals.

The author confirms Oscar Schmidt's discovery of the skipping-rope shape of the fibrillæ† so characteristic of this genus. They are 4–8 mm. long, 6 μ thick in the middle, and 3 μ at the ends; the globular or pear-shaped knobs which terminate them are 6–10 μ in diameter. For isolating them the sponges were macerated for some weeks in water mixed with ammonia, washed thoroughly with a stream of water, cut into pieces almost the size of a walnut, and placed in hydrochloric acid 10 per cent. for some days, and then washed in running water for some hours. By this means cobweb-like balls of intertwined filaments are pressed out from the cut surfaces. These are then placed in a watch-glass of water, and the individual filaments can then be isolated with needles.

The filaments consist of three layers: a smooth, membranous, highly refracting *sheath*, offering great resistance to the action of reagents; a *medullary mass*, swollen by acids; and a fine, rounded, somewhat granular *axial cord*. The terminal knob consists chiefly of medulla; it contains granules, but nothing answering to a cell-nucleus.

Fibrils of equal thickness to these, but not more than 0·9 mm. long, are also found. The filaments show no cellulose reaction, and probably agree in composition with the spongiolin fibres of the skeleton.

* This Journal, *ante*, p. 102. † Ibid., ii. (1879) p. 49.

Sometimes yellow granules occur both in the fibrillæ and in the spongiolin fibres. These are probably ferruginous; in a decomposing sponge, smelling strongly of sulphuretted hydrogen, they were observed to be of a dark blue-black colour.

Schulze considers it very improbable that the fibrillæ are really part of the sponge; although he thinks that their parasitic, and especially their algoid nature is by no means proved.

The dark red-brown colour of many varieties of this species is due to a great accumulation of parasitic algæ in the cortical layer, as deep as 2 mm. from the surface.

2. Three other species of *Hircinia* are described: *H. spinulosa*, *H. fœtida*, and *H. muscarum*, all three of which have been referred to the genera *Sarcotragus* and *Filifera*. *H. spinulosa* is shown to be monœcious.

3. *Oligoceras collectrix*, nov. gen. and nov. sp.—This new form is remarkable for the great mass of foreign bodies (bivalve shells, bits of coral, &c.) which cover its surface and penetrate into its substance. The superficial layer of the sponge is of a deep black hue, the interior white. The horny skeleton is almost obsolete, consisting of branched and occasionally anastomosing roundish fibres, including an immense number of foreign bodies, such as sand-grains, siliceous spicules, &c. Notwithstanding this great peculiarity in the skeleton, Schulze considers *Oligoceras* to be a near ally of *Cacospongia*.

Organization and Development of Chalinidæ.*—This group, interesting as forming a transition between horny and siliceous sponges, is studied by Dr. Conrad Keller, of Zürich, who has specially investigated a new species found by him in the Gulf of Naples, and named *Chalinula fertilis*.

General Features.—The entire sponge may be monozoic, i. e. consist of but one persona, or may assume the form of an irregular mass made up of several personæ. In the former case it consists of an upright conical tube, 2–3 cm. long, terminating in an osculum 2–3 mm. in diameter. As to consistency, it is very soft and easily torn, but becomes elastic when dry.

The horny skeleton consists of a set of principal or radial fibres, radiating regularly outwards from the central gastric cavity, and of secondary or cross fibres uniting these. In the horny fibres are embedded siliceous spicules 0·092–0·1 mm. long, straight or slightly bent, and pointed or rounded at their ends.

The colour is yellowish brown, the surface smooth and strewn with pores which are visible to the naked eye, being ½ mm. in diameter.

Ectoderm.—This layer covers the whole external surface of the sponge, and is continuous with the endoderm at the margin of the oscula and of the pores.† In the neighbourhood of the oscula the cells are to be made out without any previous treatment. In the young state the ectoderm is markedly contractile; probably the

* 'Zeitsch. wiss. Zool.,' xxxiii. (1879) p. 317.

† Keller's view of the sponge ectoderm is thus seen to differ from that of Schulze and Metschnikoff, who consider the cells lining the canals as ectodermal, and only the collar cells of the ciliated chambers as endodermal.

opening and closing of the pores in the adult is due to the same property.

The apertures in the ectoderm are of two kinds: permanent pores with rounded apertures, $\frac{1}{4}$–$\frac{1}{2}$ mm. in diameter, communicating with the canals which lead into the gastric cavity (dermal ostia); and small temporary pores, invisible to the naked eye, and leading into the subdermal spaces (dermal pores). The subdermal spaces are lined by a pavement epithelium, but whether or not this is ectodermal is not certain.

Mesoderm.—This layer consists of a gelatinous matrix containing amœboid corpuscles, which are often spindle-shaped, and in the neighbourhood of the pores take on a sphincter-like arrangement and probably act as muscles.

As in *Spongilla*, *Chondrosia*, &c., cells containing amyloid substances occur, though infrequently, in the mesoderm. Probably this rarity was due to the fact that, in the breeding season, when the examination was made, the reserve material was largely used up.

Endoderm.—The author considers that the endoderm lines both the gastric cavity close up to the edge of the osculum, and the whole system of afferent canals. There are two kinds of endoderm cells: flagellate, lining the ciliated chambers, and pavement lining the canals. The latter are made out by treatment with silver nitrate.

The Canal System.—This includes a central portion consisting of the large gastric cavity, and a peripheral portion consisting of radial canals opening by gastric ostia into the central portion. These canals at their outer ends open directly on the surface, but amongst them are irregularly disposed canals of various sizes, which open into the subdermal cavities; these latter communicating with the exterior by the dermal pores.

Development.—The sexes are distinct, and are outwardly recognizable by differences of colour, which also differs in the female according to whether it contains unfertilized eggs, dividing eggs, or larvæ.

The spermatozoa consist of an elongated somewhat curved head, and a long tail. They are formed from mesoderm cells, and are enclosed in special capsules lined with epithelium.

The eggs are also specially modified mesoderm cells, exhibiting while young amœboid movements. The ripe eggs are enclosed in a definite capsule, and are rendered very opaque by the number of yolk-granules contained in them.

Yolk-division is total, but unequal, the seven-celled stage consisting of six micromeres and one macromere. By further division a number of macromeres are formed at the future posterior end of the animal, and represent the endoderm, while the micromeres, undergoing more rapid division and growing over the macromeres, form the ectoderm. This phase represents, according to Keller, the gastrula stage of development, the blastopore being represented by the yolk-plug (Dotterpfropf) formed by the endoderm cells. The gastrula is thus formed by epiboly.

The ectoderm cells become columnar and acquire cilia, the embryo then consisting of an ovoidal body formed of a solid mass of endoderm cells, covered, except at one pole, by columnar, ciliated, ectoderm cells; the uncovered endoderm cells form the yolk-plug, and are at first not ciliated.

Soon the outer layer of endoderm cells begins to be distinguished from the rest, and forms the foundation of the mesoderm, the central mass of cells being now the true endoderm. The process of mesoderm-formation begins in the neighbourhood of the blastopore. The mesoderm cells are soon distinguished by the development of fusiform siliceous spicules.

Arrived at this stage, the embryo makes its way, by its somewhat pointed anterior end, through its capsule into one of the canals of the mother, and out by one of the dermal ostia. After the birth of all the embryos, of which a single female *Chalinula* may produce 100, the parent is completely disintegrated, as a result of the mechanical strain, so that each female can only produce a single brood.

After birth the yolk-plug projects considerably, and its cells develop cilia, but subsequently lose them again. In an aquarium the embryos, like the swarm-spores of some algæ, always seek the side turned away from the light.

One remarkable fact about the free larva is that at its hinder end a depression with raised edges is formed; probably this represents a rudimentary archenteron.

The larva usually swims freely for about two or three days. Then the cilia disappear from the posterior end and the larva appears suddenly to become flattened out in a direction at right angles to its long axis. The ectoderm then loses its cilia, is converted into a highly contractile layer of flattened cells, and also grows round and covers in the previously exposed endoderm cells of the hinder end.

At the end of the third day certain endoderm cells in the interior unite themselves into groups, become strongly pigmented, and form the foundations of the ciliated chambers, a cavity appearing in them subsequently. The gastric cavity is formed on the fourth day by a separation (Auseinanderweichen) of the central endoderm cells.

Sponges and the Germ-lamella Theory.—Keller considers it proved that the *Chalinula* possesses the three characteristic germ-layers; that it goes through an amphigastrula stage not preceded by an amphiblastula; that it possesses a true Rusconian anus filled up by the yoke-plug; that the mesoderm arises from the endoderm, the process beginning all round the Rusconian anus, that is, in a radially symmetrical manner.

Individuality of Sponges.—The author considers that "the sponges are true Cœlenterates, higher from a histological point of view than most Hydromedusæ, since they possess a true middle germ-layer. In their histological relations they are most nearly related to the corals."

Formation of Free-swimming Buds by a Halisarca.*—Professor F. E. Schulze adds to our knowledge of the difficult question of the development of sponges, by his observations on some free embryos

* 'Zool. Anzeiger,' ii. (1879) p. 636.

observed in his tank at Trieste. These embryos proved to belong to *Halisarca lobularis*, and to have been formed as buds, protruded and constricted off from encrusting masses which grew in the tank. They consist of spheres of 2 to 3 mm. in diameter; their surface is set with finger-like processes, which are solid and are parts of the gelatinous body-wall.

These processes contain a number of sac-shaped chambers, some scattered, some aggregated, which open by a distinctly defined mouth into the central cavity of the bud, and by from two to four narrow canals or pores, to the exterior. The cavity of the bud is filled by a clear liquid. The parietal sacs are lined by collar cells up to the mouth; the canals which open from the exterior, by flat polygonal cells agreeing with those of the body-cavity; the external surface of the bud is covered by a uniserial layer of similar, but more granular, nucleated, non-ciliated, epithelial cells; those, however, at the ends of the above-mentioned finger-like organs, are provided with protoplasmic processes endowed with amœboid movements. Between these two layers lies a connective tissue exactly similar in character to the gelatinous layer of *Halisarca* and other sponges, containing large numbers of branched cells, sometimes anastomosing. No skeleton is to be seen.

The buds originate by the outward swelling of the normal papillæ of the sponge; they take the form of inflated masses, and become detached by the constriction of their bases. The process begins in the middle of the sponge-crust and proceeds to the edges; the whole of a small crust carrying several papillæ has been observed thus to swell out and become detached as a large bud. After a chiefly free-swimming existence of about fourteen days, the buds sink to the bottom, spread out and become attached by their base, and assume the form of young *Halisarcæ*.

Any doubts as to the occurrence of these phenomena in the normal and healthy state are set at rest by the observation of the process in all its details in sponges freshly brought from the sea, showing that buds from such specimens of *H. lobularis* var. *cærulea*, after an independent life, settle down and reproduce as flattened, blue masses, the original sponge with all its varietal peculiarities.

It is noteworthy that the appearance of this mode of reproduction occurring in autumn, after the termination of the sexual process, must be very important for the preservation and diffusion of the species.

Muscle-fibres of Sponges.*—Mr. W. J. Sollas, in describing some new sponges dredged by the Rev. A. M. Norman on the Norwegian coast, says that in *Stelletta Normani* the fibres are the best marked he has yet met with in any sponge, and they likewise most closely resemble the organic muscle-fibres of the higher animals. They are about 0·0066 inch long and 0·0003 broad, fusiform, hyaline, colourless, and of sharply marked contour; their nucleus or axial thread, as it may be more correctly termed, is fusiform, homogeneous, faintly bluish in colour, highly refringent, and 0·0035 inch long. With polarized light

* 'Ann. and Mag. Nat. Hist.,' v. (1880) p. 137.

the fibres behave like uniaxial crystals. Treated with acetic acid or boiled in water they undergo no appreciable change; but potash and nitric acid produce well-marked effects. Thus, on adding a 5 or 10 per cent. solution of potash to a fragment of the teased-out tissue, the fibres at once became swollen, those which were previously curved straightened themselves out, and simultaneously the axial thread almost completely disappeared. On then adding a 10 per cent. solution of nitric acid the fibres at once contracted, and the axial thread became more visible than it had been before. Again adding potash, the fibre expanded; again nitric acid, and it contracted; and as often as one or the other reagent was applied, so often the same results were produced. With strong acids the outlines of the fibres appeared to vanish, and a homogeneous substance remained behind, in which the axial thread remained wonderfully clear and distinct. On adding magenta the threads stained deeply, but the matrix was not affected. The fibres can best be separated from their tissue by macerating thin slices for a few days in baryta water or 1 per cent. chromic acid solution, and then teasing out. The muscular layer passes at its distal margin insensibly into gelatinous connective tissue with fusiform corpuscles. The change seems to be accomplished by the loss of a distinct border to the muscle-fibres and the growth of the fusiform axial thread at the expense of their hyaline portion; at the same time a distinct but small nucleus and nucleolus become clearly visible in the axial thread, which has also acquired a granular character.

The muscles of the sphincter are darker than those of the rest of the muscular layer, owing to the increased size and proximity of their axial threads, and to the development of fine granules in their hyaline exterior.

With carmine or magenta the axial threads of the muscle-fibres are easily stained, but the hyaline part not at all; hence when a section of the muscular layer is stained the sphincters are made very prominent, since their abundant nuclei lead them to acquire a very dark colour.

Mr. Sollas applies the term "muscle-fibres" to these structures because they are morphologically similar to the fibres occurring in other animals, to which no one hesitates to apply the term "muscular," and the fact that, slightly modified, they enter into the composition of the sphincters of the cortical funnels seems to show that they are functionally muscles as well. The specialization which converts an indifferent cell into a muscular fibre consists simply of a limitation of its contractility to a particular direction, so that it contracts in a longitudinal and broadens out in a transverse direction; its irritability is by no means suppressed, and, as is well known, both striated and unstriated muscles are capable of responding to thermal, chemical, and mechanical stimuli independently of any nervous stimulus. This being so, all muscles, both those connected and those not connected with a nervous apparatus, may be regarded as "neuro-muscles," and nothing is to be gained by introducing the term into our nomenclature, as Professor Haeckel suggests. It seems to imply that in the muscles of the higher animals some property has been lost which was present in the muscles of such animals as are without a nervous supply, while we know this not to be the case.

Whatever our opinions with regard to nomenclature may be, the difficulty of explaining the manner in which the muscular layer of the sponge receives its stimuli remains the same; it is so important a tissue of the sponge, so perfectly differentiated, that one can hardly believe associated nerve-structures to be absent; and yet no trace of the presence of such structures has been discovered. The large elliptical cells underlying the muscular layer and surrounding the subcortical crypts are wonderfully like ganglionic cells; but though they sometimes are elongated in one or other direction into a tear-drop shape, yet they are never prolonged into any distinct thread which might be regarded as a nerve. They do not seem to be nerve-cells, and perhaps they may be "ova"; but without tracing their development it is impossible to say. On the whole, Mr. Sollas is disposed to regard them as the ordinary cells of the mark rendered very distinct by their occurrence in a tissue of markedly contrasted character. The spicules which extend beyond the surface of the sponge might perhaps suffice to convey a mechanical stimulus to the muscular layer, though this view is certainly attended with serious difficulties.

Replacement of Siliceous Skeletons by Carbonate of Lime.*—Mr. W. J. Sollas at the Sheffield meeting of the British Association gave an account of certain calcareous fossil remains which exhibit, both in gross and minute structure, a close resemblance to certain existing siliceous sponges, and which differ widely from any known form of calcareous sponge. The natural inference appears to be that the calcareous fossils were once siliceous sponges, the siliceous parts of which had undergone replacement by carbonate of lime. The alternative view that the fossils were originally calcareous, and that they represent an extinct group of Calcispongia, presents far greater difficulties to the zoologist than the inferred mineral replacement offers to the chemist. Siliceous sponge spicules are remarkably soluble, yielding readily to the attacks of minute boring algæ, and undergoing solution in sea-water soon after the death of the sponge which possessed them.

The Radiolaria of the carboniferous limestone the author regards as having once possessed a siliceous composition, which they have since exchanged for a calcareous one.

Protozoa.

New Infusoria† (Plates VII. and VIII.‡).—Dr. August Gruber now describes in detail the new species of Infusoria of which he previously

* 'Rep. Brit. Assoc. Adv. Sci.,' 1879, p. 350.

† 'Zeitsch. wiss. Zool.,' xxxiii. (1879) p. 439.

‡ EXPLANATION OF PLATES VII. AND VIII.

FIG. 1.—*Stichotricha socialis*. A medium-sized colony, × 90. The tubes are shown partly in optical section, partly in surface view. The colony occurred hanging downwards from the surface of the water.

FIG. 2.—*Ditto*. The animal from the ventral side. W, the first large cilia of the peristome; *m*, the so-called undulating membrane, represented as a thin line,

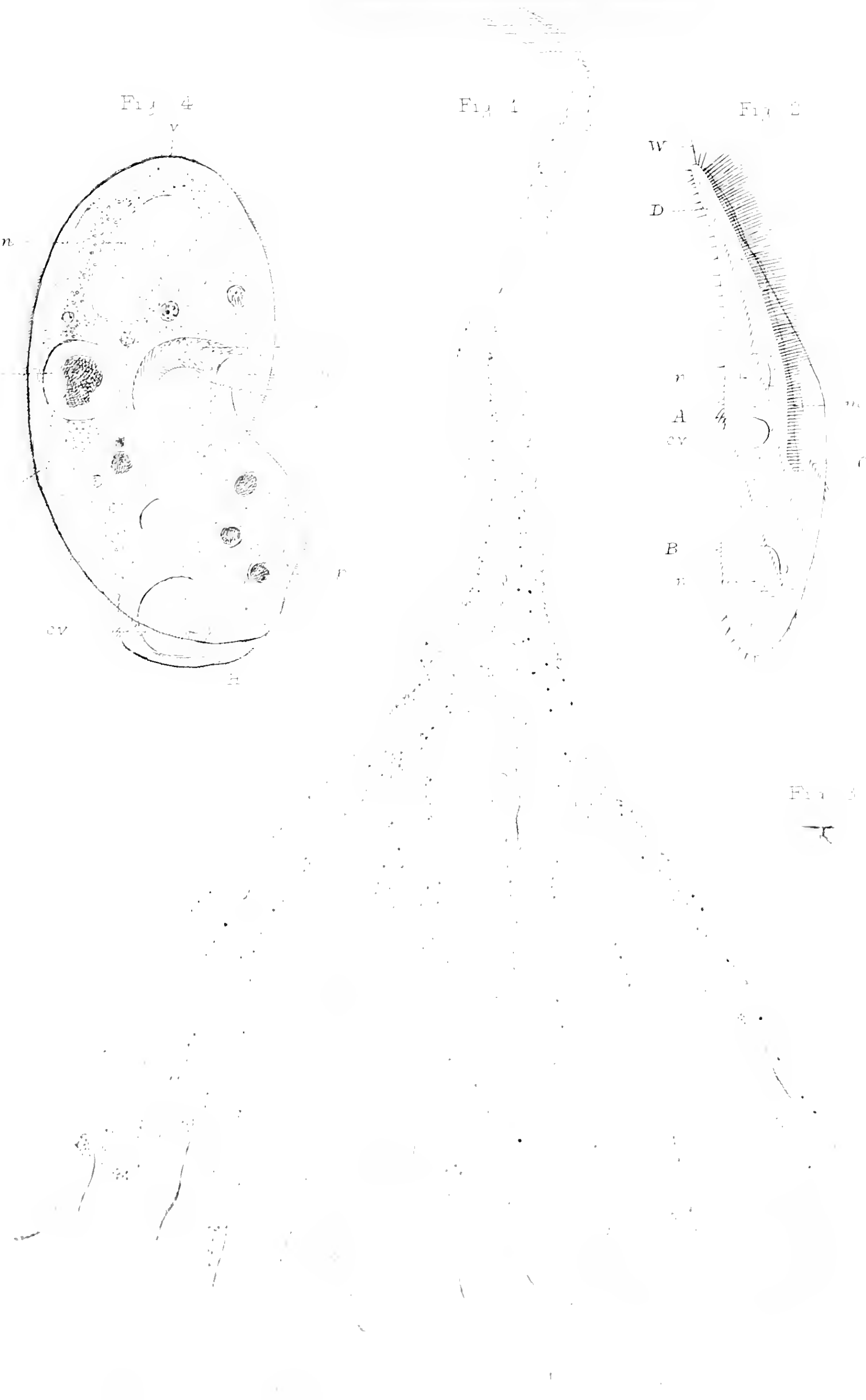


Fig 4
v
n
cv
Fig 1
Fig 2
W
D
n
A
cv
m
C
B
n
Fig 3

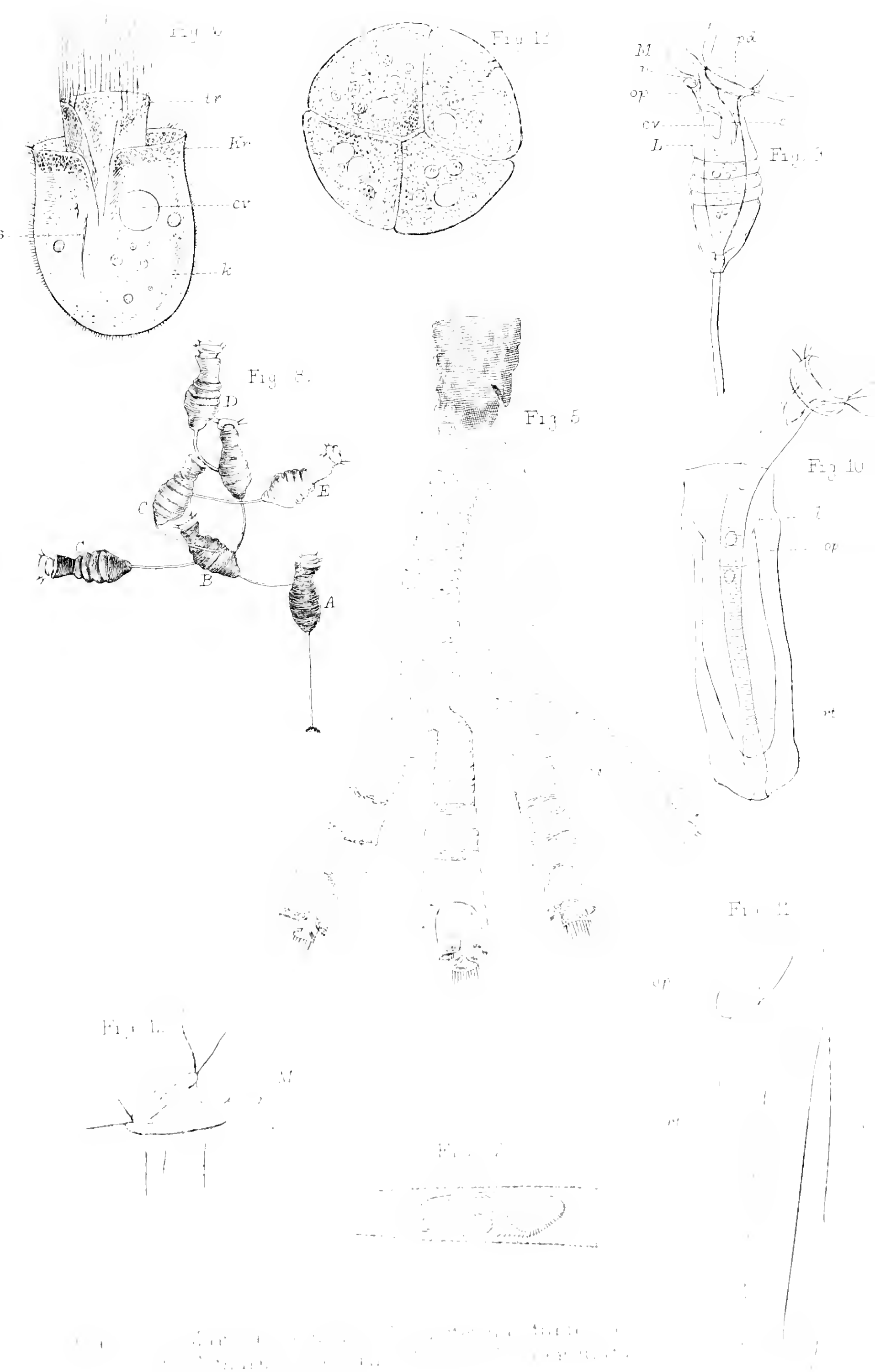


Fig 6
tr
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Fig 12
M
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Fig 9
Fig 8
D
E
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B
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Fig 5
Fig 10
l
op

published a preliminary account,* some of them interesting as being compound hypotrichous and holotrichous forms.

1. *Stichotricha socialis*, n. sp. (Figs. 1–3).—This is a compound hypotrichous species, found in an aquarium at the Zoological Institute, Vienna.

It occurs in the form of a soft, brownish, tree-like, dichotomously branched tube (Figs. 1 and 3), springing from a single stem, and with each branch open distally and containing a single infusor. The latter are in constant motion, sometimes projecting a long way out of their tubes, sometimes retreating far into them. If disturbed they often leave the tube altogether and swim free in the water, and in this case never return to their former habitation. A free form may, however, start a new stock by throwing out a secretion which gradually hardens in the water to the characteristic tube. The constant movements of the animal keep the lumen of the tube sufficiently wide. After the formation of the tube has gone on for a time, the animal divides transversely; the two individuals thus formed take up a position side by side at the mouth of the tube, proportionally widening it. A septum is then secreted between the two, so that each comes to lie in its own tube, and thus the first branching is brought about.

The animal itself is elongated (Fig. 2), produced at one end into a long neck, and has two widely separated nuclei (*n*), each with its nucleolus, and a single contractile vesicle (*cv*). The cilia fall into three sets; there are four spirally arranged bands of locomotive cilia around the body (A, B, C, D); a row of cilia to the right of the long

but really composed of fine cilia; A, B, C, D, the four rows of locomotive cilia; *n*, nucleus; *cv*, contractile vesicle.

FIG. 3.—*Ditto*. A large colony hanging from the surface of the water. Natural size.

FIG. 4.—*Tillina magna*. The animal from the right side. *v*, anterior end; H, posterior end; *rp*, ectosarc; at H is the projection in which the contractile vesicle *cv* lies; *o*, mouth; *s*, gullet; particles not required for food penetrate as far as *x*, and are then driven out again; *n*, nucleus; *p*, probably accumulations of parasitic bacteria; *nv*, food vacuole.

FIG. 5.—*Maryna socialis*. A colony of four individuals. × 90.

FIG. 6.—*Ditto*. The animal seen from the ventral side. *k*, the cup or body proper with its fine investment of cilia, the fissure in its margin being turned towards the observer; *tr*, the funnel, projecting from the cup, and bearing long cilia round its fore-edge; *Kr*, dark granules, probably giving rise to the secretion for the case; *s*, gullet; *cv*, contractile vesicle.

FIG. 7.—*Oxytricha tubicola*. A single tube with the contained animal. × 300.

FIG. 8.—*Cothurnia socialis*. A colony, × 90. A, the oldest and consequently darkest individual; B–E progressively younger and therefore lighter animals.

FIG. 9.—*Ditto*. The animal seen from the side. *pd*, disc; *p*, peristome; L, lip; M, præ-oral membrane; *op*, operculum; *x*, gullet; *cv*, contractile vesicle.

FIG. 10.—*C. operculata*. The animal in such a position that the open operculum is seen from behind. *op*, the line along which the operculum is attached to the lorica; *l*, the places where the retracting membrane *rt* is attached.

FIG. 11.—*Ditto*. Diagrammatic representation of the closing apparatus. *c*, the animal; *op*, the operculum: *rt*, retracting membrane.

FIG. 12.—*Ditto*. Distal end of the animal, showing the membrane M, surrounding the mouth *o*.

FIG. 13.—*Tillina magna*. Encysted form, divided into four.

* This Journal, ii. (1879) p. 899.

peristome (*m*), and terminating anteriorly in a tuft of long seta-like cilia (W); and another row of extremely fine cilia within the peristome (*m*), producing the so-called undulating membrane.

The author considers that the two genera *Chætospira* Lachmann and *Stichochæta* Claparède and Lachmann should both be included in Perty's genus *Stichotricha*.

2. *Tillina magna*, nov. gen. et sp. (Figs. 4 and 13).—The length of this large free holotrichous species amounts to $\frac{1}{5}$ mm. The body is bean-shaped, the mouth (*o*) being in the position of the hilum, or leading into a strongly curved gullet (*s*). At the posterior end (H) is a process of the body substance, disturbing the otherwise regular contour, and lodging the single contractile vesicle (*cv*). The nucleus (*n*) is large and oval. Besides the food-vacuoles (*nv*) the endosarc contains spherical balls (*p*) probably accumulations of parasitic bacterium-like organisms. The ectosarc (*rp*) is distinct and exhibits radial striation, as well as fine parallel superficial lines, probably due, as in *Colpoda*, to folds.

Division was observed to take place in much the same way as in *Colpoda*. A very delicate cyst is formed, and the animal then divides first into two, then four masses (Fig. 13), which afterwards escape as free *Tillinæ*.

The genus is placed in the *Paramœcinæ* between *Paramœcium* and *Colpoda*.

3. *Maryna socialis*, n. gen. et sp. (Figs. 5 and 6).—This is a remarkable holotrichous tube-forming species; its case closely resembles that of *Stichotricha*, being soft, yellowish or brownish, and dichotomously branched. But there is usually a constriction before each fork, and the branches exhibit a distinct annulation.

The animal has the form of a cup (*k*), covered externally with cilia, which are of considerable length round the edge. The latter is interrupted on the ventral surface by a deep fissure. From the interior of the cup rises a rigid funnel (*tr*), having also a fissure along its ventral surface, so that in section it appears crescentic, and edged with a row of very long, fine cilia. The mouth and gullet (*s*) are placed just to one side of the fissure in the bell : food particles are directed by the cilia down both fissures to the mouth. There is a single contractile vesicle (*cv*), and a rounded nucleus, usually invisible from the granulosity of the protoplasm. Around the edge of the bell are dark granules (*Kr*), which the author considers to be concerned in the formation of the case.

Maryna attains a length of $\frac{3}{20}$ mm. It is placed by Gruber near the family Enchelydæ.

4. *Oxytricha tubicola*, n. sp. (Fig. 7).—This species forms short, unbranched tubes of a tolerably resistant nature. Unlike *Stichotricha*, after division both animals leave the tube, and each forms a new one. The precise characters of the animal were not well made out, a very small number of specimens being found.

5. *Cothurnia socialis*, n. sp. (Figs. 8 and 9).—The mode of occurrence of this Infusor is remarkable. The stalk of one is attached to the lorica of another: sometimes one individual will

have two or three attached to it in this way, the final result being a sort of network. The species thus affords an example of the least modified form of compound animal or "stock"; the connection of the various personæ forming it being of the loosest description.

The lorica attains a length of 0·1 mm., and presents a basal portion narrowing gradually to the attachment of the slender stalk, a middle portion consisting of three distinct rings, and a distal, somewhat expanded portion. The colour is yellow in young specimens, gradually deepening in the adult to dark brown.

The peristome (*p*) and disc (*pd*) present the usual characters, but there is, in addition, a special circular lobe of the peristome on the mouth side, which acts as an operculum (*op*), shutting in the whole animal when retracted.

Gruber's observations on the structure usually described as a bristle-like cilium (Fig 9, M), overhanging the mouth on the outer side, are of great interest. He states that this is not a cilium at all, but a very delicate, transparent, tolerably stiff membrane, attached to the inner edge of the peristome, and bounding the mouth externally as an outwardly sloping wall, highest immediately opposite the mouth, and gradually sloping away on either side. The author considers that this structure is of considerable functional importance; all particles directed by the cilia of the disk against it, are immediately carried directly into the œsophagus; all others are whirled away from the animal.*

6. *Cothurnia operculata* (Figs. 10, 11, and 12).—As in *C. socialis*, the lorica presents a constricted neck, and at the constriction is a circular valve or operculum (Figs. 10 and 11, *op*), not as in the former species a prolongation of the protoplasm, but evidently made of the same delicate transparent substance as the lorica itself, to the inner surface of which it is attached. In empty loricæ the operculum is always open, so that its closure must be due to the contraction of the animal. There is, in fact, attached to its under surface, one end of a delicate cuticular membrane (Figs. 10 and 11, *rt*), bent longitudinally into a half cylinder and with its other end embracing the proximal extremity of the animal. When the latter retracts, the membrane is pulled upon and the operculum closed. The membrane is so delicate that under ordinary circumstances all that can be seen of it are its edges, which look like two delicate threads passing from the base of the animal to the operculum.

In the extended condition the protoplasm shows a fine transverse striation.

Glycogenesis in Infusoria, &c.†—According to Claude Bernard ‡ the glycogenic function is a general one to be found wherever there is nutrition, and he affirmed its existence not only in the liver of Vertebrates, but in Mollusca, Crustacea, Worms, and Insects. M.

* This membrane seems to perform much the same part in nutrition as the "collar" of Flagellates, and it seems not improbable that the two structures may be morphologically identical.

† 'Comptes Rendus,' xc. (1880) p. 77.

‡ 'Leçons sur les Phénomènes de la Vie Communs aux Animaux et aux Végétaux.' Paris, 1878–9.

Certes has now experimented with the view of ascertaining whether this general law extends to the Infusoria. Bernard showed that glycogen is revealed under the Microscope "by the wine-red, purplish, or mahogany-red colour which it takes under the influence of iodine,* and Ranvier, by means of *iodized serum*, proved its presence in the lymphatic cells, which, in more than one respect, may be compared to *Amœbæ*. "The mahogany-brown colouring by iodine," he writes,† "is the characteristic reaction of glycogen. . . . It is homogeneous; exists in a kind of gummy condition which enables it to spread everywhere; it may even escape from the cell and form little drops. If the action of the iodized serum is prolonged these little drops coalesce and end by producing round the cell a border of a brown colour. These characters added to the iodine colouring are common to glycogenic matter wherever it is found."

Treated with iodized serum the greater part of the Infusoria are not diffluent. It is hence possible to follow the phenomena caused by iodine and to prove that they in no wise differ from those described by Ranvier. At the outset, the mahogany-brown colour appears diffused; but if the action of the reagent is regulated, and if the Infusoria are gently compressed, the colour is seen always to spare certain organs; sometimes even it shows a sort of localization. The nuclei, the nucleoli, and the contractile vesicles are never coloured. The same is the case with the cuticle, the vibratile cilia, the contractile filament of the *Vorticellæ*; and even, when they exist, with the gastric vacuoles. The sarcodic expansions of freshly killed Infusoria, on the contrary, become mahogany or wine-red colour, and the colloid matter, in contact with water, slowly diffuses through it.

According to M. Certes' observations, the glycogenic function would be independent of the chlorophyllic function, even in the case of flagellate Infusoria which are very sensitive to light, and in which the chlorophyll certainly plays an important physiological part. In *Euglena acus*, the grains of chlorophyll are more or less blackened and the nucleus stands out clearly, whilst the rods of *Paramylon*, also colourless, appear in a matrix of mahogany-brown protoplasm.

In the *Amœbæ* and *Rhizopoda* the glycogenic reaction is less constant than in the Infusoria. When it is produced, the nucleus and the contractile vacuole are never coloured.

The author has not observed that the Infusoria which are conjugating, or are in process of reproduction by fission, are much more deeply coloured than the others, and has not hitherto succeeded in sensibly modifying the glycogenic function by varying the conditions of temperature and the nutritive media. The vitality of the animals is, on the contrary, an important factor. Infusoria which are crushed or killed by reagents no longer become coloured. Nevertheless, if they have been killed by desiccation, a certain number are always found containing a quantity of glycogenic matter.

The author finally points out briefly the effect of iodized serum on

* Loc. cit., ii. p. 91.

† 'Traité technique d'Histologie,' p. 158.

the microscopic organisms which live in the same water as Infusoria. The *Rotifers*, *Entomostraca*, *Anguillulæ*, and *Entozoa* are deeply coloured by the iodine. The characteristic colour is always more or less localized in certain organs. The *Bacteria* and *Vibriones* are never coloured. Amongst the smallest Monads and Flagellates some take a mahogany-brown colour, others turn to a violet-black, whilst some remain colourless. The protoplasm of Algæ and of vegetable cells in general becomes slightly yellow. The hyaline sphere of the Volvocineæ does not appear to undergo any modification.

The author says that the question may be perhaps asked whether the presence of animal starch may not constitute that criterion, so long sought for in vain, defining the limit between the animal and vegetable kingdoms, but for the elucidation of this question further experiments are necessary.

New Species of Ophrydium.*—Dr. H. C. Evarts describes a second species of *Ophrydium* (*O. Adæ*), very closely allied to *O. versatile*. The generic and specific characters are the following:—Lorica gelatinous; animals radiately clustered in numbers varying from one hundred to four or five hundred or even a thousand; each one attached by a long, non-contractile stalk, which penetrates to the interior of the jelly-mass. The expanded body extends beyond this mass; when fully contracted it is drawn down into it. The extended body is elongated, tapers gradually from its point of greatest diameter, which is in the inferior third of the body, to a small, rounded, inferior extremity. Above the dilated portion, the diameter, after diminishing for a short distance, becomes uniform almost up to the mouth, where it expands slightly. Peristome annular; disk well elevated, and higher on one side than on the other. Endoplast or nucleus very long.

The ciliated œsophagus extends half-way to the contractile vesicle. The external surface of the body exhibits very fine, transverse striation. During contraction, this striation is not more marked, except in that part below the dilated portion, and is much less conspicuous than in *O. versatile*. Moreover, during partial or complete contraction, the appearance presented is not the same as in the latter; the "flask-shape" is never assumed. There are no longitudinal folds like those of *O. versatile*, except when the animal is subjected to pressure, and even then they are not always produced.

The animals were not seen encysted, nor in the acinetiform phase that Stein has observed in *O. versatile*. They are not of a vivid green colour; the chlorophyll granules are few, mostly collected in the dilated portion. When fully contracted the body is pyriform, or nearly oval in shape. The animals are associated in smooth, globular, transparent, homogeneous masses, which are always attached, varying from one half-line to two lines in diameter.

Length of extended individuals about $\frac{1}{100}$ inch. Habitat, so far as known, only fresh water. Although the locality was frequently visited during the spring and summer, and the fauna of the stream

* 'Am. M. Micr. Journ.,' i. (1880) p. 1 (5 figs.).

studied, they were not found until the early part of the autumn. That they are hardy, is evident from the fact that the water of the jar in which they lived was frozen, yet they were alive and active after the thawing of the ice.

Leidy's Fresh-water Rhizopods of North America.* — This important work, which has long been expected, has just been issued, and is the result of a large amount of careful microscopical research into the structure, development, and habits of these lowest forms of animal life.

Dr. Leidy divides the Rhizopods into five orders: I. Protoplasta, II. Heliozoa, III. Radiolaria, IV. Foraminifera, and V. Monera, agreeing in this with the views of Schulze †; the Protoplasta and the Monera corresponding to Haeckel's Protista. Excepting a few of the Monera section, fresh-water Rhizopods belong almost entirely to the Protoplasta and Heliozoa, and all the fresh-water species described are of these two groups, excepting one Foraminifer—*Gromia terricola*—a genus exceptional among Foraminifera, in that it is represented by several species inhabiting both salt and fresh water. The Protoplasta include the genera *Amœba*, *Difflugia*, *Nebela*, *Arcella*, and others; and the Heliozoa, *Actinophrys*, *Heterophrys*, and others allied. With regard to Monera, Dr. Leidy says: "Though Haeckel has indicated and described a number of fresh-water species, I am not sure that I have had the opportunity of finding any of them, excepting perhaps the genus *Vampyrella* of Cienkowski, which he ascribes to the same order."

One of the most remarkable forms described is the *Dinamœba mirabilis*, from the cedar swamps of New Jersey. It is commonly cream-white or greenish white in colour, but spotted often with green, brown, and yellow, all the colours excepting the white being due to the food-balls, which are chiefly the Desmids *Didymoprium* and *Bambusina*. It is a gluttonous feeder, and is commonly so gorged with this vegetable food as to be more or less opaque. Every part of the surface, including the pseudopods and posterior papillæ, is ordinarily bristled with exceedingly minute spicules or ridged cils; but after some hours these may disappear, or be represented by minute molecules. A still more remarkable feature is the occurrence of a thick investment of hyaline jelly, the outer surface of which is defined by innumerable, exceedingly minute rods, standing perpendicularly, which make the animal look as if surrounded by a nimbus of *Bacteria*. In the movements of *Dinamœba*, its jelly-like cloak appears to be no obstacle, and the subulate pseudopods shoot through and beyond it as if it did not exist.

Another species of peculiar interest is *Hyalosphenia papilio*, a buff-coloured or straw-coloured species, perfectly transparent, and remarkably constant in its form. The species of *Nebela*, particularly *N. collaris*, *N. hippocrepis*, and *N. ansata*, are of special beauty.

* Leidy, J., M.D., 'Fresh-water Rhizopods of North America,' 324 pp. 48 plates (4to, Washington, 1879); see 'Am. Journ. Sci.,' xix. (1880) p. 240.
† 'Arch. Mikr. Anat.' (1877) p. 21.

The volume is illustrated by 48 plates, with crowded coloured figures. It is adapted to the uninitiated as well as to adepts in the science. Dr. Leidy says: "In the course of its preparation I have always had my pupils in mind, and I shall be glad if it serves as an additional aid to their studies." There is a bibliographical appendix containing the names of authors of works and memoirs on living Rhizopods, and lists of all the species they describe, together with the synonymy, so far as giving the names of the same adopted by Dr. Leidy.

Dr. Leidy's experience enables him to give important information as to the localities of the Rhizopods, and the best method of collecting them. The following are a part of his observations on these points.

Localities of Rhizopods.—"Fresh-water Rhizopods are to be found almost everywhere in positions kept continuously damp or wet, and not too much shaded. They are especially frequent and abundant in comparatively quiet waters, clear, and neither too cold nor too much heated by the sun, such as lakes, ponds, ditches, and pools. They are also frequent in wet bogs and savannas, among mosses, in springy places, on dripping rocks, the vicinity of waterfalls, springs, and fountains, and in marshes, wherever the ground is sufficiently damp or moist to promote the growth of algæ. They are also to be found in damp shaded places, among algæ, liverworts, and mosses, about the roots of sedges, rushes, and grasses, or those of shrubs and trees growing in and at the borders of bogs and ponds, or along ditches and sluggish watercourses. They are likewise to be found with algæ in damp shaded positions in the depressions and fissures of rocks, in the mouths of caves, among decaying logs, among mosses and lichens, on the bark of growing trees, and even in the crevices of walls and pavements about old dwellings and in cities.

"The favourite habitation of many kinds of Rhizopods is the light superficial ooze at the bottom of still waters, where they live in association with diatoms, desmids, and other minute algæ, which form the chief food of these little creatures. They never penetrate into the deeper and usually black mud, which, indeed, is almost universally devoid of life of any kind.

"Rhizopods also occur in the flocculent materials and slimy matter adherent to most submerged objects, such as rocks, the dead boughs of trees, and the stems and leaves of aquatic plants. A frequent position is the under side of floating leaves, such as those of the pond-lily, *Nymphæa odorata;* the spatter-dock, *Nuphar advena;* and the Nelumbo, *Nelumbium luteum.* Certain kinds of Rhizopods, especially the Heliozoa or Sun-animalcules, are most frequent among floating plants, such as duck-meat, *Lemna;* hornwort, *Ceratophyllum;* bladderwort, *Utricularia;* and the various confervas, as *Zygnema, Spirogyra oscillatoria*, and the water-purse, *Hydrodictyon.*

"In no other position have I found Rhizopods of the kind under consideration in such profusion, number, and beauty of form as in sphagnous bogs, living in the moist or wet bog-moss, or *Sphagnum.* Sometimes I have found this particular moss actually to swarm with multitudes of these creatures of the most extraordinary kinds and in the most highly-developed condition. A drop of water squeezed from a little pinch of bog-moss has often yielded scores of half-a-dozen genera and a greater number of species. Frequently, however, the *Sphagnum* of many localities contains comparatively few Rhizopods, though I have rarely found them entirely absent from this moss. Other mosses and liverworts I have not observed to be specially favourite habitations of Rhizopods, not even such aquatic kinds as the *Fontinalis*."

Collection of Rhizopods.—"The mode I have habitually adopted for collecting Rhizopods, which is also equally well adapted for collecting many other microscopic organisms, plants, and animals, is as follows:—

"For ponds, ditches, or other waters, I use a small tin ladle or dipper, such as is commonly employed for domestic purposes. Into the handle I insert a stick of convenient length, and for this I usually carry with me a jointed pole of two or three pieces, each about five feet. The dipper is used by slowly skimming the edge along the bottom of the water, so as to take up only the superficial portion of the ooze, which is then gently raised from the water and transferred to a glass jar. A small hole in the bottom of the ladle favours the retention of the collected material, but care should be taken that it is not so large as to permit the material to stream through. After the collecting jar is full, if more of the material is wanted, after allowing that in the bottle to settle, I pour off a portion of the water and supply an additional quantity from the locality.

"Usually I have proved more successful in obtaining Rhizopods from the ooze near the shores of lakes and ponds than I have in deeper water; but this, I suspect, was mainly due to the circumstance that near the shore I could see the ooze at the bottom of the water, and could much better manage to collect the desired material.

"Aquatic plants, if rooted in the mud, should be carefully cut off and gently lifted from the water so as to disturb as little as possible the adherent materials. A sufficient quantity being placed in a tin preserving can or other vessel, water from other portions of the plants may be squeezed upon that which is retained.

"Wet *Sphagnum* may be collected and put in tin preserving cans, and the water of other portions may be squeezed upon the portion preserved. The same process may be pursued with other mosses.

"From the surface of the ground in wet places to collect the Rhizopods, it is sufficient to scrape up with the broad blade of a knife the green algous material with which the animals are usually associated."

Endamœba Blattæ.*—The attention of Professor Leidy, while perusing the communication of Professor Bütschli on *Flagellata* and other related organisms,† was especially attracted by the description of a parasitic amœboid living in the intestine of the cockroach. It recalled to mind that he had observed the same creature a number of years ago, in association with the ciliated infusorian he had described as

* 'Proc. Acad. Nat. Sci. Phila.,' 1879, p. 204.
† 'Zeitschr. wiss. Zool.,' xxx. (1878) p. 205.

Nyctotherus ovalis. At that time he had viewed it as a young form of a Gregarina, and had intended giving it and other parasites of the cockroach more critical examination, but failed to do so. The parasitic amœboid which Bütschli described under the name of *Amœba Blattæ* is particularly interesting, on account of its habits and its somewhat peculiar character. Professor Leidy had recently examined some cockroaches, and found abundance of the amœboid in association with *Nyctotherus ovalis*, *Lophomonas Blattarum*, *Oxyurus gracilis*, and *O. appendiculatus*, and an algoid plant.

The amœboid, he thought, was worthy of generic distinction from the true *Amœba*, holding a position between this and *Protamœba*. From the former it differed in the absence of a contractile vesicle, and commonly also of vacuoles, and in the want of differentiation of endosarc and ectosarc, and from the latter in the possession of a well-defined nucleus. He proposed for it the following name, with distinctive characters:—

Endamœba.

General character and habit of *Amœba* ; composed of colourless, homogeneous, granular protoplasm, in the ordinary normal, active condition, without distinction of ectosarc and endosarc; with a distinct nucleolated nucleus, but ordinarily with neither contractile vesicle nor vacuoles.

Endamœba Blattæ.*—Initial form globular, passing into spheroidal, oval, or variously lobate forms, mostly clavate, and moving with the broader pole in advance. Protoplasm finely granular, and when in motion more or less distinctly striate. Nucleus spherical, granular, with a large nucleolus. Distinct food-particles commonly few or none. Size of globular forms 0·054 mm. to 0·075 in diameter; elongated forms 0·075 by 0·06 to 0·15 by 0·09 mm. Parasitic in the large intestine of *Blatta orientalis*.

The *Endamœba Blattæ* affords a good example of a primitive, active, *nucleated organic corpuscle*, or a so-called *organic cell without a cell-wall*. In the encysted condition it would be a complete nucleated organic cell. It may be recommended as a convenient illustration of a primitive form of the organic cell, on account of its comparatively ready accessibility.

BOTANY.

A. GENERAL, including Embryology and Histology of the Phanerogamia.

Effects of uninterrupted Sunshine on Plants.†— Professor Schübeler, of Christiania, has recorded the results of a series of observations for the purpose of ascertaining the effect produced by the almost unbroken sunlight of the short Scandinavian summer on

* "Eine Art Proteus," Siebold, 'Beitr. Naturg. wirb. Thiere,' 1839, *fide* Stein; "Amöbenform," Stein, 'Organismus d. Infusionsthiere,' 1867, ii. p. 345; "*Amœba Blattæ*," Bütschli, loc. cit.

† 'Nature,' xxi. (1880) p. 311.

plants raised from foreign seed; the experiments being made with wheat from Bessarabia and Ohio. The general results attained may be stated as follows:—

1. The grain of wheat that has been grown in low-lying lands may be propagated with success on the high fjælds, and will reach maturity earlier at such elevations, even although at a lower mean temperature. Such grain, after having been raised for several years at the highest elevation which admits of its cultivation, is found, when transferred to its original locality, to ripen earlier than the other crops which had not been moved. The same result is noticeable in grain that has been transported from a southern to a more northern locality, and *vice versâ*.

2. Seeds imported from a southern locality, when sown within the limits compatible with their cultivation, increase in size and weight; and these same seeds, when restored from a more northern locality to their original southern home, gradually diminish to their former dimensions. A similar change is observable in the leaves and blossoms of various kinds of trees and other plants. Further, it is found that plants raised from seed ripened in a northern locality are hardier, as well as larger, than those grown in the south, and are better able to resist excessive cold.

3. The further north we go, within certain fixed limits, the more energetic is the development of the pigments in flowers, leaves, and seeds. Similarly, the aroma or flavour of various plants or fruits is augmented in intensity the further north they are carried within the limits of their capacity for cultivation; and, conversely, the quantity of saccharine matter diminishes in proportion as the plant is carried further northward.

Heliotropism of Hartwegia comosa (Chlorophytum).*—According to M. Prillieux, the roots of this plant are negatively heliotropic, lengthening both by day and by night. Contrary to the view of De Wolkopf and H. Müller, he believes that this phenomenon is due to the increased amount of growth on the illuminated side; growth being promoted by the action of light.

Influence of the Electric Light upon Vegetation.—At the Royal Society on 4th March, Dr. C. W. Siemens gave a detailed description of some experiments which he had made to determine whether electric light exercised any decided effect upon the growth of plants.

The method pursued was to plant quick-growing seeds and plants, such as mustard, carrots, swedes, beans, cucumbers, and melons, in pots, and these pots were divided into three groups; one group was exposed to daylight alone, a second similar group was exposed to electric light during eleven hours of the night, and were kept in a dark chamber during the daytime, and the third similar group was exposed to eleven hours' day and eleven hours' electric light. These experiments were continued during four days and nights consecutively, and the results observed were of a very striking and decisive character. The plants that had been exposed to daylight alone (com-

* 'Bull. Soc. Bot. France,' xxvii. (1879) p. 240.

prising a fair proportion of sunlight) presented their usually healthy green appearance; those exposed to electric light alone were, in most instances, of a somewhat lighter, but, in one instance, of a somewhat darker hue than those exposed to daylight; and all the plants that had the double benefit of day and electric light far surpassed the others in darkness of green and vigorous appearance generally, the specimens of mustard and of carrots exhibited to the Society showing this difference in a very remarkable way.

These experiments are not only instructive in proving the sufficiency of electric light alone to promote vegetation, but they also go to prove the important fact that diurnal repose is not necessary for the life of plants, although the duration of the experiments is too limited perhaps to furnish that proof in an absolute manner. It may, however, be argued from analogy, that such repose is not necessary, seeing that crops grow and ripen in a wonderfully short space of time in the northern regions of Sweden and Norway, and Finland, where the summer does not exceed two months, during which period the sun scarcely sets.

Dr. Siemens only considers himself as yet on the threshold of the investigation, but thinks the experiments already made are sufficient to justify the following conclusions:—1. That electric light is efficacious in producing chlorophyll in the leaves of plants, and in promoting growth. 2. That an electric centre of light equal to 1400 candles placed at a distance of two metres from growing plants, appeared to be equal in effect to average daylight at this season of the year; but that more economical effects can be obtained by more powerful light-centres. 3. That the carbonic acid and nitrogenous compounds generated in diminutive quantities in the electric arc, produce no sensible deleterious effects upon plants enclosed in the same space. 4. That plants do not appear to require a period of rest during the twenty-four hours of the day, but make increased and vigorous progress if subjected during daytime to sunlight and during the night to electric light. 5. That the radiation of heat from powerful electric arcs can be made available to counteract the effect of night frost, and is likely to promote the setting and ripening of fruit in the open air. 6. That while under the influence of electric light plants can sustain increased stove heat without collapsing, a circumstance favourable to forcing by electric light. 7. That the expense of electro-horticulture depends mainly upon the cost of mechanical energy, and is very moderate where natural sources of such energy, such as waterfalls, can be made available.

The paper gave rise to a highly interesting discussion, in which Sir Joseph Hooker pointed out that the evidence afforded of the practical identity, as regards vegetation, of solar and electric light, besides the probability that it would be turned to immediate account by horticulturists, would afford great facilities for the scientific investigation of the influence exerted by light, as compared with other agencies, in promoting the formation of the active principles or most valuable constituents of plants, such as the quinine of the cinchona bark, the gluten of wheat, and so forth.

Dr. Siemens promises a more extended series of experiments, and, in an article in 'Nature,'* the writer points out that to give the matter a complete trial, it would certainly be desirable to compare the results during longer periods of growth when the plants were more thoroughly thrown on their own resources. It must be remembered that seedlings grow to a large extent at the expense of the materials stored up in the seeds, and the same thing is true of the foliage produced from fleshy roots like those of the carrot. In both cases the plant is mainly feeding on itself. The real test would be to take some short-lived annual and see if it would run through its course with illumination from an artificial source alone, and how the actual weight of plant-tissue manufactured would compare with that produced under an equivalent exposure to sunlight. The scientific interest of the present application of the electric light must rest mainly on the fact that the cycle of the transformation of energy engaged in plant life is now complete, and that, starting from the energy stored up in vegetable fuel, we can run through the changes from heat to electricity, and thence to light, which we now know we can store up in vegetable fuel again.

Decomposition of Carbonic Acid by Leaves illuminated by Artificial Light.†—Experiments on this subject by MM. P. P. Dehérain and P. L. Maquenne have led to the following conclusions:—

1. Leaves placed in tubes immersed in water and kept at a small distance from the source of light, decompose carbonic acid when exposed to the action of the Drummond light.

2. They also decompose carbonic acid, but less powerfully, when illuminated by the Bourbouze lamp.

3. When the leaves are protected by a stratum of water decomposition always takes place. When enveloped in benzine, which is much more diathermanous than water, the decomposition is more perceptible under the influence of the Drummond light; while under the influence of the Bourbouze lamp it is less perceptible, and the opposite phenomena of absorption of oxygen and emission of carbonic acid may be observed.

The amount of light emitted by the Drummond light and the Bourbouze lamp respectively was estimated in the former at 71, in the latter at 62 candles.

Distribution of Water in the Plant.‡—G. Kraus has carried on a series of investigations as to the relative amount of water in different parts of the plant, and its influence on various vital processes. For the purpose of the experiments the part of the plant, either entire or dissected, was dried in porcelain or platinum vessels placed in copper chambers at a uniform temperature of 110°–120° C.

With regard to the distribution of water in the growing nodes and internodes, the result attained was that an increase in the percentage

* 'Nature,' xxi. (1880) p. 438.

† 'Ann. Sci. Nat.,' ix. (1879) p. 47.

‡ 'Festschr. Feier hundertjähr. Bestehens Naturforsch. Gesell. Halle,' 1879, p. 187; see 'Naturforscher,' xii. (1879) p. 439.

of water takes place as long as the plants are growing, decreasing as soon as growth in length ceases.

A series of experiments related to the causes of geotropic and heliotropic curvatures. In negatively geotropic organs the proportion of water is greater in the convex nodes than in the concave upper side of the curvature. In the curved parts of a young root the proportion is greater in the convex upper than in the concave under side. Before curvature takes place, the proportion of water increases in the upper side.

Finally, attention was paid to the distribution of water in connection with the tension of the bark, with the following results:—As the tension of the bark changes during the day, a corresponding change takes place in the amount of water contained in the bark, an increase of tension being accompanied by an increase in the amount of water. As the stems of trees are exposed to a higher temperature, it was found that the tension and thickness of the bark, and the amount of water contained in it, also increased. These changes take place without the diameter of the wood being sensibly increased, and without any increase in the total amount of water in the branch. From this it follows that an increase of temperature drives the water out of the wood into the bark.

Sugars of Vegetation.*—The saccharine matters found in plants belong to two great groups—the saccharoses and the glucoses; the former constituting the reserve materials which are not directly assimilable, while the latter can be directly utilized by the plant. In order for a saccharose to be made use of, it must first be transformed into a glucose, the process being one of hydration, effected by a soluble nitrogenous principle known as an inverting ferment. M. Bonnier has extracted a similar soluble ferment from the tissues of sacchariferous phanerogams, as *Helleborus*, *Hyacinthus*, *Primula*, &c. This ferment has the power of transforming into a glucose sixty times its volume of a saccharose, such as cane-sugar.

The sacchariferous tissues are developed especially in the root, as in the beet and carrot, in the rhizome, as in *Cyperus esculentus*, or in the woody stems, as in *Acer* and *Syringa*. In the flower, near the ovary, is frequently found an accumulation of saccharoses, accompanied by glucoses. The most frequent saccharose, $C_{12}H_{22}O_{11}$, is that of cane-sugar; less often mélézitose is found, as in the larch, mannitose in the pith of the ash, oak, and elder. The most widely distributed glucose, $C_6H_{12}O_6$, is grape-sugar, almost always accompanied by levulose; the glucose known as sorbin occurs in *Sorbus*, *Amygdalus*, *Cydonia*, &c. Mannite, $C_6H_{14}O_6$, already known in algae and fungi, has been found by Bonnier in the leaves of *Acer*.

The following is the method employed by Bonnier for obtaining the three kinds of sugar, saccharose, glucose, and levulose, in a pure state from the sacchariferous tissues of flowers. The mixture is first treated with absolute alcohol; the insoluble cane-sugar (saccharose) crystallizes out. The crystals are dissolved in water and recrystallized,

* 'Bull. Soc. Bot. France,' xxvi. (1879) p. 208.

the sugar thus obtained not giving a trace of precipitate with cupro-potassic tartrate, the rotatory power being $\rho = +73^\circ \cdot 8$ at 15° C. The residue is then evaporated to dryness and redissolved in alcohol at 90° C.; twice the volume of ether is then added to precipitate the remainder of the saccharose; the solution contains a mixture of glucose and levulose. If this is now treated with chalk, the insoluble calcium levulosate can be separated from the soluble calcium glucosate; the addition to the former of oxalic acid separates the levulose in the form of an insoluble viscous sugar; and glucose can be obtained by a similar process. The crystals of saccharose and glucose are readily distinguishable under the Microscope.

Effects of Starvation on Vegetable and Animal Tissues.*—Surgeon D. D. Cunningham has studied the effect of partial or total deprivation of food on two mucorine fungi, *Choanephora* and *Pilobolus*, and on the tadpoles of two batrachians, *Bufo melanostictus* and *Rana tigrina*. The method adopted was to place the organism under examination in freshly distilled water.

In all cases the effect of starvation was fatty degeneration, followed by total disintegration of the protoplasm. This was observed in the hyphæ and the spores of the fungi, and in the epidermic and epithelial cells, blood-corpuscles, nuclei of adenoid tissue, and amœboid wandering cells of the tadpoles. The effect was most marked in the epithelial cells of the alimentary canal, which in an advanced stage of starvation were found to be entirely destroyed. When this took place, the alimentary canal was of course deprived of all power of absorption and secretion, and recovery was rendered impossible.

The *post-mortem* examinations made by the author showed that a similar fatty degeneration and disintegration of the alimentary epithelium was a marked symptom in the fatal cases of starvation during the famines in India. It was found that patients coming to the relief camps in an advanced stage of starvation, but with no active symptoms of disease, were almost certain to die of famine-diarrhœa and famine-dysentery, brought on by the irritation produced by the unaccustomed supply of food on the abraded surface of the intestine.

Composition of Chlorophyll.—Since the publication of Hoppe-Seyler's note on the composition of chlorophyll,† the subject has attracted much attention among French chemists and botanists. M. Gautier ‡ brought before the notice of the Academy of Sciences at Paris some researches of his, carried out in 1877, in which he claims to have separated crystalline chlorophyll in a state of purity. The crystals are in the form of flattened needles, often radiating, about 0·5 cm. in length, soft, of an intensely green colour when fresh, afterwards becoming yellowish or brownish green. They belong to the oblique rhomboidal system, the rhombohedron having an angle of

* See 'Quart. Journ. Micr. Sci.,' xx. (1880) p. 50.
† See this Journal, *ante*, p. 116.
‡ 'Comptes Rendus,' lxxxix. (1879) p. 861.

about 45°. Chlorophyll, therefore, which has been compared to a wax, a resin, and a fat, is really analogous to bilirubine in properties, reactions, and elementary composition.

Like bilirubine, it is soluble in ether, chloroform, petroleum, carbon bisulphide, and benzine, and is precipitated from its solution sometimes in a crystalline, sometimes in an amorphous state. It presents another resemblance to that substance in playing the part of a weak acid, yielding soluble instable salts with the alkalies, insoluble salts with all other bases. The alkaline solutions of both substances are very readily altered and oxidized under the influence of incident light. Both substances yield a number of coloured derivatives—yellow, green, red, and brown. Finally, both substances possess the property of uniting directly with nascent hydrogen. When chlorophyll is digested with hot concentrated hydrochloric acid, it separates into two substances, one with a beautiful blue-green solution, the phyllocyanic acid of Fremy, the other phylloxanthin, insoluble in hydrochloric acid, but forming a brown solution in ether or hot alcohol, from which it readily crystallizes out. Gautier suggests for phyllocyanic acid the composition $C_{19}H_{22}N_2O_3$, that of bilirubine being $C_{16}H_{18}N_2O_3$.

The author believes that Hoppe-Seyler's chlorophyllan is nothing but his own pure crystallized chlorophyll. The former gives the percentage composition of chlorophyllan as C 73·4, H 9·7, N 5·62, O 9·57, P 1·37, Mg 0·34 per cent.; while Gautier makes that of chlorophyll C 73·97, H 9·80, N 4·15, O 10·33, phosphates 1·75 per cent.

In commenting upon this article, M. Trécul points out * that as long ago as 1865 he separated green crystals, soluble in alcohol and ether, which gave birth directly to grains of chlorophyll.

In response to a question of M. Chevreul,† Does chlorophyll form a constituent part of the organ or is its occurrence merely accessory and without organic activity? M. Trécul replies ‡ that it is important to distinguish between the globular tufts of green crystals and the grains of chlorophyll from which they are produced. The former are not, while the latter certainly are, living organs. The principle known as chlorophyll never exists by itself in the vegetable tissue, but always associated with protoplasm, usually in the form of chlorophyll-grains.

M. Gautier's reply to this question § is that the only function of chlorophyll is the decomposition of carbonic acid under the influence of light. The chlorophyll pigment appears to be only a secondary agent, destined to absorb chiefly the red and orange rays of light. Thus luminous force, transformed in the leaf into heat and chemical action, is utilized by the protoplasm of the chlorophyll corpuscles, to bring about the necessary reductions in the green parts of plants.

Finally, M. Pringsheim ‖ calls attention to his microphotochemical experiments, with which physiologists are already acquainted.¶

* 'Comptes Rendus,' lxxxix. (1879) p. 883. † Ibid., p. 917.
‡ Ibid., p. 972. § Ibid., p. 989. ‖ Ibid., xc. (1880) p. 161.
¶ See this Journal, *ante*, p. 117.

Formation of Chlorophyll in the Dark.*—M. Flahault has re-investigated all those cases where chlorophyll has been found in organs completely excluded from the influence of light, viz. (1) the embryo of *Pinus* and other conifers which become green at the moment of germination; (2) the embryo of many phanerogamous plants protected by a thick, opaque integument, as *Euonymus*, *Acer*, *Raphanus*, *Astragalus*, *Celtis*, *Tropæolum*, *Pistacia*, *Viscum*, *Citrus*, *Geranium*, and *Cephalaria*; and (3) the fronds of some ferns. He first satisfied himself that the green colouring matter was in these cases identical; at all events, that it had the power of decomposing carbonic acid. In certain cases M. Flahault came to the conclusion that this chlorophyll was formed in the light, as in the case of some embryos whose integuments are in an early stage thin and transparent; the chlorophyll having in these cases the power of continuing its existence after the exclusion of light. In other cases, however, there can be no doubt that it is formed in absolute darkness, and that it is under these circumstances produced at the expense of the nutritive materials stored up in the plant.

Colouring Matter of Flowers.†—After reviewing the conclusions of previous writers on this subject, M. Flahault records the results of his own experiments on the origin of the various colouring matters in the petals of flowers.

A solid insoluble pigment, the *xanthine* of Fremy and Cloëz, is in the first place to be distinguished from all the soluble colouring matters, blue, yellow, red, and their mixtures, all of which are acted on very readily by reagents, and which are usually found only in the epidermal cells.

If a crocus is examined some weeks before the expansion of the leaves and flowers, the perianth is found to be almost completely developed, but still colourless, while the stamens and stigmas have already assumed their bright colour. At the same period the Jonquil, *Narcissus odorus*, *Fritillaria Meleagris*, &c., have not developed a notable quantity of any colouring matter, while the separate parts are otherwise fully formed; the moment the perianth expands, it at once acquires its bright colour. In some varieties this is even the case when the flower expands in the dark, although the leaves are completely etiolated. The petals of some flowers, as for example *Anemone fulgens* and *Gentiana acaulis*, contain a smaller or larger amount of chlorophyll, which assimilates in the ordinary way. The conclusion arrived at is that the development of the soluble colouring matter of flowers is directly dependent on the nutritive substances stored up in them, or on assimilation by chlorophyll. It may therefore be produced independently of light.

The insoluble yellow pigment xanthine occurs in the petals of a large number of flowers belonging to many different natural orders, as in *Ranunculus*, *Primula*, *Cheiranthus*, *Galeobdolon luteum*, *Doronicum plantagineum*, *Alyssum saxatile*, *Cypripedium Calceolus*, *Azalea chinensis*, *Uvularia grandiflora*, *Eranthis hyemalis*, *Forsythia viridissima*, *Tussi-*

* 'Bull. Soc. Bot. France,' xxvi. (1879) p. 249. † Ibid., p. 268.

lago Farfara, &c. It has always the form of clearly defined grains, occasionally in the epidermal, much more often in the deeper lying cells, slowly soluble in alcohol and potassa. It is in all probability a modification of chlorophyll. Flowers containing xanthine, expanding in the dark, do not generally acquire so bright a colour as those whose colouring matter is soluble, the coloration of the former being more directly dependent on light.

Absorption of Salts through the Roots.*—M. Vesque thus states the results of a series of experiments carried on with a view of determining the influence of saline substances on the absorptive power of roots for water.

1. Under ordinary conditions, i.e. when the plant is supplied with mineral food-materials, distilled water is absorbed more freely than saline solutions or nutrient fluids.

2. When the plant has been submitted for a longer or shorter time to treatment with distilled water, it absorbs saline solutions and nutrient fluids more freely than distilled water.

3. A contact, even of short duration, of the roots with distilled water acts favourably on the absorption of salts; and conversely a temporary contact of the roots with a saline solution promotes the absorption of distilled water.

4. The effects are the stronger, the more concentrated the saline solutions and the nutrient fluids.

5. There is no qualitative difference between the absorption of a solution of an isolated salt and that of a nutrient fluid.

Precisely similar results were obtained respecting the absorptive power of branches detached from their roots.

Equilibrium of the Pressure of Gases in the Tissues of Plants.†—J. Wiesner proposes to limit the term *diffusion* to an intermingling of chemically different gases subject to an equal pressure, whether separated or not by partition walls; while by *effusion* he understands the intermingling of two gases which are chemically alike or unlike but subject to different pressures, the consequent currents taking place through fine openings in thin membranes. The following are the general results of a series of elaborate experiments:—

1. There are tissues which are impermeable to air even under a great inequality of pressure, as periderm destitute of lenticels.

2. The ingoing and outgoing currents of air through the stomata are the result of effusion; the times for the passage of a definite volume of gas in such currents being proportional to the square root of the density of the gas.

3. In non-vascular wood the equilibrium of pressure is effected through the cell-walls; it is quickest in the axial, slowest in the radial direction. The delicate membrane of the bordered pit is either the exclusive channel, or at all events permits a much freer exchange than the rest of the wall.

4. In parenchyma containing air, a portion of the air passes

* 'Ann. Sci. Nat.,' ix. (1879) p. 1.
† 'SB. K. Akad. Wiss. Wien,' lxxix. (1879) p. 368.

through the capillary intercellular passages, another portion through the closed cell-walls, and chiefly or exclusively through the part that remains unthickened, which close up the pores. The process is therefore complicated, and is greatly aided by transpiration.

5. The more completely a parenchymatous cell or wood-cell is saturated with water, the more slow is the equalizing of the pressure. These cells behave like cells of clay, which when dry allow water to pass readily, but when saturated with water only with difficulty.

6. While the wall of a parenchymatous cell or wood-cell becomes more permeable for gases the less water it contains, the reverse is the case with periderm-cells. These contain fluid when young and air when mature. As long as the wall is saturated, molecules of fluid force themselves through it and escape as vapour, and air then enters the cell-wall from without. As the wall of the periderm-cells dries up, a change takes place in its molecular structure, which finally prevents the passage of gases through the cell-walls even when there is a great difference in the pressure.

7. In the case of the elder, the lenticels in the stem are not closed even in the winter, a fact not in accord with the prevalent theory.

Internal Processes which cause the Curvatures that accompany Growth in Multicellular Organs.*—H. de Vries has paid some attention to this subject, chiefly in relation to tendrils, and states the following as his general conclusion:—Growth in length or elongation depends on the constant production of substances capable of producing osmose in the cell-sap. External and internal causes bring about curvatures in growing multicellular organs by promoting the production of these osmotic substances.

Function of Vegetable Acids in the Turgidity of Cells.†—H. de Vries suggests and defends the following statement of the part played by these substances:—

Vegetable acids are the chief substances in the cells of plants that cause turgidity by means of osmose. They exercise this function partly in the free state, partly as acid or neutral salts.

The vital activity of protoplasm converts the chemical tension of the nutrient substances and of oxygen into the mechanical tension of the acids; this only requires the access of water in order to pass over into vital energy.

Function of Oxalic Acid in the Plant.‡—A recent series of experiments by Van der Ploeg seems to throw considerable light on this subject. The materials employed were leaves of the elm, sweet chestnut, beech, rhubarb, bean, beet, agave, &c.; the total amount of lime in the ash was first ascertained, then the proportion of lime-salts soluble in water, and finally the amount of oxalic acid.

In all the leaves examined, with the exception of the beech, an increase of the amount of lime in the ash, relatively to the other mineral constituents, takes place as the leaves grow older, sometimes as

* 'Bot. Zeit.,' xxxvii. (1879) p. 830. † Ibid., p. 847.

‡ 'De oxalsure kalk in de planten; Academisch proefschrift don B. J. van der Ploeg,' Leiden, 1879; see 'Naturforscher,' xiii. (1880) p. 17.

much as from 6 to 9 per cent. The same relative increase in the amount of lime also takes place with regard to the entire mass of the leaf, again with the exception of the beech. An increase in the amount of oxalic acid was observed only in the cases of the beet, rhubarb, and beech; and in the first the increase was subsequently altered to a decrease. Some leaves, as those of the chestnut and elm, appear never to contain oxalic acid. In those which do contain it, the amount of lime is frequently, as in the beet and rhubarb, insufficient to fix it. In others, as the bean and sainfoin, a large proportion of the lime is present in the soluble form.

These results do not confirm the statement commonly made that the accumulation of lime in foliar organs is dependent on the presence of oxalic acid, or that all the lime present is in the form of an oxalate. As little can it be maintained that oxalic acid is the sole agent in the permanent absorption of lime salts from the soil, setting free nitric, phosphoric, and sulphuric acid from their combinations.

On the contrary, lime is absorbed during the whole period of vegetation, especially before and during the time of blossoming, and is distributed to all the organs. It appears to play a definite part in the transport of organic substances from one organ to another. The lime accumulates in the bark and the leaves, not in the wood, root, tubers, or seeds, and is then commonly in combination with oxalic acid. Oxalic acid is probably formed out of albuminous substances, possibly also out of non-nitrogenous substances, in all organs where a new formation or a transport of nutrient substances takes place. It may diminish or entirely disappear even when united with lime. It may also serve for the purpose of dissolving albuminous substances.

Embryology of Gymnadenia conopsea.*—In a paper read before the Sheffield meeting of the British Association, Mr. H. M. Ward points out that the ovule arises on the placenta as a mass of cells consisting of an axial row surrounded by an epidermal layer of cells one deep; the terminal cell of the axial row, just beneath the epidermal layer, enlarges and cuts off two cells at its apex, as described by Strasburger. These cap-cells and the epidermal cells become flattened and finally destroyed, as the cell which remains enlarges and becomes the embryo-sac. The existence of the remains of the cap-cells as refractive masses above the embryo-sac is evidence against Vesque's view as to the origin of the embryo-sac by the fusion of two or more superposed cells. The protoplasm of the embryo-sac then divides into two masses, one passing to each end of the sac; they there undergo further division into fours. Of the four nucleated masses in the anterior part, one becomes the oosphere or egg-cell, attached to two others which have elongated as the "Gehülfinnen," or "synergidæ" of Strasburger, and have become packed into the top of the sac; the fourth remains suspended in the protoplasm of the sac, and is said by Strasburger to fuse with one of the similarly produced masses below, the product becoming the nucleus of the embryo-sac.

* 'Rep. Brit. Assoc. Adv. Sci.,' 1879, p. 375; see also 'Quart. Journ. Micr. Sci.,' xx. (1880) p. 1 (3 plates and 4 figs.).

The three remaining nuclei are the "antipodal cells" of authors. The writer confirms these views, except that the actual blending of the two nuclei has not been seen; in *Ranunculus*, *Anthericum*, and other plants, however, the evidence is sufficient to render this view most likely, since two nuclei in all stages of approach occur, as well as sacs with one large central nucleus.

The fertilized ovum divides by a horizontal wall into two similar cells, the upper one becomes the suspensor, and divides by cross walls only, the lower is cut by walls in alternating planes at right angles to one another into a few-celled simple embryo, showing no differentiation into tissues, or into cotyledons, stem, root, &c. Brief reference was made to the proposed homologies for these structures in the embryo-sac, and especially to the reasons against accepting the older views as to the correspondence between the synergidæ and the canal-cells of the archegonium of vascular cryptogams.

Confirmatory results have also been obtained in *Butomus*, *Ranunculus*, *Alisma*, *Anthericum*, and other plants. The views of Vesque do not appear to be supported by these researches, and those of Warming appear to involve considerable difficulties as to the meaning of the embryo-sac nucleus.

Embryonic Structure and Germination of Streptocarpus.*—Dr. T. Hielscher describes the singular structure of the embryo of *Streptocarpus* (*polyanthus*) belonging to the Gesneraceæ. It is surrounded by a testa composed of several layers, derived partly from the integuments and partly from the nucleus, is destitute of endosperm, dicotyledonous, but possesses neither radicle nor plumule. After germination a number of endogenous adventitious roots break out at the base of the primary stem. Of the two cotyledons one shortly dies, while the other increases remarkably in size, and lasts for several years as an ordinary leaf. On the pedicel of this single leaf, the tissues of the base of which long continue in a merismatic condition, arise numerous adventitious roots, while the primary stem and the roots which have appeared on it disappear, and the pedicel is then cut off by a layer of cork. Starch collects in the tissue of the pedicel. In the second year the cymose racemes appear in acropetal succession as adventitious shoots on the upper side of the base of the pedicel, a series of foliage-shoots making their appearance also on the pedicel at the same time or somewhat later. These shoots originate as merismatic protuberances above the base of the pedicel, their vascular bundles being in connection with that of the cotyledon.

Phyllody of the Ovules of Hesperis matronalis.†—The flowers of Cruciferæ are especially liable to phyllody of one or more of their parts, many instances of which have been described. To these L. Celakovsky adds one more with regard to the ovules. Each ovule is, as is usually the case, transformed by retrograde metamorphosis into a serrato-lobed leaflet of a deeper green colour on the upper than on the under side, and they stand very crowded on the placenta.

* 'Beitr. Biol. Pflanz.' (Cohn), iii. (1879) p. 1.
† 'Flora,' lxii. (1879) p. 465.

Many of these bear on the upper side a conical outgrowth, obviously the metamorphosed nucleus, though this is as frequently absent. Between this extreme and the normal condition are all sorts of intermediate stages. A careful consideration of the phenomena presented convinced the author that the two integuments together of the ovule represent the lamina of the leaflet. The ovule is, in fact, transformed from a simple pinna of the carpel, which produces out of itself a "metablast" in the form of an emergence or trichome. In one or two remarkable instances the leaflets bore on their dorsal side two or more inner integuments instead of one. The specialty of Celakovsky's interpretation of the leaf-like ovules of *Hesperis* is that he considers each leaflet as consisting of two parts—an upper and a lower—representing the two integuments. With respect to the analogy with vascular cryptogams, he regards the ovule with its integuments as homologous with the pinnule, sorus, and indusium of the Polypodiaceæ.

Cell-division.*—Professor Strasburger recommends the hair on the filaments of *Tradescantia virginica*, or still better of *T. elata*, as peculiarly favourable for observing the phenomena of cell-division. The nucleus remains clearly visible during the whole course of its division, and all stages of its differentiation can be well seen without the application of any chemical reagent. If immersed in a 1 per cent. solution of cane-sugar in distilled water, the hairs retain their living condition for a considerable time, even as much as twelve hours.

The nucleus of cells still in a condition capable of division has a diameter of about 0·018 mm. The division takes place especially in the terminal cell of the hair, not unfrequently in the next, comparatively rarely in those lower down. The protoplasm of the cells contains only very fine granules, and there is therefore nothing to interfere with the observation.

The nucleus is sharply defined in its whole mass, and presents the appearance of a reticulate structure. While thus sharply differentiated on the outside, the nucleus has no skin or envelope which is distinctly differentiated towards the interior. It is only rarely that large granules are visible in the living nucleus resembling the nucleoli in form.

When the nucleus is about to divide, it first of all begins to grow, the diameter in the direction of the longitudinal axis of the cell often increasing twofold in length. As soon as the nucleus has reached its full length, changes in its contents are apparent, and protoplasm begins to collect at both its poles. The nucleus now begins to become coarsely granular, and the granules to collect into lines which, of various lengths, permeate the nucleus more or less obliquely, and with more or less of an S-like curvature. The sharp external differentiation of the nucleus is then lost, and the starch-grains in its interior absorbed.

From three to four hours have now elapsed since the commencement of growth, and the following stages, till the complete formation

* 'SB. Med.-Naturwiss. Gesell. Jena,' 1879, p. 93.

of the daughter-nuclei, do not occupy much more than two hours. The granules in the lines first coalesce with one another, although the moniliform contour of the lines is still preserved; but they gradually become more and more obliterated. The object next becomes again sharper and clearer, and a larger or smaller number of threads penetrate the nucleus longitudinally, which again arrange themselves in S-like curvatures. These threads next become thicker and smaller in number, and exhibit a variety of patterns; but these changes proceed slowly, and are difficult to follow. At this stage the nucleus usually appears as if constricted in the middle.

The threads next begin to straighten themselves, this process advancing from the equatorial regions to the poles, where they somewhat approximate; and thus arises the typical form of the nucleus described by Strasburger as the "kerntonne" or "barrel." * It consists of a relatively small number of comparatively thick threads, or rather rods, which can be followed more or less continuously from one pole of the barrel to the other, both poles being characterized by an accumulation of colourless protoplasm.

Then follows the rupture of the barrel in its equator, first at the periphery, then in the interior. The rods are simply constricted in the middle, the outermost separating from one another somewhat in the form of a fan. From this time until the formation of the membrane of cellulose only about fifteen minutes elapses.

The two halves of the barrel separate from one another, but all the rods are not ruptured at precisely the same time, so that the separation is not at first very sharp. Between the separated halves of the rods there remains a hyaline substance which, when fresh, is perfectly homogeneous, and remains so with 1 per cent. osmic acid; but treated with absolute alcohol or 1 per cent. chromic acid the most beautiful longitudinal striation is revealed. There can scarcely be any doubt that this substance was previously present between the rods, for the rods can be seen evidently to withdraw themselves from it. The author is induced to recur to his original view that in the division of a nucleus the rods owe their origin to this substance, which has been taken up into the nucleus, while, on the other hand, in free cell-formation they must, at least mostly, be differentiated from the protoplasm which surrounds the nucleus.

As soon as the colourless substance becomes visible between the halves of the barrel, the cell-plate becomes apparent in its equator, composed of a simple row of dark granules, the origin of which is difficult to trace. They soon coalesce into a continuous homogeneous pellicle, which is recognized as the new cellulose-wall. The granular protoplasm collected in the equator of the cell-threads is pressed aside, and the hyaline substance now lies distinctly in the form of a convex lens between the two nascent sister-nuclei, divided by the cellulose-wall clearly distinguishable as a black line. The striation of the hyaline substance is revealed by application of alcohol or 1 per cent. chromic acid.

These observations seem greatly to increase the importance to be

* See this Journal, ii. (1879) p. 910.

attached to the part played by the nucleus in the division of vegetable cells.

The development of the two new nuclei proceeds very rapidly in *Tradescantia*. Even while separating from one another the rods begin to coalesce, the process commencing at one extremity and advancing to the whole length, a longitudinal striation remaining visible for about half an hour. As soon as this disappears the young nuclei have a speckled appearance; but soon a definite separation takes place of the substance of the nucleus from the cell-sap, indicated by a distinct black punctation. In three-quarters of an hour at most from the time when the barrel begins to divide, the new nuclei have assumed their permanent character.

The young completely formed nuclei are at once sharply differentiated from the hyaline substance of the cell-threads, which is in the living condition altogether homogeneous. A few small vacuoles make their appearance between the young nuclei and this substance; while at the spots where the connection is still maintained the contour of the nucleus soon again disappears, and the substance of the cell-threads is clearly taken up into the nucleus. The young nucleus hence grows rapidly, and approaches on both sides the new division-wall. As soon as the absorption is completed, each of the two nuclei has again a sharp contour, and retires from the division-wall to the interior of the cell. The starch-grains, which resemble nucleoli, at the same time make their appearance in the nucleus.

The mature nucleus situated in the interior of the cell is suspended in but a small amount of protoplasm. Only at the apex of the terminal cell of the hairs of *Tradescantia* is found any considerable collection of protoplasm.

The reagents found to be best adapted for these observations are alcohol and 1 per cent. chromic acid; the latter causing least change in the object. The investigations were carried out in a moist chamber. On the covering-glass was placed a drop of 1 per cent. solution of sugar, which was spread out, and the entire freshly gathered stamen placed on it, care being taken that the hairs are immersed in the fluid. The covering-glass is then turned over, and placed with its edges on a papier-maché frame. In the suspended drop a number of hairs are sufficiently close to the covering-glass to allow of their study with Zeiss's immersion system I, a magnifying power of 550 with eye-piece 2.

Structure of the Aerial Roots of Orchids.*—The aerial roots of epiphytal orchids are clothed with a special tissue of peculiar structure to which the term *velamen* has been given. Of this tissue M. Prillieux has made a special study, and gives the following description.

It may be divided into two strata:—(1) the spongy envelope, occupying more than half the diameter of the root, and composed of 10–15 or more layers of cells; (2) the protective layer, never more than one cell in thickness.

* 'Bull. Soc. Bot. France,' xxvi. (1879) p. 275.

The walls of the cells of the spongy envelope are commonly marked with spiral bands or other thickenings. The outermost layer of cells differs from the rest, and gives birth to hairs.

Beneath the spongy envelope, differentiated into several layers or not (in *Vanilla* consisting of a single layer), is a stratum differing from it altogether in its origin, and treated by some writers as the true epidermis, the *endoderm* of Oudemans.

M. Prillieux regards the entire velamen as corresponding to the epidermis, and its subjacent layer, the endoderm, to a hypodermal layer. The spiral cells of the spongy envelope are of an undoubtedly suberous character.

B. CRYPTOGAMIA.

Fungi.

Luminous Fungus from the Andaman Islands.*—Mr. Berkeley records the receipt of an extremely luminous agaric, of a small size but exceeding in brilliancy anything which has hitherto been observed. The cause of the luminosity is at present, he believes, quite unknown. Even the opportunities of examining the large olive-tree agaric of the South of Europe have been without result. The only instances of luminosity which have occurred at home have been confined to mycelia in conjunction with decaying wood or fermenting leaves; but in the numerous cases which have occurred in tropical climates there has been no question as to decomposition. The fungus is quite young, and scarcely fully developed. The name and characters of the species, which is certainly new to science, are given as follows:—*Agaricus* (*Pleurotus*) *Emerici*, n. s.—Pileus at first spathulate, quite smooth, dark brown; at length suborbicular, soon changing to white, with a slight tinge of yellow; minutely virgate; stem obsolete; gills of the same colour as the pileus, narrow interstices smooth. Pileus about ½ inch across, attached behind without any stem, either nearly flat, or helmet-shaped, emitting a most brilliant light, the entire substance being luminous. The species was found by Major Emeric S. Berkeley.

Locularia ribesicola.†—It had already been suggested by S. Schulzer that this organism, placed among the Sphæronemeæ, was the pycnidium or early form of an ascomycetous Fungus; and this suspicion he is now able to confirm, identifying it with the genus *Lophiostoma*. This genus is now known in three distinct stages of development:—1, the microstylospore-form or *Locularia*; 2, barren, the nucleus consisting merely of hyphæ; and 3, the perfect ascophorous form.

White Bilberries.‡—J. Schroeter has observed in wood clearings in Baden a number of plants of *Vaccinium Myrtillus* with white berries. As a rule, all the plants in a patch were affected in this way, and the

* 'Gardeners' Chronicle,' xiii. (1880) p. 240.
† 'Oesterr. bot. Zeitschr.,' xxix. (1879) p. 393.
‡ 'Hedwigia.' xviii. (1879) p. 177.

leaves showed evidence of unhealthiness. The leaves were in some cases attacked by *Exobasidium*, but then there were no berries.

Examination of the berries showed that beneath the white skin was a sclerotium-like body, resembling the berry in form, and forming a hollow globe; it was of a horny consistency, and composed on the upper and under surfaces of a black, smooth, cortical substance, within of a white, cartilaginous medullary mass. It had consumed the flesh of the berry, sclerenchyma-cells remaining enclosed in the sclerotium. On being made artificially to germinate the sclerotium developed into an ascomycetous fungus, the asci each containing eight ascospores. This was determined by Schroeter to be a *Peziza*, belonging to the section *Sclerotinia* of Fuckel, and the genus *Rutstroemia* of Karsten. He considers it nearly allied to *P. Fuckeliana* de By., and proposes for it the name *Rutstroemia (Sclerotinia) baccarum*.

The plantations of cranberry (*Oxycoccus macrocarpus*) which cover large tracts of ground in New Jersey, Maryland, and Pennsylvania, are liable to a disease which results in decay of the berries. Schroeter suggests that it may be due to the attacks of a parasitic fungus of a similar nature.

Researches on Uredineæ.* — Dr. J. Schroeter continues his careful investigations of this interesting family of fungi, respecting the life-history of which much still remains to be learnt. He is able to give a full description of the rare *Uredo Ledi*, the uredospores of which indicate that the fungus is really a *Coleosporium*, and he proposes the name *Coleosporium Ledi*. To the same species he also refers *Uredo Rhododendri*.

In this instalment of his paper Dr. Schroeter gives a synopsis of the genus *Coleosporium*; of the Uredineæ parasitic on European Ranunculaceæ, on European grasses, and on European Umbelliferæ. A large number of observations on other species are also recorded.

Uredo Circææ.† — A fungus growing on *Circæa* was long ago described under this name by Albertini and Schweinitz. Schroeter mentions it under the uredo-forms of which the teleuto-forms are not yet known. Dr. G. Winter has now detected the teleutospores, and determines the fungus to belong to *Melampsora* according to the old definition of this genus, and L. Magnus's section of it *Phragmopsora*. He therefore assigns to it the name *Phragmopsora Circææ*, and considers it near to *P. Epilobii*, which was growing at a short distance on *Epilobium roseum*.

Onion-rust, Urocystis Cepulæ.‡—In continuation of his previous researches on this subject,§ M. Cornu reviews what is at present known respecting this pest. He does not regard the fungus as a variety of *Urocystis Colchici* as suggested by Dr. Cooke, but rather as an independent species; and the disease, therefore, as one that has only quite recently made its appearance, carried probably to the

* 'Beitr. Biol. Pflanz.' (Cohn), iii. (1879) p. 51.
† 'Hedwigia,' xviii. (1879) p. 170.
‡ 'Bull. Soc. Bot. France,' xxvi. (1879) p. 263.
§ See this Journal, ii. (1879) p. 921.

cultivated onion from some wild species where it has not yet been detected.

M. Cornu enumerates also the other diseases to which the onion is subjected, viz.: (1) the disease known as "la graisse," by which in wet seasons and in certain soils the whole substance of the onion becomes oily and fœtid; this is generally accompanied by the appearance of *Peronospora Schleideniana*; (2) a *Cladosporium* which produces black spots, but is not serious.

Æcidium abietinum.*—Professor De Bary has made a careful examination of this fungus, found throughout the Alps on the spruce fir, from an altitude of 1000 metres to the upper limit of the tree. It is found only on the shoots of the present season, the æcidium fruits appearing on the leaves in the form of cylindrical or usually flattened tubes, of a pale red colour, projecting to a height of 1 mm. above the surface, and with quite the ordinary structure of the Uredineæ. When the æcidium fruits are mature, the spermogonia are visible as brown spots on the surface of the leaf. The parasite, widely distributed through the Alps, is not found in other similar situations, as the Vosges, Black Forest, &c. A careful examination shows that the tissue of other non-infected parts of the tree is not infected by the mycelium of the parasite; while the spores readily germinate into a curved filament. From this it is seen that the æcidium must be brought to the foliage of the pine in some other form; and analogy indicates that this would be in the form of teleutospores. The only teleutospore-form at present known on the pine is that described under the name *Chrysomyxa Abietis*, which does not produce æcidia. The æcidium of the spruce fir is therefore clearly a heterœcious or diœcious species.

In pursuing this inquiry it struck Professor De Bary that the *Æcidium abietinum* was found only in those districts marked by the presence of *Rhododendron ferrugineum* or *hirsutum*. The uredo-form common on these species, *Uredo Rhododendri*, had however not been known to produce teleutospores. But in July, 1878, Dr. Blytt brought from the Great Scheideck leaves of *R. ferrugineum*, on the under side of which were uredo-pustules producing abundance of teleutospores; and they were subsequently found abundantly in the same situation in the early spring. From this situation they undoubtedly reach the young shoots of the pine, and germinate in the well-known æcidium-form. The æcidiospores are disseminated when ripe in immense quantities, and easily again reach the rhododendron.

Albertini and Schweinitz have described the *A. abietinum* as occurring on the spruce fir in the neighbourhood of *Ledum palustre*, which again is attacked by a uredo-form *Uredo Ledi*. These two uredos show considerable differences from one another, but whether specific or only induced by growing on a different host, De Bary is at present unable to decide.

With regard to the systematic position of the fungus, De Bary considers it very nearly allied to the other parasite of the spruce fir

* 'Bot. Zeit.,' xxxvii. (1879) p. 761.

Chrysomyxa Abietis, which may be regarded as an æcidio-form in which the production of æcidia has been suppressed, and whose uredo-form is also unknown. The genus *Chrysomyxa* may then be divided into two subgenera, *Euchrysomyxa* (= *Melampsoropsis* Schroeter), embracing *C. Ledi* and *Rhododendri*, and *Leptochrysomyxa*, embracing *C. Abietis* only. As to the position of this genus, he would place it near to, rather than include it under, the Coleosporieæ.

Finally, De Bary regards *Chrysomyxa Abietis* as in reality a very simple tremellinous fungus, or at all events as presenting a link between the Uredineæ and the Tremellini, and confirming the close relationship of these families already suggested by Tulasne.

Excrescences on the Roots of the Alder.*—M. Gravis returns to this subject; and while thinking that further investigation is yet required to clear up all the difficult points connected with it, is of opinion that the fungus frequently found in the cells is an accidental accompaniment rather than the cause of the disease. He finds that some of the cells in the part affected contain an amorphous viscid mass resembling more or less the plasmodium of the *Plasmodiophora Brassicæ* found by M. Woronin in the excrescences on the roots of the cabbage, while neighbouring cells contain granules which may be the spores of the same organism. In other cells again are ovoid masses which may be the *Schinzia Alni* of the same author,† but no distinct hyphæ nor spores were to be detected. The only means of setting the question of the cause of the disease at rest would be to induce the spores to germinate artificially; but all attempts at this have hitherto failed.

Influence of Temperature on the increase of Yeast.‡—The effect of various temperatures on the rate of increase of yeast-cells has been made a subject of study by R. Pedersen, the test employed being counting the number of the cells.

Carefully planting out 100 yeast-cells, it was found that during a space of twenty-four hours they increased to 225 at 4° C., to 476 at 13°·5, to 1206 at 23°, to 1759 at 28°, to 639 at 34°, while at 38° no increase had taken place. The "optimum" temperature is therefore between 28° and 34° C., and nearer to the former; on each side of the optimum the rapidity of increase diminishes, and at 38° C. it ceases altogether. During the second day the multiplication of the yeast-cells was much more rapid at 15°·5 than at 4° or at 23°; at the latter temperature it had almost entirely ceased. After eight days the nutrient fluid sowed with an equal number of yeast-cells contained nearly the same number of cells, but twenty times that originally introduced, whether the temperature were 13°·5 or 23°.

The total result of the experiments was that temperature exercises a great influence on the rapidity with which yeast-cells propagate, but that it produces no alteration on the total number of cells finally

* 'Bull. Soc. Roy. Bot. Belgique,' xviii. 2nd Div. (1879) p. 52, and xix. 2nd Div. (1880) p. 15.

† See this Journal, ii. (1879) p. 929.

‡ 'Meddelser fra Carlsberg Laboratoriet,' Heft 1, p. 38; see 'Naturforscher,' xii. (1879) p. 144

resulting in a definite quantity of a nutrient fluid of definite composition.

Corrosion of Grains of Starch by a Micrococcus.*—When grains of wheat germinate, before the starch-grains can pass into the embryo for its sustenance, they have to undergo a process of partial decomposition or fermentation, which is brought about by the agent known as diastase. This substance insinuates itself between the laminæ of the starch-grain, and causes crevices and fissures by which the grain is completely broken up. In the pink grains of corn, the colour of which is caused by a micrococcus,† the corrosion is effected in a totally different manner. No such crevices are found in the starch-grains, which gradually waste away without materially changing their form. The conclusion drawn by M. Prillieux is that the micrococcus does not secrete any liquid ferment which penetrates into the starch-grains after the manner of diastase and other solvents of starch, but that the particles of starch are decomposed only by actual contact with the micrococcus.

Micrococcus prodigiosus.‡—The vital phenomena of this blood-red protophyte have recently been investigated by Dr. A. Wernich of Berlin. He found that it attacked starch-meal and rice under any circumstances, but that uncooked white or yolk of egg, turnip, or potato were unaffected, infection only taking place after boiling; thin slices of cold boiled potato are the best substratum. Infection is caused either by actual contact or by carriage through the air, but only with a strong current; a stopper of wadding completely prevents the carriage of the germs. Water, whether warm or cold, is unfavourable to the propagation of the micrococcus; glycerine preserves it for some days; alcohol, hydrochloric, nitric, and carbolic acids kill it speedily; potassium hypermanganate has no injurious effect in a solution of 2 to 5 per cent.; dilute salicylic acid appears to promote its growth.

Bacillus amylobacter in the Carboniferous Period.§—M. Van Tieghem has made the interesting observation that in fossil vegetable remains (from the carboniferous period) of roots of gymnosperms presenting the strongest similarity to those of the cypress or yew, a process of disintegration of the tissue is observable precisely like that caused by *Bacillus amylobacter*. He therefore concludes that in that remote epoch, as in our own, this minute organism was the grand destructive agent of vegetable tissues, and that the butyric fermentation which it sets up in cellulose, as in all other substances from which it derives its nutriment, is one of the most universally distributed phenomena in the organic world.

Bacillus of Leprosy.‖—Investigations on the nature of the contagion of leprosy, by G. A. Hansen, have led him to the conclusion

* 'Bull. Soc. Bot. France,' xxvi. (1879) p. 187.
† See this Journal, *ante*, p. 131.
‡ 'Beitr. Biol. Pflanz.' (Cohn), iii. (1879) p. 105.
§ 'Comptes Rendus,' lxxxix. (1879) p. 1102.
‖ 'Quart. Journ. Micr. Sci.,' xx. (1880) p. 92.

that the small rod-shaped bodies that are always found in the cells of the leprous tubercles are either masses of zooglœa or collections of bacilli enclosed in cells. He has not yet succeeded in a more exact determination of the organism.

Influence of the Electric Current on the Development of Bacteria.* —According to a careful series of experiments carried on by Professor Cohn and Dr. B. Mendelsohn, the following are some of the most important effects produced on the propagation of bacteria by the galvanic current:—

As respects the increase in mineral nutrient fluids: A single element has no effect, or only a retarding one, on the increase of bacteria. A battery of two powerful elements completely sterilizes the solution at the positive pole in from twelve to twenty-four hours; at the negative pole it is not completely sterilized; but at neither pole are the bacteria killed; when removed to a fresh solution they continue to propagate. They are, however, completely killed within twenty-four hours by a battery of five powerful elements

A second series of experiments referred to the effects of a constant galvanic current on the development of *Micrococcus prodigiosus* on the surface of boiled potatoes. Both at the positive and negative electrodes the increase of the micrococcus was prevented in the immediate vicinity on both sides, but much more completely at the positive electrode. When the current was weaker, there appeared on both sides of the positive electrode a broader or narrower, sharply-defined, colourless strip, while on both sides of the negative electrode the development of the micrococcus was prevented in only a very narrow zone. The more powerful the current, the broader was the zone at both electrodes where the increase of the micrococcus was prevented. When the current was very powerful, it was altogether suppressed; the germs were killed and both halves of the potato sterilized with the exception of the neutral boundary-line.

Presence of Bacteria in the Air.†—A large series of experiments on the suspension of bacteria in the air, carried on at Breslau by Dr. Miflet, of Kiew, under the superintendence of Professor Cohn, have led to the following results:—

1. A number of bacterial germs capable of germination are suspended in the air.

2. By means of an apparatus constructed for the purpose, and which is fully described, the germs may be collected, made to germinate, and systematically determined.

3. The larger number of germs thus detected in the air were those of micrococci and bacilli. Most of these were already known as growing in other media; some were of very peculiar and hitherto unknown forms.

4. Many bacteria, on the other hand, ordinarily found in fermenting substances, were not detected in the air; this is true especially of *Bacterium Termo*, the ordinary ferment of putrefaction, *Spirillum*, *Spirochæte*, and some others.

* 'Beitr. Biol. Pflanz.' (Cohn). iii. (1879) p. 141. † Ibid. p. 119

5. The presence of bacterial germs was in some cases proved in air absorbed from the soil.

6. The air, on the other hand, from the typhus-ward of a hospital was found to be free from living bacterial germs, probably in consequence of ventilation and disinfection.

7. The air from a sewer was rich in such germs.

8. The number of these experiments was not sufficient to determine whether the difference between *bacteria* collected from the air in different places, and especially in certain localities, has any pathogenous significance, the results at present being negative.

Bacteria and Insect-Larvæ.*—Mr. J. J. Friedrich finds that septic liquids containing putrid meat and decaying plants were purified after the larvæ of *Culex pipiens* had developed in them and feasted upon the myriads of *bacteria*, &c. The liquids became perfectly clear, transparent, and odourless, the bacteria at the same time disappearing entirely, and he considers that he has established that the larvæ of *Culex* and other insects are the most important factors for controlling and preventing septic processes.

Destruction of Insect Pests by means of Fungi.—Cf. p. 246.

Septic Organisms in Living Tissues.†—In 1874 Professor Tiegel undertook experiments to decide whether septic organisms exist in the living tissues. He sealed up parts of the bodies of newly-killed rabbits by dropping them into melted paraffin at a temperature assumed to be high enough to destroy any infection in transit from the animal's body to the paraffin. He found that in most instances the unheated centre of the flesh became in a few days putrid and swarming with bacteria.‡ Dr. Burdon Sanderson repeated these experiments § with the result of *always* finding bacteria. On the other hand Chiene and Cossar Ewart,|| using the additional precaution of antiseptic spray, came to a very different conclusion.

In the winter of 1875, Staff-Surgeon E. L. Moss, R.N., sealed up musk-ox meat in clean Arctic air, and it remained perfectly fresh until the glass tube containing it was accidentally broken thirteen months afterwards. Any sources of putrefaction which may have existed were possibly, he thinks, destroyed by the low temperature to which it had been exposed.

Mr. Moss subsequently made some experiments to try whether flesh would keep equally well if removed warm from the body of a recently killed animal, and simply sealed in an atmosphere whose freedom from life could be guaranteed. He led a pipe from the nozzle of a well-weighted blacksmith's bellows, through a tube of hard glass 6 feet long packed with platinum foil, and heated to redness in a Hoffmann combustion furnace, thus obtaining a stream of air at the rate of 70 cubic feet an hour at a temperature of between 380° and 420° Fahr. This current was cooled to between 70° and 80° by passing through a brass

* 'Am. Journ. Micr.,' v. (1880) p. 34, from 'Medical Record.'
† 'Rep. Brit. Assoc.,' 1879, p. 416.
‡ Virchow's 'Archiv.,' xvi. p. 453.
§ 'Brit. Med. Journ.,' 1878.
|| 'Journ. Anat. and Physiol.,' 1873.

pipe (first cleansed by heating to redness), surrounded by a freezing mixture. In the air thus obtained, flesh was removed from the dorsal muscles of a decapitated rabbit, using a scorched knife and forceps, and hermetically sealed in three glass tubes cleansed by heating to redness. Another tube containing brain, and two other tubes containing muscle, were left closed with cotton-wool only, covered with a cap of resin and wax cement.

This was done on September 2nd, 1878, and the tubes were left in a temperature averaging 60° Fahr. On the 9th, the tubes Nos. 1–4, containing muscle, showed minute hairs of mycelium projecting in one or two places from the flesh. In Nos. 1–3 the mycelium never fruited, but disappeared with an increase of the moisture of the flesh. In No. 4 (stopped with wool only) it fruited, the flesh became putrid, and held myriads of active *bacteria*. The brain remained unchanged for ten days, and then suddenly softened and broke down. Thus one specimen alone was left, and this was exhibited (August 1879) by the author still intact, apparently having neither held nor received infection.

Although Nos. 1–3 developed mycelium and extruded a quantity of slightly glairy fluid almost equal in bulk to the flesh, it is remarkable that they did not become putrid. One of them opened in August 1879, had an odour like boiled rabbit and catchup, and was decidedly not offensive. It, like the others, was speckled over with white aggregations, which proved to be bunches of acicular crystals insoluble in alcohol or ether, like creatin, and were only slightly soluble in warm water. No *Bacteria* were found in the fluid.

Prevented by circumstances from continuing these experiments, Mr. Moss turned his attention to observations on human venous blood, by a method which appeared to exclude possibility of infection, and which at the same time allows the blood to be examined at intervals. The apparatus consists of a series of small glass bulbs connected together by capillary tubes, so that one bulb and its contents can be separated from the rest by the blowpipe. The tubes and bulbs are bent on each other, so that the whole series can be readily baked in a water or paraffin bath. One end of the series is left open, packed with baked wool, and connected with an aspirator, the other drawn to a fine point and sealed. The sealed point is secured in a short piece of stout indiarubber connection pipe, which is fastened over the collar of a fine hypodermic needle, protected ready for use in a calcined glass sheath. The whole arrangement is then repeatedly baked in a water-bath at intervals of four hours.

In using the apparatus, the sheath is removed from the needle, and the latter plunged into any suitable vein. The sealed point inside the indiarubber connection tube is broken, and the blood flows gently through the series of bulbs, drawn on by the aspirator acting through the cotton plug. When sufficient has entered, the blowpipe severs the tube next the needle, and instantly afterwards that next the wool plug.

By this method Mr. Moss has constantly found, after the lapse of forty-eight or more hours, organisms in the blood of intermittent fever, which he was unable to find in fresh blood. They consist of bacterine pairs or single individuals in active locomotion, sometimes stationary in zooglea groups, and occasionally in chains of four or more. The ghost cells recently described at the meeting of the British Medical Association in Cork, are also to be demonstrated by this method in blood a month sealed.

Influence of Aromatic Decomposition-Products on certain Fungi.*—Dr. Wernich has, with the co-operation of Professor Salkowski, set before himself the problem of discovering whether the aromatic products found during the putrefaction of albuminous substances have any destructive effects on *Bacteria*, and whether these substances have an influence proportionate to their amount; the investigations extended over the influences of indol, phenol, phenyl-propionic acid, and other bodies. After a careful account of his various experiments, the author draws attention to the fact that they give no little support to the view that disease-producing fungi are, after a time, destroyed by the poisons to which they themselves give rise during their growth and multiplication; this of course explains the cyclical course of various infectious diseases; while it is clear that it is only by careful observations and experiments of this kind that pathological riddles will ever be unravelled.

Ferment of Nitrification.†—The term *nitrification* is used by MM. Schloesing and Muntz for the oxidation of nitrogenous organic substances, and the consequent production of nitrates, which goes on to a large extent in the soil. This process they regard as one analogous to fermentation. On examining with a sufficiently high power the soil containing these substances, the organic debris is seen to be accompanied by an immense variety of minute organisms. Pasteur has given the name "shining corpuscles" (*corpuscules brillants*) to the excessively minute particles which he regards as the germs of *Bacteria;* and it is these bodies which Schloesing and Muntz believe to be the agents in the oxidation of nitrogenous substances, or the *nitric ferment.* It multiplies slowly in suitable liquids by budding. It is killed in a few minutes by a temperature of 100° C., and one of 90° arrests its action. It is very widely distributed, it being very rare to find a particle of soil from which it is entirely absent.

Alopecia areata.‡—Whether this disease, one manifestation of which is the appearance of bare spots on the hair and beard, is the result of the attacks of a parasitic fungus or not, has long been a subject of doubt among medical men. Dr. H. Eichhorst has carefully examined a case, and made microscopical preparations which clearly show the presence of fungus-spores at the part affected; though to what species or even group they belong he was unable to determine.

Microthelia and Didymosphæria.§—Dr. Rehm identifies these two genera, of which the former has been described by Körber as a genus of lichens, the latter by Fuckel as a genus of fungi, and

* 'Archiv. path. Anat.' (Virchow), lxxviii. (1879) p. 51.
† 'Comptes Rendus,' lxxxix. (1879) p. 891.
‡ 'Arch. path. Anat. u. Physiol.' (Virchow), lxxviii. (1879) p. 197.
§ 'Hedwigia,' xviii. (1879) p. 161.

assigns the priority to Körber's name. He points out that we have here a division of ascophorous thallophytes, which has been claimed by both lichenologists and mycologists, and does not himself decide the question whether they are lichens or not, though they doubtless belong to the Ascomycetes. He gives the diagnoses of five species hitherto ascribed to *Microthelia*, and eighteen hitherto ascribed to *Didymosphæria*.

Lichenes.

Colours of Lichens.*—Nylander thus sums up the facts regarding the colour of lichens. That of the thallus is most commonly white or nearly so; less often dusky green, ruddy, yellow, straw-coloured, orange, cinnabar, or black. It is not uncommon for it to be black or blackish above; and this colour sometimes extends to the rhizines and hypothallus. The colour of the internal tissue is usually white, but in some cases golden yellow or less often ochre; in a few instances scarlet or purple. The colouring matters are erythrinic, lecanoric, and chysophanic acids, to which Nylander adds two more, glaucinic and lecithophanic.

The apothecia are sometimes colourless, at other times black, dusky, yellow, rose, flesh-coloured, ferruginous, or red; but the conceptacle and epithecium are seldom of the same colour. The hypothecium is colourless or coloured; the paraphyses colourless, except at the tips. The spores are usually colourless, sometimes dusky or blackish.

The spermogonia are sometimes coloured on the outside, but always colourless within; the spermatia always colourless.

Hypothallus of Lichens.†—According to Nylander, the prothallus of lichens often passes insensibly into the hypothallus. By the prothallus (not to be confounded with the prothallium of vascular cryptogams which bears the sexual organs), he understands the early stage of the hypothallus which proceeds at once from the germinating spore. Both consist entirely of hyphæ, scarcely exceeding 3–4 μ in diameter. The hypothallus is usually more or less white, sometimes grey.

The veteran lichenologist takes the opportunity of again recording his dissent from the fungo-algal lichen-theory of Schwendener; stating that the hyphæ of which the prothallus is composed never have the power of investing substances which are embedded in them. No *Protococcus* or other alga can possibly enter into the composition of a lichen, the gonidia being developments from the hyphal structure itself.

Algæ.

Structure and Classification of Scytonemaceæ.‡—In the most recent of his important series of papers on the morphology and biology of the Phycochromaceæ, Signor Borzi thus sums up his results, as far as regards the Scytonemaceæ:—

1. The vegetative increase of the filaments takes place by repeated

* 'Flora,' lxii. (1879) p. 557. † Ibid., p. 574

‡ 'Nuov. Giorn. Bot. Ital.,' xi. (1879) p. 384.

division at right angles to the longer diameter of the cells (*Coleodesmium*, *Tolypothrix*, *Hilsea*, *Scytonema*), or by both longitudinal and transverse division (*Stigonema*, *Hapalosiphon*, *Capsosira*).

2. The increase of the colonies takes place by the formation of "pseudoramuli" and true branching, or by fracture.

3. The pseudoramuli are portions of filaments which deviate from the ordinary direction in consequence of the interposition of heterocysts (*Tolypothrix*), or without their intervention (*Hilsea*, *Scytonema*).

4. The formation of pseudoramuli may be regarded as a process of multiplication by means of immobile fragments, which are sometimes capable of isolating themselves and developing independently into new colonies (*Hilsea*, *Scytonema* sp., *Tolypothrix* sp.).

5. In the genus *Coleodesmium* the increase of the colony is effected by spontaneous fraction of the filaments; the different portions remain united in a bundle within a common gelatinous envelope, where they increase independently.

6. True ramifications originate from repeated division of any cell in the series, in a direction at right angles to the last division (*Stigonema*, *Capsosira*, *Hapalosiphon*).

7. All the Scytonemaceæ multiply by means of mobile fragments or hormogonia, or by spores.

8. The hormogonia are set at liberty by the dissolution of the gelatinous envelope, when the filament breaks up into fragments, each of which becomes a hormogonium; or by the whole of the filaments becoming transformed into hormogonia.

9. The hormogonia move slowly in the water in a rectilinear direction; light exercises no influence on their movement.

10. During germination the hormogonia are enclosed in a delicate, transparent, mucilaginous envelope, while breaking up into portions of various lengths (*Tolypothrix*, *Coleodesmium*, *Scytonema* sp., *Stigonema* sp., *Capsosira*), or each is completely transformed into a new colony without breaking up (*Scytonema* sp., *Stigonema* sp.).

11. During the transformation of an entire hormogonium, or of each fragment of one, into a colony, one of the two apical cells of the filament becomes a heterocyst, except in *Coleodesmium*.

12. The spores are isolated cells capable of resisting cold and excessive drought; they germinate after a certain period of rest.

13. During germination the exospore bursts transversely to give exit to the internal germ.

The Scytonemaceæ may be classified as follows:—

A. The cells divide transversely only. Tribe I. *Scytonemeæ*.

a. No pseudoramuli; filaments united in a bundle within a common envelope. Subtribe 1. *Coleodesmieæ*. Genus 1. *Coleodesmium* Bzi.

b. Pseudoramuli; filaments free, or rarely in proximity laterally, but not united in a bundle within a common envelope. Subtribe 2. *Euscytonemeæ*.

α. Colonies cæspitose, and with definite growth; pseudoramuli with 1–3 heterocysts at the base. Genus 2. *Tolypothrix* Ktz.

β. Colonies with indefinite growth; pseudoramuli not connected by heterocysts.

* Pseudoramuli very soft and delicate, produced irregularly, sometimes joined laterally, or united in a bundle. Genus 3. *Hilsea* Kirchn.

** Pseudoramuli in parallel pairs. Genus 4. *Scytonema* Ktz.

Sect. 1. Petalonema. Envelope exceeding the internal filament, several lines in size.

Sect. 2. Euscytonema. Envelope smaller; pseudoramuli free.

Sec. 3. Symphyosiphon. Envelope small; pseudoramuli more or less united laterally.

B. Cells dividing also longitudinally. Tribe II. *Stigonemeæ.*

a. Filaments composed of a double or multiple series of cells. Genus 5. *Stigonema* Ag.

b. Filaments composed of a simple series of cells.

α. Filaments erect or united into a pulvinate cushion of definite size. Genus 6. *Capsosira* Ktz.

β. Filaments not united; heterocysts solitary and produced by direct transformation of any cell of a series. Genus 7. *Hapalosiphon* Näg.

Development of the Conceptacle of Fucaceæ.*—T. O. Bower has been carrying on a series of researches on this subject, relating to the genera *Fucus*, *Himanthalia*, *Halidrys*, and others, conducted in Professor De Bary's laboratory at Strassburg. The materials were treated, while fresh, with a dilute solution of chromic acid in water, and afterwards preserved in alcohol; others were preserved in a saturated solution of common salt, and then hardened in alcohol. The sections were in all cases mounted in glycerine and acetic acid.

The formation of the conceptacle is preceded by the decay of one or more cells which occupy a central position with regard to the changes which follow. The number of cells thus removed is various, and the manner of their destruction is not constant, but the fact remains in all cases. The cell or cells which decay are all members of a linear series.

The differences in the mode of development, at least in the early stages, depend on the differences in activity of tangential division of the cells of the central series. In *Fucus* the terminal or initial cell of the central series ceases to divide tangentially, and is left behind by the surrounding tissue, and when it decays, leaves a cavity which extends further into the tissue than the base of the cells of the surrounding limiting tissue. The tissue lining the cavity is therefore in this case derived in its basal part from the cortical, in its upper part from the limiting tissue. In *Himanthalia*, on the other hand, the cavity thus formed extends only at most to the base of the cells of the limiting tissue; the lower lining of the cavity is thus derived only from the limiting tissue.

* 'Quart. Journ. Micr. Sci.,' xx. (1880) p. 36.

The "Fasergrübchen" or sterile conceptacles are regarded by Mr. Bower as incomplete sexual conceptacles. The male and female conceptacles are indistinguishable in their early stages, the first differentiation making itself apparent in a difference in the nature of the hairs which line them, especially of the neutral hairs and those which do not produce antheridia or oogonia. It is the rule that no branching occurs in the neutral hairs of the female conceptacle; while in the male conceptacle, even before the formation of the antheridia, the hairs branch according to a monopodial racemose system. The antheridia and oogonia he regards as, in most cases at least, morphologically identical in their origin.

Influence of Light on the Movements of Desmidieæ and Swarmspores.*—With the exception of a single observation in Braun's 'Verjüngung in der Natur,' hardly any attention has been paid to the influence of light on the movements of Desmids. E. Stahl has now made it a subject of investigation, directing his attention chiefly to *Closterium moniliferum*, specimens of which he enclosed in a glass cube with walls about 1 cm. in height, changing the direction of the incident light by means of mirrors.

It was soon evident that the direction of the light exercised a material influence on the position of the longer axis of the cell, this axis having a tendency to place itself in the direction of the rays of light; and that there is also a polarity between the two halves of the cell, in consequence of which one is attracted towards and the other driven away from the source of light. The direction is subject to alternations in consequence of which the cell is continually shifting its position through an angle of 180°, presenting each end alternately to the light. In one experiment, at a temperature of 33° C., the time occupied by this reversal of position was from six to eight minutes; in another, where the temperature was 17° C., from fifteen to thirty-five minutes. In addition to this reversal, there was also a slow movement of the individual along the bottom in the direction of the source of light. When the light is very intense, the conditions are reversed, and the cell places itself with its longer axis at right angles to the direction of the light.

Dr. Göbel has made similar experiments on another Desmid, *Micrasterias rotata*, which was found to place itself with the plane of its disk at right angles to the direction of the rays of light. The direction of the band of chlorophyll in which the nucleus is embedded varies with that of the incident light.

In Strasburger's work on the influence of light on the movements of swarmspores,† he applies the term *phototaxis* to the law by which these bodies place themselves with their larger axis in the direction of the rays of light, calling the swarmspores themselves phototactic. Phototactic swarmspores are, according to him, either photometric, when they turn sometimes one end, sometimes the other end towards the light, or aphotometric, when the same end is constantly turned

* 'Verh. physikal.-med. Gesell. Würzburg,' xiv. (1880) p. 24.
† See this Journal, ii. (1879) p. 307.

towards the light. Among the former he includes the swarmspores of *Hæmatococcus* and *Bryopsis;* among the latter the gametes of *Botrydium*. Stahl has repeated the experiments with the gametes or conjugating swarmspores of *Botrydium*, but is in this particular unable to confirm Strasburger's statements. He finds that, like typical swarmspores, they are photometric.

The same tendency to place the two extremities alternately towards the incident light was observed also with fixed individuals of *Euglena*.

Palmelline and Characine in Fresh-water Algæ.*—Since the publication of his note on *Palmelline*,† Mr. Phipson has found that if, before extracting palmelline, *Palmella cruenta* is soaked for twenty-four hours in bisulphide of carbon, the liquid becomes a golden yellow, and leaves, on evaporation, a yellow substance with a little earthy matter. This yellow substance appears to be xanthophyll (the yellow colouring matter of autumn leaves), as it dissolves in concentrated sulphuric acid, giving an emerald green solution. When the bisulphide of carbon has been separated, alcohol extracts all the chlorophyll, and when the alcohol has been completely driven off and the plant dried at the ordinary temperature, the water with which it is to be covered becomes in a few hours charged with palmelline; three substances being thus successively extracted from one microscopic Alga which to the eye seems to be blood-red.

In addition there is found in small quantities another very interesting product—*Characine* (so called on account of its very pronounced marshy odour like *Chara*). This is a substance lighter than water, a species of camphor, which forms very small pellicles on the surface, but only dissolves in extremely small quantities. If *Palmella*, *Oscillaria*, *Nostoc*, &c., are dried in the air and afterwards covered with cold water, the liquid, in eight to ten hours, will show on its surface some thin and often iridescent layers. The liquid should be poured off into a long narrow tube and shaken up with some cubic centimetres of ether, which dissolves the characine, and leaves it, on evaporation, as a white greasy substance, volatile, inflammable, non-saponific, soluble in alcohol and ether, almost insoluble in water, and possessing a strong marshy smell which is very characteristic and which it communicates to the water. After a few days it volatilizes, or rather disappears by oxidation from the surface of the water, which completely loses its marshy odour. This odour, so strongly developed in *Chara*, is due to this substance, which is formed by the plant itself during life, and is not a product of decomposition. Characine is met with in all the terrestrial Algæ, such as *Palmella*, *Vaucheria*, *Anabæna*, *Oscillaria*, &c., and in the Confervæ.

Structure of Spirulina.‡—The species of this genus resemble the other genera of Oscillatorieæ, to which it belongs, in consisting of cylindrical segmented threads containing phycochrome, and in being invested with a mucilaginous envelope; but they are peculiar in

* 'Comptes Rendus,' lxxxix. (1879) p. 1078.
† Ibid., p. 316, and see this Journ. ii. (1879) p. 938.
‡ 'Oesterr. Bot. Zeitschr.,' xxx. (1880) p. 11.

having the filament twisted several times on its own axis, so as to resemble a corkscrew. Herr Zukal states that the oscillatory motion which the filaments possess, in common with other members of the family, but more distinctly than in any other genus, consists in a slow torsion of the entire helix round its own axis. If the motion is suddenly interrupted, the filaments become for a moment stationary, and then retreat towards the central point of the movement, forming a dark green lump. The movements are stated by the writer to be obviously and intimately connected with the growth of the alga; having in fact a close analogy to the well-known rotation of growing shoots and tendrils. The cause of the corkscrew-like torsion is the more rapid growth in length of the filaments than that of the ideal axis of growth. *Spirulina* retains its colour for years in glycerine, which seems to indicate that the colouring matter is something different from the ordinary mixture of chlorophyll and phycocyan.

MICROSCOPY, &c.

Method of making Sections of Insects and their Appendages.* —Mr. J. W. Hyatt, President of the New York Microscopical Society, says that how to make a section through hard, chitinous organs, consisting of several pieces, such as stings and ovipositors, sufficiently thin to allow of examination by transmitted light, and at the same time retain all the parts in their normal position, was a problem that for several years defied all his attempts to solve by any process on record. After many fruitless attempts by other devices of his own, the following very simple method has proved entirely successful.

The insect or organ is placed in alcohol until it is thoroughly permeated, and then removed to a clear alcoholic solution of shellac, in which it may remain for a day or two. Fit a cylinder of soft wood into the well of the section-cutter; split this cylinder through the middle, and cut a groove in one or both of the half cylinders, sufficiently large to admit the object without pressure; put the two pieces together with plenty of thick shellac, and tie them with a thread. When the shellac is quite hard, which will be the case in a day or two, place the cylinder in the section-cutter, and after soaking the wood with warm water, sections the $\frac{1}{500}$ of an inch in thickness, or less, may readily be made.

Should the shellac prove so opaque as to interfere with a proper examination, a drop of borax solution will immediately remove this difficulty.

Collecting and Mounting Spiders' Webs.†—Several methods have been suggested for preserving and mounting spiders' webs. One method was to take the web direct upon a slide having a cell fixed upon it, and at once proceed to mount it. It is, however, very difficult to secure the exact portion of the web you wish, it not being so well

* 'Am. M. Micr. Journ.,' i. (1880) p. 8.
† 'Journ. Quek. Micr. Club,' v. (1880) p. 10.

under control when suspended, and it is also difficult to get rid of the moisture that is sure to be present.

Mr. George Hind describes the following as a method which he has found very successful:—Take a few pieces of wire about 12 inches long, and bend them up so as to form rectangular frames. Make a number of these frames and keep them in a racked box made for the purpose, previously gumming them all round so that the web may adhere to them. On finding a web, some portion of which it is desired to preserve, one of the frames should be taken and put behind the web and drawn towards the operator, when the web will become cemented to the frame all round. With a pair of sharp scissors clip away the rest of the web free from the wire, and if this be carefully done it will be found that the desired portion of the web is tightly stretched upon the frame, which can be placed in the racked box, and kept ready to be mounted.

In order to mount any portion of the web thus obtained, first cement a thin paper (or metal) cell upon a glass slip. Then having slightly gummed the cell, place one of the wire frames over it, taking care to bring the portion of the web that is to be mounted exactly in the centre. With the scissors remove the superfluous web, and place another cell upon the first one, and a thin glass cover over all, securing the cover with a little gum.

Preparing Sponges.*—In a paper on the sponges dredged by the Rev. A. M. Norman on the coast of Norway, Mr. Sollas makes the following remarks, which are of general interest:—"In preparing specimens for microscopical examination, I followed the ordinary methods for obtaining the spicules in the free state; but in cutting and mounting 'sections,' I adopted the processes which have hitherto, in this country at least, been confined to the examination of quite soft tissues. A piece was cut from the sponge large enough to contain a representative of each of its different tissues; this was then soaked in distilled water till its contained alcohol was as nearly as possible all extracted; it was then transferred to a strong solution of gum, in which it was allowed to stand for an hour or so; finally it was placed in the well of a freezing microtome, and frozen in the usual way. From the frozen specimen, slices could be cut of any required thinness, the razor, strange to say, passing through the soft tissues and hard spicules with apparently equal ease.

The slices so obtained were variously treated; some stained and some not, were mounted in glycerine of various degrees of strength; others were treated first with absolute alcohol, then with carbolic acid and turpentine and mounted in Canada balsam. 'Teasing' was resorted to in the case of some tissues with success, especially when it was found desirable to observe the behaviour of the tissue with reagents. Altogether the various methods pursued have, I believe, succeeded in eliciting nearly all the information that could be extracted from the specimens; and that this is very far from being so complete as could be wished is to a great extent owing to the imperfect manner in which

* 'Ann. and Mag. Nat. Hist.,' v. (1880) p. 130.

histological characters are exhibited in sponges which have been preserved in spirits without any previous treatment. Mr. Norman's specimens are perfect as spirit specimens; they were not preserved with a view to submitting them to detailed histological examination. And here it may be worth while suggesting that if in the future it should be desired to preserve sponges with this object, a preliminary soaking in osmic acid solution of ·02 or ·03 per cent. should be given to them before placing them in spirits; this will effect nearly everything that may be desired. With osmic-acid-treated specimens and the help of a freezing microtome, no difficulty should be experienced in obtaining an almost complete knowledge of the minute structure of any sponge."

Collection of Fresh-water Rhizopods.—See *ante*, p. 290.

Cleaning Diatoms, Seaweeds, &c.*—Mr. G. C. Morris describes a plan which he thinks is more easy than that of M. Petit,† to clean diatomaceous earths (not containing a large percentage of lime), seaweeds, and the ordinary collections from ponds, &c. Dry them in any convenient way and then mix them in a platinum crucible with rather more than an equal bulk of pure bisulphate of potash, and fuse for five minutes at a bright red heat over a Bunsen burner. Such materials as the Jutland cement-stein and guano, which contain a large quantity of lime, must first be soaked in muriatic acid in a test-tube until all action ceases, washed, and then fused in the bisulphate of potash. In all cases, after fusing in the bisulphate of potash, allow the mass to cool in the crucible and then place crucible and all in a beaker of water which will dissolve the bisulphate and leave the diatoms and other siliceous matter free from alumina and organic matters. Wash with clean water until there is no acid reaction with litmus paper, and then separate the diatoms from the sand as usually directed.

The advantages of this plan are freedom from the injurious fumes of boiling nitro-muriatic acid, and also from the liability to spurt the acid out of the test-tubes. The diatoms are clean and white, requiring no bleaching with chlorate of potash, and the work is all done with one operation, except when the materials contain lime. Even from guano the silica will all come out white and clean. With diatoms *in situ* on seaweed the author sometimes burns the material before adding the bisulphate.

Separating Micro-organisms.‡—In order to reduce the quantity of water containing micro-organisms, obtained by means of a collecting bottle or otherwise, Mr. M. A. Veeder allows the liquid to stand in a bowl until it has settled, and then takes up the water by means of a sponge *placed in a pouch made of fine silk*. If the water is allowed to soak into the sponge very gradually, and a slight squeeze is given before removing it from the bowl so as to wash away adherent particles, even the finer organisms diffused through a pint of water may

* 'Am. M. Micr. Journ.,' i. (1880) p. 38.
† See this Journal, ii. (1879) p. 616.
‡ 'Am. Nat.,' xiv. (1880) p. 227.

be left in great abundance in a quantity not larger than a table-spoonful.

Pringsheim's Method of Investigation by concentrated Sunlight.*—We have already given at p. 117 the substance of Dr. Pringsheim's paper on the Function of Chlorophyll, so far as regards the results arrived at, but we add a somewhat fuller explanation of what the author terms "a new and peculiar method" of investigation in *concentrated sunlight*.

He has made use of this method for some years in order to gather experimental knowledge of the relations of light to the absorption of gases by growing plants, and of the part played therein by chlorophyll. Amid the confusion of contradictory opinions and statements which pervade the literature of the subject, after many vain endeavours to advance upon the path usually trodden, he turned to the employment of *intensified light*, hoping thus to be able in a short time unequivocally to observe in the cell, and immediately under the Microscope, the processes called forth in plants by the action of light. The experiments which have hitherto been made have laboured under the serious defect that a too inconsiderable intensity of light was employed. This is especially true of those experiments in which it was endeavoured to prove that the different colours of the spectrum act differently upon plants. If plants are grown in diffused daylight, or even in direct sunshine behind coloured screens or coloured glasses or liquids, they evidently grow in relative obscurity in comparison with their normal condition, even in relation to the colour, the action of which is wished to be investigated; hence the results thus obtained correspond only to the actions produced in plants by *insufficient* intensities of light. Moreover, the function of chlorophyll itself contributes to the weakening of the result.

So long as only comparatively inconsiderable augmentations of the intensity were employed, no decisive results were obtained. Satisfactory effects were at last attained when organic forms, vegetable and animal cells and tissues, were brought into the plane of an image of the sun projected in the focus of an achromatic lens of 60 mm. diameter.

The apprehension which perhaps at first arises, that organic structures must under these circumstances be forthwith destroyed by the thermal action of the solar image, is, as a closer consideration and direct experiment show, unfounded. With proper precautions, the object can be observed undisturbed for a considerable time in the sun's image, as indeed is approximately shown by the phenomena in the so-called solar Microscope. In this way the influence of the radiation upon an entire tissue, and upon *each single cell*, nay, even upon *the different form-constituents of a single cell*, can be *separately* studied, and with a little attention the thermal and photochemical effects of the radiation can be certainly and sharply distinguished.

Hence this method of *microscopical photochemistry* (as the author calls it) is pre-eminently adapted for investigating whether any, and what, photochemical actions of light take place in protoplasm and in

* 'MB. K. Preuss. Akad. Wiss. Berlin,' 1879, p. 532; see 'Ann. and Mag. Nat Hist.,' v. (1880) p. 62.

the formed constituents of the cell-body; and it is equally suitable for determining the relative degree of diathermasy of the cell-contents and the cell-membrane. In this way also the effects of higher degrees of heat can be more conveniently brought into view than by aid of heated object-plates. Lastly, it is self-evident that the method is applicable for animals and animal tissues as well as for plants; and with it we can at the same time demonstrate the sensation of heat in the lowest classes of animals (Protozoa and Cœlenterata), and in certain cases ascertain the truth respecting the presence and the seat of the perception of light.

Microscopic Examination of Sands and Clays.—Dr. Sorby's Annual Address at the Geological Society on February 20th, dealt with the application of the Microscope (in most cases with polarized light) to the study of the formations of some of the sands and clays with a view to see how much they could be found to tell of their own history.

The greater part of the material of the non-calcareous stratified rocks must be traced to the mechanical breaking-up or chemical decomposition of igneous or metamorphic rocks, though some of the more recent may be derived directly from analogous rocks of the early periods. The method of this breaking-up or decomposition was described, and it was pointed out that the change from the temperature and conditions under which igneous rocks had been formed to subsequent conditions had immense influence in these changes. The plutonic and metamorphic rocks again, formed under the influence of water, were so formed at a high temperature, and in subsequent times water at a low temperature, especially when highly charged with carbonic acid, has a disintegrating effect upon them. When igneous and metamorphic rocks are weathered and broken up, sand and fine mud result, composed not only of the original materials, but also of products of chemical changes. In describing some of the more important materials derived from older rocks, quartz was first mentioned. It is found that the optical characters, the internal structure, and the shape of some of the grains are so characteristic, that they may teach their whole history and throw much light on the true character of associated materials, though many are worthless for such purposes. Other sands, besides quartz sands, and also clays, have been studied in detail. Among the many interesting results, it is found that micaceous sand, previously supposed to originate from disintegrated granite, may come from felsite, as in felsite the Microscope reveals flakes of mica the $\frac{1}{20000}$ of an inch in thickness.

Considerable additional light is also thrown by Dr. Sorby's methods on the recognition of volcanic glass and ashes in a deposit. The glass has no depolarizing effect on polarized light, and in many cases the characteristic vesicular structure can be seen. The external forms of the fragments are also characteristic, while quite unmistakable is the appearance resulting from the melted glass being blown out by the internal evolution of gas. Fragments of pumice can be easily recognized from the fact that it is made up of cells with more or less curved walls of glass, sometimes only the $\frac{1}{10000}$ of an inch in thickness.

In studying the grains of sand, Dr. Sorby by sifting rejects those more than $\frac{1}{70}$ of an inch in diameter or below $\frac{1}{120}$, so that an average of $\frac{1}{100}$ is obtained. He was astonished in working in this way to find that what seemed all similar to the naked eye contained really five well-marked types—(1) the angular; (2) the well-worn rounded; (3) the mechanically broken; (4) the chemically corroded; (5) the perfect crystal. It is important to distinguish between the age of the grains and the age of the deposit. A very old bed may contain grains but little modified, while a younger bed may have very old grains—that is, grains that have passed through many vicissitudes, and have belonged successively to many different formations. Several practical tests of the value of the method were mentioned with reference to the study of the age and conditions of the beds as compared with the results deduced from other methods—for example, the sharp angular sand-grains of the boulder clay well accord with the theory of its glacial origin.

Cutting Rock-sections.—At the December meeting of the San Francisco Microscopical Society, a paper by Mr. M. Atwood was read, in which he described a plan of cutting rock-sections for the Microscope at little cost and labour. He uses a few emery stones, or blocks, of different degrees of fineness—say, from one and a half to two inches square, and eight or nine inches long. The chips to be cut should be first made as thin as possible; the plan recommended by Mr. Rutley, to use a cold-chisel, the end let into a block of wood, and then by holding the specimen on the edge of the chisel and striking it a sharp blow with a light hammer, will generally give a satisfactory chip. The chip must then be rubbed on the emery blocks, with water, till a good, even surface is obtained on one side of it, commencing with the coarse emery blocks first; then, with Canada balsam, fasten the smooth surface of the chip to a common glass slide, which is done by heating the slide over a spirit lamp and then applying a small quantity of the balsam. As soon as the balsam liquefies, press the smooth surface of the chip into it, and allow it to cool. The balsam is better dried, so that it can be used like a stick of sealing-wax. As soon as the slide and chip are cold, the outer, or rough surface of the chip attached to the slide, can be rubbed on the emery blocks until it is nearly thin enough for mounting. To finish, use the fine, smaller blocks, as you would a file. The section can be held up to the light and examined during the operation. Mount and cover the section with thin glass, in the usual way.

Amongst the specimens shown were two, which were cut in London, by a professional, with expensive apparatus. Two others were from the same rock, but cut by the author, with the emery blocks, in the way described, and, if the mounting material was of as good quality, would have been equal to the former in every respect.

New Preservative Liquid.*—Under the title "The Wickersheimer method of preserving" is described a process which claims to preserve human and animal bodies with their proper form, colour,

* 'Zool. Anzeiger,' ii. (1879) p. 669.

and pliability; to exclude decomposition for years; to maintain the consistence of the various parts; and to give the same results with the lower animals and with all sorts of vegetable substances. Morbid formations removed by an operation will appear after months as if in a fresh state. The Prussian Minister of Instruction has recently officially published the formula for the benefit of the scientific world.

The liquid is prepared by dissolving

100 grammes of alum,	60 grammes of carbonate of potash,
25 „ common salt,	10 „ arsenious acid,
12 „ saltpetre,	

in 3000 grammes of boiling water, allowing the solution to cool, and filtering: to 10 litres of this liquid are added 4 litres glycerine, and 1 litre methylic alcohol.

The guiding principle for its use is that of impregnating and saturating the bodies with the liquid. Substances intended to be kept hereafter in a dry state are soaked in it from six to twelve days, according to size, and dried in the air. Hollow organs, as lungs, are filled with the liquid previous to immersion in it, then emptied and dried: intestines should be inflated after emptying. Small specimens, such as crabs, beetles, frogs, &c., if the natural colours are to be preserved unchanged, are not to be dried, but put immediately into the liquid.

Microphotographical Notes.*—According to Dr. Carl Seiler's experience, there is no advantage in objectives specially constructed for photography over other good objectives, provided monochromatic light is used, which brings the visual and the chemical focus in the same plane.

Having found some difficulty in making a cell to contain the solution of ammonio-sulphate of copper, through which the sun's rays are passed before they enter the substage condenser (the copper salt dissolving almost any cement, and if exposed to the action of the air very rapidly becoming decomposed and turbid), the author uses a cell made of a brass ring lined on the inner side with lead, and having a thread cut on its outside, to which flanged rings are screwed. Upon the edges of the inner ring a ring of rubber packing is applied, and upon it a disk of plate glass is laid, which is tightly pressed upon the rubber by the flanged ring. Thus a cell is obtained very similar to the round, flat spirit level, and which will hold the ammonio-sulphate solution for months without change. In filling the cell, care should be taken to leave room for a small air bubble, for if the cell is completely filled, the heat of the sun's rays will expand the solution sufficiently to cause leakage.

At the present time, when dry-plate photography has been developed to such an extent that it has superseded in a great measure the old wet process, it has been thought that it would be the most simple, economical, and satisfactory process for photomicroscopy; but after repeated trials by Dr. Seiler, as well as by others working in the same direction, it is found that it is not only more expensive, but also takes more time in the long run. The reason of this is, that it is

* 'Am. Journ. Micr.,' iv. (1879) p. 159.

impossible to judge with any degree of certainty as to the actinic power of the light forming the image on the screen by merely looking at it, and that a trial plate only will give an idea as to the length of exposure of the plate for a given day, time of day, and subject to be photographed. It is true we can expose a dry plate for trial, but then we must develop it immediately, and the time it takes to develop a dry plate is about three times that of developing a wet plate, and a dry plate is also about three times as costly as a wet one. Therefore the old wet process is, he considers, the best.

Micrometre or Micromillimetre.*—Dr. J. Phin points out that about ten or fifteen years ago the prefix *micro* came into general use in English in certain departments of physics denoting the *millionth* part of the unit, and about five years ago the British Association adopted this term, which was embodied in the report of the Committee on Dynamical and Electrical Units. This report, which includes the relations of weights and measures to all measurable quantities, has been generally adopted by the scientific men of Great Britain and America. It will therefore, he thinks, be a very unfortunate thing if microscopists retain the word "micromillimetre" for the *thousandth of a millimetre*, as that special use of the word *micro* will give rise to endless confusion and misunderstanding, and will tend to separate microscopists from the rest of the scientific world.

As the author concludes by saying that he "cannot see the advantage which is claimed for such a term, as the expression two micromillimetres is not more intelligible than ·002 millimetres," we gather that the remedy he proposes is to drop any special designation for a division of a millimetre. The same reasoning on which this conclusion is based leads us, however, to recommend the adoption of "*micrometre*" instead of "micromillimetre," which would secure the uniformity desired, besides being a more convenient word.

Museum Microscope.—This Microscope, which has not previously been figured, is shown in Fig. 16.

It consists of a brass drum A B, 20 inches long, and 14 inches in diameter, in the interior of which are six hollow cylinders, one of which is shown in Fig. 17. Each of these cylinders can be rotated independently by means of the milled heads shown at I, and traverse as they rotate, so that each of the apertures with which they are pierced, and which are arranged spirally, are successively brought under the Microscope body C.

The latter can be monocular or binocular, or better still a double or treble-bodied tube, so that two or three persons can see the object at the same time. The adjustment for focus is made in the ordinary way by the milled head F, and rectangular movements are given to the body by the four milled heads at E E, so as to bring any desired part of the object into the centre of the field of view.

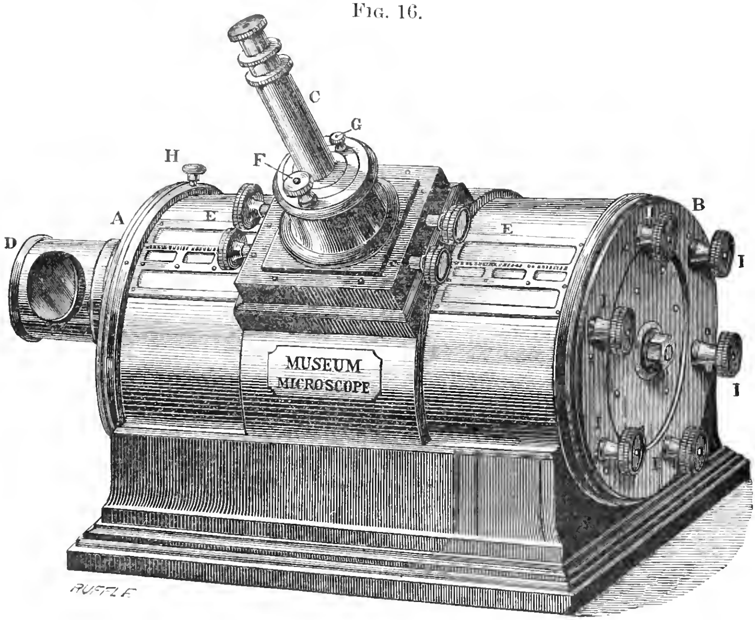
Two additional objectives of different powers can be used by moving the catch G to the right or left of the central point.

Illumination of the objects is effected by means of the mirror D,

* 'Am. Journ. Micr.,' v. (1880) p. 19.

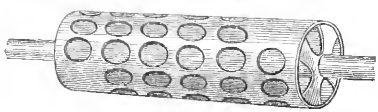
which reflects light to a mirror placed in the interior of each of the cylinders, whence it is reflected to the objective.

FIG. 16.

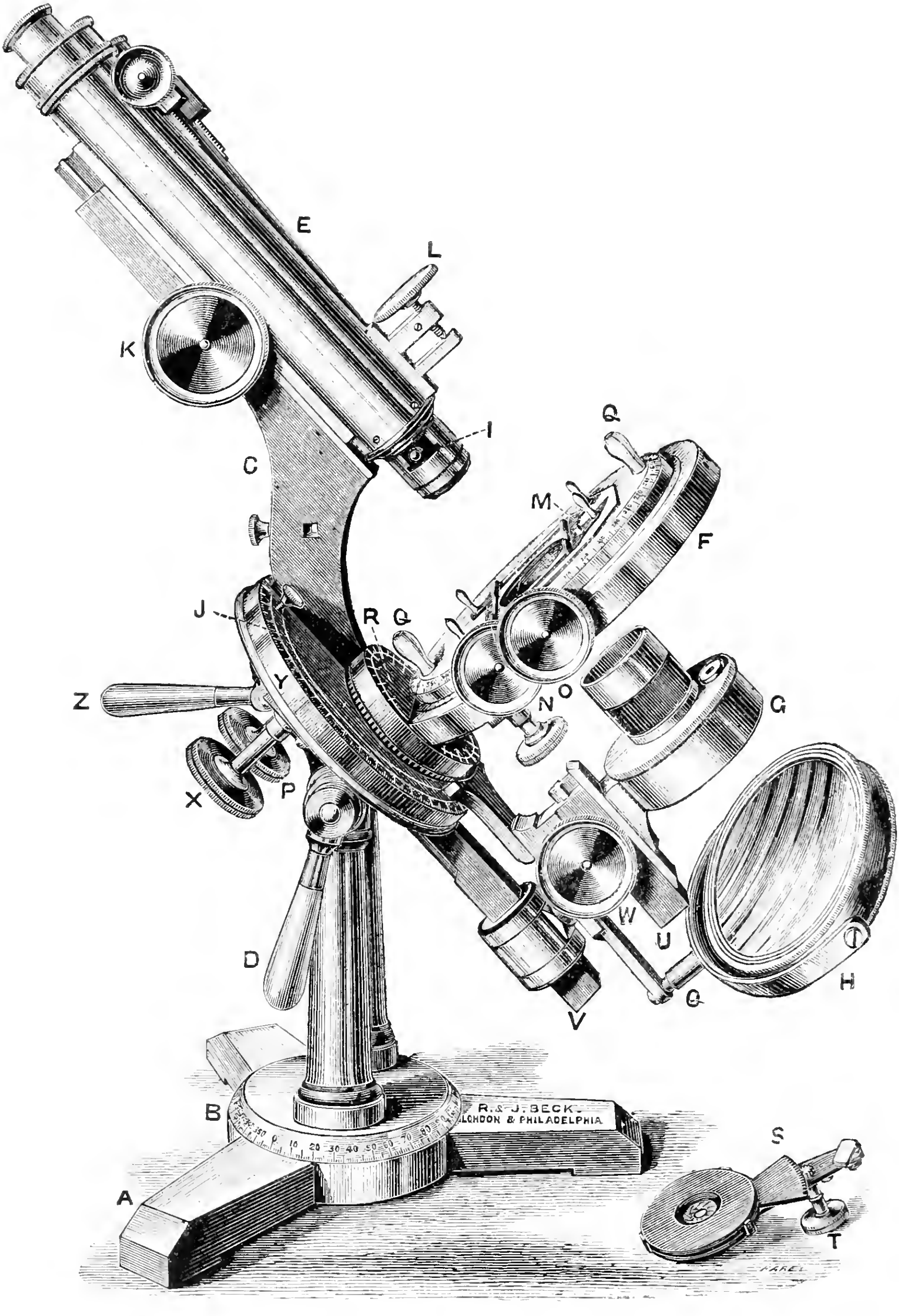


The drum holds five hundred objects, and when those in one cylinder have been examined, the pin H is pressed and the cylinders can then be revolved collectively within the outer case (the "heads" of the drum revolving also), and another cylinder brought under the objective and rotated by its milled head as before.

FIG. 17.



The instrument (made by Messrs. Beck) was exhibited at the last International Exhibition, and is now in Mr. Crisp's collection. The report of the jurors (Class XIII. p. 24) says that "this elaborate contrivance is well adapted for the purpose for which it was designed, and will effectually protect the collection of objects from dishonesty as well as from carelessness." It has also been found invaluable as a means of gratifying the desire of friends to be "shown something through the Microscope," without the loss of time which the ordinary process so often entails, the instrument having for this purpose the further advantage that as each object comes into the field of view its name appears at one of the six openings below E E.



Beck's Improved Microscope-Stand, with Swinging Sub-stage

Beck's Improved Microscope-Stand with swinging Substage (Plate IX.).—The *Stand* has a tripod A for its base, upon which is placed a revolving fitting B, graduated to degrees, so that the Microscope can be turned round without being lifted from the table, and the amount of rotation registered; upon this fitting are two pillars and between them the limb C can be elevated or depressed to any angle, and tightened in its position by the lever D. The limb carries at one end the body E, with binocular prism I, and coarse (K) and fine (L) adjustments; in its centre is the compound stage F, beneath which is the circular plate J, carrying the swinging bar U with the substage G, and at the lower end of the limb is another triangular bar V carrying the mirror H.

The compound *Stage* is of a new construction. It is attached to the limb on a pivot, and can be rotated so as to be set at any inclination, the angle being recorded on the divided plate R, or it can be turned completely over, so that the object is then underneath and can be viewed by light of any obliquity without interference from the thickness of the stage. It revolves in a circular ring by the milled head P, or this can be drawn out, and then it turns rapidly by merely applying the fingers to the two ivory studs Q Q fastened on the top plate, which is divided into degrees to register the amount of revolution. M is the usual spring-piece for clamping the object, and N, O the milled heads of the rectangular movements. Beneath and attached to the stage is an iris diaphragm S, which can be altogether removed from its dovetailed fitting, so as not to interfere during the rotation of the stage. The variations in the aperture of this diaphragm are made by a pinion working into a racked arc and adjusted by the milled head T.

Of the two triangular bars beneath the stage, V is rigid in the optical axis of the instrument, the other, U, swings to either side and carries the *Substage* G which is racked up and down by the milled head W. The bar U is attached to an arc J working in the circular fitting Y, and is revolved by a rack and pinion X, the amount of angular movement being recorded on the upper surface of the plate. This allows of illumination being used at any angle beneath the stage, or if desired the bar U can be carried round and above the stage for opaque illumination. Having once fixed the angular direction of the light, the focussing of it is effected by the lever Z, which moves the circles J, Y up and down, on a dovetailed fitting, and with them the arm U (carrying the illuminating apparatus) *in the optical axis of the instrument*, the amount of the elevation and depression being registered on a scale attached to the limb.

The *Mirror* H is carried on the bar V when the illumination is required to be concentric with the optical axis of the Microscope, and independent of the movements of other illuminating apparatus; when desired, however, it slides on U, and can then be moved below or above the stage in the same way as the substage. It revolves on a circular fitting for giving greater facilities in regulating the direction of the reflected beam, and is made to reverse in the socket so as to bring the centre of the mirror concentric with the axis of the instrument in either case.

Ahrens' Arrangement for using the Wenham Prism with High Powers.—One difficulty in using the Wenham prism with the higher objectives arises, as is known, from the fact that the prism is at some distance from the back lens of the objective, part of the field being thus cut off. Mr. Wenham some years ago constructed some small prisms (one of which was shown at the February meeting), which were attached to a tube fitting into the objective and bringing the prism very close to the back lens: this method, which is otherwise entirely successful, requires each objective to be specially fitted, and an arrangement for turning the prism so that it is in the proper position.

Mr. Crisp at the same meeting showed (with an $\frac{1}{8}$) an arrangement devised by Mr. Ahrens, which enables the prism to be brought close to the back lens with any objective. The tube of the Microscope, instead of terminating in the ordinary way with the universal screw, has two grooves, in which slide two adapters, having the universal screw at one end to receive objectives. One of these carries a Wenham prism, mounted in a projecting tube, so that when the objective is screwed to the adapter the prism dips into it, and is thus brought closer to the back lens.

When it is desired to use the Microscope as a monocular, the adapter containing the prism is slipped off, and the other, which is without a prism, takes its place.*

Fig. 19.

Fig. 18.

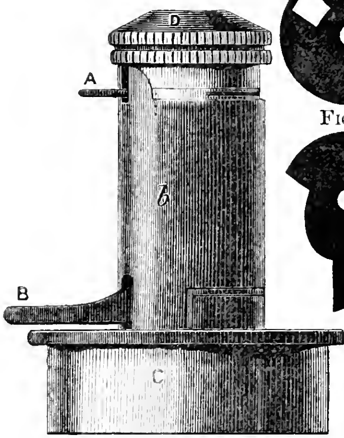


Fig. 20.

Powell and Lealand's Improved Immersion Condenser.—Messrs. Powell and Lealand have improved the arrangement of the dia-

* At the March meeting, Dr. Gibbes exhibited a $\frac{1}{12}$-inch homogeneous-immersion objective, with the ordinary Wenham prism, both fields being fully and equally illuminated. See Proceedings of Meeting of 10th March, *infra*.

phragms of this instrument.* As at first made, it was provided with a diaphragm for using one or two oblique pencils only. The necessary movement was made by means of a small projecting arm A (Fig. 18), which was inconveniently near the stage.

The diaphragms (Figs. 19 and 20) now have a central aperture, and the movement is made by means of an outer sliding tube *b* with a slot at the top, in which the arm A fits, and another arm B is placed at the lower end so as to give ready command of the rotation. The new plan allows of the use of either central light alone, or one or two oblique pencils incident 90° apart in azimuth. D is the optical part of the condenser, placed immediately above the diaphragms, and in oil-immersion contact with the base of the slide. The circular diaphragm is fixed into the inner tube attached to the substage tube C, just below the position of the arm A; and the other diaphragm is screwed to it by a screw in the excentrical hole, shown in each. It will be seen that when the diaphragms are placed together in this manner, the movement of the arm will produce the changes in the light as above mentioned.

Illumination with High Powers.—At the March meeting, Mr. James Smith explained a simple and effective method which had occurred to him of illuminating *Podura* scales, diatoms, &c., under powers as high as the $\frac{1}{16}$, by using the ordinary bull's-eye condenser only. The mode in which Mr. Smith prefers to use the condenser is to place the lens just above the stage with the flat side uppermost, a lamp being in front at a distance of 2 or 3 inches. The light enters the condenser, and is reflected from the plane surface at a very oblique angle upon the slide.

West's Universal-Motion Stage and Object-holder.†—Mr. R. G. West proposes a new arrangement for examining those bodies which, when seen obliquely, show some features of colour or structure that are invisible when they are viewed perpendicularly to their surfaces. Morris's object-holder has the drawback that, with the exception of rotation of the carrier in a horizontal position, every movement involves a lateral and vertical displacement of the object, which is thus continually thrown out of the field and out of focus.

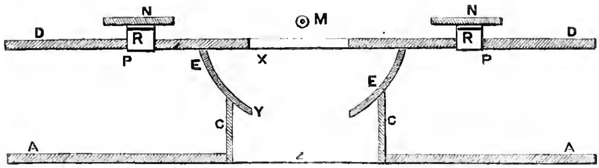
The principle of Mr. West's arrangement is that the object is placed *in the centre* of a movable sphere, so that all lateral displacement is abolished, and the small inevitable focal displacement of the margin of the object is reduced to a minimum, while the centre remains undisturbed.

Figs. 21 and 22 represent the apparatus, the latter figure being a transverse section of the former. A A is a base plate, with an aperture Z in its centre. To this plate is soldered a short brass tube C C. D D is the carrying plate (with a central aperture X) and to the lower side of which is soldered a brass hemispherical shell E E, which has also a circular aperture Y, on the under side for about a third of

* See this Journal, *ante*, p. 117.
† 'Journ. Quek. Micr. Club,' vi. (1880) p. 25.

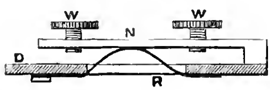
its extent. The dot M indicates the centre of the sphere, and should be fully $\frac{1}{10}$ of an inch above the upper surface of the plate D.

Fig. 21.



The carrier plate is provided with brass forks N N, and a narrow transverse opening P P, through which springs R R press the object slide against the lower surfaces of the forks N N. As these surfaces are in line with the centre M of the hemisphere, minute objects mounted on an ordinary glass slide can readily be placed in that centre, and will be practically free from displacement, lateral or vertical, in any position of the carrier plate. It will be seen that this arrangement automatically compensates for the varying thickness of slides, and that of objects may be compensated for by the screws W W. Two of the screws may be tapped into one of the forks N, and one into the other fork.

Fig. 22.



The weight of the upper part of this arrangement is sufficient to retain it in any position, especially if the upper edge of the tube C be finished square or bevelled outwards so as to give a better bite on E.

Mr. West describes another form, available only for opaque objects, in which E E is secured to C C by springs, and also a modified form for disk-mounted objects.

In each form of the apparatus the point M must be kept in the axis of the Microscope. The carrier plate D should therefore be large enough to permit of any necessary movement of the slide upon it; and for use with non-mechanical stages, a tubular projection from the lower surface of the base plate A, to fit the "well" of the stage, would be advantageous.

Modification of Stephenson's Safety Stage.—At the March meeting of the Society, Mr. Washington Teasdale exhibited a modification of this stage made of ebonite, which was generally commended for its lightness, the material also allowing of a considerable reduction in the cost. An arrangement is provided for introducing and revolving selenites, diaphragms, light modifiers, &c., beneath the object.

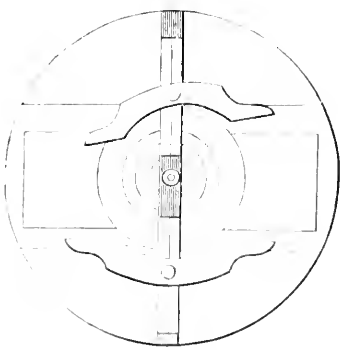
Deby's Growing Slide.*—This slide is shown at Fig. 23, in longitudinal section. A is a 3 × 1 glass slip, having a glass ring cemented to it so as to form a cell of about $\frac{1}{8}$ inch deep and $\frac{3}{4}$ inch diameter.

Fig. 23.

A small hole is bored through the slip at *a*, inside and near the edge of the cell. The objects, such as *bacteria*, &c., are placed with a very minute drop of water on a thin glass cover B, which is attached to the top of the cell by a little lard. The slip is then laid upon another of the same size but not perforated, and a couple of indiarubber bands *b* are passed over the ends. One end of this arrangement is then placed in a little water, which, by capillary attraction, will occupy the space between the two slips, and by evaporation will rise into the cell, and prevent the minute drop of water on the glass cover from drying up. By this contrivance a drop of water no larger than a pin's head can be retained of nearly the same size for weeks together, and the development of *bacteria* or other minute organisms kept constantly under observation.

Dunning's Turntable.—Mr. C. G. Dunning suggests a form of turntable to enable the operator readily to centre any slide for mounting up to 2 inches in width, and also to apply the finishing varnish, or repair the same where necessary, to slides, the covering glasses of which may have been placed *away from the centre in either direction*. The apparatus, which is shown in Fig. 24 (half size),

Fig. 24.



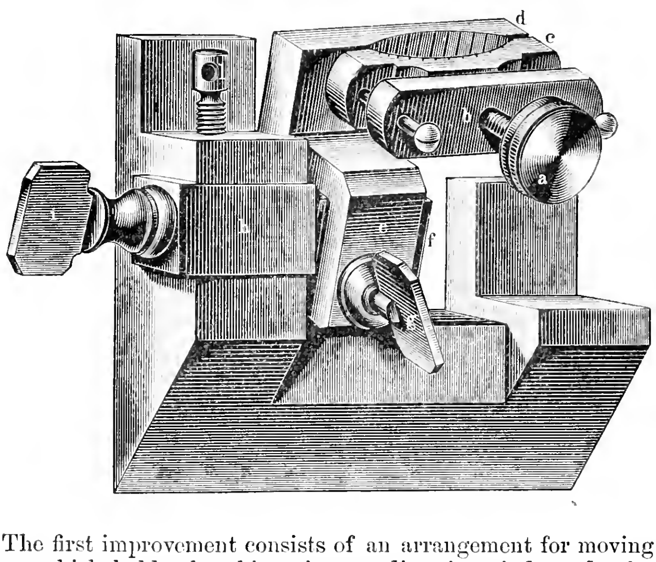
consists of the usual circular table, with the addition of a dovetail groove across the centre, in which work the guides of two clips. One of these clips is fixed to its guide, and the other works on a pivot in order that it may adjust itself to any little irregularity in the width

* 'Journ. Quek. Micr. Club,' v. (1880) p. 28.

of the slides, the sides of which are frequently not quite parallel. The ends of the guides are cut and "sprung," so as to give sufficient tension in the groove to obtain a firm grip of the slide. Guiding lines and circles are ruled on the table to facilitate the centring, and all that has to be done after placing the slide in position is to bring the clips together by means of the pins until the requisite grip is obtained.

Further Improvements in the Rivet-Leiser Microtome.*—Although this microtome is still superior in its chief points to previous instruments, particularly in the substitution of an inclined plane for a screw, and in the guidance (controllable by the hand of the operator) which is given to the knife, Dr. Spengel found that further modifications were needed. A model used at the Zoological Station at Naples (now some years old) has the advantage of allowing increased thinness in the sections, which is accomplished by lengthening the instrument to 20 cm. instead of 10 cm., so that a movement of $\frac{1}{4}$ mm. of the object slide (the rise being 1 in 20) elevates the object $\frac{1}{80}$ mm. More recent attempts have resulted in the production of an instrument shown in the annexed figures.

Fig. 25.



The first improvement consists of an arrangement for moving the clamp, which holds the object, in two directions independently, the object being capable in consequence of far more delicate adjustment as regards its position than with an immovable clamp.

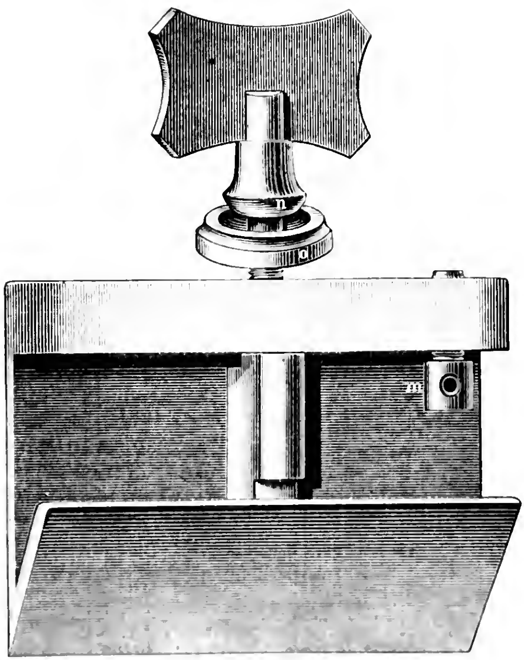
The clamp and object-carrier are shown in Fig. 25. By the screw *a* passing through *b* (which is connected with *d* by two pins), the

* 'Zool. Anzeiger,' ii. (1879) p. 641.

movable piece *c* is made to approach to or recede from *d*, so that a more convenient and secure fixing of the object is obtained. By means of the bent arm *e* the clamp is attached to the block *f* (the upper surface of which is rounded), to which it can be secured by the screw *g*. When the latter is loosened the clamp can be moved through a small arc in a plane parallel to the middle plate of the instrument, and so set in an oblique position. The block *f* is connected with a second (fixed) block *h* by a screw passing through the latter, and can be secured to it by *i*, or when the screw is loosened *f*, with *e* and the clamp, can be rotated in a plane at right angles to the middle plate and placed in the oblique position shown in the figure.

By the combination of these two movements the object can be placed in any desired position, and, as they act independently, there is no danger that in correcting the position in one direction the other will be interfered with. For cleaning the block *h* can be separated from the carrier by loosening the screw *l*.

Fig. 26.



Several clamps can be used with one microtome, which is very useful in large laboratories.

The second improvement is in the construction of the knife-carrier (Fig. 26). To obviate the tendency of the knife to be more depressed

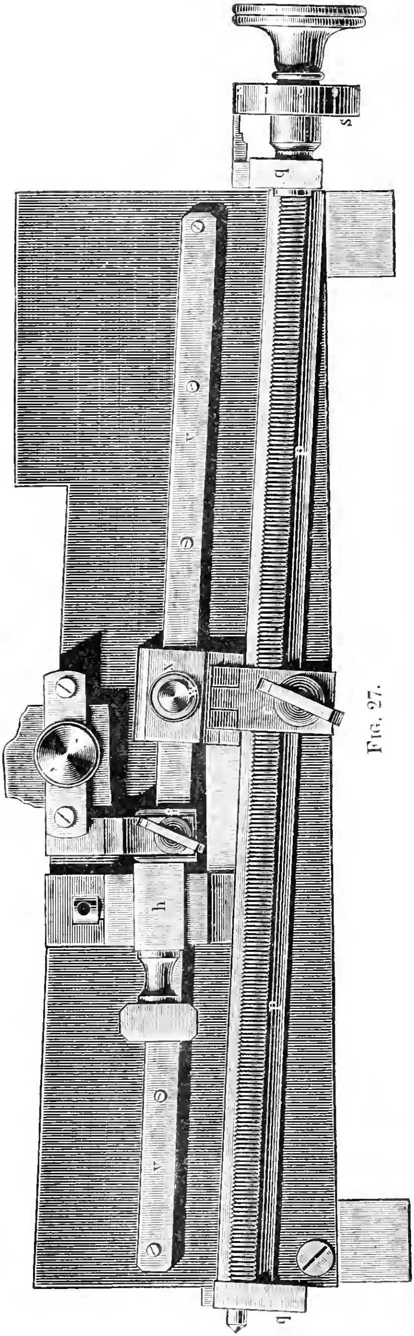


Fig. 27.

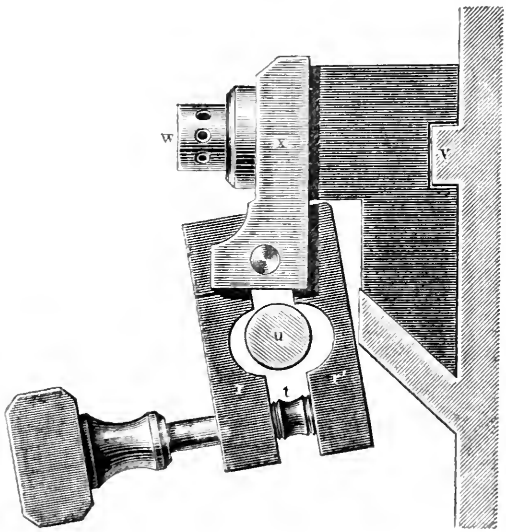
at the free end, which results in its ineffectually passing over the object (the latter merely tilting it up), a screw *m* is inserted in the horizontal plate of the knife-carrier which serves to raise the free end of the knife more or less. The alteration of angle caused by an elevation of one end of the knife without that of the other may be compensated by a corresponding inclination of the object clamp.

In theory the best position for the knife is horizontal, but in practice this has the disadvantage that the under side of the knife drags on the surface of the object. This can be remedied by raising the back of the knife, which can also be done by the screw *m*. To clamp the knife when set otherwise than in a horizontal position, the ordinary form of screw, with an under surface of fixed inclination would be useless; a spherical form is therefore given to the under surface of the screw *n* so as to fit into a corresponding collar *o* inserted between the knife and the screw. The collar can then be made to follow the inclination of the knife, and is readily fixed by the clamping screw.

The third improvement consists in the movement of the object clamp by means of a micrometer screw instead of by the hand (Fig. 27). This screw *p* as it turns in the sockets *q q* moves the piece *r*, which is attached to *x* and the latter by the screw *w* to the object-carrier, so that each turn of the screw moves the latter through a certain small distance. One turn of the screw (which has a wheel *s* attached to it divided into ten parts) moves the carrier 1 mm., and each of the divisions represents $\frac{1}{10}$ mm., and gives an elevation of $\frac{1}{200}$ mm. to the object.

In order to be able to place the carrier at any desired point of the instrument, a "coarse adjustment" is necessary. This is accomplished by the arrangement shown in Fig. 28, which represents a vertical section of the apparatus taken at the point *r* of Fig. 27. The piece *r* is seen to be in two parts, *r* and *r'*, forming a clamp round the screw *u* (= *p* of Fig. 27), and hinged in such a way that, by means of a partly right-handed and partly left-handed screw *t*, they can be

FIG. 28



separated or brought together. By loosening the screw, the piece *r* with the object-carrier can be moved freely by the hand, until the latter rests at any desired point. The piece *r* can be screwed up to *p* (*u*) again, the instrument being then ready for use as before. (*v* is a "guide" along which the object-carrier slides.)

Thin Covering Glass.*—At a meeting of the Section for Microscopical Science of the Royal Society of New South Wales, Mr. Hirst is reported to have "exhibited some very thin glass suitable for the covering of micro-objects. This glass is simply blown from ordinary glass tubing, is incomparably thinner than the thinnest covering glass, and is so elastic that it is easier torn than broken, and may be readily cut to any shape with scissors."

* 'Journ. and Proc. Roy. Soc. N. S. Wales,' xii. (1879) p. 262.

Refractive Index of Cover-glass.—In reply to a query by Mr. J. Mayall, jun., as to the nature of the glass used as cover-glass, Dr. Hopkinson, F.R.S., writing on behalf of Messrs. Chance of Birmingham, states that it is ordinary crown glass having a mean refractive index of 1·5 to 1·525, and that they have never used flint glass for the manufacture of microscopical covering glass. This is noted as many microscopists are under the impression that it is flint glass.*

* See 'Mon. Micr. Journ,' viii. (1872) p. 271.

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Julien, A. A.—Preparation of thin Rock Sections in the Field. [*Abstr.*] *Am. Journ. Micr.*, IV., p. 231.
Magnifying Power, the highest ever reached. " " V., pp. 47–9.
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MORRIS, G. C.—[Cleaning Diatomaceous Earths, Seaweeds, &c.] *Am. M. Micr. Journ.*, I., p. 38.

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[PHIN, J.]—[On Dr. R. H. Ward's Presidential Address.—*See infra.*] *Am. Journ. Micr.*, IV., pp. 224–7.

„ „ Our Expert System. „ „ pp. 227–8.

„ „ Micromillimetres. „ „ V., p. 49.

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SEILER, C.—Cleaning of Slides and thin Covers. *Am. Journ. Micr.*, V., p. 50.

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Spring Collections. [Suggestions as to what to look for and where to find it, &c.] *Am. M. Micr. Journ.*, I., pp. 52–4.

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SWIFT, J.—Hints to the Uninitiated on the Selection and Proper Method of Testing the Quality of the Mechanical and Optical Portions of a Microscope. 25 pp. 7 figs. (8vo. London.) [1880.]

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VERDER, M. A.—Preparations of Crystals for the Polariscope. 1 fig. *Am. Nat.*, XIV., pp. 146–7.

VORCE, C. M.—Cleaning Foraminifera. *Am. M. Micr. Journ.*, I., p. 24.

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WARD, R. H.—President's Address to the Buffalo Meeting of the American Society of Microscopists. *Am. Journ. Micr.*, IV., pp. 191–206.

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Wenham's Disc Illuminator, new mounting for. 1 fig. *Engl. Mech.*, XXXI., p. 33.

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PROCEEDINGS OF THE SOCIETY.

Annual Meeting of 11th February, 1880, at King's College, Strand, W.C., The President (Dr. Beale, F.R.S.) in the Chair.

The Minutes of the meeting of 14th January last were read and confirmed, and were signed by the President.

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

	From
Catalogue of Scientific Papers (1864–73), compiled by the Royal Society of London. Vol. viii. (1–z), 1310 pp. (4to. London, 1879)	*The Royal Society.*
Huxley, Prof. T. H., F.R.S.—The Crayfish: An Introduction to the Study of Zoology. 371 pp., 81 figs., and 1 plate. (8vo. London, 1880)	*Mr. Crisp.*
M'Alpine, D. and A. N.—Biological Atlas. 49 pp., 24 plates. (4to. Edinburgh and London, 1880)	*The Publishers.*
London Clay with Diatoms in situ	*Mr. W. H. Shrubsole.*

Mr. Crisp called attention to the ingenious arrangement of Wales' "Iris Diaphragm," and read a description of Mr. Ahrens' arrangement for using the Wenham prism with high powers, comparing it with Mr. Wenham's original device of a small prism fitting into the object-glass.

The Report of the Council was read by Mr. Stewart (see p. 368), many portions of which were received with much applause.

Sir Antonio Brady moved—"That the Report now read be adopted and printed, and that a special vote of thanks be presented to Mr. Crisp for his honorary services in connection with the Journal." He had great pleasure in doing this, as he thought the condition of the Society was eminently satisfactory, and that the Journal reflected the highest credit upon them.

Mr. Beck, in seconding the motion, was also glad to congratulate the Society on its prosperity. He never recollected any year when the Fellows had had so much provided for them as during the last, or when the papers read at their meetings had possessed so much interest. They now had not only meetings of a most interesting character, but they had also a Journal which he did not hesitate to say was a model of what a scientific Society's Journal should be in every respect. He was very glad to find that the Council had proposed a special vote of thanks to Mr. Crisp in connection with the Journal, and he was sure that it would meet with the cordial approval of all the Fellows. The Society now took rank as a scientific society of the first order, and he thought they were to be highly congratulated upon it.

The President put the resolution to the Meeting, and declared it carried by acclamation. He said that by their applause they had acknowledged how much they were indebted to Mr. Crisp for his exertions in helping on the Journal, and indeed he could hardly tell them in how many important ways this had been done. In the name of the Society, therefore, he had great pleasure in presenting Mr. Crisp with two bound volumes of the Journal for 1878 and 1879, as a very small acknowledgment of their high appreciation of his services. (Two volumes, handsomely bound in red morocco and with a suitable inscription, were then handed to Mr. Crisp by the President amidst the applause of the Meeting.)

Mr. Crisp said, "I am much indebted to the Meeting for the cordiality with which they have received the resolution. The Society can now fairly claim that they have paid me out in my own coin. It is not by any means however as a figure of speech that I say the only reward I wish to receive for anything undertaken is that it may be crowned with success, which will of itself be ample reward.

"I hope I am not too sanguine in believing that the results of a certain amount of hard work in recent months are beginning to be manifested both in regard to the internal condition of the Society and also its external relations. As to the former, it can hardly be doubted that the vitality of the Society has increased, as may be seen from the larger attendance at the meetings, and in other ways, notable among which is the fact that Fellows have voluntarily come forward and paid their subscriptions upon the modern scale on the ground of the additional benefits they receive. As to the Society's external relations, I think it will be found that we have effected a great change for the better, the Society now being in communication with most of the provincial societies and with nearly every important biological society throughout the Old and New World.

"There is only one little point that I have ever heard suggested, and that is that the expenditure of the Society has increased, and I ask for a few minutes to deal with that question.

"When we remember, as some of us will remember, how narrowly the Council has had in recent years to scrutinize the proposed expenditure of comparatively small sums, it is of course a little startling to find that after investing all the composition fees received and fitting up the new room (out of the cash in hand) at an expense of 100*l*., we have increased our publication expenditure by 120*l*., our postages by more than 20*l*., and other expenses by more than 60*l*. This, however, is looking at only one side of the picture, and will always be startling if we look only at that. It must, however, be borne in mind that if our expenses have been greater our receipts have also increased by the same amount.

"If we were to attempt to lay down any principle to guide us in the administration of our finances, I should say that if we have investments in hand to represent all the money that has ever been given us by way of legacies or otherwise, and if in addition we have also in hand all the money paid by existing Fellows for their compositions, we have done all that is required of us. But in fact we have gone beyond this, and we are now endeavouring to reach the point when the interest on our investments will produce a sum equal to that of the annual subscriptions which would be otherwise payable by the Fellows compounding. This, I think, is a luxurious prudence that leaves nothing to be desired.

"Being, therefore, in that position, I submit that we may fairly spend (provided we do not spend injudiciously, which is not suggested) all that we receive year by year. Why should we save? I will not perpetrate the old joke about the want of reciprocity on the part of posterity, but if ever there was a case in which posterity may be left to look after itself it is in the case of a Society such as this. If succeeding generations take sufficient interest in Microscopy to have 500 Members they will be able to get on as we are now getting on, and why should we tax or starve ourselves to give them more? If they will exert themselves to increase their numbers they will be better off, but even if they have fewer it cannot be said that any of the sins of the fathers are visited upon the children, but it will be simply the sins of the children coming home to roost, and I cannot, therefore, conceive any principle on which we should be called upon to abstain from spending the money which we ourselves have collected, either to provide for the shortcomings of, or to confer exceptional benefits on, our posterity.

"I would also point out that what is applicable to commercial ventures is also applicable in principle, if in a less degree, to a Society like ours, viz.:—that the receipts increase as a direct consequence of the increase in the expenses. If we had not expended so much we should not have received so much.

"Finally, I wish to point out that the prosperity of the Society cannot be allowed to depend on the energy or enthusiasm of any one man or set of men. Unless all co-operate it is inevitable that the Society will in time languish, and I would therefore make an earnest appeal to all the Fellows not to let any year go by without being able to say that they have contributed *something* to the advancement of the interests of the Society. I venture to think that in regard to subscriptions to scientific societies there is too great a tendency to consider the payment of the subscription as the whole duty to be performed, and that it then only remains to watch and see that some one else returns value for the money. It is obvious, however, when once the matter is stated, that this is a wrong notion, and that the association of persons in a scientific society ought to depend upon a very different tie to that of a pecuniary one merely, the subscription being really only the *minimum* contribution which it is necessary to insist that all the members should make.

"It is hardly necessary to point out what an increased amount of activity we should present if we had 1000 Fellows instead of 500, and having regard to the widespread interest in the Microscope, I see no reason why we should not equal the numbers either of Chemists, Geologists, or Zoologists.

"To allow the resolution just passed to stand by itself would give rise to the notion that the Journal was the production of a single individual, which it certainly is not, and I beg therefore to propose that the thanks of the Society be also given to the Publication Committee, and to Messrs. Parker, Bennett, and Bell for their important share in its production."

Dr. Sorby said he had great pleasure in seconding the proposition, and in congratulating the Society on its very satisfactory position.

The President, having put the resolution to the Meeting, declared it to be unanimously carried.

The List of gentlemen proposed as Officers and Council for the ensuing year was read by Mr. Crisp as follows:—

President—Lionel S. Beale, Esq., M.B., F.R.S.

Vice-Presidents—Robert Braithwaite, Esq., M.D.; * W. B. Carpenter, Esq., C.B., F.R.S., M.D.; * Prof. P. Martin Duncan, M.B. (Lond.), F.R.S.; Henry J. Slack, Esq., F.G.S.

Treasurer—John Ware Stephenson, Esq., F.R.A.S.

Secretaries—Charles Stewart, Esq., M.R.C.S.; Frank Crisp, Esq., LL.B., B.A.

Twelve other Members of Council—John Badcock, Esq.; William A. Bevington, Esq.; * Arthur E. Durham, Esq., F.R.C.S.; Charles James Fox, Esq.; James Glaisher, Esq., F.R.S., F.R.A.S.; A. de Souza Guimaraens, Esq.; William J. Gray, Esq., M.D.; John Matthews, Esq., M.D.; * Albert D. Michael, Esq., F.L.S.; John Millar, Esq., L.R.C.P.E.; * Frederic H. Ward, Esq., M.R.C.S.; * T. Charters White, Esq., M.R.C.S.

The President having requested Mr. Hardingham and Dr. Ord to act as Scrutineers the ballot was proceeded with; and upon the Scrutineers presenting their report, the President declared all the above gentlemen to be duly elected.

Mr. J. W. Stephenson, the Treasurer, then read his Annual Statement as to the Society's property, receipts, and expenditure (see p. 371).

On the motion of Dr. Millar, it was resolved that the Treasurer's Statement be received and adopted, and that the thanks of the Society be given to Mr. Stephenson for his services as Treasurer. Dr. Millar said that the fact that there were only six Fellows of the Society whose subscriptions were in arrear showed how efficiently the duties had been performed.

Mr. Badcock pointed out that in addition to the investments in consols and mortgages mentioned in the Treasurer's report, there was other property belonging to the Society which he regarded as quite as important—viz. their property in books, journals, and scientific instruments, which were of no little value. Indeed, he considered that the money that had been so expended was equally an "investment," and not an ordinary expenditure. Whilst congratulating the Society on the very prosperous state in which the report showed them to be, he was prepared to go further than Mr. Crisp, and thought they were not only justified in spending a larger proportion of their annual income, but a portion of their capital also in books and instruments, and that there was no necessity for keeping several thousands

* Have not held during the preceding year the office for which they were nominated.

of pounds in hand when they might be profitably expended in providing a better library.

The President then delivered his Annual Address, which was listened to throughout with marked attention, and frequently applauded. He resumed his seat amidst the continued applause of the Meeting.

Mr. Glaisher said he rose to ask the Meeting to give a hearty vote of thanks to the President for his very interesting and admirable address. It was a most thoughtful production, which they would read at home with pleasure and with profit. Mr. Glaisher having put the proposal to the Meeting declared it to be carried unanimously.

The President said he was much obliged to the Meeting for the extremely cordial way in which they had received the address and had voted their thanks. He only regretted that it was so long, and that the Meeting had been protracted somewhat on that account.

The thanks of the Meeting were given to the Auditors and Scrutineers for their services.

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

Mr. Bolton:—(1) Nudibranchiate Mollusc—*Eolis concinna.* (2) *Sertularia* with parasitic Polyzoa. (3) Various forms of dipping-tubes.

Mr. Crisp:—(1) Ahrens' arrangement for using Wenham's prism with high powers (see p. 330). (2) Wenham's original device for the same purpose (see p. 330). (3) Wales' Iris Diaphragm.

Mr. Shrubsole:—London clay with Diatoms in situ.

New Fellows:—The following were elected *Ordinary Fellows*:—(At the December meeting*):—Messrs. A. W. Bennett, M.A., B.Sc., G. E. Blackham, M.D., A. Nachet, U. Pritchard, M.D., R. H. S. Spicer, B.Sc., R. B. Tolles, W. B. Turner, H. T. Whittell, C. Willmott, and C. Zeiss. (At the Annual Meeting):—Messrs. W. S. Greenfield, M.D., H. R. Hutton, F. W. Millett, S. O. Ridley, and B. B. Woodward.

REPORT OF THE COUNCIL

Presented to the Annual Meeting on 11th February, 1880.

The Council are glad to be able to report that the past year has been one of altogether exceptional prosperity in the Society's affairs.

Elections, &c., of Fellows.

At the commencement of 1879 the number of *Ordinary Fellows* was 399. Since that date 58 new Ordinary Fellows have been added

* Omitted at p. 173.

to the list, and in addition 21 other Fellows have been elected or nominated since the beginning of this year.

This accession of new Fellows exceeds that of any other year since the foundation of the Society, with the single exception of 1867, when the announcement was made of the intended increase of the subscription from 1*l.* 1*s.* to 2*l.* 2*s.*

The vacancies in the list of *Honorary Fellows* have been filled up by the election of gentlemen eminent in Biological research or Microscopy, resident for the most part abroad, each of the principal foreign countries having now one or more representatives.

The Council have every reason to congratulate the Society on the success which has attended the new Bye-Law allowing the election of *Ex-officio Fellows.* Eighty-six Societies in all have been nominated, and these have been selected from the various leading Societies throughout the continent of Europe, the United States, and the Colonies, as well as in this country. The Council have from time to time received very gratifying evidence of the appreciation with which this association of kindred Societies has been regarded.

During the past year, 17 Ordinary Fellows have died or resigned (6 compounders and 11 subscribers). The total number of Ordinary Fellows, on the 31st December, 1879, was therefore 440, of Honorary Fellows, 49, and of Ex-officio Fellows, 86, or 575 in all.

Invested Funds and Revenue.

Having regard to the expenditure required for the fitting and arrangement of the New Library, together with the expenses entailed by other improvements made during the course of the year, the Council fully anticipated that it would be found necessary to intrench upon the Capital of the Society, but they were glad to find that as the increase in the year's Revenue, after allowing for deaths, &c., amounted to more than 210*l.*, they were able not only to meet the special expenses above referred to, but to invest the whole of the Composition fees received during the year, and still leave a surplus, which has been applied for the Journal as hereinafter explained.

By the reinvestment of part of the funds upon Freehold Mortgages, an additional revenue of 22*l.* 10*s.* per annum has been obtained.

Library, Instruments, &c.

The negotiations referred to in the last Report of the Council were subsequently completed, and the Society is now in possession of an admirable *Library,* which affords many advantages over the old arrangements.

During the past year the Books have been rearranged, and some important additions have been made, consisting of the purchases out of the Quekett Fund, a list of which is given in the Proceedings of the Meeting of the 9th April, 1879.

The collection of *Instruments* has been increased by four Microscopes, presented by Mr. Crisp—three modern instruments, and one which is of interest, as being the first form of Binocular Microscope designed by M. Nachet. Several pieces of accessory apparatus have also been presented, which have been noted in the list of donations from time to time, and will be found recorded in the Journal. Drawers have been added to the Instrument Cabinet, to hold the whole of the object-glasses and apparatus.

Many additions have also been made to the *Cabinet of Objects*, amongst the most important of which is the gift of 173 slides from the representatives of the late Mr. Charles Brooke, F.R.S., a Past President of the Society.

The other donations have included a revolving Microscope-table from Mr. Badcock, which has proved extremely useful at the weekly evening meetings in the Library; a clock from Dr. Gray; a ruling machine from the representatives of the late Mr. J. Waterhouse, F.R.S.; three chairs for the President and Secretaries, and a second Cabinet from Mr. Crisp, the Cabinet being intended to hold the instruments of the Society which have an historical interest, including the large Martin Microscope. These instruments have hitherto for the most part been kept in boxes, and were practically inaccessible to the Fellows, but as arranged in the new Cabinet, they can be inspected to the best advantage.

The Journal.

The Council, in considering the mode in which the surplus income of the Society should be applied, came to the conclusion that it could not be more usefully employed than in enlarging the Journal, and they are confident that this will meet the views of the Fellows generally.

Not only from the Fellows, but also from Biologists outside the Society, the Council have received the most gratifying expressions of approval both of the plan and execution of the Journal, a leading feature of which is the information which it affords both to zoologists and botanists in regard to the current researches of workers in this country and abroad.

The Council cannot refer to the Journal without expressing the high appreciation which they entertain of the services of Mr. Crisp, without whose untiring energy and zeal the production of the Journal, in its present form, would have been impracticable. The Council are sure that the Fellows will cordially join in a special vote of thanks to Mr. Crisp for the benefit which the Society has derived from his honorary exertions in this matter.

In proposing such a vote, the Council do not overlook the services of the Publication Committee, or of Messrs. Parker, Bennett, and Bell, to all of whom the thanks of the Society are also due.

Business at the Meetings.

The Meetings have been so fully occupied throughout the Session with the papers read and objects and apparatus exhibited and described, that it has been found impossible to carry out the intention referred to in the last Report of the Council, of noticing and illustrating from time to time any important observations of foreign Biologists.

Dr. J. W. STEPHENSON IN ACCOUNT WITH THE ROYAL MICROSCOPICAL SOCIETY. Cr.

1879.				£	s.	d.
To Balance brought from 31st December, 1878				186	4	4
,, Proceeds of sale of 1250*l.* Consols				1200	0	0
,, ,, 131*l.* 1*s.* 3*d.* India 5 per cent. Stock transferred from Quekett Fund				138	4	11
,, Uninvested interest on ditto				13	3	8
,, Half-year's Dividend on 1856*l.* 0*s.* 6*d.* Consols				26	12	2
,, ,, ,, 606*l.* 0*s.* 6*d.* ,,				8	18	0
,, ,, Interest on Mortgage for 1200*l.*				29	7	6
,, Interest on ditto to 17th Nov., 1879, on making transfer				18	13	4
,, Subscriptions commuted				94	10	0
,, Annual Subscriptions, &c.				662	12	0
,, Sale of 'Monthly Microscopical Journal'	£22	17	6			
,, ,, Reprints of Papers	22	8	3			
,, ,, Journal by Assistant Secretary	6	14	0			
				51	19	9
,, ,, Old Cupboards, &c.				2	15	0
				£2433	0	8

1879.	£	s.	d.
By Cash advanced on Mortgage	1200	0	0
,, ,, paid for 183*l.* 16*s.* 2*d.* Consols	182	0	1
,, Rent, &c., at King's College	76	1	0
,, Mr. Reeves' Salary	90	0	0
,, ,, for Collecting	19	0	0
,, Reporter	9	9	0
,, Cash paid for Journal	410	7	3
,, ,, Reprints of Papers	24	9	0
,, Books	84	3	2
,, Ray Society	1	1	0
,, Printing	27	12	0
,, Stationery	14	12	4
,, Removing Furniture, and Alterations and Fittings to Library	80	18	0
,, New Chairs	16	2	0
,, Petty Cash	77	12	0
,, Powers of Attorney and Cheque-books	1	11	4
,, Fire Insurance	1	4	0
,, Remaining Balance 31st December, 1879	116	18	6
	£2433	0	8

Invested Capital 31*st December*, 1879.

1200*l.* on Freehold Mortgage.

789*l.* 16*s.* 8*d.* 3 per cent. Consols, including Quekett Fund, 100*l.*

Examined and found correct, February 9th, 1880.

J. W. GOODINGE }
S. J. McINTIRE } *Auditors.*

2 B 2

MEETING OF 10TH MARCH, 1880, AT KING'S COLLEGE, STRAND, W.C.
THE PRESIDENT (DR. BEALE, F.R.S.) IN THE CHAIR.

The Minutes of the meeting of 11th February last were read and confirmed, and were signed by the President.

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

	From
Cornu, M.—"Monographie des Saprolégniées," and separate copies of 30 of the author's other papers	*The Author.*
Cutter, E.—Primer of the Clinical Microscope. 32 pp., 7 figs. (8vo. Boston, 1879)	*Ditto.*
Gulliver, Prof. G., F.R.S.—The Hunterian Oration delivered at the Royal College of Surgeons of England, 14th February, 1863. Second Edition, 21 pp. (8vo. Canterbury, 1880)	*Ditto.*
Möller, Prof. V. v.—Die Foraminiferen des Russischen Kohlenkalks. 132 pp., 7 plates, and 30 figs. (4to. St. Petersburg, 1879) ..	*Ditto.*
Section of the stem of Lime Tree	*Mr. Beck.*
Two Microscopes (by Ahrens), one Monocular and one Binocular ..	*Mr. Crisp.*

Professor P. Martin Duncan, F.R.S., read a paper "On a parasitic Sponge of the order Calcarea" (within *Carpenteria raphidodendron*), illustrated by drawings on the board and by specimens exhibited under the Microscope.

Dr. Millar said he had the opportunity some time ago of seeing Professor Duncan's specimens, and they struck him as being extremely like the casts of *Clionæ* which are so frequently found in flint.

Dr. Matthews said that the question of parasitism seemed to be very doubtful yet. He had examined many specimens of so-called parasitism of sponge on coral, and found that in many cases the coral was parasitic upon the sponge which it seemed to have grown round and included. He had, however, other specimens in which it was clearly the sponge which was parasitic upon the coral.

Mr. Stewart said that the question was whether it was a sponge or not? In order to determine this, something more was necessary to judge by; they ought, in fact, to have some of the soft parts. The mere presence of spicules like those of the sponges would not settle the question, because so many other organisms had spines almost identical in character. An organism which will at one time form carbonate of lime, and at another time will destroy it, had a parallel in certain of the Mollusca, which were quite capable of secreting shell at one period and of removing it subsequently. They also knew that certain cells would at one time form bone and at another would become actual bone destroyers.

Professor Duncan said that if they wanted to classify properly they must of course have the whole structure before them, but if they could not get it what were they to do? In such a case they must of course take the general character of the thing and be guided by that. It might be a Foraminifer—it was quite possible—but still he did not know any Foraminifera with spicules like it.

The President welcomed Mr. Fuller, Ex-President of the State Microscopical Society of Illinois, Chicago, U.S.A., who was present at the meeting.

Mr. Beck called attention to a section of the stem of the lime tree which he presented to the Society; it was of two and a half years' growth, cut slightly obliquely through the junction of a branch with the stem, and contained starch, raphides, &c., *in situ*.

Mr. Beck also described and exhibited an improved form of Microscope with swinging Substage (see p. 329).

Mr. Mayall exhibited and described, by means of black-board sketches, a new traverse lens by Mr. Tolles.

Mr. Dunning exhibited and described a new form of Turntable, by means of which it was easy to revarnish slides which had been excentrically mounted (see p. 333).

Mr. Crisp exhibited Klönne and Müller's "Demonstration Microscope," together with the revolving object-stage devised by Mr. Lobb (see p. 144). Also a specimen of Micrometric ruling made by Professor Rogers, of Harvard University, Mass., U.S.A., with his new ruling machine.

Mr. James Smith explained his method of illuminating *Podura*-scales, diatoms, &c., under high powers (see p. 331).

M. Nachet's paper, "On a Petrographical Microscope," was read by Mr. Crisp (see p. 227).

Dr. H. Gibbes read a paper "On the Double and Treble Staining of Animal Tissues for Microscopical Investigations, with a note on Cleaning thin Cover-glasses."

Mr. Stewart said he had examined many of Dr. Gibbes' specimens, and if permanent they would be very excellent additions to the cabinet. Of course time alone could show whether they were permanent or not.

Dr. Gibbes also exhibited a $\frac{1}{12}$ homogeneous-immersion Objective (by Powell and Lealand), which, with the ordinary Wenham prism, showed both fields fully and equally illuminated. The front part of the objective containing the lenses ($\frac{7}{16}$ of an inch in depth) was made to unscrew just behind the back combination, and was attached to a short adapter which, when screwed into the body of the Microscope, left the objective projecting only $\frac{3}{16}$ of an inch below the tube. The optical combination was thus brought very close to the prism, and no part of either field was cut off.

Mr. Badcock read a paper, "On *Podophyra quadripartita*," illustrating the subject by numerous drawings on the black-board.

Mr. Crisp announced that in future the Journals, &c., received since the previous meeting would not be put on the shelves, but would lie on the table during the meeting for examination by the Fellows.

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

Mr. Badcock:—*Podophyra quadripartita.*

Mr. Beck:—(1) Improved Microscope with swinging Substage (see p. 329). (2) Section of the stem of lime tree—stained with magenta and blue aniline.

Mr. Bolton:—*Coleps hirtus.*

Mr. Crisp:—(1) Klönne and Müller's demonstration Microscope (see p. 144). (2) Lobb's revolving object-holder. (3) Zeiss's quadruple nose-piece, with four object-glasses *in situ.* (4) Micrometer rulings by Professor Rogers.

Prof. Martin Duncan:—Parasitic sponge, illustrating his paper.

Mr. Dunning:—Improved turntable (see p. 333).

Dr. Gibbes:—(1) One-twelfth homogeneous-immersion objective, by Powell and Lealand, with adapter for use with the Wenham binocular prism. (2) Specimens of double and treble staining.

Mr. Guimaraens:—Powell and Lealand's improved immersion condenser (see p. 330).

Mr. J. Mayall, jun.:—New form of Tolles' traverse lens.

Mr. James Smith:—Scales of *Podura*, illuminated in the manner described by him.

Mr. Teasdale:—Modification of Stephenson's Safety Stage made of ebonite (see p. 332).

New Fellows.—The following were elected *Ordinary Fellows:*—Messrs. E. Bostock, O. Brandt, C. Horsley, C.E., R. Letchford, A. Lingard, G. C. Morris, and E. Rosling.

The President for the time being of the Hertfordshire Natural History Society and Field Club was elected an *Ex-officio Fellow* of the Society.

Scientific Evening.

The first Scientific Evening of the Session was held in the Libraries of King's College, on the evening of Wednesday the 3rd December, 1879.

The following were the objects, &c., exhibited:—

Mr. John Badcock:

Lophopus crystallinus, Alcyonella fungosa, Stentor polymorpha, and *S. Mülleri.*

Mr. Charles Baker:

New portable Microscope, Zeiss' adjusting Objective, portable binocular Microscope on Stephenson's principle, and Ward's Microtome.

Mr. William Beeby:
Seeds of Orchis (*Spiranthes æstivalis*).

Mr. D. B. Cazaux:
Head and tongue of sand wasp (*Cerceris arenarea*), ditto of honey bee (*Apis mellifera*).

Dr. W. B. Carpenter, C.B., F.R.S., &c.:
Larval zooids of Echinoderms (prepared by Mr. Percy Sladen), Zeiss' adjusting Objective. Internal casts of canal system of *Eozoon Canadense*.

Mr. Frank Crisp:
Revolving Museum Microscope for 500 slides,* Nachet's "Microscope nouveau grand modèle renversé avec miroir argenté." †

Mr. L. Dreyfus:
Chætogaster (Naidina).

Mr. F. Enock:
Head of common wasp (*Vespa vulgaris*), prepared without pressure, and retaining its natural form and colour.
Indian tortoise beetle (*Platypria echidna*) polarized.

Mr. F. Fitch:
Rectal valve of blow-fly *in situ* and detached and uncovered.

Dr. Gray:
Some rare diatoms.

Mr. W. H. Gilburt:
Oil glands in leaf of *Citrus aurantium*.
Ditto, ditto, *Salisburia adiantifolia*.
Resin glands in leaf of *Eucalyptus globulus*.

Mr. J. W. Groves:
Sections of kidney, liver, tongue, and lip of dog stained, mesentery of rat and of kitten, &c.

Mr. J. W. Goodinge:
Leaf of *Onosma taurica*.

Mr. How:
Rosa canina in section, lava from Etna in section, and some mounted gall-flies.

Mr. Henry Hailes:
Foraminifera (*Alveolina*, &c.) in flint.

Mr. W. Joshua:
Conferva echinata (Berk.), from the filter beds of the Bradgate Reservoir, at Leicester, and *Talypothrix distorta* (Kütz.).

Mr. William Moginie:
New form of dissecting Microscope, Canadian salmon fry, and a young Hippocampus.

Dr. Millar:
Hyalonema Sieboldii and *Holtenia Carpenterii* in section.

Messrs. Murray and Heath:
Steinheil's aplanatic triplet magnifying lenses.‡

Dr. Matthews:
Section-cutting machine.§

* See *ante*, p. 327.
† Ibid., ii. (1879) p. 765.
‡ Ibid., *ante*, p. 115.
§ Ibid., ii. (1879) p. 957.

Mr. A. D. Michael:
A hymenopterous insect, showing the abortion of the hind wings, which merely support the fore pair, and one of the Oribatidæ, *Nothrus spiniger*.

Messrs. Powell and Lealand:
Pleurosigma angulatum with $\frac{1}{16}$ oil-immersion objective, *Amphipleura pellucida* with water-immersion $\frac{1}{8}$ and new oil-immersion condenser.

Mr. B. W. Priest:
Grantia compressa, showing the osculum.

Mr. Walter W. Reeves:
An alga, new to this country, *Sphæroplea annulina* (Roth.).

Mr. James Smith:
Pleurosigma formosum and $\frac{1}{16}$ immersion objective.

Mr. Alpheus Smith:
Foraminifera (*Polytrema rubra*).

Mr. Charles Stewart:
Spicula cells of *Welwitschia mirabilis*, showing crystals in the wall.

Mr. Amos Topping:
Stained palates of whelk, periwinkle, &c., in two colours.

Rev. J. E. Vize:
Glœocapsa sanguinea (Kütz.).

Mr. F. H. Ward:
Twelve sections of plant stems, double stained.

WALTER W. REEVES,
Assist.-Secretary.

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JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A RECORD OF CURRENT RESEARCHES RELATING TO

INVERTEBRATA, CRYPTOGAMIA, MICROSCOPY, &c.

Edited, under the direction of the Publication Committee, by

FRANK CRISP, LL.B., B.A., F.L.S.,

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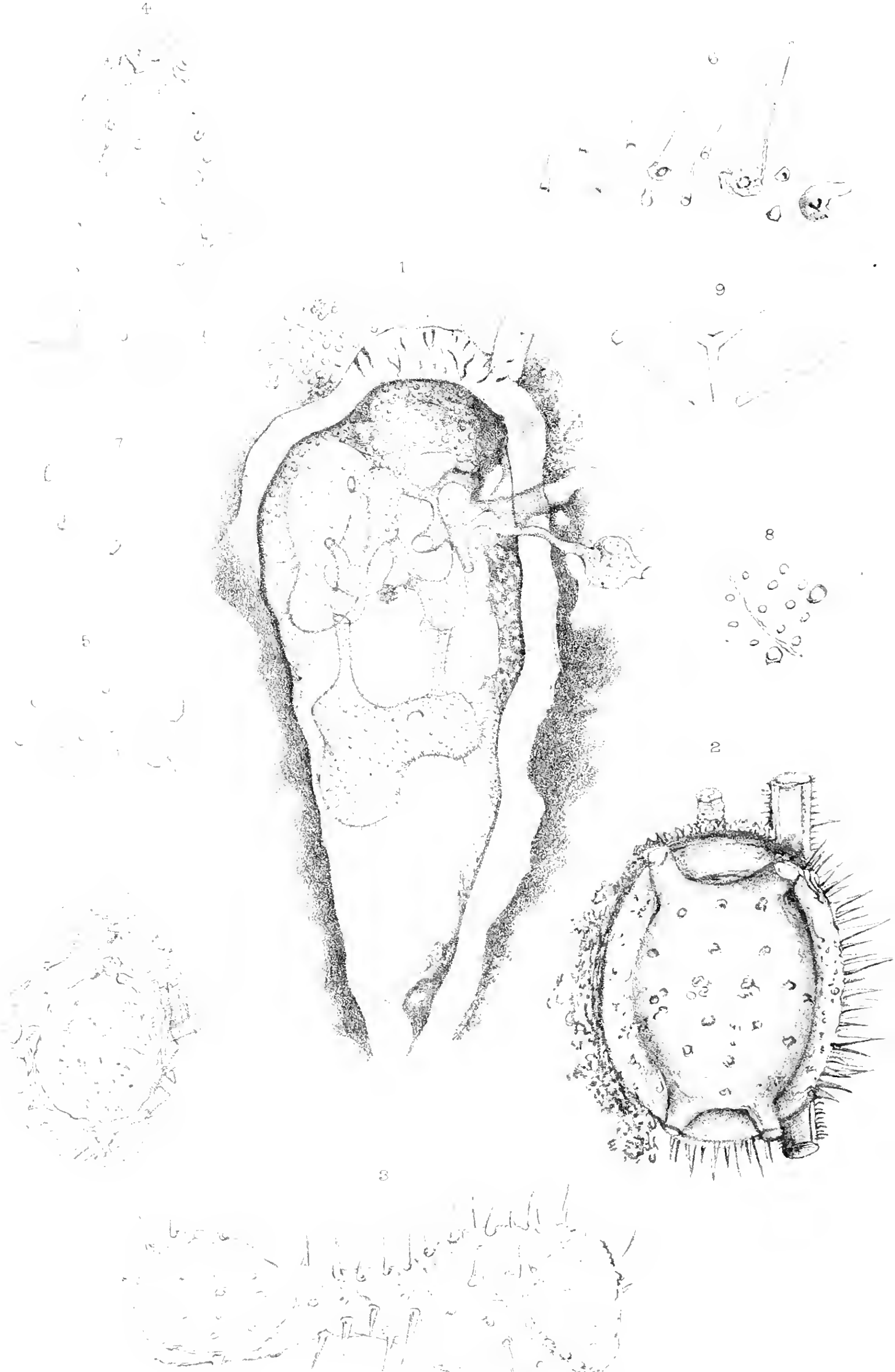

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Mol[illegible]spongia parasitica

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

JUNE, 1880.

TRANSACTIONS OF THE SOCIETY.

XI.—*On a Parasitic Sponge of the Order Calcarea.*

By Prof. P. Martin Duncan, M.B. (Lond.), F.R.S., V.P.R.M.S.

(*Read* 10*th March*, 1880.)

Plate X.

There is a large, coarsely growing Foraminifer on the reefs at the Mauritius, which Möbius has called *Carpenteria raphidodendron*. It has a very coarse nummuline structure, its chambers are large and superimposed, and the surface is somewhat irregular from its special mode of growth. Covering much space for a Foraminifer, it encrusts the previous inhabitants of the surface upon which it extends; and other Foraminifera, especially *Polytremæ*, and Polyzoa and *Serpulæ*, are seen to occupy its base. The upper surface is, on the other hand, crowded with minute Foraminifera, Nullipores, worm-tubes, and confervoid-looking plants. Evidently a rapid and acervuline grower, the Foraminifer has included within and between its chambers some of the minute forms which had lived for a while on its surface, and it is perforated here and there by multitudes of Thallophytes.

Specimens of *Carpenteria raphidodendron* were given by its

EXPLANATION OF PLATE X.

Fig. 1.—*Möbiusispongia parasitica* within *Carpenteria raphidodendron*, magnified. Normal breadth of the parent sac $\frac{1}{100}$ inch.

Fig. 2.—A free specimen with the body and commencing stolons, magnified.

Fig. 3.—A portion of a specimen within the *Carpenteria*, magnified.

Fig. 4.—Highly magnified surface of a stolon-tube, showing the cellular element, the light-transmitting spots, and the large spinules.

Fig. 5.—Portion of the same: the dark cells are the bases of nascent spinules.

Fig. 6.—Spinules and minute spinules, magnified.

Fig. 7.—The cells and the refractive spots which are absolute penetrations, magnified.

Fig. 8.—The perforations and a delicate spicule in a specimen which is free in the Canada balsam. Figs. 4 to 8 inclusive are magnified about 300 diameters.

Fig. 9.—Some of the spicules, magnified.

Fig. 10.—A large sac from another *Carpenteria*, magnified.

discoverer to Dr. Carpenter, C.B., F.R.S., &c., who lent them to me, during an examination I was undertaking into the nature of nummuline structure. One specimen consisted of several thin sections, which had been mounted in Canada balsam before decomposition of the sarcode of the Foraminifer had occurred. The sections, mostly made at right angles to the surface, exposed a succession of chambers, bounded by well-developed nummuline walls, whose perforations are remarkably large. Some chambers are filled with Canada balsam, and others contain the sarcodic substances usually seen in living and in recently dead Foraminifera. A few chambers contain a small quantity of sarcode and much balsam; and it would appear that the fortunate roughness of the manipulation has scattered some of the contents around the sections, where they are preserved.

One chamber, of considerable size, bounded by a wall of nummuline structure, has a small quantity of sarcode near the foramina on one side, and the rest of the space is occupied by a very remarkably shaped organism, which is environed and filled with Canada balsam (Plate X., Fig. 1). This organism is $\frac{1}{100}$ inch broad and $\frac{1}{75}$ inch in total length, and consists of a broad sac which is bulged inferiorly where free, and is rather concave in its outline superiorly, where it gives origin to three narrow, long, and exceedingly delicate tubes resembling stolons. These enlarge at their further ends and expand into bag-shaped chambers which are much smaller than the parent sac. Again, each of these chambers has tubules issuing in different directions: some enlarge into other bags; others enter a large sac on the side of the main body and above it; and one or two are continued through the nummuline wall, and reach another foraminiferal chamber, terminating in a curiously shaped enlargement with openings in it. This combination of large sacs, delicate stolon-like tubes, ending in small chambers, communicating through the wall of the Foraminifer with another sac, has a very thin and transparent external membrane which is hirsute with minute spinules.

Sacs, tubes, and chambers are hollow, and there are no internal structures. The whole organism is suspended freely in the chamber of the Foraminifer, by the stolon which passes through the nummuline wall, and there is considerable space between the large sac and the walls.

The resemblance of the shape of the organism to the casts of *Cliona* from chalk fossils described by Professor John Morris is striking.

Under the use of the spot lens, the tissue of the sacs and stolon-like tubes becomes opalescent, and the spinules are rendered very evident.

A higher magnifying power than that at first used—about

270 diameters—resolves, under transmitted light, the thin membrane of the whole into very definite histological elements.

1. A series of external cells, circular in outline, large, in contact at their edges and thin (Figs. 4, 5, 7).

2. Minute circular spots, one on each cell centrally, which permit light to pass through them more readily than through the surrounding tissue (Figs. 4, 5, 7, 8).

3. Spinules which project at right angles from the sacs, tubes, and chambers; they are transparent, rather blunt at the tip and broad at the base, usually straight and cylindro-conical, but sometimes they are bent and rather deformed. They spring from a dark base with sometimes a central luminous spot, and their bases are modifications of the cellular element (No. 1). They are more numerous and longer in some places than in others, and are crowded on some parts of the parent sac, and are sparely yet decidedly distributed on the stolons and smaller chambers (Figs. 1, 2, 3, 4, 6).

4. Minute spinules, which resemble the larger in their shape, and are outward continuations of the cell-membrane around the luminous spots (Fig. 6).

5. A deep layer of cells is evident; but they are very thin, and resemble those on the surface.

6. In some parts, the spinules and luminous spots tend to form groups and irregular patterns (Fig. 2).

7. No fibres are to be distinguished, and no canals permeate the thin membrane. This is porous, and a side view indicates that the continuity of the outside tissue is imperfect at the luminous points and between the edges of the circular cells.

Doubtful Histological Elements.—A very delicate refracting fibre is seen adhering to the under part of the parent sac, and in another part there is a glassy-looking acicular spicule in the same position. But careful focussing shows that neither enter into the composition of the organism, and that they are simply adherent and probably foreign to it. Nevertheless they are of importance in relation to similar structures which are seen in other specimens.

The higher magnifying power distinguishes some small openings, with relics of stolons attached to them, on the parent sac, in one of the smaller chambers and on one of the stolons, and it casts some doubt upon the entry of a stolon into a large sac at the side of the foraminiferal chamber. Very probably—for unfortunately the thickness of the section and glass cover prevents certainty—there are two of these organisms close together, both having communication with a neighbouring foraminiferal chamber through the nummuline wall.

Under polarized light, the whole of the organism gave faint yet decided indications of double refraction, in and about a host of minute points, suggesting their calcareous nature. A moderately decided black cross could be seen, in the tissues of the sac, on rotating the polarizer, and all the spinules polarized. The spicules noticed as doubtful histological elements, clearly belong to calcareous Spongida.

This very unexpected result of the examination of the specimen, led to the application of the polarizing apparatus to numerous minute portions of the organism which are to be found, here and there, in the Canada balsam around the *Carpenteria*. These are portions of stolon-tubes and parts of sacs. Some of these have spicules on them, and especially a portion of a large sac within a foraminiferal chamber has a triradiate spicule on it. Now all of these portions and the spicules gave the same results as those just noticed, and it is evident from ordinary microscopic examination that all have the same calcareous structures. Under the employment of a thin quartz plate, the crossed Nicols produce a most splendid play of colours in this little organism. In one specimen which happens to be included within the walls of the Carpenteria there is a tube-stolon and part of two chambers, and the membrane, out of which the spinules stand forth, presents, here and there, the appearance of some thickening at their bases (Fig. 3).

During an extended examination of this large slide, which contains six specimens of *Carpenteria raphidodendron*, a body was discovered free in the Canada balsam which is evidently a parent sac of another of the organisms under consideration, and it has its tubes and their developments broken off.

It is oval in shape, about $\frac{1}{100}$ inch long, and it is less in breadth; two tubes pass from it from both ends, and they diverge. Under transmitted light the thickness of the body is seen along the track of the stolons which start from the internal membrane. It is greater than that of the specimen already described, but its construction appears to be the same. The spinules are long and very crowded in some parts, especially at the edges, and are in stellate groups on the upper surface. There are the relics of a stolon belonging to another body, on which this very Ascidian-like creature rested. Its spinules polarized light like those of the other forms, but the opacity of the body prevents the coloration of its tissues taking place under the crossed Nicols except in a very faint manner.

On examining the dry specimen of the *Carpenteria*, a portion of one of these bodies was found in one of the chambers, and it was carefully removed. It was dry, brilliantly white in colour, and its elongate sac was covered with minute prickly spinules, and the whole was perfectly opaque. The sac was carefully separated into two portions after being washed in fresh water, which rendered it translucent. One portion was mounted in Canada balsam, and the other was broken into two parts. One of them was placed on a slide under a low power, and dilute nitric acid was added to the small quantity of water in which it floated. The whole disappeared during a rapid effervescence. The second part was placed in much water, and was well washed, and it became much more transparent. It polarized like the specimen already alluded to; and as minute quantities of the acid solution were added, it gradually disappeared, leaving an excessively delicate organic film behind.

The portion which had been mounted in Canada balsam became transparent, and on the application of the polarizing apparatus it not only gave indications of the presence of carbonate of lime in minute particles, but of two needle-shaped spiculæ which traverse it and which are calcareous. The tissues are exceedingly thin, however, and their microscopic details are not so perfectly visible as those of the larger specimen first mentioned. The spicules within this specimen are very small aciculate, but with rather an angular transverse outline.

Many calcareous spiculæ are to be noticed free in the Canada balsam in the specimen first described, and in one of the chambers of the *Carpenteria* there is a sac which has been cut across, and it overlies a triradiate and polarizing spicule. It does not appear, however, to have any organic connection with it.

The spinules on the cellular membrane of the specimens are calcareous, and in their shape they resemble the larger and correspondingly placed spicules of some Calcarea.

The membrane is stiff, and has the power of not collapsing under some pressure, and the tube-like stolons keep their form after fracture.

It has been noticed that the sections of *Carpenteria* which are mounted in Canada balsam contain two other specimens of this remarkable organism—one being fragmentary and consisting of two small sacs united by a stolon, and the other being a parent sac which has been cut in half. This last approximates probably to the shape of the interior of a small foraminiferal chamber, and traces of stolon growth are only visible at one of the terminations of the body. The question arises very naturally, Do these bodies ever fill up the foraminiferal chambers and line them? Many of the chambers of the *Carpenteria* are lined with a membranous-looking tissue, but it cannot be identified.

There is a specimen of the ordinary *Carpenteria* which has covered in part a *Porites*, and Dr. Carpenter many years since made sections of it to indicate the presence of sponge spicules within its chambers. These are siliceous spicules, and evidently pertain to a *Cliona*. But a careful examination of one of the chambers proves that several were once occupied by a body greatly resembling that now brought under notice. One chamber in particular is entirely filled with a large sac with one tubular opening which is fractured across. This sac is membranous in appearance, and presents numerous minute spots which resemble those already mentioned as existing upon the body in the midst of *Carpenteria raphidodendron.* No spinules are observed, and there is no room for them, but the tissue gives indications of double refraction. Doubtless the tubular opening was once in relation with a stolon leading to another chamber, and this form may be considered as a modification of the other. A very decided calcareous spicule traverses this body.

The extraordinary shape of the organism found within *Carpenteria raphidodendron,* and its curious position within a chamber of a freely-growing Foraminifer, and the fact that a tubular structure connects it with part of a corresponding form which occupied a second and newer chamber, render this minute creature very interesting.

It may be assumed that it occupied the foraminiferal chamber when there was sarcode there, for there are relics of it left; but whether the organism perforated the nummuline wall, or whether this structure grew and enveloped the stolons, must be a matter for conjecture. It is within our comprehension, how a siliceous Sponge or a Thallophyte like *Achlya penetrans* Dunc., can penetrate calcareous structures, but there are difficulties in the way of explaining how these microscopic tubes, built up of a delicate tissue containing carbonate of lime, could traverse the Foraminifer. But it may be conceded that if this parasitic organism did penetrate, it may have done so when the nummuline structure was a mere film.

It may be reasonably assumed that there was a circulation of water through the sacs, tube-stolons and chambers, and that there was a communication with the very outside of the Foraminifer. Probably the parasite nourished itself by absorption of the sarcode of its host to a certain extent.

Of the zoological position of the parasite, there may be some diversity of opinion. But its calcareous tissue is not the result of simple aggregation, and there is a cellular element in relation to minute perforations and spinules. The small stolon openings in the main sac must be remembered in relation to the whole series of cavities and intermediate tubes, and the free body with its four oscule-like openings is very suggestive.

Unfortunately, except in one instance, the presence of definite body spiculæ is uncertain, and in that one it is possible that the sac grew around the aciculate pieces of carbonate of lime. But taking all things into consideration, I think that the organism is a minute parasitic sponge belonging to the Calcarea. Chambers, sacs, and tube-stolon growth are seen in some of the groups of that order, and in both of the great divisions of it established by Haeckel; but all such sponges are attached, and are not parasitic.

There are no tubules in the delicate tissue of the sponge, and I regard the whole as one of the composite Ascones modified for a parasitic life, and have named it after the discoverer of its host—*Möbiusispongia parasitica.*

XII.—*The Genus Ravenelia.*

By M. C. Cooke, M.A., LL.D.

(*Read* 14*th April*, 1880.)

Plate XI.

The life-history of minute plants, especially when they cannot be studied in their native country, can only be obtained after many observations, and by the gradual accumulation of small facts. *Ravenelia* is one of the genera of microscopical fungi which is scarcely known except systematically, or from its one phase of mature specimens dried and preserved in herbaria.

In the year 1853 the Rev M. J. Berkeley first announced in the 'Gardeners' Chronicle' his discovery of two new species of fungi which he called *Ravenelia Indica* and *Ravenelia glandulosa.* The characters of the genus were not given, and, as far as we are aware, have never been published to this day. As to the structure of these new fungi, all was included in the following paragraphs:—"The glandular bodies consist of a large umbrella-shaped dark cap, often ·004 inch across, composed of a number of closely packed cells supported by a long, hyaline, delicate, and apparently compound stem, round the top of which are suspended a circle of elongated hyaline bodies, calling to mind in point of arrangement the appendages in some species of *Medusæ*, or in general appearance the fruit of some *Marchantia.*" These observations refer to the Indian species, which was called *Ravenelia Indica.* Afterwards it is added, "In the South Carolina species, on the contrary, the peduncle is shorter and the appendages are united by their sides into a solid mass." Although the latter is called *Ravenelia glandulosa*, it is the same as was subsequently called *Ravenelia glandulæformis.*

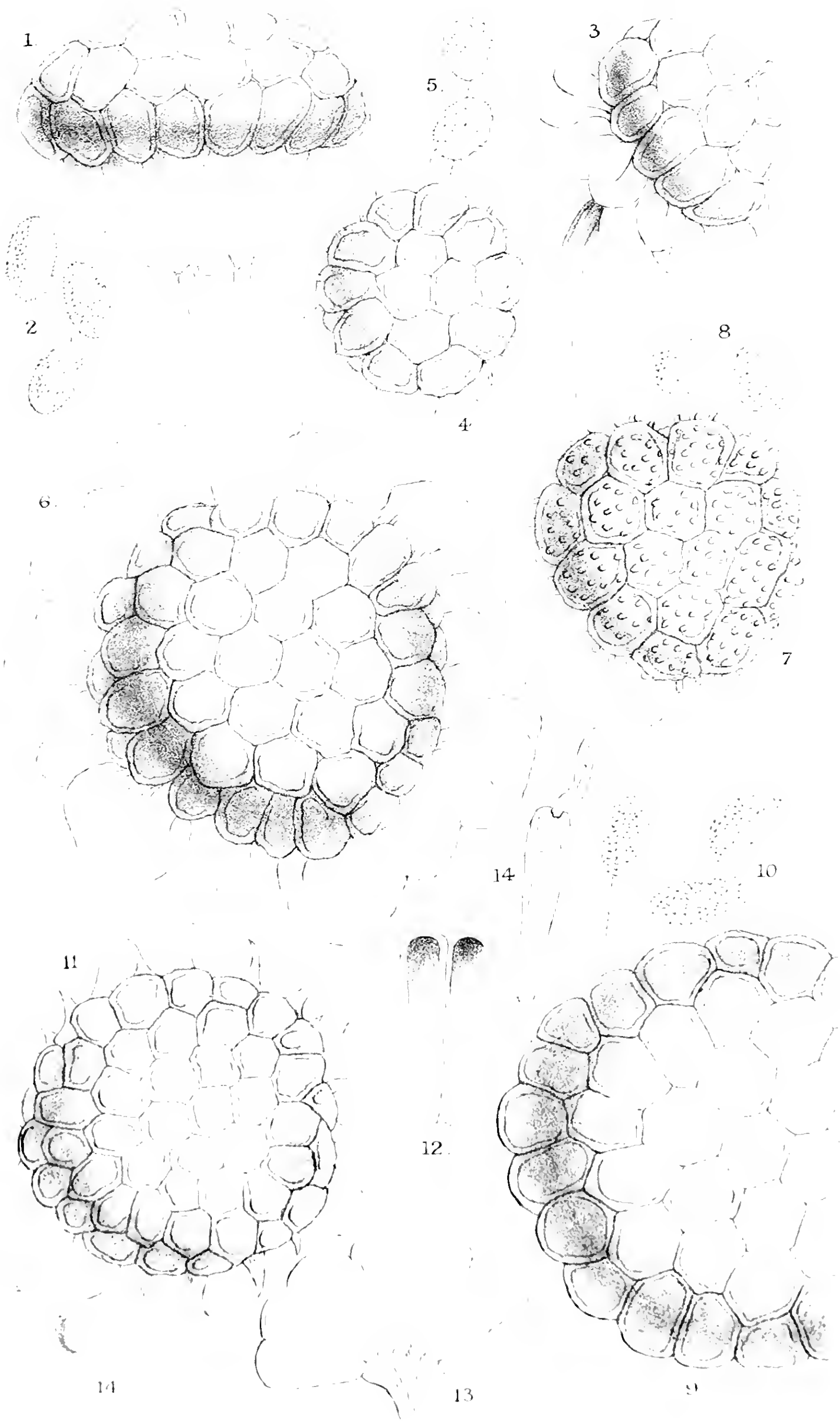
The next mention of *Ravenelia* occurs in 1857, when the above

---

EXPLANATION OF PLATE XI.

Fig. 1.—Side view of capitule of *R. glandulæformis.*
,, 2.—Protospores (*Uredo*) of the same.
,, 3.—Side view of capitule of *R. Indica.*
,, 4.—Upper view of capitule of *R. Hobsoni.*
,, 5.—Protospores of the same.
,, 6.—Capitule of *R. sessilis*, seen from above.
,, 7.—Capitule of *R. stictica.*
,, 8.—Protospores of the same.
,, 9.—Capitule of *R. glabra.*
,, 10.—Protospores of the same.
,, 11.—Capitule of *R. aculeifera.*
,, 12.—Individual cells, or pseudospores of the same species.
,, 13.—Diagrammatic representation of the structure of the capitule.
,, 14.—Germinating pseudospores.

All the figures are uniformly magnified 500 diameters.



Fructification of Pavenema

two species are alluded to in the 'Introduction to Cryptogamic Botany,' but with no additional information.

In 1873 the technical descriptions of five species, of which *Ravenelia Indica* was one, were given in the Journal of the Linnean Society, with figures of the fruit.

In 1874 *Ravenelia glandulæformis* was first described in 'Grevillea' (vol. iii. p. 56).

This appears to be all which has been written on the subject, with the exception of the short note appended to the description of *R. stictica* as to the occurrence of "Uredinoid bodies," hereafter cited, and the paragraph in 'Cryptogamic Botany,' also quoted, which relates to the structure of *Ravenelia*.

It may be remarked that hitherto all the species have been found on leguminous plants, that they usually occur on living leaves, and that the habit and external appearance is very much that of *Phragmidium*, the spore-masses being collected in sori, and bursting through the cuticle, as in *Puccinia* and *Phragmidium*, although sometimes these sori are so minute that they can scarce include more than two or three of the spore-masses called hitherto "pseudospores."

It has always been supposed by the Rev. M. J. Berkeley that *Ravenelia* was allied to *Phragmidium*, and in his "Introduction" it is included in the *Cæomacei*. There now remains no doubt of its affinity with *Triphragmium*, and its immediate allies.

It may assist in the comprehension of our subsequent remarks if at once we enumerate the species included up to the present in this genus.

These are, *Ravenelia glandulæformis* Berk., with the capitules (or pseudospores as Berkeley calls them) stipitate, about 0·1 to 0·12 mm. in diameter, with an average of five or six cells in each direction, so that the cells are ·02 mm. in diameter. The capitules are smooth, convex above and contracted beneath into an uncoloured base which diminishes into the stem. This base, which is described as plicate, appears to consist of empty cysts which cling closely to the stem, the divisions of the cysts giving the plicate appearance. It is a North American species, occurring on the leaves of various species of *Tephrosia* (Pl. XI. Fig. 1).

Another stipitate species is *Ravenelia Indica* B., which has been found on the legumes of certain plants in India. The capitules are thick and have more the form of a truncated cone than any other species, reminding one of a strawberry. At the base a great number of uncoloured cysts surround the capitule like a frill, and the diameter of the coloured portion is about ·08 mm. There are on the average four cells in each direction, so that in size these cells are about equal to those of the preceding species. (Fig. 3.)

The remaining species do not exhibit a distinct stem, but although described as sessile this must rather be interpreted to intimate that the stem is reduced to such a minimum as to be little more than a mere point of attachment. It is not at all improbable that certain conditions, such as an unusual lateral compression when growing closely together, may serve to elongate the point of attachment into a very distinct stem. We mention this tendency because we have observed undoubted indications of a stem to some of the capitules in those which are described as sessile species. In so far as North American specimens are concerned, it seems difficult to define the limits between *R. glandulæformis* and *R. sessilis.* That, however, is a technical point which need not be discussed here.

The species called *Ravenelia sessilis* B. occurs in North America on leaves of *Tephrosia*, and in Ceylon on leaves of *Acacia Lebbek.* The capitules are convex, but rather flattened, about 0·12 mm. diam., with from six to eight cells in each direction. Surrounding the capitules is a delicate hyaline frill of sterile cysts, the lateral margins of which it is sometimes difficult to define, so that the frill appears to be continuous all round the capitule. We prefer to call these bodies "capitules" instead of "pseudospores" of Berkeley, as we shall hereafter show that the latter is a misnomer. (Fig. 6.)

Closely allied to the last is *Ravenelia glabra* K. and Cke. on leaves of *Calpurnia sylvatica* at the Cape of Good Hope. The capitules are large, as much as 0·15 mm. diam., convex above, without any visible stem or barren cysts, by which latter feature it may at once be distinguished from *R. sessilis.* There are from six to eight cells in each direction, so that the individual coloured cells are about the same size as in the preceding species, ·02 mm. or rather more. It is not improbable that if examined fresh and living, sterile cysts in some form, perhaps diminutive, would be found concealed beneath the lower margin of the capitules. (Fig. 9.)

Following the two sessile species just named, which have the capitules smooth, we may note two species in which the capitules are surrounded at the base by a series of hyaline processes resembling spines. *Ravenelia aculeifera* B. occurs on the leaves of *Megonemium* in Ceylon, and some unknown tree in India. The capitules are about 0·1 mm. diam., with from six to eight cells, the outer series of which are furnished with acute spines, fully as long as the diameter of the cells, the residue of the cells being unarmed and smooth. Neither stem nor barren cysts visible. (Fig. 11.)

The other species, if really distinct, is *Ravenelia Hobsoni* Cke. on leaves of an unknown tree in India (*R. stictica* B. and Br. in 'Grevillea,' vol. v. p. 15), with rather small and flattened capitules ·05–·07 mm. diam. containing about four cells in each direction, the outer and lower series armed with thin hyaline projecting spines about half the length and thickness of those in *R. aculeifera* B. This would alone be insufficient ground on which to consider them distinct species, the length of the component cells and character of protospores must be taken also into consideration: but of this hereafter. (Fig. 4.)

There are still two other species to be named which differ materially from the foregoing. *Ravenelia stictica* B. and Br. on leaves of *Pongamia glabra* and *Tephrosia suberosa* in Ceylon, has sessile capitules, measuring ·08–·09 mm. diam., with about four cells in each direction. The sterile cysts are small and inconspicuous, but the coloured cells differ from all the rest in having the exterior surface rough with minute warts. (Fig. 7.)

The last is *Ravenelia macrocystis* B. and Br., which has only been found upon *Cassia tora* in Ceylon. The capitules are convex, surrounded by radiating filaments of mycelium, so that they are perhaps more truly sessile than in any other species. As the name indicates, the coloured cells of which the capitules are composed are unusually large. This is the only species of which hitherto we have seen no specimens.

Of the eight species, five are found in Ceylon and one in India, so that six are Asiatic, one is exclusively African, and one exclusively North American, the other North American species being also Asiatic.

In describing one of the Ceylon species in 1873, the Rev. M. J. Berkeley first mentions in connection with that species the presence of other bodies. He writes, "The larger pseudospores are accompanied by Uredinoid bodies which are minutely papillate." About the same time Mr. C. H. Peck remarked with respect to the common North American species, that it was often accompanied by an *Uredo* which probably bore the same relation to the larger spores as *Trichobasis* to *Puccinia*, and *Lecythea* to *Phragmidium*. Some time elapses before exotic species like these can be examined under favourable circumstances, and it is only very recently that we have been enabled to convince ourselves that nearly all the species of *Ravenelia* are preceded by an *Uredo* condition, in the same manner as *Puccinia*, *Triphragmium*, and *Phragmidium*, thus establishing their affinity. In *R. glandulæformis* the protospores, or Uredinoid spores, are subelliptical and rough, about ·025 × ·016 mm. (Fig. 2). In *Ravenelia Indica* they are figured by Berkeley as globose and smooth In *R. glabra* they are elliptical and rough, ·035 × ·012–·015 mm. (Fig. 10). In *Ravenelia Hobsoni* they are nearly globose and but slightly granular, ·02–·023 × ·015 mm. (Fig. 5). In *R. aculeifera* we have not as yet met with any protospores. In *R. stictica* globose and rough, ·025 mm. diam., or subglobose, ·025 × ·02 mm. (Fig. 8). In five species, therefore, protospores of a yellow or orange colour have been observed, and whatever may be the true relationship of the protospores to the septate spores in *Phragmidium* (and this has not as yet been determined) the same relationship will doubtless exist between these protospores and the capitules in *Ravenelia.*

Hitherto the bodies which we have termed capitules in this genus have been spoken and written about as spores. Berkeley calls them pseudospores, and his intention is probably to foreshadow the idea that the true spores are produced on germinating threads which proceed from them as demonstrated in *Puccinia.* His observations on another occasion * lead to this inference, when he says "The spore in this case is of considerable size, and evidently reticulated, and below it, either free or in contact with the stem, is a circle of colourless bags foreshadowing a more complicated system of articulation than even in the *Pucciniei.* The germination of these has not at present been observed. It is probable that the number of threads to which the spores give rise is considerable."

It was during the examination of the capitules of *R. aculeifera* that we first became satisfied as to the structure of these bodies. The convex, almost hemispherical capitules, or complex spores, are about one-tenth of a millimetre in diameter, composed, as we have demonstrated, of cells, about seven in each direction closely packed and agglutinated together side by side. By means of a gentle pressure exerted upon the mature capitule we forced these cells apart, and found them to be club-shaped, nearly ·07 mm. long, ·016 mm. broad at the apex, and ·01 mm. or less at the base (Fig. 12); the upper portion coloured deep sienna brown, the base uncoloured, the colour diminishing from above downwards. These cells, which remind one so strongly of the spores in *Melampsora*, are undoubtedly the individual spores (or pseudospores) which together combined into a hemispherical mass form the complex spore or capitule of *Ravenelia.* These clavate pseudospores converge at their bases towards the stem or central point by which the capitule is attached (Fig. 13). The "reticulations of the spore" as applied to the capitule indicate the lines of union into one common capitulum. Comparing it with a familiar object, one of these capitules may be said to resemble the fruiting capitulum of the "sunflower" in which the seeds represent the pseudospores and the reflexed limbs of the involucre the sterile cysts.

Having thus observed in one species the ready separation of the component pseudospores, it became advisable to ascertain how far this facility existed in the other species; and we are convinced that the structure is the same in all, that the cells are complete in themselves each with its own proper cell-wall, that they are only temporarily attached to each other, and on arriving at maturity, sooner or later, the capitules resolve themselves into the individual pseudospores. Only in *R. Indica* have we yet seen them so proportionately long as in *R. aculeifera;* in some the cells do not much

* 'Introduction to Cryptogamic Botany,' pp. 324.

exceed their diameter in length; this is the case with *R. Hobsoni* which in some respects is very similar to *R. aculeifera.*

The barren cysts which surround the capitules in some species yet require to be investigated. All that we have yet succeeded in determining is that these cysts readily separate individually in *R. Indica,* that after prolonged saturation they become inflated and subglobose, but the cell membrane is thin and delicate, and in no instance have we seen them with any granular or protoplasmic contents. As already observed, these are points which cannot be cleared up at once, in the absence of living or fresh specimens.

As to the stem, in both *R. Indica* and *R. glandulæformis,* it is quite certain that, under pressure, it separates into parallel tubes, as in the stem of Stilbum and some other moulds with a compound stem. Probably, but this is only a speculation, the number of threads may equal that of the pseudospores in the capitule.

Finally, as to germination. The very cold weather and very old specimens are not at all favourable for experiments in germination, and hence the utmost that we have been able to accomplish has been to obtain single short germinating threads from the apices of a few of the pseudospores in *R. aculeifera* which were the production of last year (Fig. 14). *R. glandulæformis* of three to five years old refused to germinate at all, and until we can obtain more recent specimens, at least not more than twelve months old, we cannot hope to carry on the germination of the pseudospores so far as the production of the secondary spores, if such bodies are really produced on the germinating threads, as in *Puccinia* and *Phragmidium.*

XIII.—*On the Double and Treble Staining of Animal Tissues for Microscopical Investigations; with a Note on Cleaning Thin Cover-glasses.* By Heneage Gibbes, M.B., F.R.M.S.

(*Read 10th March*, 1880.)

While engaged last year in an examination into the structure of the Vertebrate spermatozoon, I tried the effect of a large number of staining agents, and succeeded at last in staining the head and body of the spermatozoon of *Triton cristatus* different colours, showing thereby a different chemical reaction. This led me to try these stains on sections of animal tissues, and the specimens under the Microscopes will show with what results. It may be interesting to give a few details of the different processes I have used, in the hope that some who have more leisure than myself may work out the subject thoroughly.

The first double stain to be mentioned is the well-known picrocarmine and logwood, which gives very good results in sections of skin and other parts. I have also found it answer better than any other stain in an investigation into the development of spermatozoa, in which I am at present engaged with Dr. Klein.

There is one point which greatly facilitates a good result with this process—that is, after staining the sections in picrocarmine to place them in plain water acidulated with a few drops of acetic or picric acid for an hour before staining with logwood; they take the second stain better and do not fade afterwards.

The next process consists of—

1. A solution of carmine and borax.
2. A mixture of hydrochloric acid and absolute alcohol.
3. A solution of indigo-carmine.

The carmine solution is prepared by mixing

Carmine	.. ..	ʒss
Borax	.. ..	ʒij
Aqua	.. ..	℥iv

and pouring off the clear fluid. It must not be filtered. Three or four drops of this solution are placed in a watch-glass, and the sections immersed for a few minutes; they are then removed to a mixture of hydrochloric acid and absolute alcohol, one part of the acid to twenty parts of alcohol, and allowed to remain there until they take on a bright rose colour; this happens in a few seconds. They must then be washed in methylated spirit several times to remove the acid, when they will be ready for staining with the indigo-carmine, which is prepared in the following manner:—

A saturated solution of indigo-carmine is made in distilled water and filtered; a portion of this solution is then added to some methylated spirit until it has attained a moderately deep-blue colour; this must then be filtered to remove the colouring matter, a good deal of which is precipitated; it will then be fit for use.

A small quantity is placed in a watch-glass, and the sections allowed to remain until they have a distinctly blue colour.

I have found this process very useful in pathological investigation, especially in the Carcinomata; and in specimens hardened in chromic acid it does away with the tedious process of passing them through a solution of bicarbonate of soda.

This method is modified from one mentioned in the 'American Quarterly Microscopical Journal' by Dr. Seiler.

I next come to the anilines; and of these, after a large number of experiments, I have found roseine, aniline violet, aniline blue, and iodine green, give the most satisfactory results. The principle I worked on was to make a spirituous solution of one colour and a watery solution of another, and in this way I could depend on the result.

I made solutions of roseine and aniline violet in spirit, and of aniline blue and iodine green in distilled water. A few drops of one of the spirit solutions being placed in a watch-glass and diluted with spirit, the sections were immersed for a short time (this will depend on the strength of the solution and the tissue itself, as some stain more quickly than others); they ought to be taken out of the stain and examined in clean spirit, and a little practice will soon show when they are stained enough. They are then washed in methylated spirit until no more colour comes away from them. A little of the aqueous solution is now placed in a watch-glass and diluted, the section is removed from the spirit to it; the spirit causes the section to spread itself out and float on the watery solution, and it may be seen taking on the new colour. For a light stain this is sufficient, and it need not be wholly immersed. It is then well washed in plain water and placed in spirit, when more of the first colour generally comes out. When it is quite clean, it is ready for mounting in the usual way. This is a very good process for double staining, and if the section is of the same thickness throughout, the staining will be perfectly even, and each colour will have picked out those tissues for which it has a special affinity.

To stain with more than two colours is much more difficult, as they so often combine and produce an entirely different colour uniform throughout. I have obtained the best results from chloride of gold or picrocarmine with the anilines just mentioned.

The specimen of rat's tail was first stained with chloride of gold in the usual manner, and then submitted to the aniline process I have already described.

To stain with picrocarmine I make a dilute solution about ten drops to a watch-glass of distilled water, and leave the sections in it for about half an hour; the time will vary with the tissue and the manner in which it has been prepared. They are then removed to plain water acidulated with a few drops of acetic or picric acid, and left in it for an hour, after which they are ready for the aniline process.

This method succeeds very well in the tongue of different animals, as will be seen from the specimens under the Microscope; and I can also say that it does equally well in every other tissue as far as I have tried it But its great utility consists, I think, in its power to differentiate glandular structures according to their secretions. For instance, in the section of dog's tongue the ordinary mucous gland will be found to have taken on a purple colour, while the serous glands which supply the secretions to the taste-organs stain a totally different colour. Again, in an examination I made lately in a case of Dysidrosis I was able to stain the duct of the sweat-gland an entirely different colour from the surrounding tissues, and so demonstrate its relation to the vesicles. For minute structures, such as the dividing nuclei of germinating epithelium or developing spermatozoa, I think logwood is far above every other stain, and when used with picrocarmine I find its effect is intensified.

The carmine and indigo-carmine process is of great use in demonstrating the blood-vessels in the web of the frog's foot, the tail of the tadpole, and similar structures, as it entirely does away with the necessity of injecting them, and shows the vessels in their natural state, without the bulges in them depicted by some writers, which are caused by the injection mass unduly distending them. It also shows the amyloid substance in amyloid degeneration of the liver to perfection, as the blue stains it alone.

I should like to call attention to the great importance of preparing all tissues properly in the first instance, as unless this is done no good result can be obtained from any staining process. Every specimen properly prepared will bear the highest magnifying power that can be applied to it, and will show plainly the structure of each epithelial cell, muscular fibre, or other element of which it may be composed, and it is utterly impossible to make a good specimen unless it has been first properly hardened.

The following process for cleaning thin cover-glasses has proved very effectual, and has reduced the breakage of ·003 to about half a dozen per half ounce:—First place the cover-glasses in strong sulphuric acid for an hour or two; then wash well until the drainings give no acid reaction; then place them in methylated spirit, and as each glass is taken out with a pair of broad pointed forceps dip it in absolute alcohol and wipe carefully with an old silk handkerchief.

I should like to impress practical microscopists with the benefit to be derived from using cover-glasses of a known thickness, and as these can now be procured at a slight advance on the cost of the others, there is really no reason why they should not be universally used. For a long time I only used two thicknesses, ·006 and ·004; but since I have had a $\frac{1}{25}$ made by Messrs. Powell and Lealand, I have been obliged to use cover-glasses thinner still.

The great advantage of knowing the thickness of the cover-glass will be at once apparent to those accustomed to use glasses with a correction collar, and those glasses without it are generally corrected to a cover-glass ·006, so that as there are comparatively few so thin as this in the glass sold as extra thin, the best result is seldom obtained; and, again, in making exchanges of duplicates, how vexing it is to find that your favourite glasses will not work through the cover-glass.

XIV.—*On some New Species of Nitzschia.**

By A. Grunow, Hon. F.R.M.S.

(*Read 14th April*, 1880.)

Plates XII. and XIII.

Nitzschia, Sectio Pseudotryblionella.

N. Rabenhorstii Grun., in Cleve and Grunow, 'Arct. Diat.'—Large, valves linear, with cuneate obtuse ends. Carinal puncta forming very short striæ 8–9 in 0·01 mm.; transverse striæ moniliform, 17 in 0·01 mm. Valve with very short longitudinal furrows. Length, 0·21–0·25 mm.; breadth, 0·02–0·021 mm. Calcutta, in salt lakes (*leg.* Kurz). Plate XII. Fig. 1, $\frac{900}{1}$.

N. Graeffii Grun. *l. c.*†—Large, valve broad linear, with shallow longitudinal furrows, obsoletely constricted in the middle, cuneate or rounded ends. Carinal puncta forming short striæ 5–6 in 0·01 mm.; transverse striæ moniliform, 11–12 in 0·01 mm. Length, 0·145–0·21 mm.; breadth of valve, 0·027–0·33 mm. Seychelle Islands (*leg.* Dr. E. Graeffe). Plate XII. Fig. 4. The narrow forms resemble *N. Rabenhorstii*, but differ in having more distant carinal puncta and coarser striæ. [This species is somewhat widely distributed, I have seen it in gatherings from Colon, Jamaica, Pisagua, Bahia, and Barbadoes.—F. K.]

N. Nicobarica Grun. *l. c.* (*N. panduriformis* var. *Nicobarica* Grun., Novara Exp., T. 1*a*, fig. 4).—Carinal puncta large, semicircular, 2–3 in 0·01 mm.; striæ moniliform, 21–24 in 0·01 mm. Longitudinal furrows very conspicuous. Length, 0·09–0·20 mm.;

EXPLANATION OF PLATES XII. AND XIII.

All the figures are drawn to a scale of 900 diameters. The line *a*—*b* in some figures separates the parts of the diatom when seen under a higher or a lower power.

Plate XII.

Fig. 1.—*Nitzschia Rabenhorstii* Grun.
" 2.— " *Nicobarica* "
" 3.— " *scaligera* "
" 4.— " *Graeffii* "
" 5.—*a*, *b* " *cocconeiformis* "
" 6.— " *perversa* "
" 7.— " *granulata* "
" 8.—*Hantschia Amphyoxys* var. *amphilepta* "
" 9.—*Nitschia amphicephala* "

Plate XIII.

Fig. 10.—*Nitzschia limicola* Grun.
" 11.—*Gomphonitzschia Clevei* "
" 12.—*a*, *b*, *c*, *N. Senegalensis* "
" 13.—*Hantschia Wittii* "
" 14.—*Nitzschia Janischii* (*a*, central pseudo-nodule) "
" 15.—*Nitzschia Febigeri* "
" 16.—*a*, *b* " *Campechiana* "
" 17.—*Gomphonitzschia Ungeri* "

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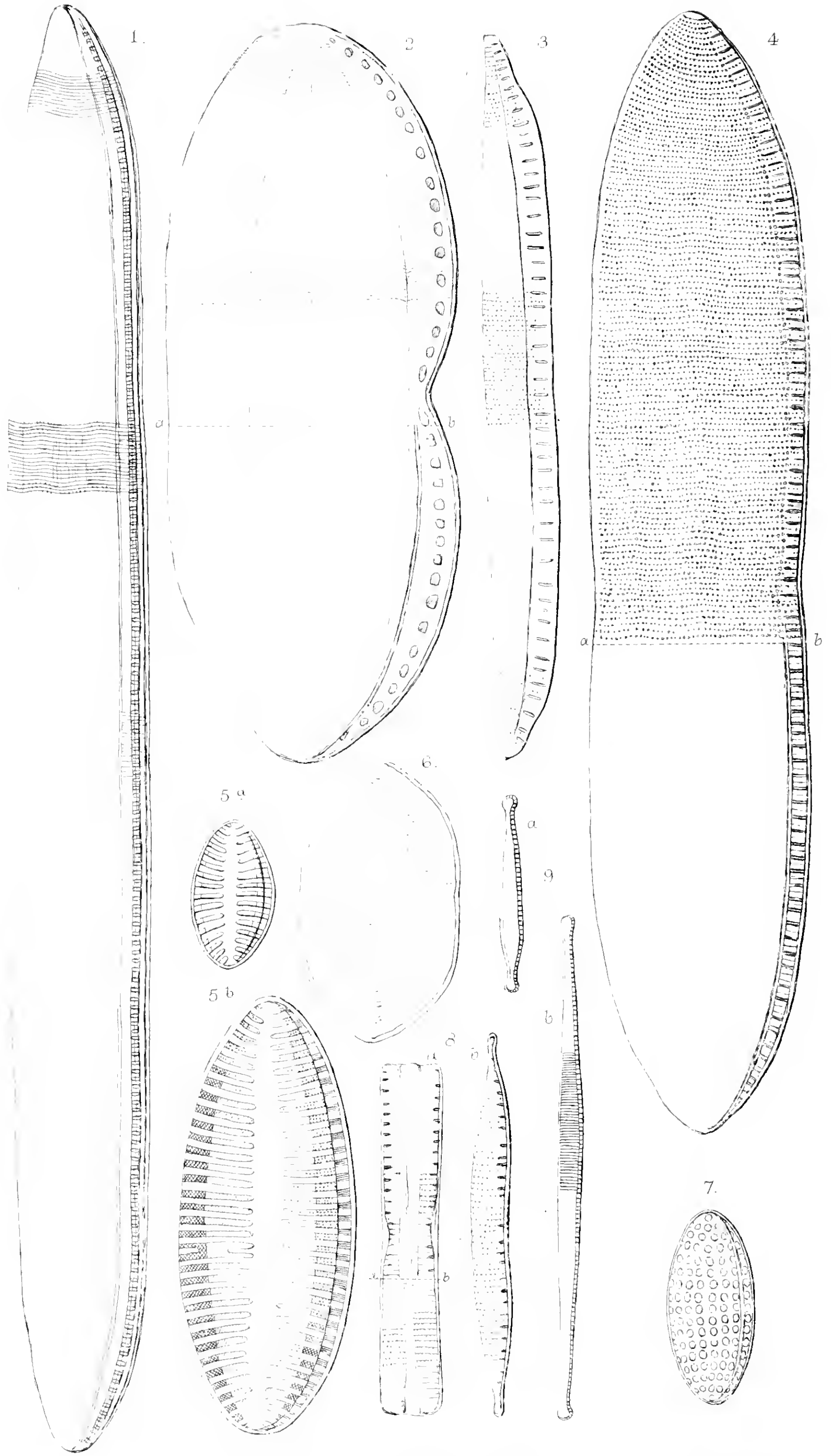
* Notes by Mr. F. Kitton, Hon. F.R.M.S.

† This species is described and figured by Prof. P. T. Cleve in the 'Bihang till K. Svenska vot. Akad. Handlingar,' No. 8.—F. K.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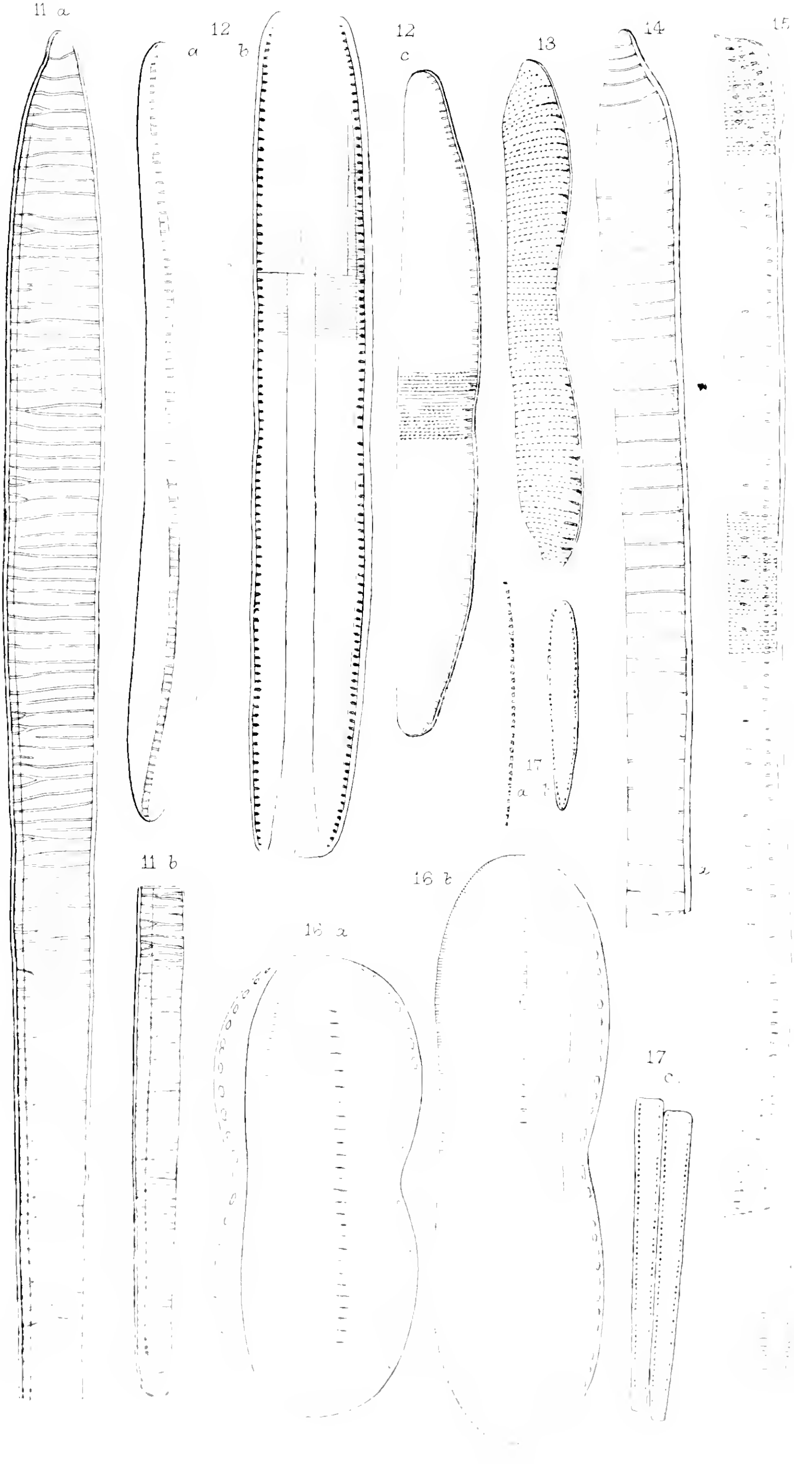
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breadth, 0·035–0·049 mm. Samoa Islands, Nicobar Islands, Ceylon, Northern and Eastern Australia, West Indies. Pl. XII. Fig. 2, $\frac{900}{1}$.

N. Campechiana Grun. *l. c.*—This beautiful species bears some resemblance to the former, but it is smaller, and is distinguished by rows of short striæ, which cross the longitudinal furrows. Carinal puncta 3–4 in 0·01 mm.; transverse striæ delicate, moniliform, 22 in 0·01 mm. Length, 0·068–0·087 mm.; breadth, 0·022–0·025. Campeche Bay. Pl. XIII. Fig. 16, *a–b*, $\frac{900}{1}$.

Sectio Tryblionella.

N. cocconeiformis Grun. *l. c.*—Valve elliptical, striæ broad, composed of rows of very minute puncta (forming transverse and oblique lines, as on *Pleurosigma angulatum*, 26 in 0·01 mm.) interrupted by a central, linear, lanceolate, blank space. Length, 0·022–0·076 mm.; breadth of valve, 0·011–0·028 mm. Pl. XII. Fig. 5, *a*, *b*, $\frac{900}{1}$. Bengal, Gulf of Carpentaria, Zwatrop River in South Africa.

N. perversa Grun. *l. c.*—Valves broad, elliptic, marked on one side by a semicircular band of slightly radial striæ (costæ) 10 11 in 0·01 mm., and on the other (upon the margin of which a small central nodule is visible) by regular rows of small puncta. Length, 0·042–0·046 mm.; breadth of valve, 0·022–0·026 mm. Sierra Leone, mouth of Rokelle River, Santos. Pl. XII. Fig. 6, $\frac{900}{1}$.

N. granulata Grun. *l. c.*—Small, valves elliptic, with a few rows of large puncta (5–7 in 0·01 mm.). Length, 0·026–0·043 mm.; breadth of valve, 0·012–0·02 mm. Samoa Islands, Santos, New York, Savannah, in rice fields, mud, &c. Pl. XII. Fig. 7, $\frac{900}{1}$. Allied to *N. punctata*, but differing by its smaller size and much larger puncta.

N. limicola Grun. *l. c.*—Very small, valve broadly elliptic, with shallow longitudinal furrows; transverse striæ, 11–16 in 0·01 mm. Length, 0·016 mm.; breadth of valve, 0·008–0·01 mm. Savannah, in rice fields, mud. Pl. XII. Fig. 10, $\frac{900}{1}$. Allied to small forms of *N.* (*Tryblionella*) *Hantschii*.

Sectio Scalares.

N. scaligera, Grun. *l. c.*—Allied to *N. Gründleri* Grun., and perhaps a small form of that species. Carinal costæ 3–4 in 0·01 mm.; transverse moniliform striæ 15 in 0·01 mm. Valves 0·108 mm. long, 0·0105 mm. broad. Campeche Bay, very rare. Pl. XII. Fig. 3, $\frac{900}{1}$. Smaller forms of *N. Gründleri* occur in a gathering from Florida, 0·145 mm. long, 0·021 broad, with 3–4 carinal costæ, and 11 moniliform striæ in 0·01 mm. The nearest ally to

N. Gründleri is *N. grandis* (Kitton), whose valves are 0·22–33 mm. long, and 0·04 mm. broad, with 3–4 carinal costæ and 8 moniliform striæ in 0·01 mm.

Sectio Perrya Kitton.*

N. Febigeri, Grun., n. sp.—Valve narrow linear, with oblique truncate ends, and very sharp keel which is inflated on both ends (as in *N. spatulata*, and others). Carinal striæ short, 4–6 in 0·01 mm.; a second longitudinal band of similar striæ (3–4 in 0·01 mm.) runs along the middle of the valve, to which is added a third towards the ends. Transverse moniliform striæ delicate, 20–21 in 0·01 mm. Florida (communicated by M. Febiger). Pl. XIII. Fig. 15, $\frac{900}{1}$.

Sectio Epithemoides.

N. Janischii Grun. *l. c.*—Long, valves linear, thickened towards the cuneate ends. Transverse moniliform striæ fine, 22½ in 0·01 mm., interrupted by stouter transverse striæ, which are prolongations of the carinal puncta (2½–4 in 0·01 mm.). The puncta of the transverse striæ form also oblique lines like those on *Pleurosigma angulatum*. Pseudo-central nodule obvious. Length, 0·245 mm.; breadth of valve in the middle, 0·0095 mm., near the ends, 0·012 mm. Sandwich Islands, very rare. Pl. XIII. Fig. 14, $\frac{900}{1}$. Only one half of the valve is represented, the entire valve being too long for the size of the plate.

Sectio Arcuatæ.

N. Senegalensis Grun.—Valves slightly arcuate, with cuneate blunt apices and convex dorsum, which is now and then obsoletely constricted in the middle. Carinal puncta (or short striæ) on the *convex* side of the valve, 8–9 in 0·01 mm.; transverse striæ moniliform, 20–21 in 0·01 mm. Length 0·099–0·138; breadth of valve, 0·011–0·013 mm. Side view linear, slightly attenuated towards the truncate ends, straight, or more or less arcuate. Senegal River on Nitella (*leg.* Perrotet). Pl. XIII. Fig. 12, *a b c*, $\frac{900}{1}$.

[This form, judging from the author's figures, appears to me to belong to the section (or genus) Perrya, *a* being a partial s. v. and *b*, *c*, frustular views.—F. K.]

* I cannot agree with my friend Herr Grunow in considering the genus Perrya as belonging to the Nitzschia, the structure of the valve being very different. A transverse section somewhat resembles a very narrow U with a long keel at the base. The s.v. is very narrow and has a row of large dots along its entire length; this view can only be obtained by manipulating the valve in balsam; without this we only obtain a frustular aspect.—F. K.

Sectio Lanceolatæ.

N. amphicephala, Grun. *l. c.*—Small, valves narrow, linear lanceolate, with capitate ends. Carinal puncta 13 in 0·01 mm., transverse striæ 27 in 0·01 mm. Length, 0·02–0·08 mm.; breadth, 0·0035. In *Salpæ spinosa* from Southern Sea. Pl. XII. Fig. 9, *a*, *b*, $\frac{900}{1}$.

Gomphonitzschia Grun.

G. Ungeri, Novara Exp., Tab. 1, fig. 1.—I have given here a better delineation of this interesting diatom which represents the *Gomphonema* types in the family Nitzschieæ.

Carinal puncta 10 in 0·01; transverse striæ 21 in 0·01 mm. Egypt, on *Cladophora* (*leg.* Professor Unger). Pl. XIII. Fig. 17, *a*, *b*, *c*, $\frac{900}{1}$.

G. (?) *Clevei* Grun. *l. c.*—Very long, with narrow clavate valves rounded at the base and cuneate at the summit, with numerous transverse costæ (4½–8 in 0·01 mm.), which are often bifurcate on the carinal scale. I have not delineated the very fine striation (transverse and longitudinal) between the costæ. Transverse striæ circa 24 in 0·01 mm.; longitudinal, fine, indistinct. Length, exceeding 0·28 mm.; breadth of valve, lower part, 0·006 mm., upper part, 0·014 mm. In a gathering from Batavia, communicated by Professor Cleve, very rare. Pl. XIII. Fig. 11, *a* upper, *b* lower portion of valve, $\frac{900}{1}$.

Hantschia Grun.

H. Wittii Grun. *l. c.*—Valve with cuneate blunt apices, linear, with ventral sides constricted in the middle. Carinal striæ short in the middle, longer towards the ends (4–5½ in 0·01 mm.); transverse striæ moniliform, 10½ in 0·01 mm. Length, 0·076; breadth of valve in middle, 0·0075 mm., near the ends 0·01 mm. West Indies. Pl. XIII. Fig. 12, $\frac{900}{1}$.

H. amphioxis var. *amphilepta* Grun. *l. c.* (*Eunotia amphilepta* Ehr.?).—Ends of valve produced into a narrow beak. Carinal puncta short, 5–6 in 0·01 mm.; transverse striæ moniliform, 11½ in 0·01. Length, 0·053–0·065 mm.; breadth of valve, 0·006 mm. Bengal. Pl. XII. Fig. 8, *a*, *b*, $\frac{900}{1}$.

XV.—*On the Illumination of Objects under the Higher Powers of the Microscope.*

By James Smith, F.R.M.S.

(*Read* 10*th March*, 1880.)

Various ingenious appliances have from time to time been brought under the notice of microscopists, having for their aim the better illumination of objects under the higher powers of the Microscope. I venture to lay before the Society the following method of illumination, which I have successfully carried out, and which will, I think, commend itself as at once simple and effective, and ready to the hand of every possessor of a Microscope.

The method is simply a mode of using the bull's-eye condenser, enabling it to be employed under circumstances which prevent its effective use in the ordinary way, and is as follows:—

The Microscope is placed in position for observation, with the lamp in front (or at the side, as may be most convenient), about 3 inches off the flame, which should be somewhat lower than the stage, and turned edgewise to the Microscope. The bull's-eye condenser is then placed between the stage and the lamp, with the plane side uppermost, the convex surface being a little higher than the stage. The light strikes the plane surface of the condenser, and is again reflected at a very oblique angle upon the object on the stage, a sharp and brilliant wedge of light being cast upon the slide. This is better seen, and the adjustment of lamp and condenser more readily made, by placing in the first instance a small slip of white card on the stage; the object may then be placed in position, and the objective focussed upon it, and the final adjustment of the illuminator made while looking through the Microscope at the object.

With respect to the powers used, I have worked with excellent effect upon scales of Lepidoptera with the $\frac{1}{4}$ and $\frac{1}{5}$ inch objectives, and some of the Diatomaceæ (*Pleurosigma*), both dry and in balsam, are beautifully shown, as are also scales of *Podura*; upon these latter the $\frac{1}{10}$-inch (dry) has been used most successfully. With the $\frac{1}{16}$ immersion, however, I have obtained the finest results with a power varying from 1100 to 2000 diameters. I have worked upon a slide of *Pleurosigma* (in balsam), and such diatoms as *P. formosum*, *elongatum*, *hippocampus*, &c., are shown finely illuminated on a dark ground. It is scarcely necessary to add that with these high powers a careful manipulation of the light is necessary to bring out the best effect, but with powers varying from 200 to 400 diameters no difficulty is experienced in getting good results.

I might observe that, so far as I have seen, this way of illumination best suits glasses of moderate aperture.

In conclusion, I venture to express a hope that the method I have described may be found of some practical use, and that, without interfering in any way with other modes of illumination, it may be at any rate an addition to the means of microscopic observation that may be found of value to some of my fellow-workers.*

* Since reading the above paper, I have through the kindness of Mr. Curties been enabled to try a $\frac{1}{25}$ immersion of Gundlach with the greatest success; the light when properly managed being ample, and the definition very fine.

RECORD

OF CURRENT RESEARCHES RELATING TO

INVERTEBRATA, CRYPTOGAMIA, MICROSCOPY, &c.*

ZOOLOGY.

A. GENERAL, including Embryology and Histology of the Vertebrata.

Formation of Ova and Ovaries.†—M. Cadiat is not satisfied with the view generally held that the ova are formed before the ovary, and that the germinal epithelium is the direct originator of the former. His observations have led him to the conclusion that the germinal epithelium and the ovary itself do not contain true ova until an advanced period of development is reached, and till the time when external characters indicate that the sex of the individual is distinctly differentiated. He also finds that the epithelium of the Graafian vesicle is not derived from the germinal epithelium. The ovary and the Graafian vesicles are, in fact, derived from elements which, even at the fourth or fifth day of the incubation of the chick, may be recognized in the midst of the cells of the germinal epithelium: they very soon become provided with a distinct and thick wall, which plays an important part hereafter. The cellular body is highly granular, and though there is no distinct nucleus, there are one or two large nucleoli—this is the *ovoblast*. At first the ovoblasts increase in size and acquire nuclei and nucleoli; they then divide, and, later on, in the embryo of the sheep, it is possible to see gemmæform bodies, somewhat similar to the directive corpuscles of the ovum; an envelope of epithelial cells is gradually formed, which isolates the primitive body from the neighbouring cells. Later on, the ovoblasts, or the greater number of them, are converted into Graafian vesicles. At the period when the follicular epithelium is developed, the central cells become provided with a large slightly transparent nucleus, and we soon see all the characters of the true ovum, with the exception of the vitelline membrane; this, then, has no relation to the primitive wall of the ovoblast.

Destruction of Ova and Spermatozoa.‡—Professor Schneider has observed, in the testes and ovaries of *Nephelis*, *Aulostomum*, and *Hirudo*, cells which exhibit slow amœboid movements; resembling at first, and in their natural position, stellate connective-tissue cells, they become, under the influence of dilute acetic acid, rounded, and, save

* ☞ It should be understood that the Society do not hold themselves responsible for the views of the authors of the papers, &c., referred to, nor for the manner in which those views may be expressed, the object of the Record being to present a summary of the papers *as actually published*. Objections and corrections should therefore, for the most part, be addressed to the authors.

† 'Comptes Rendus,' xc. (1880) p. 371.

‡ 'Zool. Anzeiger,' iii. (1880) p. 19.

that they are so much larger, they resemble blood-corpuscles. *These cells destroy the spermatozoa and ova.* In a testis it may be observed that these cells, at various stages of development, surround the spermatoblasts; the latter disappear and break up, and each cell takes up a portion of its substance; these now alter in appearance, cease to exhibit amœboid movements, and pass into the *vas deferens.* Very similar phenomena were observed in the ovarian tubes of *Aulostomum;* the cells pass through the vitelline membrane, the yolk decreases in size, and then divides; the membrane soon becomes lost. The number of ova thus destroyed is said to be greater than those which come to maturity. Bacteria were observed in the vagina of *Aulostomum* and *Hirudo.*

In the Hirudinea the ova also undergo fatty degeneration; this commences at the hinder end of the ovary and gradually passes on to the median portion.

These observations afford some explanation of what has been seen by various embryologists; La Valette had noticed amœboid cells in the testes of various animals; and Pflüger had observed fatty degeneration in the ovary of the calf and of the cat. The nutrition of ova and embryos by yolk-cells, which is so common a phenomenon among the Hirudinea and Daphnida, may also be regarded as a case of fatty degeneration. Finally, it is of interest to note that Pflüger has observed a similar destruction of reproductive material in the vegetable kingdom.

Theory of the Ovum.*—Dr. Brandt regards the germinal vesicle as a primary cell, in contradistinction to the whole egg, and to the other more complicated secondary cells which make up most of the tissues of the higher animals. One argument in support of his view is, he thinks, to be found in the existence of two kinds of elements in the developing insect ovum; the blastoderm cells and the yolk-spheres. The former are regarded as exclusively derivable from the germinal vesicle; the germinal vesicle persists in some form, and so makes certain the continuity of succeeding generations; it is especially distinguished by its amœboid characters, and similar amœboid movements obtain in fertilization. Every approximation and fusion of two nucleated structures in the egg is not necessarily conjugation; true conjugation or fertilization is seen in an amœboid approximation, and subsequent fusion, of two morphologically equivalent structures.

Development of the Germ-layers of the Rabbit.†—In the first part of the new journal of biology, which M. E. van Beneden, in conjunction with Professor van Bambeke, has just started in Belgium, the naturalist first named commences an account of his "Researches on the Embryology of the Mammalia."

As Weil was the first to show, the most opportune period for investigating the characters of the mature ova is that of delivery; if, then, a rabbit is killed two days before this we ought to find almost ripe eggs; and so, again, for five days. The disappear-

* 'Arch. Mikr. Anat.,' xvii. (1880) p. 551.
† 'Arch. Biol. (Van Beneden), i. (1880) p. 138 (3 plates).

ance of the germinal vesicle, the formation of the first directive corpuscle, and the shrinking of the vitellus at the animal pole are the distinctive phenomena of maturity; these are always effected before the Graafian follicle is burst. At the moment when the vitellus begins to shrink, a delicate layer is formed from the cortical layer and just below the zona pellucida; this is the true vitelline membrane, and its formation, just as much as the formation of the directive corpuscle and the shrinking of the vitellus, is due to the same cause. The rejuvenescence of the cell presents two phases; in the first the cell frees itself of a definite portion of its nucleus (directive corpuscles), and of certain protoplasmic elements (perivitelline liquid and vitelline membrane); in the second phase the expelled bodies are replaced, owing to the conjugation which is effected between the female portion of the ovum and the one or more spermatozoids.

Like the ovum of all other Vertebrata, that of the Mammalia exhibits a distinct polarity; one pole is marked by the presence of the germinal vesicle, which gets near the surface of the egg. Several weeks before maturity, between it and the zona pellucida, there is a hyaline protoplasmic plate, very similar to the "couvercle" described in *Petromyzon*.

The ova found in any given rabbit vary very considerably in size; it is not necessary to give all M. van Beneden's measurements, as those of one case afford a sufficient example—the rabbit which was killed seven days four hours after copulation. In it he found four ellipsoidal ova, of which the major axis measured respectively 4, 3·7, 2·8, and 2·8 mm., while the minor axis measured 3·3, 3·2, 2·2, and 2·3 mm. Great differences are also to be observed in the size of the germinal spot, as compared with the whole size of the uterine egg.

The date of impregnation of all the rabbits which were killed during this investigation was carefully noted, and the time of the first copulation was that which was taken as the starting-point. The abdomen having been opened along the *linea alba*, the uterus, after removal, was opened from its vaginal extremity, and the incision was always made along the middle line of the face opposite to the insertion of the meso-peritoneal mesentery. The ova were then carefully removed, and examined either in the fresh state, in a solution of albumen, salt solution, or aqueous humour, and some were measured and drawn before being subjected to the action of any reagent. Of all methods the most successful is perhaps that of treatment with osmic acid and Müller's fluid; this causes no alteration in the character of the vesicle or of the earliest stages of segmentation, and there is no change in the transparency, form, or aspect of the constituent cells. Ova thus treated show no change after preservation for five years in glycerine; the protoplasm alone takes a slightly yellowish or brown colour, while the *zona pellucida* becomes bright green, and the albuminous layers remain uncoloured. If the egg is placed directly in Müller's fluid, without the intermediation of osmic acid, it becomes considerably altered.

Preparations were also made from specimens treated with nitrate of silver; these were brought at once into a $\frac{1}{3}$ per cent. solution, and after remaining in it from one-half to two minutes, according to their age, were immersed in distilled water, and exposed to the light. If more than four days old they were opened by means of fine needles and the envelopes carefully removed. The preparations were then treated with picrocarmine, eosin, or other colouring matters, and mounted in glycerine or balsam. Sections were cut in a manner which is described.

The periods of development are divided into nine stages, the first of which is the metagastrula. The embryo under description was taken from the uterus seventy hours after the coitus, and exhibited the following dimensions:—

Diameter of the metagastrula	0·09 mm.
Mean thickness of the ectoderm ..	0·018 mm.
Diameter of the endodermic mass ..	0·052 to 0·06 mm.
Thickness of the *zona pellucida*	0·015 to 0·016 mm.

The egg was completely spherical; the ectodermal cells were all convex outwards; some spermatozoids could be made out, but the directive globules seemed to have completely disappeared. In optical section forty ectodermal cells could be counted; their form, really polyhedral, appeared to be cuboid, and their delimitations were with difficulty discernible. The limits between these cells and those of the endoderm were, however, very well marked; the former are also both clearer and more finely granulated, notwithstanding the fact that larger granulations were also visible. The endodermal mass had an almost ovoid form, and it filled completely the cavity formed for it by the ectoderm; more opaque than the outer layer, it takes a brownish tint under the action of osmic acid, which also brings into stronger relief the boundaries of its constituent cells. The cells are polyhedral, and those which take part in the formation of the region of the blastopore are elongated in the direction of the axis of the embryo; they are larger and more granular than the ectodermal cells, and the granulations are more equally disposed through their protoplasm. When the endodermal mass is isolated, the nuclei of its cells, which are large, and provided with several nucleoli, become much more distinct.

It is impossible to follow the author through his detailed account of all the different stages with equal minuteness. Attention may be more especially directed to the conclusions at which he arrives. At the end of the segmentation period, at the moment when the ovum penetrates into the uterus, the embryo is formed of two distinct cell-layers, the ecto- and endo-dermal. At this moment there is a solution of continuity in the ectoderm, which forms the blastopore; in other words, the embryo is a gastrula, which is formed during the segmentation by epiboly. To this embryonic stage the name of metagastrula is applied. The blastopore generally closes a short time after the ovum passes into the uterus, and before the development of the blastodermic cavity; the position of this orifice appears to be relatively excentric to the future gastrodiscus, and when it becomes closed no trace of its existence is left on the ectoderm. This last now forms a closed vesicle enclosing the remainder of the vitelline mass or endoderm, and the changes which it undergoes during development obtain throughout its whole extent. The endoderm grows into a mass which is thick at its centre and more delicate towards its edges; the gastrodiscus, the median portion of which forms the beginning of the embryonic spot, is formed by part of the ectoderm, and the endoderm. The marginal cells of the latter become isolated, while the central cells adhere to one another and form several layers. At the beginning of the sixth day the peripheral gastrodiscal cells and the deeper layers of the central spot become flattened and form a continuous hypoblast; while the cells of the central spot, which are not thus modified, go to form the mesoblast. *The hypoblast and mesoblast are, therefore, derived from the primitive endoderm.* At the end of the sixth day, the outermost layer, or epiblast, alters its character; ceasing to be pavement cells, the constituent parts become prismatic or cylindroidal, and at this period the embryonic spot becomes apparent. The flat cells of the ectoderm and those of the hypoblast present a very marked reticular structure, and the protoplasm of the former is always partly made up of bacilliform rods, which have a most remarkable resemblance to Bacteria. The embryonic spot (germinal disk) is at first circular, and then passes through an oval form to a pyriform; in the earlier stages the central is always much clearer than the peripheral portion, and it was probably this circumstance which led Bischoff to assert the presence of an area pellucida and an area opaca. The change in form is due to the enlargement of the posterior edge. The embryonic area is, from the first, composed of two distinct regions. The mesoblast primitively extends through the whole of the germinal disk; at the commencement of the seventh day it is only found at the posterior extremity and at the sides of the embryo; when this disappears from the circular area that region becomes "didermic."

Production of Sex.*—Referring to an article contributed by himself to a Venetian journal, in which he attributes the determination of the sexes to the number of spermatozoa which enter the ovum, M. Canestrini considers that experiments are needed in order to ascertain what amounts of sperm are necessary for the production of each sex. M. Thury's theory, that the lateness or earliness of the period of fertilization is the determining cause, though not an exact theory, is yet favourable to that of the author; for the reason why fertilization early in the period of heat of the female produces female offspring appears to be the distance at which the ovum then is from the source of the sperm, and the consequently small number of spermatozoa which penetrate so far up the Fallopian tube as to reach it.

In some cases the sex may be said to be determined by accident, as when, of many sperm-cells produced, but few meet the ovum owing to a combination of unnoticed causes, and so a female offspring is the result. But given that the circumstances generally are favourable in both parents, and that the fertilization takes place towards

* 'Bull. Soc. Ven.-Trent. Sci. Nat.,' i. (1879) p. 18.

the end of the period of heat of the female, a male may be expected to be generated. On the other hand, a morbid condition or malformation of the female generative organs, or a scantiness of sperm in the male, should result in the production of a female. Among actual facts which bear out these theoretical considerations are cited twenty experiments made by Dr. Heitzmann; of these, twelve bore out the prediction previously made as to the sex to be expected. It is a known fact, confirmed by experiments made with poultry, that an old male generates more males than females, and *vice versâ* with a young one. This may be explained, in accordance with the hypothesis, either on the assumption that the semen is more concentrated as a rule in an old male, or that copulations being less frequent in such cases, the spermatozoa would be more abundant.

The ovum may develop without contact of semen, i. e. parthenogenetically, in which case the sex of the offspring will be always the same for the same species, or if receiving a minimum amount, will go through merely the primary stages of development, and will abort; or it may receive a greater amount and produce a female, or a still greater amount and a male will be the result.

Origin of the Sexes.* — Dr. Nussbaum concludes a paper of 120 pages by pointing out that the differentiation of the sexes is not due to the association of the two previously united functions with two different series of descendants of a common rudiment, but that it is rather due to the variation of homologous cells, with a view to the more complete success of conjugation. The ova and spermatozoa are derived from equivalent cells, and the first differentiation of the sex lies in the greater amount of division undergone by the male generative cells; this is seen in plants as well as in animals. Then, the ovarian cell remains passive, while the male exhibits amœboid or ciliated movements. As we ascend in the scale of organization, other differences become added on to the difference in character of the tissues of the glands and of the efferent ducts, which themselves only appear at a comparatively late period. Differences in the appendages, in external form, in instinct and intellect, thus appear, and the "male" and the "female" are completely distinguished.

Dichogamous Animals.†—M. Canestrini calls attention to the fact that the phenomenon of dichogamy, so often occurring in the vegetable kingdom, takes place in the animal kingdom also, citing the Cestode worms as a case in point. The male sexual organs of a segment are first matured, and later the female organs; a proglottis is therefore unable to fertilize itself, but can be fertilized by the next following proglottis of the series. Animals such as these may be called *dichogamous* and *proterandrous*. In some Gasteropodous Molluscs, which are hermaphrodite, the sexual elements might meet within the hermaphrodite gland, but as a fact copulation is the rule, because the elements are not mature at the same time. Similar facts have been observed in the oysters and other Lamellibranchs.

* 'Arch. Mikr. Anat.,' xviii. (1880) p. 1.
† 'Bull. Soc. Ven.-Trent. Sci. Nat.,' i. (1879) p. 22.

Origin of the Red Corpuscles of Mammalian Blood.*—Professor Rindfleisch's special contribution to this subject consists in, 1st, a description of the vascular plexus of the marrow of mammalian bones which he has succeeded in injecting (using the rib of a young guinea-pig), and of the wall-less character of its smaller vessels; 2nd, and of greatest importance, an answer to the question, "How do the nucleated red corpuscles of the red bone-marrow give rise to the non-nucleated corpuscles of the blood?" It is well known that this question has always been answered by hypotheses based on very slender foundation.

The old view as to the origin of the red blood-corpuscles was that the nucleus of certain colourless corpuscles became red and escaped as a free nucleus—the homogeneous red blood-corpuscle. Later knowledge as to the red coloration of the whole of the mother-cell of the red corpuscle led to the assumption that the nucleus became atrophied and the whole cell converted into the non-nucleated red corpuscle. The attempts which have been made from time to time during the past few years to detect a nucleus in some form or other in the red mammalian corpuscles, point to a foregone conclusion in favour of this total conversion.

Professor Rindfleisch has, however, seen, both in embryos and more advanced individuals, the steps in the transformation of the red-coloured cell of the marrow into the non-nucleated red corpuscle, which demonstrate that *the nucleus of the red-coloured cell escapes and atrophies, whilst the body of the cell contracts and becomes the red corpuscle.* He gives figures of the red cells with their nuclei in the act of escaping, lying just on the limit of the cell-body, or protruding from, or even hanging by a mere thread to the latter. Then, beside these, he has seen and figures the freed nucleus and the irregular, collapsed, coloured body of the cell, which will soon be shaped by pressure and rolling into the disk-form of the circulating red corpuscle. He has endeavoured, but unsuccessfully, to witness under his own eyes the actual extrusion of a nucleus from a red cell. At the same time, the intermediate series of forms observed by him are very strong evidence in favour of the view which he takes.

Professor Lankester thinks that Professor Rindfleisch's view is supported by certain facts of comparative anatomy which he has not himself adduced in its favour. In the Chætopodous and some other worms, the nuclei of the vascular walls are often loosened and float in the blood as corpuscles. They are not impregnated by hæmoglobin, but the plasma, in which they float, is. Whence comes the hæmoglobin of the plasma? Clearly, the cells forming the walls of the vascular system in certain regions are in the Chætopoda, as in Vertebrata, hæmatogenous; in them, as in Vertebrata, the body of the cell forms the hæmoglobin, which in this case becomes liquid instead of retaining the form of a corpuscle, and *at the same time the nucleus is separated from the hæmoglobin-bearing body just as it is in the Mammalia*, but here, as it does not there, enters into the blood stream.

* 'Arch. Mikr. Anat.,' xvii. (1879); see 'Quart. Journ. Micr. Sci.,' xx. (1880) p. 241.

Any discussion of the mode and significance of the formation of hæmoglobin in the mammalian blood ought to take cognizance of the fact that hæmoglobin is formed in the blood of the worms above noted, in insect larvæ, crustacea, and even molluscs; and further, that whilst it usually occurs diffused in the plasma of the blood, it does occasionally, as in the Chætopods *Glycera* and *Capitella*, the molluscs *Solen legumen* and *Arca* sp., &c., take the form of special nucleated corpuscles differing from and accompanied by the usual amœboid colourless corpuscles; also, it is to be noted that just as fat occurs in other cells than specialized fat-cells, so do we find the muscular tissue of many vertebrates and of some molluscs (buccal mass) impregnated with hæmoglobin. And even in one annelid (the sea-mouse *Aphrodite*), we have the cells of the nervous tissue so rich in it, that the nerve-cord is of a deep crimson colour.*

Epithelial Cells.†—Signor Trinchese considers that neither in these nor perhaps in any animal cells does protoplasm exist—in the condition generally described by histologists—during life. In other words, the so-called "protoplasm" is the result of profound post-mortem changes, which produce the ground substance, interspersed with granules, which we know under that name.

When alive, the epithelial cell consists of

1. A nucleus and nucleolus.

2. A network of spherical granules, spreading over the body from the nucleus.

3. Some spheroidal, homogeneous corpuscles, each containing a central granule resembling the nucleolus suspended in the network just mentioned, to be called *protomeres*. These are probably identical with the "elementary globules" described by Arndt in the ganglion-cells of Vertebrata.

When the cell is treated with $\frac{1}{1000}$ per cent. osmic acid, the nucleus and the protomeres assume a transparent gray colour, while the granules, the nucleolus, and the corpuscles of the protomeres become black.

The reticular intracellular structure first described by Heitzmann is not, therefore, an artificial product, but exists in the living state; its existence may be satisfactorily determined in the dorsal papillæ of the mollusc *Janus cristatus* by a high magnifying power. The meshes of the network vary greatly in size in different animals.

Living Cartilaginous Cells.‡—Herr Schleicher's observations follow on those lately published by Pruden, which were thus effected; in a curarized frog the episternal cartilage was dissected out and placed on a glass plate under the Microscope. The cartilaginous plate thus remained in connection with the blood-vessels, and researches could be carried on in a living tissue.

In giving an account of his own investigations, Schleicher commences by saying that the interior of the nucleus of a living car-

* See 'Proc. Roy. Soc.,' No. 140 (1873).

† 'Atti R. Accad. Lincei (Transunt.)' iv. (1880) p. 45.

‡ 'Arch. Biol.' (Van Beneden) i. (1880) p. 65.

tilaginous cell differs in different regions; thus, in the cranial plates of the tadpole the nuclei are homogeneous, and composed of solid elements of delicate structure; in most of the cartilages of the adult frog or triton the solid elements of the nucleus are more thick and coarse; but between these two there are various intermediate stages. This nucleus may undergo movements, as a whole, and these are independent of the position which it occupies in the cell; but when it is situated in the centre of the protoplasmic mass it moves irregularly, while when it is found at the periphery it passes from right to left, or *vice versâ*. These movements are due to the solid elements of the protoplasm around the nucleus, and are solely due to them. The solid elements within the nucleus are no less contractile than those of the protoplasm; that they are rarely seen is due to the circumscribed space in which they are found. The intensity of the movements may be increased by raising the surrounding temperature to 20°–25° C.; each element of the nucleus may then be seen to be executing free and independent movements, and the nuclear liquid is stirred into activity.

From these observations the author draws the conclusion that it is incorrect to give the name of "reticular structure" to the refractive elements of the nucleus; for just as the protoplasm of the cartilaginous cell is composed of two different substances, one almost homogeneous and liquid, the other of contractile and freely moving elements, so too is the nucleus; and the capsule on the one side and the nuclear membrane on the other form a boundary for the constituents of the cell and of the nucleus respectively.

Growth as a Function of Cells.*—Mr. Minot is of opinion that the weight of an animal depends on the number and size of its cells, and that these two variables require to be determined before we can speak definitely as to the phenomena of growth. He points out that the growth of a body is usually measured by its weight, but that this method takes no account of the amount of non-protoplasmic matters present. All Metazoa, at any rate, pass through successive cycles, in which we can distinguish the two processes of *senescence* and of *rejuvenation*; substituting for Huxley's term *individual*, or Haeckel's name *person*, the expression *biad*, we see that in one cycle of cells the number of *biads* varies, for Hydroids, Cestoids, Naids, &c., have several, whereas the higher animals have only one. As growth is a function of rejuvenescence effected by impregnation, it follows that growth can only be measured by taking into account the number of cells living at any given time, whether they form one or several biads.

The impregnated egg gives rise to successive generations of cells, and as the parent generation disappears when division takes place, two generations of cells can only exist at once when they are of different lineage, but as cells do not all develop simultaneously the cells of the body only belong to one generation *upon the average*. From this conception the author establishes the following laws:—

* 'Proc. Boston Soc. Nat. Hist.,' xx. (1879) p. 190.

(1) *The number of cells increases in geometrical ratio.*

(2) *The rate of multiplication increases;* this increase is, however, counteracted by the death and loss of a portion of the cells (e.g. epidermis).

(3) *The interval between the birth of two successive generations continually increases.*

(4) *The weight of the cells diminishes at every division and again increases until the cells regain approximately their original size.*

(5) *The weight of the cells may alter in one direction during several generations.*

(6) *The same cell may vary in weight.* This may be due to the normal activity of the cell (salivary and pancreatic e.g.) or to the decrease or increase in the amount of water or fat.

By the aid of a formula based on these laws the author finds that the number of cells is determined by the ratio of multiplication and the frequency of division, while the average weight is determined by these two causes and by the weight of the cells, and the loss of cells. The probable fact that the rate of growth in weight increases for about half the period of growth, then remains constant, and finally diminishes to zero, is interpreted by saying that at first the increment of senescence is less than the increment of the number of cells at each division; soon the former surpasses the latter, till growth either ceases or only counterbalances the loss of cells; when the rejuvenating power is exhausted the sexual products are developed.

Animal Cellulose.*—Herr A. Franchimont has examined some Tunicate tests with the view of ascertaining which of the sugars is produced from them. By triturating the carefully cleaned tests with concentrated sulphuric acid and leaving them in it for twenty-four hours, a liquid was obtained which when diluted with water exhibited dextral polarization. On boiling this, and saturating with barium carbonate and exposing to steam, a crystallized substance appeared after some weeks, which presented precisely the appearance of glucose obtained from vegetable cellulose by the same method. For the present, therefore, he would regard the sugar as ordinary glucose, awaiting the result of further investigation. It is still possible that the molecular relations of tunicin differ from those of cellulose; in other words, that the radicle $C_6H_{10}O_5$ is present in different proportions in the molecules of the two; and that thus isomerism may explain the differences, if these exist, between the two compounds.

Influence of Light on Animals.†—In this interesting note, Moleschott and Fubini point out how little this subject has been as yet investigated. Herr Schenck appears to have undertaken some experiments; eggs of *Rana temporaria* and *Bufo cinereus* were placed in vessels and covered with glasses or fluids of different colours; the

* 'Ber. Deutsch. Chem. Gesell.,' xii.; see 'Naturforscher,' xiii. (1880) p. 96.

† 'Untersuch. Naturlehre Mensch. und Thiere,' xii. p. 266; see 'Naturforscher,' xiii. (1880) p. 113.

colour was carefully compared with that of the spectrum, and means were taken to prevent any affection of the results by differences in the water, temperature, and so on. The glasses were (1) red, which absorbed all light from violet to the line C of the spectrum; or (2) blue, which cut off the red from B to C and the greenish-yellow from C to D; or (3) yellow, which only allowed the red, orange, yellow, and green rays to pass; or (4) green, which absorbed the red to the line C and cut off the violet. At first the developmental processes did not differ among the different ova, or from those which were exposed to ordinary daylight. When rotation commenced it was found that the eggs exposed to red light rotated most rapidly; as this is due to the action of the cilia, and as the cleavage processes were still similar in all, we may suppose that red light has some exciting influence on the cilia. When the tail and its musculature were developed the most evident movements of the former occurred in those larvæ which were exposed to red light; those under the blue glass were nearly or quite inactive. Similar results were obtained when the circulation was completely in function; the larvæ under the red glasses were still the most active of all. Great torpor was exhibited by those under the blue glass, while the rest, exposed to yellow or green light, differed not at all from those developed under uncoloured glasses. The most greedy were those under the blue glass. When brought from their artificial influence its effects gradually passed off. When changed from one colour to another the activity displayed became gradually more or less.

Leaving other investigations we come to the resolution of the question which Moleschott and Fubini have set themselves: does the light act directly on the body, or by means of the eyes, in affecting the excretion of carbonic acid? The results are given in the following table:—

	Uninjured Animals.		Blind Animals.	
	Light.	Darkness.	Light.	Darkness.
Amphibia	120	100	111	100
Birds	134	100	127	100
Mammals	140	100	112	100

Investigations with two tissues gave these results:—

	Muscle.		Brain and Spinal Cord.	
	Light.	Darkness.	Light.	Darkness.
Frog	170	100	..	..
Rabbit	177	100	114	100
Dog	141	100	149	100
Guinea-pig	..	..	137	100

It was now necessary to investigate the action of different kinds of coloured light on the excretion of carbonic acid; the following are the mean results:—

	Darkness.	Red.	Blue-violet.	White.
Uninjured frog	100	100·5	115	112
" bird	100	128	139	142
" rat	100	111	140	137
Blind mammal	100	109	114	113

Light has, then, a considerable influence on metabolic activity; it increases the excretion of carbonic acid and the ingestion of oxygen; but this influence is not only mediate through the eyes, it obtains through the skin, for it is seen in eyeless animals. When the eyes only or the skin only are affected the result is less than when the whole animal is brought under its influence. The tissues are no less affected than the whole body. The chemical rays have greater effect than the heating ones, and the result that light has a chemical influence on metabolism cannot be evaded.

Alcohol in Animal Tissues during Life and after Death.*—In order to verify the truth of the statement that flesh superficially coagulated would rapidly putrefy under conditions in which well-cooked flesh would remain sound for many weeks, M. J. Béchamp coagulated some horse flesh by immersion for ten minutes in boiling water, then wrapped it in a closely woven cloth, and placed aside for eight days. At the expiration of that time, the meat was found in an advanced state of decomposition, and the muscular striation had disappeared, although the air had not penetrated to the interior of the substance, whilst *Bacteria* and *Vibrios* abounded. By methods described in the original memoir, the author isolated and identified about 0·8 gram of alcohol and 10 grams of sodium salts formed by acetic, butyric, and other acids. The alcohol was converted into aldehyde, and oxidized to acetic acid, so that its identity was established beyond doubt; within certain limits the quantity obtained was larger, the further the extent of the decomposition.

It would seem, therefore, that the phenomena accompanying putrefaction are very closely allied to those belonging to fermentation properly so called, perhaps more directly with those of the butyric fermentation. By the same process alcohol was obtained from the *fresh* tissues. The brain of sheep gave a larger quantity than the liver, but the largest quantity was obtained from the brain of an ox, which furnished sufficient alcohol to measure with the hydrometer. It may be argued, therefore, that in medico-legal cases, the detection or separation of alcohol from putrid or healthy tissues, is not sufficient evidence to show that alcohol has been administered at all, still less that this liquid has been the cause of death.

* 'Comptes Rendus,' lxxxix. (1879) p. 573; see 'Journ. Chem. Soc.' Abstr., xxxviii. (1880) p. 171

Changes in Form, Movements, &c.*—Dr. Krukenberg points out that changes in form, movements, &c., may take place in various ways:

(1) By the direct influence of external forces:
  (*a*) Change in the form of the surface of the body (Medusæ).
  (*b*) Protoplasm being influenced by light, heat, or gravitation (heliotropism and geotropism of various plants).
  (*c*) Change in specific gravity (Ctenophora).
  (*d*) When the specific weight is greater than that of the surrounding medium (birds in air).

(2) By the elasticity of organized bodies, and parts secreted by an organism (joints of various animals).

(3) By the retention of fluids in cavernous structures:
  (*a*) Pure blood is retained in the pecten of the fowl.
  (*b*) Blood and water erect the anal appendage in *Porina*.
  (*c*) Water with some organized constituents erects the ambulacral feet in the Asterida.
  (*d*) Almost pure water fills the tentacles of the Actiniæ.

(4) By the attraction of water:
  (*a*) In protoplasm (leaf-stalks of *Mimosa pudica*).
  (*b*) In extensile substances (mantle of *Botryllus*).

(5) Without any evident loss of water:
  (*a*) Amœboid protoplasm (wandering cells).
  (*b*) Contractile tissues of definite structure (muscles).

B. INVERTEBRATA.

Process of Digestion in the Invertebrata.†—Dr. Krukenberg discusses this subject; commencing with some general considerations on the various modes of nutrition exhibited in living forms, he points out that they may be thus grouped:—

(1) Nutrition is effected merely by absorption and assimilation; or

(2) Digestive processes are added on.

Digestion itself may be effected—
  (i.) By means of enzymatous secretions in the contents;
  (ii.) Intracellularly, by enzymatous substances;
  (iii.) Intracellularly, by morphological ferments.

(3) Mechanical arrangements may aid in the absorption of food; or

(4) Digestive processes and mechanical arrangements may combine with the processes of absorption and assimilation to effect nutrition.

The mode of nutrition is not necessarily connected with the arrangement of cells into tissues and organs; firm bodies may become flowed around by cytods, and intracellular digestion may thus be effected. Where, in the Invertebrata, digestion is effected by means of enzymatous digestive secretions, the author states that he has always been able to find them in the tract during the

* 'Vergl.-Physiol. Stud. Küst. Adria' (Krukenberg), i. (1880) p. 1.
† Ibid., (1879) p. 38.

digestion period, but in the Cœlenterata no such secretion is to be discovered and it is to be concluded that the nutritive processes of the Cœlenterata are all resorptive.

The author gives further an account of his investigations into a number of Sponges, Echinodermata and Mollusca.

Effects of Poisons on Invertebrata.*—Dr. Krukenberg also gives an account of his "comparative toxicological" studies on various Invertebrata; the subjects were *Hirudo officinalis*, *Astacus fluviatilis*, *Helix pomatia*, *Spurilla neapolitana*, *Synapta digitata*, *Sagartia troglodytes*, and *Turris digitalis*. The chief drugs used were chloroform, atropin, camphor, strychnin, morphin, caffein, compounds of sodium and potassium, curare, and veratrin. There is also a short note on the influence of curare on the larva of *Sphinx euphorbiæ*.

Distribution of Chlorophyll in Invertebrata.†—In a postscript to his paper on the Chlorophyll of the Green Planaria,‡ Mr. Geddes states that he has more recently examined *Bonellia viridis* and *Idotea viridis* at Naples. With regard to the former he supports the views of M. Lacaze-Duthiers and of Mr. Sorby, as against the chlorophylloid character of the green colouring matter of *Bonellia*. A *Bonellia* in full activity was placed in a glass tube in the light; after half an hour the water took on a pale green tint, and half an hour afterwards the animal appeared to be dead. Not one bubble of gas was formed during the investigation. Very similar results were obtained with *Idotea*. These investigations are exceedingly interesting when compared with the very striking differences exhibited by the green Planarians.

Pelagic Fauna of the Lakes of Tessin and Italy.§—The observations in which Professor Pavesi, of Pavia, has lately been engaged on the pelagic fauna of the lakes of Tessin and of Italy have yielded interesting results. Twenty-one lakes were examined, mostly in Italy.

The tables show that *Leptodora* is found almost everywhere. *Daphnella brachyura*, *Daphnia hyalina*, *D. galeata*, *Bosmina longirostris*, *Cyclops minutus*, &c., are very common; on the other hand, *Sida crystallina*, *Daphnia quadrangula*, *Bosmina longispina*, and *Bythotrephes* are rare; lastly, *Daphnia magna* and *D. crystallina* are localized in the single Lake of Idro. It is a curious fact that of two lakes, near each other and of the same geological origin, and frequented by the same aquatic birds, one may present hardly any pelagic forms, while the other may have many. Such are the small Lake of Candia and the Lake of Viverone (they also show a difference of the opposite kind in algological flora). The latter lake, indeed, is triple that of the former, and about five times as deep. Still, great depth is not necessary to the existence of pelagic animals, though it is more favourable to their

* Loc. cit., p. 57.
† 'Arch. Zool. expér. et gén.' (Lacaze-Duthiers), viii. (1880) p. 51.
‡ See this Journal, ii. (1879) p. 161.
§ 'Arch. Sci. Phys. et Nat.,' iii. (1880) p. 151; see 'Nature,' xxi. (1880) p. 525.

development; e. g., they multiply in the lakes of Brianza and Endine, which are only 10 metres deep. Some forms, as *Bythotrephes*, are found only in the deepest lakes. As to the bathymetrical limits of the fauna, *Leptodora* lives generally, by day, at about 15 metres depth. At 10 and 30 metres it is generally rare, though in some cases it has been found even at 100 metres, and in shallow lakes is common at 5 metres. *Daphnia cristata* of Lake Idro is common at 5 to 15 metres, very rare at 50 metres. *Daphnia magna* is most abundant at 30 to 50 metres. On stormy days few forms were found at 5 metres depth. The almost absolute absence of Crustacea in the Lake of Garda, at 5 metres even in calm weather, is attributed to the great transparency of the water.

Professor Pavesi thinks the influence of temperature nil or inappreciable. He assigns a marine origin to the fauna in question; fiords changed to lakes, part of the isolated species dying out, others becoming adapted to new conditions of life, diffusion of these forms, by various means of transport, to neighbouring lakes of different epoch and origin, such as the lakes of Switzerland, Bavaria, and Lake Trasimeno. This confirms Stoppani's theory of the origin of the lakes in Upper Italy.

Mollusca.

Development of the Pulmonate Gasteropoda.*—M. Fol commences with an account of the time and mode of oviposition in these creatures. The genus *Planorbis* seems to have eggs best adapted for investigation; the author found their eggs in the environs of Geneva, during the months of May and June; those of the small *P. contortus* were found on the lower surface of dead leaves in small ponds. From July to September *P. marginatus* deposits its eggs very largely on the leaves of the water-lilies at the edge of marshes; eggs of *Ancylus fluviatilis* are to be found under the stones of the bed of streamlets, and those of *A. lacustris* on the leaves and branches of the water-lilies. Those are best studied that are found in completely natural positions. For the terrestrial Pulmonata, the author used *Helix*, *Arion*, and *Limax;* after a shower the spots where the snails are seen making holes in the ground should be carefully marked, but the eggs should not be sought for till the succeeding day, when they will certainly be found. *H. pomatia* lays its eggs in June and July. The hard shell of the eggs of *H. hortensis* seems to offer an insuperable objection to their examination. *Limax* has very transparent eggs. *L. agrestis* lays a large number, at the commencement of winter, around the roots of lettuces in market gardens, but the larvæ are too opaque and their rotation is too rapid for useful examination. *L. maximus* var. *cellarius* is very favourable; its eggs are found from September to November in damp spots, and under boards which have been some time on the ground.

Methods of Investigation.—These were of two kinds, by means of living specimens, and by means of sections; the former were compressed by the compressorium, of which M. Fol gave an account in

* 'Arch. Zool. expér. et gén. (Lacaze-Duthiers), viii. (1880) p. 103.

the 'Morphol. Jahrbuch,' ii. p. 440; here their rotation soon becomes slackened, and that long before any change occurs in the form or structure of the eggs. With regard to the method of observation by sections, it is necessary to point out that these are only really useful where every section is carefully numbered, and no part is lost at all. The sections should be strictly parallel, and have a definite direction; of this last there should, in each important case, be three; one transverse, one "facial," and one sagittal. The longitudinal axis is that which passes through the mouth and the aboral axis of the body; the transverse axis is perpendicular to this; the sagittal plane passes through the longitudinal axis and the median ventral and dorsal lines, and all sections parallel to this plane are sagittal sections. The facial plane likewise passes through the longitudinal axis, but it is perpendicular to the two preceding ones, and is parallel to the dorsal and ventral faces of the embryo. The embryos are isolated by plunging the eggs in very dilute chromic acid; in this the embryos harden, while the albumen remains comparatively soft and can be easily removed, and the embryos can then be hardened in successive quantities of alcohol; to remove the shells, where present, it is only necessary to add a few drops of nitric acid to the alcohol.

Development of Lymnæus stagnalis.*—Herr Wolfson's method of examination was to harden the ova in one-third per cent. chromic acid, wash in water, place in various solutions of alcohol, embed in paraffin, and cut by Leiser's microtome; the sections were stained with picrocarmine, clarified in lavender oil, and put up in Canada balsam. Eggs which had been hardened in chromic acid and then treated with even boiling water, also gave very good results.

As a result of the early stages, the author finds that the whole amphiaster is a nuclear, but not a protoplasmic structure, and that the rays of the stellate figure are not expressions of any radiate arrangement of the protoplasm, but a kind of pseudopodia; the so-called spindle-nucleus is nothing more than the point of interlacement of the rays of the two stars. He finds, moreover, nothing to support the doctrine of attraction centres.

In the early processes of cleavage four stages are to be distinguished; the first is a *passive* one, and is characterized by the feeble power of attraction possessed by the cleavage spheres; the second is *semi-passive*, the cleavage spheres run together, but the nuclei are still colourless and vacuolar; the third stage is *active*, for the cleavage-groove is obscured by the attraction of the spheres, the nuclei become intensely coloured, and take on their definite form. In the fourth or *semi-active* stage, which is always preliminary to a new division, the spheres separate from one another.

After shortly describing the morula stage, the author says that he has given very great care to the investigation of the gastrula, and he finds that in *Lymnæus* a gastrula without a mesoderm does not exist, and, moreover, cannot exist, inasmuch as the mesodermal cells are formed in an early cleavage stage.

* 'Bull. Acad. Imp. St. Petersbourg,' xxvi. (1880) p. 79

With regard to the history of the velum the author is hardly more in accord with well-known observers than he has shown himself up to this point, for he states that the velum does not become converted into the mouth-lobes, but undergoes gradual atrophy, and that the parts which are said to be developed from it only appear at a later stage; similarly, Fol's statement as to the multicellular character of the primitive kidneys is traversed, while M. Ganin's results are confirmed, and their unicellular character is illustrated by a figure.

As regards the history of the development of the enteric tract—The endodermal cells of the gastrula begin to take in spheres of deutolecithin, which are formed in the albuminous spheres enclosed in their cavity; these spheres unite in each cell and form a dark-coloured homogeneous mass. In all, five kinds of nutrient elements may be detected: (1) Homogeneous vesicular drops, which are also present in large quantities in the albuminous spheres; (2) Spheres with very small vacuoles inside them; (3) Spheres with one large and several small vacuoles; (4) Dark non-vacuolated spheres, rich in granules; and (5) Spheres with a single homogeneous granule, which is regarded as a modified cell-nucleus.

It is, however, only a part of the endoderm which exhibits such a metamorphosis of its cells; at either end no change of this kind takes place, but the constituent cells go to form the whole of the midgut; at one end the œsophagus is definitely fashioned, in such a way that the primitive mouth (blastopore, Lankester) corresponds to about the cardia of the definite stomach; this region is at first a solid cord of endodermal cells. The anal invagination appears very early, on the right side of the embryo and below the margin of the mantle; the enteron, the blind end of which has, by the coiling of the embryo, been pushed towards the right side, comes into close contact with the pit; the mode of communication between them was not made out by the author. The liver commences in the form of two blind sacs. In somewhat later stages, the cells of the œsophagus and stomach are provided with distinct flagella; the mouth is encircled by large cells, in which, however, it was not possible to detect flagella. In this account the author makes no comparisons with the results of earlier observers.

Proceeding, next, to the account of the development of the nervous system, we find that before there is any differentiation of the circum-œsophageal ganglia, there appears in the cervical region a considerable mass of large cells, which occupies the whole of the cavity above the œsophagus, and has some of its cells placed below it; the cells of the mesoderm form an investment of connective tissue around it; and distinctly mark it off from the surrounding parts. Its structure is distinctly nervous in character. In the adult animal there is no trace of this organ, and the author believes that it, with such other larval structures as the velum, shell-gland, &c., disappears; it may be known as the *embryonic cerebral mass*. The definite ganglia of the central nervous system arise from local, though perhaps connected thickenings (never invaginations) of the ectoderm; almost all the pairs of ganglia are differentiated simultaneously, and are connected with one another by distinct commissures. At first the ganglia are all formed of compact groups of small cells; later on the nerve-cells pass to the periphery, and the central region comes to be occupied by their processes only.

The eye first commences as an invagination of part of the ectoderm of the rudimentary tentacle; the lens is a metamorphosed cell of the wall of the optic vesicle; as it becomes spherical, its protoplasm gets to be homogeneous and highly refractive, while the nucleus almost completely disappears. The otocysts arise from a somewhat indistinct invagination of the side wall of the foot; later on, they approach one another, and become connected with the pedal ganglia.

As the cells of the mesoderm increase in number they undergo various modifications; those near the ectoderm form a cuticular layer; others form connective tissue; the serous layer of the enteron forms a thick pigmented investment to the stomach. The muscle-fibres, best seen in the columella muscles and in the retractor of the radula, are merely elongated mesodermal cells, in each of which the nucleus remains distinct.

Formation of the Shell in the Snails.*—This subject is dealt with by MM. Longe and E. Mer. The shell of *Helix* is composed of two principal layers of organic and mineral nature covered by a cuticle solely organic. The first layer is composed, commencing exteriorly, of a structure showing confused striation, having nearly the same thickness as the cuticle, and of another, thicker, formed of vertical prisms. It is to this that the general coloration of the shell is due as well as that of the spots and bands. The second layer (nacre) is colourless and consists of several strata of prisms arranged horizontally and whose axes in two successive layers are nearly perpendicular to each other.

The cuticle and the calcareous layers are produced by different regions of the mantle, approaching nearer the collar in proportion as the layers are more superficial. The cuticle is formed by an apparatus which the authors think has not hitherto been described, and which they call the "appareil cutogène." This consists of two special organs immediately behind the collar. The one is composed of a groove named by the authors the pallial groove, parallel to the border of the mantle, at the bottom of which glandular cæca open; the other, behind the first, appears on an antero-posterior section like an epithelial wedge forced into the substance of the mantle. It is formed of long vertical cells, like bottles, whose orifices open at the base of the organ provisionally termed the epithelial organ. These cells enclose granules separable in potash and a nucleus in their deeper-seated part. They must be regarded as differentiated epithelial cells.

The cutogenic apparatus exists in the embryo when still enclosed in the ovular envelopes, at which period the shell is already provided with a cuticle. It subsists during the whole growth of the young *Helix*; the epithelial organ showing itself under the aspect of a

* 'Comptes Rendus,' xc. (1880) p. 882.

narrow white border bounding the edge of the mantle. In the adult it disappears and is replaced by the tissue of the mantle. The long-necked cells are transformed into ordinary epithelial cells, capable of producing nacre. The pallial groove, on the other hand, is permanent, but the glandular cæca which line the bottom gradually atrophy. The consequence of this disappearance and atrophy is that a cicatrix in the shell can no more be covered over by cuticle in this region than in the other parts of the mantle, whilst this does takes place when the animal is still growing.

The function of the cutogenic organ is as follows.

The glands of the pallial groove secrete mucus, perhaps that substance which chemists have found associated with the calcareous matter of the shells and have called *conchyoline.*

The long-necked cells of the epithelial organ then deposit in the membrane emanating from the pallial groove the granules which they contain. The cuticle is the result of this double secretion. When a young *Helix* adds to its shell, it applies the edge of the mantle closely to the last formed part so that the cutogenic apparatus borders this part. Above the groove there soon appears a membrane destitute of lime. The animal is so adherent to the shell, that it does not react against slight irritations which, at another time, would cause it immediately to withdraw. It can sometimes be killed in this position, and interesting antero-posterior sections be obtained at the same time of the apparatus and the cuticle in the course of formation. In some of these sections, a streak of matter is seen proceeding from the groove and becoming impregnated above the epithelial organ with granules escaping from the cells of the latter, whose function would seem to be to consolidate the membrane secreted by the glandular cæca.

The turning out of the margin of the shell in the adult *Helix* is explained thus:—After the atrophy of the epithelial organ the portion of the mantle which it occupied sinks down and carries with it the part of the cuticle which covered it. The anterior portion of this membrane above the pallial groove, the level of which has not changed, is thus raised and is soon lined on its internal face by calcareous deposits.

If a fragment of the fine membrane detached from the margin of a shell in process of increment be examined, it is seen that the most recent part is formed almost exclusively by the cuticle; a little further back this is lined with rows of spherical granules; further back still these granules form a continuous calcareous layer lining the under surface of the cuticle. In a young *Helix* from which a portion of the cutogenic apparatus has been removed, the exterior layer above the mutilated part is formed in another way. Some little rods of a calcareous nature appear first, which swell gradually at the two extremities and take the form of wallets. By the addition of new particles these wallets are transformed into spheres whose dimensions augment by concentric deposits with radiating striæ. These spheres finally touch each other. The first calcareous layer is therefore formed differently according as it is exposed or protected by the cuticle. The same process takes place in the adult under like circumstances. So too in the epiphragms, with this difference, that the spheres with concentric layers are mixed with granules poured forth by the calcareous glands of the collar. The cicatrices of the shell are produced even when the denuded part is immediately covered over by a fragment corresponding to that which had been taken away. Fine plates of mica introduced between the shell and the mantle are lined, on the internal surface, by a calcareous deposit.

Molluscoida.

Early Developmental Phenomena of the Salpæ.*—The ovary in these animals, Signor Todaro reminds us, lies in a blood-sinus of the compound animal, which communicates with that of the rudimentary uterus. On the side where the oviduct enters, which is the side next to the respiratory chamber, the uterine wall is clothed with an epithelium continuous with that which clothes that chamber. The oviduct is solid, except where it traverses the uterine sinus. The single ovum of the ovarian follicle has a large germinal vesicle with a germinal spot suspended by a protoplasmic network; the nutritive yolk is added subsequently in the form of globules of lecithin.

The first changes which occur are the assumption of an oval form by the ovum, and the departure of the germinal vesicle to the posterior pole, where it disappears and is replaced by three, four, or five nuclei, and a polar corpuscle which is ejected. With the breaking of the chain, the follicle is brought near to the opening of the genital canal, and fecundation takes place. The spermatic nucleus appears directly afterwards at the anterior pole, and the follicle passes into the uterine sinus. It is uncertain what part the posterior nuclei play; they disappear in succession at this stage, and the spermatic nucleus also at the same time. This appears first to have become the segmentation nucleus, as its volume has become double of its original volume.

Segmentation commences after the nuclei have gone; after the first cleavage, the follicular epithelial cells enlarge and develop nucleated lecithin cells which are thrust into the midst of the blastoderm cells, forming with them a solid mass. After segmentation the wall of the follicle sends out a process which grows out and is almost constricted off; this connection becomes wide again, and the union of the follicle with this diverticulum forms a cylindrical tube projecting into the uterine sinus. Later, the follicle becomes round again; it then contains the morula, which consists of small blastoderm cells aggregated into masses with the lecithin cells.

The uterus now undergoes interesting changes. Its epithelial and connective-tissue elements increase, and the latter give rise to contractile cells; from the margin of the epithelial layer a fold is developed at the time of the outgrowth of the follicle, and, enclosing some connective tissue, shuts off from the respiratory chamber a secondary chamber, the "epithelial uterine cavity," which is believed to be homologous with the gravid mammalian uterus. The membrane separating it from the uterus forms a decidua, distinguishable into a

* 'Atti R. Accad. Lincei' (Transunt.), iv. (1880) p. 86.

vera (on the side of the sinus) and a reflexa on the respiratory chamber wall. The latter consists of two epithelial layers enclosing connective tissue, and is perforated by an aperture closed by epithelium; this is the mouth of the uterus, and afterwards gives passage to the embryo. By the contraction at this time of the blood-sinus walls round the follicle, the walls of this, which become cavernous, form a maternal placenta. A chorion is formed by the fusion of the decidua which lies on this side of the ovum with the ovisac.

The blastocœle (segmentation cavity) appears on the same side of the ovum; and here the blastoderm consists of the morula cells combined with those of the ovisac and the decidua; on the opposite hemispheres the segmentation cells subsequently form the epiblast; a small group of them in its centre forms the rudiment of the cerebral ganglion; close to this some surviving small cells become invaginated, and an amnion which adheres to the ganglion is the result.

The hypoblast originates in some cells derived from the lecithin cells, occurring between the blastocœle and the epiblast; it is folded over towards the blastocœle and encloses a cavity, the primitive intestine. Of two layers which are differentiated from the epiblast, the inner one develops a fold which projects inwards and joins the hypoblast opposite to the point of closure of the primitive intestine; a canal appears in it and leads ultimately into the intestine; the epiblast also forms the ectoderm and secretes the cellulosa externally. The cells *within* the ganglion rudiment form a transitory, elongated, longitudinally grooved thickening,—the dorsal plate. The hypoblast consists first of two strata: the internal becomes the endoderm; the external one, forming the mesoderm, gives rise to the muscular elements; the blood and connective tissue arise from cells derived from the internal side of the blastoderm. From the cells within the invagination-mouth arises a transitory organ, the "dorsal disk."

The cells of the outer side of the blastoderm form the fœtal placenta. The equatorial segmentation cells form the so-called "germinative ring," giving rise to a membrane from which the cells which later originate the stolon are derived.

It is the varying extent to which the nutritive is combined with the formative yolk, which appears to produce such varied transformations in this ovum.

Arthropoda.

α. Insecta.

Testes of the Lepidoptera.*—Herr Cholodkowsky here adds to and formulates the present state of knowledge as to the anatomy of these organs. He finds that the testis, even when outwardly single, is always primordially made up of several tubes. This was already known to be the case in *Hepialus humuli*, where the two tubes each branch into four, also in larvæ, and in the embryos of many species. His investigations, made on 34 species of Rhopalocera, taken from 17 genera, demonstrate the primordial division of the testis into eight tubes in all. The tubes are shown by steeping the male organs in 75 per

* 'Zool. Anzeiger,' iii. (1880) p. 115.

cent. spirit, and removing the capsule of the testis; they exhibit various degrees of aggregation in the different forms. In *Lycæna*, a median constriction of the capsule alone serves to indicate externally the connection with the paired type of organs: the eight tubes within it are arranged fan-like, four on each side. In *Argynnis selene* the tubes are packed like the segments of an orange; in several species the tubes of one side are wound round those of the other side. *Pygæra anachoreta* and *Aglia tau* are now shown to have two testes.

The Lepidoptera are thus arranged according to these characters:—

Type 1. With two compound testes (the fundamental type)—*Hepialus*.
„ 2. With two apparently simple testes—*Pygæra anachoreta*, &c.
„ 3. With one testis, the capsule medially constricted—e. g. *Lycæna ægon*.
„ 4. With one unpaired testis—*Pieris*, *Vanessa*, *Argynnis*, &c.

All these forms are closely connected by their internal structure, inasmuch as either in the larvæ or in the embryo, each vas deferens is connected with four tubes. The external capsule may be wanting, and has a connection with the testes analogous to that of the scrotum in Vertebrata.

Thorax of the Blow-fly.*—The object of this paper (by Mr. A. Hammond) is to determine the limits of the several segments of which the connate thorax of the Diptera, as exemplified in the blow-fly, is composed.

After introductory remarks on the present state of our knowledge as to the constituent parts of the thoracic segment of the Insecta, the author describes in detail the several pieces of which the thorax of the blow-fly is made up, as they are presented from different points of view, noticing the interpretation put upon each of these pieces by previous observers, especially Burmeister and Lowne. Evidence derived from three separate sources is adduced to show, first, that the posterior vertical wall of the thorax, described as metathoracic by these two authors, is really the postscutellar region of the mesothorax greatly developed; all that remains consequently of the metathorax being reduced to the halteres, the entostomum, and the posterior coxæ and legs; secondly, that the prominent anterior angles of the dorsum, called humeri, and described by Burmeister as his pronotum, are correctly so described, being the homologues of the posterior angle of the collar of the Hymenoptera.

The three convergent lines of reasoning brought to bear upon these points are:—

1. The analogy presented by other insects.
2. The evidence from developmental change.
3. That obtainable from the nervous and muscular systems.

By the first of these a relation is sought to be established between the development of the meso- and metathorax in the three associated

* 'Journ. Linn. Soc. (Bot.),' xv. (1880) p. 9.

orders of the Lepidoptera, the Hymenoptera, and the Diptera, of such a nature as to show that the proposed reduction in the limits of the latter segment is in strict accordance with what might be expected from the abortion of the posterior wings as organs of flight. Incidentally the question of the limits of this segment in the Hymenoptera is discussed, and support given to Andouin's views on this subject by reference to Packard's figures of the development of the humble bee, and to the collateral structure of the Coleopterous thorax.

The evidence of developmental change is adduced to support the prothoracic character of the humeri. It is also stated that the square plate lying between the halteres of the crane-fly, which is seen to correspond with the posterior wall in question of the blow-fly, underlies the mesothoracic integument of the former insect, and must therefore itself be regarded as mesothoracic.

Lastly, the importance of the muscular system of insects is urged as an accessory source of information in disputed questions as to the relations of their external parts. It is contended that in no known instance are the great longitudinal muscles of two segments merged into one homogeneous mass, as must be the case if the views hitherto accepted upon this subject be maintained, and that the same arguments apply to the lateral vertical muscles, which are in no other instance found to pass from the scutum of one segment to the sternum of the next, as here they would be found to do on the same disputed hypothesis.

Insects which injure Books.*—In a paper read to the British Association, Professor Westwood reviewed the life-history of the insects which destroy books and printed papers, several of which had not been noticed by Dr. Hagen in his address to the American Library Association in July, 1879.

The caterpillars of *Aglossa pinguinalis*, and of a species of *Depressaria*, often injure books by spinning their webs between the volumes, and gnawing the paper with which to form their cocoons. A small mite (*Cheyletus eruditus*) is also found occasionally in books kept in damp situations, where it gnaws the paper. A very minute beetle (*Hypothenemus eruditus* Westw.) forms its tiny burrows within the binding of books. *Lepisma saccharina*, found in closets and cupboards where provisions are kept, also feeds on paper, as was seen from a framed and glazed print, of which the plain portion was eaten, whilst the parts covered by the printing-ink were untouched. This habit of the *Lepismæ* has not been previously recorded. The white ants (*Termiditæ*) are a constant source of annoyance in warm climates. Cockroaches are also equally destructive to books.

But it is the *Death-watches* (*Anobium pertinax* and *striatum*) which do the greatest injury, gnawing and burrowing not only in and through the bindings, but also through the volume, and an instance is recorded where twenty-seven folio volumes placed together on a shelf had been so cleanly drilled through by the larva, that a string might be run through the hole made by it, and the volumes raised by the

* 'Rep. Brit. Assoc.,' 1879, p. 371.

string. For the destruction of these insects it is necessary to have recourse to *vaporization*, and infected volumes have been placed in a large glass case made as air-tight as possible, with small saucers containing benzine, or sponge saturated with carbolic acid. A strong infusion of colocynth and quassia, chloroform, spirits of turpentine, expressed juice of green walnuts, and pyroligneous acid, have also been employed successfully. Fumigation on a large scale may also be adopted by filling the room with fumes of brimstone, prussic acid, or benzine; or an infected volume may be placed under the bell-glass of an air-pump, and extracting the air, the larvæ will be found to be killed after an hour's exhaustion.

γ. Arachnida.

Generative Organs of the Phalangida.*—The chief results of Herr Loman's investigations, obtained from *Phalangium*, four species, *Leobunus*, three species, and an *Opilio*, are as follows:—

Ova have been met with upon the testes, without affecting the production in them of sperm; they occurred there at the end of the reproductive period. The ova arise in the ovary from epithelial cells. A prolongation of the oviduct, with chitinous rings, here called ovipositor, is enclosed in a sheath composed internally of connective and externally of muscular tissue. The penis sheath only differs from the preceding by its inferior thickness. The two small organs opening into the vagina at the front end of the ovipositor contain sperm, and are the receptacula seminis. Each of the two valves of the ovipositor carries a bristle, into which a nerve penetrates, and which act as feelers during the act of oviposition. The egg-chorion is structureless. No cementing together of the eggs takes place. The spermatozoa are flattened, oval, non-nucleated bodies, ·002 mm. in diameter, whose development within the sperm-cells was followed out. The characters of the penis and ovipositor are valuable agents in the determination of the species. The existence of Phalangida in North America is established.

δ. Crustacea.

New Parasitic Crustacea.†—Of the two new species described by Professor Richiardi, the one, *Brachiella ramosa*, lives in the branchial arches of the swordfish. It is distinguished from the other species of the genus by the ramose form of the second pair of maxillipedes and of the two lateral lobes at the end of the abdomen. The other species inhabits the sinuses and "mucous canals" of the head of the Scomberoid fish, *Stromateus fiatola* Linn. It is named *Philichthys fiatolæ*; and is characterized chiefly by the hooked termination of the fourth appendage of the median section of the body; the hooks are turned towards the dorsal aspect of the body and are minutely spined. He is now able to confirm an opinion expressed by him two years ago, that *Sphærifer* belongs to the Philichthydæ, an opinion which, now

* 'Zool. Anzeiger,' iii. (1880) p. 90.
† 'Atti Soc. Tosc. Sci. Nat.' (Proc. Verb.), ii. (1880) p. 26.

that a male of that genus has at last been found, is fully borne out by its entire agreement with the typical forms already known.

Structure and Functions of the Crustacean Liver.*—In the discussion of this difficult question Dr. Max Weber commences with an account of the liver of the Isopoda; the glands in question are tubular, and they pour out their secretion into the commencement of the midgut; the separate glands are, from within outwards, provided with three coats: a *tunica propria*, a retiform muscular tunic in which circular fibres are very well developed, and a *tunica serosa*, which owes its origin to the fatty body. The secretion from these glandular tubes has peptic properties; but it does not follow that it is derived from the true hepatic cells, for there are, in addition to these, other cells which the author speaks of as ferment cells. The fatty nature of the former, together with the fact that the secretion is not extracted from the cells by water or by glycerine, but by ether, is altogether against them. On the other hand, the method of exclusion is not the only one which leads us to regard the ferment cells as the authors of the digestive secretion. There are such positive facts as these: they are rapidly and intensely blackened by osmic acid, while the so-called liver cells, just like fat and bile, are indifferent to this reagent; the granules of the ferment cells of the Isopoda are very similar to those of the salivary cells of the Vertebrata, which likewise readily blacken with osmic acid. The so-called liver, or midgut gland, as the author objectively calls it, has, then, two functions; one of these is comparable to part of the hepatic activity of the liver of the Vertebrata, the formation, that is, of animal colouring matters; the other is comparable to that of the digestive glands of the Vertebrate intestine, the formation of a digestive ferment. To avoid confusion, the author suggests the term of "hepato-pancreas" for the gland now under examination.

Passing on to the Amphipoda, we find that with some resemblances there are certain differences; the cells of the "liver" are much smaller, and the muscular reticulum, though not stronger, is more close; the nuclei are almost always found dividing at the blind end of the tubes only. In the Decapoda we find a higher grade of development; each glandular tube is surrounded by a well-differentiated membrane of connective tissue, is separated from the surrounding organs, and the active cells of the glands are more numerous. As with the Isopoda, the secretions of the so-called hepatic glands of the Amphipoda and Decapoda have a digestive action on albuminous compounds, and as in them there is a secretion comparable to bile. In addition to the two sets of cells already distinguished in the Isopoda, it is possible in the two other sets of forms to make out a third series, which produce a clear secretion in the form of a large vesicle; but this is not totally distinct from the other two, but only a kind of predecessor to them. Although the organ is called the "hepato-pancreas," it must not be supposed that it is homologous with the two structures in the higher animals,

* 'Arch. Mikr. Anat.,' xvii. (1880) p. 385.

but only that it has partly the same functions; nor must it be supposed that the gland produces either trypsin or pepsin.

Gastric Apparatus of the Brachyura.*—Dr. Nauck gives a table of the terminologies applied by authors to the different parts or processes which make up the complex gastric mill of the higher Crustacea; these have each certain advantages and certain disadvantages; the one now proposed is perhaps superior in being altogether based on topographical relations. It will not be necessary to give the whole of the table, but in face of the interest which has been excited by the publication of Professor Huxley's work on the Crayfish, we give the synonymy of the parts named by these two authors. The cardiac ossicle of Huxley is the *anterior superomedian* of Nauck, the pterocardiac ossicle the *anterior superolateral*, the urocardiac process is the *median superomedian*, the prepyloric ossicle is the *posterior superomedian*, the zygocardiac ossicle is the *median superolateral*, the inferolateral tooth is the *median* "*twixt-piece*," and the cardiopyloric valve is the *inferomedian*.†

After an elaborate account of these structures in a number of genera and species, the author points out that although it is impossible to find in the characters of the gastric apparatus of the Brachyura any means by which forms may be specifically or generically separated, yet it is possible to see that, by its aid, they may be divided into the Heterodontea and Cyclodontea; in the former the median teeth never consist of simple lamellæ, and the superolateral cardiac pieces lie in front of the superomedian; in the latter the median teeth (with one exception) are formed of lamellæ, and the anterior superolateral pieces lie behind the superomedian. An investigation into the course of development of the cardiac portions of the mill seems to show that the Gelasimida, Pinnotherida, Portunida, and Cancrida are the oldest representatives of the Brachyura, and this result is in accordance with what is taught by palæontological data. An opportunity is taken to describe some new genera and species, and the facts are illustrated by a carefully drawn plate of 31 figures.

Reproduction of the Isopod Crustaceans.‡—The earlier papers of Dr. Schöbl contain several new propositions in Isopod anatomy which are now generally accepted, with one exception—his discovery of the female generative openings and of the receptacula seminis. Since many competent observers had completely failed to find any trace of them in the place where he had described them, the hypothesis suggested itself that at certain seasons the openings may be present, at others not.

By keeping as many as 10,000 specimens of *Porcellio scaber* and other Oniscidæ, in large glass vivaria containing layers of moistened sand, bark, and moss, he has now been able to study an abundance of specimens at all periods of the year, and thus fairly test the validity of his explanation. From January to April one easily finds the minute

* 'Zeitschr. wiss. Zool.,' xxxiv. (1880) p. 1.
† Cf. Huxley, 'Crayfish,' fig. 9.
‡ 'Arch. Mikr. Anat.,' xvii. (1879) p. 125 (2 plates).

female generative openings, one on each side of the ventral surface of the fifth body segment. Each opening leads into a receptaculum seminis, which is formed of a thin chitinous membrane, invaginated into the oviduct, and completely closing it, so that it was equally difficult to understand either how the ova could be fertilized, or how they could pass out.

Some days after the receptacula seminis have been distended by copulation, they burst and set free the spermatozoids into the oviduct. These at first form a coil at the top of the duct, but soon press into the ovary, disperse themselves through it, and so fertilize the eggs.

About this time the female casts the posterior half of her chitinous integument, beginning with the fifth body segment, and in a few days more the anterior portion also. The ecdysis is attended with so much pain and difficulty that many females die of exhaustion. The new skin is continuous over the mouth of the oviduct, the female generative openings and receptacula seminis are lost, and the latter is represented by a mere filament of chitin lying along the closed oviduct. The author's hypothesis of the alternate presence and absence of the disputed organs was completely verified.

The new integument bears a pair of large overlapping broad plates on each of the first five body segments, thus providing a large pouch for the development of the eggs. These now descend the oviduct, but on arriving at its blind end break loose into the body cavity, and escape into the brood-pouch through a broad median slit in the chitinous integument of the sixth body segment. The ovary then shrivels, and any unfertilized ova degenerate and disappear. The irregularly scattered residual spermatozoa return into the oviduct, and there wind themselves neatly into a somewhat spectacle-shaped bundle. A new development of ova from the epithelium of the ovary soon commences, and in about twenty-three days after the first batch of eggs left the ovary a new set are distinctly formed. These continue growing for twenty to twenty-six days more, by which time the first brood is hatched and set free. The spermatozoa then arouse and uncoil themselves, re-enter the ovary, and fertilize the ova, which then pass into the brood-pouch by the median slit already mentioned. Thus one act of fertilization serves for two broods, a circumstance which Dr. Schöbl thinks may throw new light upon many of the supposed cases of parthenogenesis.

That the spermatozoids of Isopods are not inert and motionless is further proved by direct microscopic observation of freshly-shed specimens. Not only have they a movement of rotation around their own axis, but they are capable of slow locomotion.

In autumn the skin is again cast; the broad plates are then lost, the genital openings and receptacula seminis are recovered, and the animal is ready to be fertilized anew.

Filiform Læmodipoda.*—Dr. Heller seems to have enjoyed peculiar facilities on the Italian and Sicilian coasts for his work on the Caprellidæ, since he not only gives a detailed account of their ana-

* 'Zeitschr. wiss. Zool.,' xxxiii. (1879) p. 350 (3 plates).

tomy, but adds something like a revision of the group, with several new species.

In the study of the *Nervous System*, which is much obscured by pigment, staining with Beale's carmine, after treatment with 2 per cent. osmic acid, was found useful. In *Protella* the brain is three times the size of one of the large thoracic ganglia. The "chief brain" consists of two pear-shaped bodies, which form the apex of the whole by two pointed processes, terminated by connective-tissue bands, which are directed upwards and inwards. It is connected by broad, thin commissures with the other large ganglia, of which there are four pairs. In front of its base, and connecting it with the other ganglia, lie those which originate the upper antennary nerves, from which the nerves pass directly forwards; below this pair are the inferior antennary ganglia, of similar size and shape. The chief part of the base is formed by two large subquadrangular masses, the ganglia of the commissure, which lie behind the last named. The commissure proceeds from their lower edges. On a kind of ledge on the upper surface rest the optic ganglia, which are smaller rounded masses lying at the back of the brain, connected only with the chief brain; the eyes lie at their sides. These details are much the same in *Proto* as in *Caprella æquilabra*. In this species the outline of the whole brain is that of a rude oblong, with the long axis passing through the chief brain above and the inferior antennary ganglion below. This is caused by the fusion of the upper antennary with the commissural ganglion, forming a large joint mass above the lower antennary; the optic ganglia lie between this mass and the chief brain. The sub-œsophageal ganglion and the first of the body ganglia do not fuse together—as stated by Dohrn* and Gamroth†—in *Protella*. The former sends small nerves to the beginning of the alimentary canal and to the mouth organs; the latter supplies the first pair of feet, and perhaps also the alimentary canal.

The posterior ganglia present some points of interest; the penultimate thoracic segment contains two, of which the first supplies the penultimate, the second the last pair of legs by stout branches; a division of the nerve from the latter goes upwards to the intestine. Behind the latter ganglion, and connected with it by two trunks, follows a pair of much smaller nervous masses, sending two twigs to the abdomen, and between it and the posterior thoracic lie two more such, connected with their anterior and posterior neighbours, but, as is also the case with the other two small ones, not with each other; behind them both lies an azygos mass which completes the plexus of five small ganglia. Of these the anterior pair represents a lost abdominal segment; the second pair belongs to the last, and the unpaired mass to the first abdominal segment. Of the lost segment itself a trace seems to occur in *Proto*.

In young individuals, taken from the brood-chamber of the female, the brain presents a less differentiated condition than in the adult, the distinction of the ganglia from the chief brain being indicated only by grooves; the second thoracic ganglion is larger, and the third and

* 'Zeitschr. wiss. Zool.,' xvi. p. 215, &c.
† Ibid., xxxi. p. 101, &c.

fourth are smaller, than the rest; the ganglia of the terminal plexus project somewhat into the last thoracic segment. The histology of a segmental ganglion shows that a connective-tissue sheath containing a mass of large cells, to be called "fibrogenous cells," invests the nervous mass, and is strongly pigmented by a brownish granular pigment contained in stellate cells, as in other parts of the body; the pigment cells are contractile. Beneath the neurilemma lies a layer of large polygonal cells with dark nuclei, which stain readily; beneath these lies the central mass of the ganglion, composed of two apposed oval grey masses in which the outlines of cells are discernible. Of the entering nerve-cord a part passes through the ganglion unaltered, a part is lost in the superficial layer, and the greater part breaks up in the central mass. The structure of the brain and the abdominal ganglion-plexus is somewhat different. In the former the grey central substance prevails, and is present wherever the two lateral halves unite; it is invested by a thin transparent layer. The fibres which unite the chief brain with the lower ganglia show a *chiasma*, the commissural fibres of one side being derived from the opposite side of the upper mass. The lower ganglia—antennary, &c.—each contain two hemispheres of medullary substance; one of these is formed by the breaking up of the entering nerves, the other by the large-celled cortical substance, together with a bridge of grey matter which is in connection with that of the other ganglia.

The connection of the optic ganglion with the chief brain is only apparent; the band uniting them is merely connective tissue, and the real connection of the former is with the upper antennary. Of the small abdominal ganglia, the last differs little from the segmental ganglia; the smaller first pair is connected with it by a commissure, and consists chiefly of cortical substance; the second pair consists entirely of cortical substance, and has no posterior commissure.

Sense-Organs. — The upper antennary nerve divides into two branches in the third joint—the one for the convex, the other for the concave aspect of the antenna. These branches go on to the end, giving off a number of variously-sized twigs, some to the muscles, some to act as sensory nerves, on the way. A group of these latter are distinguished as *cutaneous;* and of these may be seen, running up the side of the antenna, three long, unbranched twigs, containing small granular and apparently nucleated dilatations at short intervals; they are transparent and strongly refractive, and are found besides in various parts of the body; they have no special end-organs.

Another set of sense-organs consists of small chitinous elevations on the antennæ; they stain red with osmic acid and picrocarmine, and in large species contain triangular or bacillar granulations set side by side, among which a fine nerve ends; possibly they may be primitive visual organs. Further, certain sabre-shaped hairs are found constantly projecting from some wall-like chitinous elevations, all over the body, supplied each by a nerve. On the first pair of antennæ a few thick hairs, each terminated by finer ones, and supplied by a four-fibred nerve twig, perhaps constitute auditory organs. Eight organs similar to these, but in pairs, occur in the same position. The antennule bears some paired, somewhat retractile processes, medially constricted, and containing granular nucleated masses; they are open at the distal end. A nerve enters proximally; they are probably olfactory. The sense of touch seems to belong to the terminal hairs. The edge of the chelæ, which lies opposite to the "palm" of the joints on which they close, shows small canals, entered proximally by a nerve and closed externally by a knob, which probably convey tactile sensations.

Hair-structures with Mechanical Functions.—In contrast to the above-mentioned hairs, many, such as those on the feet, are used in swimming, grasping, &c. The former function is discharged by the hairs of the second pair of antennæ in those *Caprellæ* in which these are locomotor organs; in this case the hairs are pilose and basally jointed; on the first maxillipede they are plumose. The feet carry thorn-like points specially adapted for holding prey.

Circulatory System.—The elongated heart extends from the first to the fourth segment, and is constricted between each two segments, being almost cylindrical between the constrictions. The anterior aorta divides, one branch passes between the halves of the chief brain, the other passes back inferiorly to the stomach; a posterior aorta runs to the end of the fifth segment. The corpuscles are chiefly round in the arterial, fusiform in the venous blood.

Reproductive Organs.—These have been described fairly well by Dohrn and Gamroth. The male generative opening is in front of the base of the last maxillipede and lies in a small jointed process which is present in many species, through which the vas deferens passes. In the female the opening of the oviduct is guarded by a muscular ring,—not chitinous, as Gamroth states. A rudimentary third pair of laminæ for the retention of the ova is wrongly described by Gamroth as a copulation-pouch.

Digestive Organs.—Their structure agrees with that of other Amphipods in almost every point. The stomach is imperfectly divided into an upper division for mastication, and a lower, paired, digestive portion; the chitinous capsule is prolonged forwards for some distance along the intestine on the inner side of its walls, as Dohrn has described: the lateral plates and a downwardly projecting masticatory process complete the chewing stomach-apparatus. The inferior—digestive—division differs from that described for the Amphipoda in being entered posteriorly by a pair of thin chitin-lined cæca; the sides of the main sacs are lined by obliquely striated chitinous plates, which present decided plications at the point nearest to the intestine, and the cæca are entered on each side by a bile duct, and it is perhaps here that the food is mixed with the digestive fluids. In the chitin of the stomach two laminæ are distinguishable: the matrix, which consists of polygonal nucleated cells, and the chitinous membrane itself, which is thin, transparent, and glass-like. The relation of the stomach to the intestine is remarkable; a tumour-like protuberance above the posterior end of the stomach, is simply the fold formed by the invagination of the anterior end of the intestine into itself by the stomach-tube (see above), and contains all the elements of the intestinal wall, except where it rests against the stomach, and here the muscular fibres are wanting. The paired tubes which lie at the posterior end of the intestine have been rightly described as urinary.

The gland described by Mayer * in the clasping claw of *Phronima* occurs in many other Amphipoda. In *Caprella Dohrnii* sp. n., it occurs in two distinct masses; the one near the apex of the large "hand" consists of three to four lobes, which each send a number of small ducts to form one large duct which opens at the base of a tubercle on the inner aspect of the hand; a similar but smaller one lies at the proximal end of the joint, and has a similar duct and opening. In *Protella phasma* there is but one gland formed of a great number of lobuli, which spread out at the base of the thorn-like tubercle, their common duct opening at its apex; each lobule is flattened and rosettiform, and consists of a group of nucleated cells with nucleoli which are grouped round a space which is the beginning of the duct. Their function may be that of poison-glands, from their position.

Connective-tissue Elements.—Accompanying the fibres which hold the various internal organs in their positions, and in the capsules which invest the ganglia, are—as already seen for the latter—aggregations of large cells. In young individuals these contain homogeneous protoplasm, and a nucleus somewhat green or yellow coloured; they divide actively. In adults the appearances are altered by the loss of colour and the granulation of the contents, and the indistinctness which the outline and the nuclei assume; probably their function was fibrogenous. Gamroth's cephalic funnel-shaped sense-organ is merely an aggregation of these cells.

Proto pedata varies to a wide extent according to locality. A filamentous alga is commensal in the intestine of the smaller species. A flagellate infusorian resembling *Anthophysa Mülleri*, and a new species of *Podophrya*—*P. crustaceorum*—are common attendants on these and other Crustacea.

The four genera, *Proto*, *Protella*, *Caprella*, *Podalirius*, are re-characterized and the species met with described. Under *Proto* is described a new species, *P. brunneovittata*, from Messina. *Caprella* is divided into two subgenera: (1) with the inferior antennæ carrying swimming hairs; (2) with the inferior antennæ acting as sense-organs. A new species, *C. liparotensis*, comes from a bay near Lipari; another, *C. Helleri*, from Scylla and Messina; a very small one, *C. Dohrnii*, from Villafranca; and one, called *C. elongata*, from Messina. A new species of *Podalirius*, *P. Kröyeri*, was found at Messina.

The affinities of the genera may be expressed thus:—

Crevettina
(Amphithoe).
|
Proto.
|
Protella
(P. gracilis, Dana).
/ |
Cyamidæ. |
Ægina.
|
Caprella.
|
Podalirius.

* 'Mitth. Zool. Stat. Neapel,' i. (1879) p. 40.

Parthenogenesis in the Ostracoda.*—Dr. Weismann considers parthenogenesis to be essentially a unisexual and not an asexual process of reproduction. It is derived from the regular sexual method, being dependent for its occurrence on certain conditions which render a rapid multiplication desirable. Hitherto it has not been observed in the Ostracoda, although they are exposed to the same conditions—among others the periodical drying up of the medium in which they live—which render a rapid renewal of their colonies necessary in the case of the Daphnidæ. Hence as parthenogenesis prevails in the latter group it was to be expected that a similar provision would be made for the Ostracoda also, especially as, like the Daphnioids, they are endowed with all the organs necessary for such a process.

Dr. Weismann's experiments made to test the truth of this assumption have met with remarkable success. It is found that one species, *Cypris incongruens*, could be reared for nine months, reproducing solely by parthenogenetic means; thus, female individuals which were isolated at their birth, produced only similar females which were similarly treated, and so on. In colonies also the multiplication went on without the appearance of a single male. The female possesses a large receptaculum seminis, hence it is probable that at certain times or places fertilization does take place; but sperm has never yet been found in this organ. In bisexual colonies of *Candona candida*, *Cypris punctata*, *ovum*, and *Cyprois monacha* every female (even half grown) had its receptaculum full of spermatozoa, and this when there was no great preponderance of males present; it therefore appears to be the rule that when males are present at all, they impregnate all the females; and so the discovery in any colony of an adult female with an empty receptaculum would seem of itself to argue that parthenogenesis prevails in that colony.

Besides *Cypris incongruens*, unisexual colonies of *C. fuscata*, *C. vidua*, and *C. reptans* also occur, and in these instances also neither a male nor any impregnated females have been found, although all species except the last, which was not fully developed, had perfect receptacula. *Candona candida* has been found to present colonies of two sexes in spring and summer, and in winter only females with empty pouches and ripe ova, which appears to indicate an alternation of methods as possibly a rule in the Cyprididæ. At present appearances rather tend to the conclusion that certain colonies maintain one method of reproduction regardless of season; for *C. fuscata* has solely female colonies at a time when other species are reproducing bisexually; while on the other hand *Cyprois monacha* appears never to reproduce by parthenogenesis. Thus a fundamental difference exists between this family and the Daphnoidæ in the absence of a regular alternation of reproductive methods in the one, and its constant occurrence in the other family.

As to the origin of the parthenogenesis, although it is only an hypothesis that it is a derived process in the Daphnioids, yet the Cyprididæ seem to prove by their fully developed receptacula and other accessory organs that they have received it merely as a modification of the older bisexual method.

* 'Zool. Anzeiger,' iii. (1880) p. 82.

With regard to the anatomy of the Ostracoda, it may be pointed out that the large organ described by Zenker as a "mucus gland" in the male, is really a remarkable ejaculatory organ; it lies in the channel of the vas deferens, and the seminal duct leads into its proximal end by a very narrow orifice. It consists chiefly of muscles delicately striated; they act by contracting the tube longitudinally, and lie thickly one upon another, binding the chitinous rings of the tube together.

Vermes.

Worm-fauna of Madeira.* —Dr. Langerhans continues his report on this subject.† He now deals with the families of the Typhloscolecidæ:—Ariciea: one new species, *Aricia acustica;* Spiodea: of these, *Spio atlanticus*, *Polydora hamata*, and *P. armata* are new; Chætoptera: the only representative is a new species, *Spiochætopterus madeirensis;* Cirratulea, with *Cirratulus viridis* and *Chætozone macrophthalma* for new forms; Capitellacea: *Notomastus roseus*, n. sp.; Opheliacea and Chlorhæmina, with a single known species respectively; Maldaniæ: *Axiothea cirrifera*, n. sp.; Ammocharidea; Ampharetea, with a new species, *Ampharete minuta*. In the Terebellacea, we have as new, *Leæna oculata*, *Polycirrus triglandula*, and *P. tenuisetis*. The Serpulacea are divided into two tribes, one (*Sabellidæ*) without, and one (*Serpulidæ*) with a thoracic membrane; *Sabella* (*Potamilla*) *rubra*, n. sp. *Jasmineria* is a new genus, allied to *Dialychone*, but distinguished from it by the form of its abdominal uncini. *J. caudata*, *Chone arenicola*, *C. collaris*, *Oria Eimeri*, *Fabricia nigra* are new species of the Sabellid tribe; *Serpula concharum*, n. sp. There is a key given for the genera of the Sabellidæ. *Polygordius Schneideri*, n. sp., is described in an appendix to the paper, and in a review of his results the author points out that he has found 153 Chætopoda at Madeira, of which 57, or about one-third, are new to science. Almost one-half of the Madeiran Chætopod fauna has been found in the Mediterranean, and about a half of these, or 33, have been found on the oceanic coasts of Europe; of the 24 forms already known to science, and not found in the Mediterranean, three are especially interesting as being as yet only found in the West Indies; three others have only been found in more or less northern latitudes. On the whole, the wide area over which it is possible for forms to range is now seen to be more common than could before be supposed, and their modification at different localities is extremely slight.

Passing to the Chætognatha, the author distinguishes two new genera, so that we have (1) forms with a delicate body, two pairs of accessory jaws, and two pairs of free lateral fins—*Sagitta*, with the new species *S. magna* (4 cm. long); (2) forms with a delicate body, one pair of accessory jaws, and one pair of free lateral fins—*Krohnia* (non *Krohnia* Quatrefages), the species *hamata* of Möbius belongs to this genus; and (3) *Spadella*, with the body compressed, the subcutaneous tissue greatly developed, a single lateral fin, and two pairs

* 'Zeitschr. wiss. Zool.,' xxxiv. (1880) p. 87.
† See this Journal, iii. (1880) p. 84.

of accessory jaws. The species are *cephaloptera* of Busch, *draco* of Krohn, *gallica* of Pagenstecher, and *batziana* of Giard.

The author then deals with the Nemertinea, of which eighteen species are found at Madeira; *Cerebratulus Macintoshii*, *C. Hubrechti*, and *Tetrastemma quadriseriatum* are new.

Nine Appendiculariæ were also found, and of these *Oikopleura velifera* and *O. magna* are new; the latter has a body of 8 mm. and a tail of 8–10 mm. long in the largest forms.

Anatomy of the Leech.*—Professor Lankester gives the results of a very minute investigation into the histology of the epidermis, connective tissue, blood-vessels, and other parts of *Hirudo officinalis*, which supplement what has been already written by Leydig and others.

The *epidermis* is a unilaminar series of simply cylindrical cells, producing a separable cuticle on the surface; branches of coloured connective-tissue cells sometimes appear between them. It is noticed for the first time that fine blood-vessels also penetrate the epidermis, and run horizontally among its cylindrical cells, in all parts except the extremities of the body—an arrangement doubtless effecting a cutaneous respiration. This also occurs in the clitellus of the earthworm.

The epidermis also contains isolated gland cells, buried deep in the body walls, with ducts rising between the epidermic cells; they are surface glands, not connected with the brown subjacent tissue, as Leydig states, and as they resemble the salivary glands, they are probably homologous in origin with these.

The *connective tissue* is not always to be distinguished from the walls of the blood-vessels. One variety, forming the most massive tracts, is slightly fibrillated, and contains numerous oblong, finely-branched corpuscles, which are coarsely granulated by highly refracting particles in the older forms. A second variety is formed of ramifying fibres, generally with brownish granules, beset with protoplasmic corpuscles at intervals: it constitutes an investment to the chief organs, as the lateral blood-vessels, the nephridia, and the body-wall muscles, &c. It is not sharply distinct from the blood-vessels themselves, for these are sometimes merely hollowed fibres of this kind—a fact paralleled by the facts of the development of the blood-vessels in the rat's omentum. The third variety is the brown botryoidal tissue described by Leydig as a fat-body like that of insects, by Brandt as a liver, and by Leuckart as part of the epidermal glands. It consists of moniliform, tortuous, branched tubes, passing gradually into blood-vessels; the walls are set with dark brownish granular cells, staining deeply with gold and with osmic acid; it contains the ordinary red blood, and constitutes, in fact, simply a vascular plexus. A similar plexus occurs in the Oligochæta, and it is, perhaps, most closely allied to the vascular yellow tufts on the alimentary canal of *Lumbricus*. Possibly the brown cells act both as a liver and in the manufacture of hæmoglobin.

Blood-vessels.—Though there is no body cavity with colourless liquid, as in the Chætopoda, yet large spaces do occur between the

* 'Zool. Anzeiger,' iii. (1880) p. 85.

vessels, and in the smaller ones—those formed within the connective-tissue fibres, as above mentioned—minute pale corpuscles sometimes occur. The blood supply to the nephridia is very perfect, each cell being enclosed by at least one capillary loop.

The *nephridia*, or excretory glands, as now determined by Mr. Bourne, present different characters in different parts; in one part the duct has an arborescent origin in each cell; or the cells may be entirely perforated by a duct; or they may—as at the base of the gland—simply be hollow cylinders encapsuling a duct. The lobes of the glands also each present a large intercellular duct. The vesicle or bladder has ciliated walls, and contains needle-like particles of a substance apparently allied to uric acid. Maceration in Müller's fluid breaks up the gland cells into fibrillæ. Cellular structure was not detected in the walls of the blood-vessels, and no communication was found between the nephridial duct and the body cavity.

The *intestinal epithelium* lining the cæca differs from that usually found in such a position in consisting of hemispherical granulated cells with pale nuclei, each emitting during digestion a drop of viscid hyaline liquid.

Structure of the Echiurida.*—Dr. Greef has been examining the curious small tubes of the Echiurida, to which so many different functions have been ascribed; he now looks upon them as gills and as homologous with the "water-lungs" of the Holothuroida. A careful investigation of *Thalassema Moebii* revealed no sign of the presence of infundibular orifices in these structures, but, much to the astonishment of the writer, they were found to be completely cut off from the cœlom. Injections through the orifice into the rectum were then made with *Echiurus Pallasii*, in which infundibula are so abundant; here it was found that neither the funnels nor their canals received any of the colouring matter; this only filled the numerous cleft-like lacunæ which project into the lumen of the tube, and the canal system of which does not communicate with the infundibula; these latter have, however, a special system of canals connected with them which traverse the other set; this system appears to belong to the blood-vascular series, and the function of the anal tubes as gills, and apparently as gills only, is hereby confirmed. The cœlom of the Echiurida, just as of the Holothuroida, is filled with blood, and both the tubes connected with the anal region have a respiratory function.

The new species *Thalassema Moebii* has three pairs of genital tubes, corresponding in form and position to the two pairs of *Echiurus Pallasii*, and in all the specimens examined the tubes were either filled with ripe eggs or with masses of semen. Further observations on *Echiurus* lead the author to support the doctrine that in all Echiuri the generative organs have the same structure and position, and that the anterior pair are to be regarded as true segmental organs. Nothing as yet known about other Gephyrea leads us to believe that there obtains in them the remarkable dimorphism of the sexes which has been signalized by Vejdovsky and by Marion in *Bonellia;* at any

* 'Arch. Naturg.,' xlvi. (1880) p. 88.

rate, in *E. Pallasii*, *T. Moebii*, and *T. Baronii* the sexes are exactly similar in size, in external form, and in organization.

Free Terrestrial and Fresh-water Nematoda of Holland.*—In this paper Dr. De Max only enters into the systematic portion of his subject; the paper extends over one hundred pages, and contains descriptions of several new genera and species, together with an account of forms already described, and a list of the names of the forms described. A hundred and forty-one species are described, and of these twelve only are exclusively inhabitants of fresh water, the rest live on or near the roots of various plants; in order to shorten the descriptions, parts which are continually referred to are spoken of by symbols (taken from the Greek alphabet).

Like *Bastiania*, already described by the author, the new genera *Alaimus*, *Deontolaimus*, and *Aphanolaimus* have no buccal cavity; the first of these has no accessory pieces connected with the genital spicula, the second has a rod-shaped accessory piece, and the third, in addition to an accessory piece, has, in the male, a median row of four chitinous efferent ducts in front of the anus. In the new genus *Desmolaimus* the buccal cavity is very small, has very thin walls, and is provided with three concentric chitinous thickenings, the innermost of which extends along the base of the cavity; *Microlaimus* (nov. gen.) has likewise a small buccal cavity, but it is distinguished by the presence of a feebly developed, dorsally-placed denticle. *Ethmolaimus* is again a new genus, which is distinguished by having the chitinous walls of its buccal cavity made up of two parts; the anterior portion has longitudinal ridges, and the posterior is formed by a circular chitinous process which separates the anterior from the succeeding portion of the buccal cavity. The sixteenth genus in the list is also a new one, and receives the name of *Choanolaimus* from the funnel-like shape of its buccal cavity, which has chitinous walls, and is formed of an anterior wider, and a posterior narrower portion; it is without teeth. *Aulolaimus* is likewise distinguished by the form of its buccal cavity, which is here greatly elongated and tubular; it is very narrow, is longer than the true œsophagus, and has chitinous walls. *Prismatolaimus*, which comes next, has a buccal cavity of a short prismatic form, without teeth or any armature, but with chitinous walls. *Leptolaimus* has been already described by the author; it has an elongated buccal cavity, which is tubular, but has very thin walls and no teeth. *Cylindrolaimus* is the name of a new genus, with a buccal cavity forming an elongated cylindrical tube with chitinous walls. *Rhabdolaimus* has its buccal cavity greatly elongated and very narrow, but it is further distinguished by being bounded by three chitinous rods, which converge a little, posteriorly, and have connected with their anterior end a small hook-shaped body, which is, perhaps, movable. The greatly elongated and very narrow buccal cavity of *Odontolaimus* is distinguished by having at its commencement a triangular, dorso-median, chitinous tooth. The new genus *Diptherophora* is somewhat remarkable, for its oval, elongated,

* 'Tijd. Nederl. Dierk. Vereen.,' v. (1880) p. 1.

pouch-shaped buccal cavity has three closely approximated rods, each of which ends in a small knob; at their anterior end they appear to be connected with a chitinous triangular valve. *Tylomaiphorus* (nov. gen.) has one buccal spine, which, at its anterior end, is surrounded by a cap, formed of three short rods, connected with one another at their anterior ends.

The paper, which is purely systematic, concludes with the description of the species of *Dorylaimus*, a large number of which are new.

Structure of Echinorhynchus.*—Herr Carl Baltzer describes—(1) *The Integumentary Tissue.*—Below the true cuticular layer there lies a subcuticle, which is remarkable for the labyrinthine arrangement of the fibres of which it is composed, and of the lacunar spaces that anastomose among them; of these fibres some are radial and others take a wavy circular, or longitudinal course, but the latter, to which Leuckart has applied the name of granular layer, is no less fibrous than the other, which that same anatomist has distinguished as the fibrous layer. Differences are stated to obtain in different species as to the thickness of the connective tissue which separates the subcuticle from the circular layer of muscles and in the arrangement of the bundles of fibres which compose it; the lacunæ between these fibres are stated to be connected with the vascular system.

(2) *The Neck and Proboscis.*—In *E. Proteus* the neck is as much as 3·5 mm. long, and in it three parts can be distinguished: a broadened conical basal portion, a filamentous median piece, and a swollen out upper extremity, with which the proboscis is connected. The neck is separated from the posterior region by a deep constriction. The lemnisci are to be regarded as appendages of the subcuticula of the neck; they are oval in form, have a bright brownish yellow colour, and form lobules which depend into the cœlom; they are inserted into the neck at the point where the circular cuticular fold is placed, and they are very intimately connected with the vascular system of the anterior portion of the body, by means of the circular vessel at its base. In transverse sections these lobules have an almost semilunar appearance. The whole network of the lemnisci is filled with a granular mass, which also penetrates into the vascular spaces. The opinion of Leuckart that these bodies serve as pumping organs by means of which the vascular spaces of the proboscis and neck are filled, is supported by the fact that the presence of some such organ is necessitated by the feeble development of the subcuticular fibres in the neck and proboscis. The tegumentary tissue of the neck and of the proboscis was found to be continuous. The relation of the vascular system to the hooks is illustrated by a figure; there are eighteen ridges formed by the former, nine of which are traversed by hooks; the intermediate ones contain a semilunar cavity. In the upper portion of the proboscis, where the hooks are more closely packed, the base of the next highest hook projects into every one of these spaces. By this means the communication between the hooks and the lacunar system is effected. After describing the same parts in *E. angustatus*, the author passes to

* 'Arch. Naturg.,' xlvi. (1880) p. 1 (2 plates).

(3) *The structure of the Sheath of the Proboscis and of the connected parts.*—In *E. Proteus* the sheath is about 2 mm. long, and the diameter about 0·4 mm. It consists of two cylindriform rolls of muscular substance, one internal and the other external; the former, or true sheath, is closed posteriorly, save only to give passage to the fibres of the *retractor proboscidis;* the latter is open at both ends. Fibres of connective tissue pass into these two muscle plates, horizontally into the exterior, and obliquely into the interior one; this gives rise to a difference in the appearance of transverse sections. The retractor proboscidis is attached to the base of the inner cylinder, and takes an upward direction. Not far from the lower end of the receptaculum proboscidis there is a ganglion which is oval in form; this is best seen, however, in *E. angustatus*, where it is distinctly composed of an outer and of an inner layer of cells, which are so packed together as to be pentagonal or hexagonal in form. There is no envelope to the ganglion. The separate cells give off fibres, several of which always unite to form nerves, and of these six well-developed rami can always be easily detected. The course of the anterior and posterior median nerves and of the two antero-lateral and postero-lateral is then shortly traced.

(4) *The Female Generative Organs.*—These have excited the interest of a number of observers, and they are, without doubt, worthy of study. In *E. Proteus*, where it is somewhat longer than in *E. angustatus*, the uterus is said to be composed of fifteen cells, which are thus distributed: two form the "bell," and two the muscular ring; behind the bell there are two elongated cells, at the base of which there are placed the two which are set opposite to the posterior orifice of the bell; these support the two lateral cells; the meshwork is formed of another two, two invest the ligament, and an unpaired cell is placed in front of the meshwork; these last three appear to be glandular in function. The way in which the ova pass into the bell and the complicated structure of the vagina are then described.

New Observations on the Nemertinea.*—Dr. Hubrecht gives a brief account of the results of his work at Naples. In very many Nemertines there appears to be a third nerve-cord, in addition to the two lateral, and this occupies the dorsal median line; contrary to the results of most observers, the author states that, in some forms, he has found the two lateral cords uniting at their posterior extremity, and he states that the commissure of union lies *superiorly* to the intestine. A true "vagus" nerve appears to be present, while the proboscis has a special system of nerve branches, which, arising from the neighbourhood of the anterior cerebral commissures, are evidently connected with the cerebral ganglion. Dr. Hubrecht has found new evidence to support his hypothesis of the respiratory activity of the nervous tissue of these worms; the whole of this nervous tissue appears to be impregnated with hæmoglobin, which is brought into immediate contact with the sea-water by means of highly ciliated and coiled canals.

The metamerically arranged internal dissepiments noted by

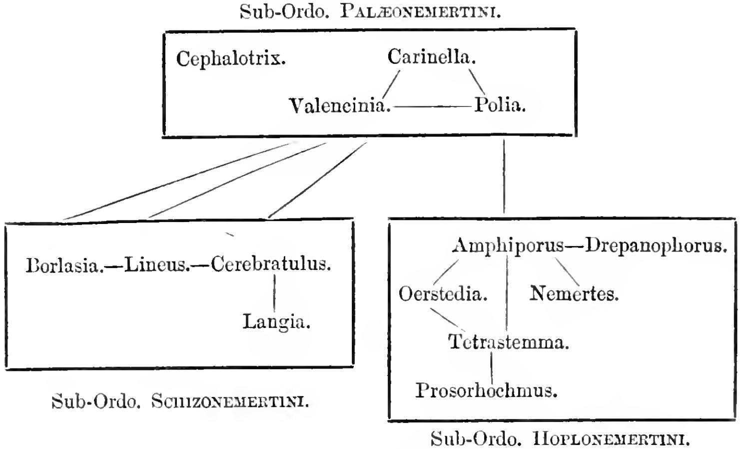
* 'Zool. Anzeig.,' ii. (1879) p. 471.

Barrois in the armed forms (Enopla) are stated definitely to be also present in the Anopla; in these latter, or unarmed forms, stinging organs, in the form of rods of very various sizes, are to be found in the proboscis, and their number appears to be very considerable. The fluid contained in the sheath of the proboscis is provided with special corpuscles, which, in some forms, appeared to be tinged red by hæmoglobin. Forty-seven species were examined by the author at Naples, and of these, he says, sixteen are new.

Revision of the Genera of European Nemerteans.*—In an article of 40 pp. (written in English) Dr. A. A. W. Hubrecht gives the preliminary results of his researches into the Nemertini (with descriptions of fifty species he recently found at Naples). It is clear that for an order which is yet so imperfectly known, the large number of forty-eight (European) genera must contain many synonyms. Authors who failed to find well-marked characters by which to distinguish the species of these worms (which, moreover, showed such a protean variability in their external appearance), highly overvalued any small structural difference which happened to be common to two or more species, and immediately founded a generic distinction on so insufficient a basis. The short and incomplete description of many of the genera was further one of the causes which led to unnecessary multiplication of their number, whereas the fact that in many cases no account whatever was taken of the internal anatomical characters when establishing a new genus, gave rise to considerable confusion which it will be difficult to get rid of.

The author proposes therefore to reduce the forty-eight genera to the fourteen named in the subjoined tables, the first of which is intended to show at a glance the general conclusions which the author has come to respecting the degrees of affinity between the different genera, and the latter, he thinks, will be useful for determining the genus of a given specimen.

Sub-Ordo. Palæonemertini.



* 'Notes from R. Zool. Mus. of Netherlands,' i. (1879) p. 193.

NEMERTINI

- Mouth before the ganglia, proboscis furnished with stylets; body (HOPLONEMERTINI)
  - Very long and slender, often coiled together in knots; proboscis rather short .. .. *Nemertes.*
  - more or less short and bulky; proboscis long; head
    - with four
      - large eyes, body short and stout *Oerstedia.*
      - small eyes, body more slender, very contractile
        - viviparous *Prosorhochmus.*
        - oviparous *Tetrastemma.*
    - with numerous eyes
      - with one central stylet in the proboscis .. .. *Amphiporus.*
      - with curved hook in the proboscis, provided with numerous small stylets .. .. *Drepanophorus.*
- no stylets in the proboscis; mouth behind the ganglia.
  - a deep lateral fissure on both sides of the head (SCHIZONEMERTINI)
    - body margins bent upwards, the frilled edges nearly meeting .. .. *Langia.*
    - body flat or rounded
      - not so very long in comparison to its width; eyes rarely numerous, generally absent; proboscis
        - well developed, furnished with urticating organs *Cerebratulus.*
        - attenuated, muscles of body-wall very strongly tinged with red .. .. *Borlasia.*
      - extremely long, eyes very numerous .. .. *Lineus.*
  - no deep lateral fissures on the head. (PALÆONEMERTINI)
    - posterior lobes of the ganglion present, coalesced with the supero-anterior lobe
      - no eyes, opening for the proboscis distant from the tip of the snout *Valencinia.*
      - eyes, opening for the proboscis terminal .. .. *Polia.*
    - no visible posterior lobe to the ganglia
      - head pointed, continuous with the body .. .. *Cephalotrix.*
      - head distinct from the body, spathuliform .. .. *Carinella.*

The following is a list of the new species, most of which were found in the Bay of Naples:—*Cephalotrix signatus; Polia curta, P. minor; Cerebratulus pantherinus, C. Dohrnii, C. Grubei, C. tristis, C. hepaticus; Langia formosa* nov. gen. et sp.; *Amphiporus dubius; A. marmoratus; A. pugnax; Tetrastemma diadema, T. octopunctatum; Oerstedia vittata, O. unicolor; Nemertes Marioni.* Dr. Hubrecht promises a full description of these forms, together with coloured figures.

The Turbellaria.—The work of M. Paul Hallez appears to be of sufficient importance to justify us in following the 'Revue Scientifique'* in directing attention to it as a whole; we shall, however, pass by those points to which we have previously † drawn attention.

The water-vascular or excretory vessels are confined to the Rhabdocœla and are not to be found in the Dendrocœla, for the system which Blanchard regarded as having this character in the latter is shown now to be nervous in function.

Observations on *Stenostomum leucops* and *Microstomum lineare* demonstrate that, in these animals, the *ovaries* are formed by budding at the expense of the intestine, while the *testicles* are derived from the ectoderm; this is an interesting confirmation of the views of E. van Beneden as to the primary origin of the generative products. Although hermaphrodite, the Dendrocœla are at a given time definitely of one sex, and the male organs are, as a rule, those which are first active; in the Rhabdocœla, on the other hand, spermatozoa and ova are matured contemporaneously. The products of the accessory male glands are shown by Hallez to have the function of sustaining the vitality of the spermatozoa, save in those cases where they secrete a veritable poison; and in these cases it is interesting to note that the walls of the receptaculum seminis secrete an albuminous liquid which takes on the function of the products of the accessory glands. The seminal vesicle and the reservoir of the accessory glands may be (1) distinct and communicating, (2) united into a single vesicle, or (3) completely independent. The third case is only found in those animals in which these glands have a poisonous function.

With regard to the ova the author is of opinion that they are merely cells detached from the wall of the ovary; and states that he thinks that the soft-shelled ova (summer-eggs) are produced as a result of mimicry.

The crystalloids of *Mesostomum* appear to have been carefully studied, and as a result we find that towards the end of summer the protoplasm of the different tissues undergoes a retrograde metamorphosis by which it is converted into bodies that seem to have the same function as starch-granules.

The results of his investigations on the development of *Leptoplana tremellaris* and *Eurylepta auriculata* are to show that, different as their history is, the earlier phenomena are the same in both; during and after the period of the extrusion of the polar globules the egg

* 1879, No. 19, p. 436. † See, *ante* pp. 90 and 263.

incessantly undergoes changes in form; the significance of these movements seems to lie in this, that after the extrusion of the polar globule the creature presents an example of atavism inasmuch as the Amœba phase is continued on till the Synamœba phase commences to exhibit itself. The gastrula is formed by "epiboly"; during the segmentation the nuclear protoplasm is alone active, the cellular remains passive; when the centre of the amphiaster coincides with that of the cell, and when the two axes correspond or are set obliquely, the two asters are equal, and the plane of segmentation is perpendicular to the axis of the amphiaster and divides it into two equal parts; but when the centres do not correspond, &c., the two asters are unequal, the smaller aster is that which is further from the centre, and the plane of segmentation divides the axis of the amphiaster into two unequal parts, and these parts are unequal in proportion to the difference in the attractive forces of the two asters.

The mesoderm is formed at the expense of four large endodermal cells at the oral pole, and before they unite into a continuous layer they form four primitive lines. An interesting point is the appearance of a fifth endodermal sphere, which becomes intercalated among the rest. It is only during development that the Rhabdocœlous intestine takes on, in the Dendrocœla, a dendritic form. The ectoderm is differentiated, as is the mesoderm, into two layers; the inner one of the former is that which gives rise to the "rods," and of the latter that which forms the reticulum which so greatly occupies the body cavity.

Turbellaria of Prague.*—Dr. Vejdovsky states that the Turbellaria form a very characteristic component of the fauna of the springs of Prague. Among the Mesostomidæ he has found a new species which he designates *M. Hallezianum;* it was found in dark spots, is snow-white, and has no eyes. *Stenostomum ignavum* n. sp. was found with *Æolosoma tenebrarum*, also a new species, and is easily distinguished from *S. unicolor*, at least by its much larger chitinous corpuscles and by its rods. In the *S. leucops* of authors he has discovered an oval gland which lies in the pharyngeal region over the water-vascular system, and is provided with a short efferent duct which opens to the exterior behind the central ganglion; it appears to belong to the generative apparatus and is regarded, so far as its orifice is concerned, as homologous with the cephalic pore of the Oligochæta.

New Parasitic Rhabdocœle.†—*Graffilla muricicola*, the subject of Dr. von Ihering's paper, is found as a parasite in the renal organ of *Murex trunculus* and *M. brandaris*, where it is easily distinguishable owing to its reddish-brown coloration. This discovery is very interesting as the number of parasitic Turbellaria as yet known is exceedingly small. The species in question, which sometimes attains to a length of 5 mm. is remarkable among its congeners from having a thick

* [Sep. rept.] 'SB. K. Böhm. Gesell. Wiss. Prag,' 1879, p. 501.
† 'Zeitschr. wiss. Zool.,' xxxiv. (1880) p. 147.

anterior and a narrow tail-like posterior region, these two being pretty distinctly marked off from one another. The cilia of the integument may be seen distinctly to exhibit their movement along parallel longitudinal lines; owing, perhaps, to its parasitic habits, the creature is not provided with those rods which have been called nematocysts or sagittocysts. The dermo-muscular layer consists of a layer of external circular, and of another of internal longitudinal muscles, and is separated by a basal membrane or protoplasmic layer from the epidermis.

The subjacent connective tissue is remarkable for only consisting of very large cells, applied directly to one another, without the intermediation of the slightest amount of fibrous or reticular tissue; the cells are of some size, and their membrane is very thick. As there is no differentiated enteric tract it is, of course, difficult to say where the connective tissue ends and the enteron begins; large as the connective-tissue cells are, their nucleus is exceedingly small; and as it colours not at all, or only at points, it is very difficult to see. Connected with this system there are a number of small spindle-shaped or branched cells, which lie just within the musculature, together with another system of subcutaneous branched and anastomosing cells, which have a plexiform arrangement, and which may be easily taken for nerves. It was not possible to demonstrate the existence of any water-vascular system.

The nervous system is well developed, its central portion being placed anteriorly, both above and below the œsophagus. The central portion is composed of a fibrous mass, round which there are set the small ganglion cells. The cerebral mass gives off anteriorly a number of fibres, which unite here and there into small ganglionic masses, and so get, lying as they do just below the integument, to have very much the appearance of the subcutaneous connective plexus, already referred to. The longitudinal lateral trunks, which are often so well-developed in other Turbellaria, are here feebly represented. There is reason to suspect, but there is not yet evidence to prove, the presence of an œsophageal nerve-ring. A distinct optic nerve was seen to pass to the eye, which consisted of a large dark mass of pigment with a large lens. No auditory organs were detected. The size of the cerebral mass is very remarkable, a transverse section taken though the region of the body in which it is placed being almost completely occupied by it.

The enteric tract consists of a well-developed pharynx, and a saccular aproctous intestine, which is, as a rule, devoid of processes. The pharynx communicates directly with the mouth, an arrangement not known in any other Turbellarian, in which it is always placed in a sac; the mouth, which is nearly round and capable of lively swallowing movements, is placed on the ventral side, a little posteriorly to the anterior end of the body. Just below the epithelium of the pharynx there is a circular layer of muscular fibres, which is separated from the outer circular layer by a large mass of radial muscles and connective-tissue cells; at the anterior end the circular muscles unite to form a powerful sphincter. The enteric tract presents some interesting characters, which leads the author to regard it as intermediate between the Acœlate and the Cœlate type. In most cases, a transverse section reveals no enteric lumen, and, even where one does seem to be present, it is easy to see that it is due to an artificial rupture of the tissue. Longitudinal sections reveal the fact that the ventral and dorsal walls differ in character; the former has a low epithelium, the cells of which are with difficulty distinguished. There is a small round nucleus and larger and smaller vacuoles can be made out in the protoplasm of the cells. The cells of the upper wall are much longer, and are not all placed in the same plane; their vacuoles are of considerable size; it is only in the most anterior portion that it is possible to see any indications of a lumen.

The study of the generative organs is complicated by the necessity of examining specimens of different ages, owing to the fact that, in these hermaphrodites, the male and female elements are not developed contemporaneously. In specimens 1 mm. long the two testes with the large seminal vesicle and the penis are alone present; in completely grown forms the vesicle is diminished in size and the testes have completely disappeared; but the female organs, consisting of two long, band-shaped ovaries, two greatly ramified yolk-glands, uterus, and receptaculum seminis, together with a number of unicellular glands which open into the uterus and form the shell of the egg-capsule, are exceedingly well-developed. There is a common genital pore. It is only possible to note one or two points in these organs:—

(1) The accessory glands, said by Hallez to be so common in the male Rhabdocœla, are altogether absent.

(2) There are a number of nuclei in each testicular cell.

(3) The spermatozoa seem to be provided with a delicate forked process at one extremity; but these are very difficult to detect.

(4) The ovaries are remarkable for being long and band-shaped; and the yolk-sacs for their ramifications.

The author concludes by pointing out some general results; the fact that *Graffilla* is the only Rhabdocœle in which the pharynx is not provided with a special sac or pouch, makes it necessary to form the family *Graffillida* for its reception. When we come to ask what relation this holds to the rest, we are brought face to face with the division of the group into *Acœla* and *Cœlata*, on which Uljanin was the first to insist. Later investigations seem to show that the presence or absence of a cœlom is not a point of primary importance. The Acœla share with the Cœlate genera *Macrostomum* and *Vera*, the absence of a pharynx and the union of the yolk-glands and ovaries—these are the Microstomida; but as the absence of a pharynx is of importance, we may place them in the division Apharyngea. The rest of the Rhabdocœla form the Pharyngea and among them the Graffillida occupy the lowest place. The absence of a gastric cavity is of importance as bearing on the Gastræa theory and on the probability of the descent of a Rhabdocœle from a Planæa or from an agastric Infusorian; Dr. von Ihering inclines to the latter view.

Characters of Tristomum Molæ.*—Dr. O. Taschenberg has lately come to the conclusion that this parasite of *Orthagoriscus molæ* is distinct from *T. coccineum*, with which it is often confounded. It is distinguished not only by the deep constriction at the hinder end of the body, but by the smaller size of the suckers at the sides of the mouth, as well as by other points. The largest examples of the species known to the author are from 13–15 mm. long, and from 15–17 mm. broad, and have a rounded form; the ventral sucker is $4\frac{1}{2}$–5 mm. in diameter; all the specimens examined had their intestine filled with a dark brown mass, whereas in the other species the contents are so slight that it is difficult to follow the course of the intestine. These dark contents seem to be formed by the mucus from the integument of the host, which is intermixed with dirt; at the same time, *T. molæ* is found on the gills as well as on the integument of the sunfish.

Loss of the Hooklets and Scolex in the Tæniæ.† — M. P. Mégnin has in a former communication‡ maintained that the armed and unarmed states of the *Tæniæ* are simply different degrees of development in the same parasite, and he now offers fresh proofs of this, and also shows that there is a third state quite as constant as the two others to which it regularly succeeds; this is the *acephalous* state.

The acephalous state is the index and proof of the cessation of the functions of an organ hitherto regarded as permanent and indispensable to the life of the individual—namely, the *scolex*, or head. The scolex is, however, a transitory organ of the same value as the hydatid cyst; it is only one of the numerous means of multiplication of which nature has been so prodigal in the *Tæniæ*.

The *Tæniæ*, when they exist under the form of the hydatid cyst, a form which succeeds to the infusiform embryo, multiply at first (or have a tendency to multiply) by fission. Then appears the germinal membrane, index of a second mode of multiplication and of the cessation of the first. This new mode is the multiplication by the *scolex*, true stolons armed with prehensile hooklets and suckers, which come into action as soon as these stolons, separated from the mother vesicle through its destruction, come in contact with an intestinal mucus, or in certain cases with a peritoneal serum.

At this moment these scolices become the seat of a third method of multiplication, that of buds, which always originate from the point opposite to the crown of hooklets, and these buds, adhering to each other, give rise to a chaplet or *strobila* of greater or less length. They are nourished by imbibition, grow, and become sexualized hermaphrodites, when a fourth—*oviparous*—mode of multiplication commences.

The maturation of the ova coincides in the *Tæniæ* with the detachment of the segment which contains them, and which sets them free by its death and destruction of its tissue. The ripening of the ova in most species of *Tænia* observed by the author is the signal of the

* 'Zool. Anzeig.,' iii. (1880) p. 17.
† 'Comptes Rendus,' xc. (1880) p. 715.
‡ See this Journal, ii. (1879) pp. 162 and 878.

cessation of the functions of the scolex, which at that moment cease to produce segments. It is then absorbed gradually, losing first its hooklets, then its suckers; it diminishes insensibly in bulk, and finally disappears. The *Tænia* is then literally *acephalic*, but its segments continue to grow, to sexualize, to fill with ova, and to detach themselves successively down to the last.

Thus, naturally, the parasite ends.

The duration of life in the *Tæniæ* is doubtless very variable, according to the species, and especially the medium in which it lives. These phases are relatively short among the *Tæniæ* of certain birds, in two of which (*Tænia infundibuliformis* and *T. lanceolata*), the author was best able to follow them out.

The specific determination of *Tæniæ* by the presence or absence of the hooklets is therefore entirely insufficient, and a revision of the nomenclature of these parasites has become necessary.

New Tænia.*—M. Mégnin has discovered the vesicular stage of a *Tænia* in a jerboa, which he is not able to group under any of the three old heads of *Cysticercus*, *Cœnurus*, or *Echinococcus*. Found in a tumour it resembled a mass of fibrinous concretions, each part of which was multitubercular; it resembled a very tortuous root, covered with distinct nodes, which again were charged with nodules; the smallest of these were of an elongated cordiform shape. The interior was filled with a clear liquid which communicated with all the parts, and so showed the vesicle to be single; the internal surface was provided with large cylindrical papillæ, each of which proved to be an invaginated scolex, with four suckers and the characteristic double crown of hooks. As the scolices belonged to the external surface the cyst most resembled the Cœnurus-stage, from which it differs, however, by its remarkable form, and by the fact that the buds remain attached to the parent vesicle. The author is unable to say whether this "polytubercular Cœnurus" belongs to a new species, or whether it owes its form to the special region of the body (face) which it inhabits.

In a more elaborate communication,† M. Mégnin discusses the view of Kuhn that there are two modes of proliferation among Echinococci, one exogenous and one endogenous, and describes a remarkable case of the former mode, which he observed in an entozoon in a horse; in one of the muscles of the thigh there was found an immense multilocular cyst, or rather a large number of contiguous cysts differing in size, and separated by tissue from one another; the contained hydatids varied in size from a pea to a pigeon's egg.

M. Mégnin then details some examples of Cœnuri and Cysticerci presenting the phenomena of proliferation during the hydatid stage, and concludes by briefly criticising the account given by Villot as to that author's new form *Staphylocystis;* he shows that as Staphylocystis is "monocephalous" and not "polycephalous" it ought rather to be allied to the Cysticerci than to the Echinococci, and that M. Villot is not the first to describe the phenomena of exogenous proliferation.

* 'Comptes Rendus,' lxxxix. (1879) p. 1015

† 'Journ. Anat. et Physiol.' (Robin), xvi (1880) p. 181

Echinodermata.

Buccal Skeleton of the Asterida and Ophiurida.* — This is another of Dr. Ludwig's interesting contributions to the morphology of the Echinodermata; it is primarily directed against the views put out by M. Viguier.† Both authors have, however, in view the same object, a desire, namely, to refer the parts of the buccal skeleton to definite parts of the arm, and the essential difference between them appears to Dr. Ludwig to lie in this: Viguier considers that four pairs of skeletal pieces, two ambulacral and two adambulacral, are to be found in the buccal skeleton; Ludwig thinks that only three pieces, two ambulacral and one adambulacral, enter into the composition of the same parts. The view of the former is based on the following facts, or supposed facts:—As every pore for the ambulacral suckers is in the arm bounded by four skeletal pieces, two ambulacral and two adambulacral, the same arrangement must obtain around the mouth. On the other hand, Ludwig holds that every ambulacral pore is, as a rule, bounded only by three pieces, namely, by two successive ambulacral pieces, which form the median, aboral, and adoral margins, and an adambulacral piece, which closes the pore laterally. If this view be correct, and it is one that is supported by anatomical and embryological investigations, it follows that Viguier's view is not supported by facts, and must therefore fall.

A further doctrine supported by the French anatomist is that the process and body of the "tooth" are, morphologically, of the same series as the adambulacral pieces; here again, Ludwig takes the directly opposite view, and says that they belong to the ambulacral set, and this view he bases on the following considerations:—(1) The muscular connection between the two "dental processes" has the same disposition as the lower transverse one of the ambulacral groove which connects together the two ambulacral pieces of the same pair; the view that this muscle is specially developed in the peristomial region is a corollary of the doctrine that the "dental process" belongs to the adambulacral series. (2) In young star-fishes the first ambulacral pieces are not distinct, but articulate with one another in the median plane, just as do all the other pairs of ambulacral pieces.

The author proposes to give the name of "ambulacral skeletal segment" to the skeletal pieces, which are set around the radial water-vessel, and are arranged in successive groups; each of these consists of two ambulacral, and of two adambulacral pieces. In the Asterida these parts take on the following characteristic arrangement around the mouth: the whole of the first skeletal segment and the ambulacral pieces of the second become more firmly united, and are converted into the parts of the buccal skeleton. *Ctenodiscus* is remarkable for having this arrangement extended to a further set of each series.

Passing over the other points in controversy between these writers, we come to Ludwig's account of his examination of the dry specimens of *Astrophyton arborescens*. Confirming on the whole the views of Johannes Müller, he directs attention to an interesting, and as yet

* 'Zeitschr. wiss. Zool.,' xxxii. (1880) p. 672.
† See this Journal, ii. (1879) p. 428.

unobserved arrangement; to make this clear, it will be necessary to state what obtains in the allied forms. In the Ophiurida the mouth-parts are more metamorphosed than they are in the Asterida; in the latter, the first two suckers arise independently of one another from the radial water-vessel, but in the Ophiurida they have a common canal, and this, as well as its two branches, lies in the calcareous pieces of the peristome, but the water-vascular ring is not enclosed in these pieces. Now, in *Astrophyton* a part of the ring is so enclosed, and we have, therefore, in it (and perhaps in all other Euryalida) a further metamorphosis of the constituent parts of the peristome than we find in the Ophiurida and, *à fortiori*, than in the Asterida.

In conclusion, the author discusses the homology of the buccal shields of the Ophiurida, and finds that they are homologous with the oral plates of the Crinoids, and the genital plates of the Echinoidea. Herein he so far agrees with Mr. Philip Carpenter that he thinks to be certain what the English observer thinks to be possible—namely, that the oral shields of the Ophiurida are homologous with the oral plates of the Crinoidea.

Undescribed Comatulæ from the British Secondary Rocks.*—Mr. P. H. Carpenter describes seven new Comatulæ from the cretaceous and oolitic series of southern England, together with some new facts respecting the *Glenotremites paradoxus* of Goldfuss, from the upper chalk. This species is remarkable for the presence of certain characters which are very conspicuous in the recent *Antedon Eschrichtii*, and also in a new species dredged by the 'Challenger' at Heard Island in the South Atlantic, namely, the presence of strong ribs on the inner wall of the centrodorsal, five of which, interradial in position, are much more prominent than the rest. So far as is yet known, these features occur in no other recent Comatula, with the exception of one species from the South Pacific, in which there is a faint indication of such ribs; but they are all equal. Another *Antedon* species is described from the chalk of Sussex. It differs from *Antedon paradoxus* in the absence of these ribs, and in the shallowness of the centrodorsal cavity.

Two species are described from the gault of Folkestone. One is an *Antedon* with no special relations to any recent forms. It might have lived as well at twenty as at five hundred fathoms. But the other species is an *Actinometra*, possessing certain characters only known to occur in species from quite shallow water, twenty fathoms or less, in the Philippine Islands and Malay Archipelago. The centrodorsal is a flat plate, nearly on a level with the surface of the radials, or sometimes even below them, separated from them by clefts at its sides, and entirely devoid, not only of cirrhi, but also of cirrhus-sockets. This condition is only an extreme stage of the metamorphosis of the centrodorsal piece, which bears cirrhi for a time after its liberation from the larval stem; but these cirrhi eventually disappear, and their sockets become obliterated. The 'Challenger' collection contains a series of specimens of *Act. Jukesii* from the

* 'Quart. Journ. Geol. Soc.,' xxxvi. (1880) p. 36. (1 plate.)

Torres Straits, which illustrate this point very completely; and it is therefore of no small interest to find a fossil Comatula which shows one of the extreme stages of the metamorphosis.

The large size of the three *Antedon* species from the chalk and gault is very remarkable. *Ant. paradoxus* has a centrodorsal half as wide again as that of any recent form; while *Ant. Eschrichtii* is the only recent species with a centrodorsal approaching the size of those of the other chalk *Antedon*, and of that from the gault. *Act. Lovéni* from the gault, however, and the older Comatulæ, all had small calices like most recent species. An elegant centrodorsal (*Ant. rotundus*) is described from the Haldon greensand, and also two species from the Bradford clay. One is an *Antedon*, the oldest known, with no special characters; the other is an *Actinometra*, with a centrodorsal essentially like those of species now living in shallow water in the Philippines and Malay Archipelago. The oldest known Comatula, an *Actinometra* from the Bath oolite, has similar relations.

Synthetic Starfish.*—Under the name of *Astrophiura permira*, Mr. W. Percy Sladen has described a most remarkable form of Echinoderm from the coast of Madagascar. While the ordinary starfishes present usually the well-known starlike form, with five or more rays springing from a central body, with which they are perfectly continuous, the body in the Ophiurids is a rounded or more or less pentagonal disk, from which issue five jointed arms, quite distinct in structure from the disk, and from the much stouter rays of the ordinary starfishes. Mr. Sladen's new form combines the characters of the two groups in a very singular manner, and, curiously enough, it is towards the somewhat aberrant forms of starfishes (such as *Goniodiscus*), in which the enlargement of the disk and shortening of the rays converts the whole body into a pentagonal disk, that the new type seems most to approximate in outward appearance. In fact, the arms are for the greater part of their length enclosed in a disk formed of calcareous plates, both above and below; but a small portion of jointed arm projects from each angle of the pentagon thus formed, and with the structure displayed along the lines of the arms on the lower surface sufficiently demonstrates the Ophiuridan affinities of the organism. By careful study, indeed, Mr. Sladen makes out that the whole skeletal structure is due to an abnormal development of the ordinary plates of an Ophiurid, but at the same time he recognizes in the structure of the animal a number of characters which tend towards the Asteroida, such as a great development of the ambulacral system, with formation of supplementary plates separating the tentacular compartments, the extension of the peritoneal cavity into the radial portions of the animal, and the organization of the mouth.

Teeth of the Echinoidea.†—Herr Giesbrecht finds that the structure of the teeth of the Echinoidea is very different from that of the test or of the spines; these latter are composed of a calcareous

* 'Ann. and Mag. Nat. Hist.,' iv. (1879) p. 401 (1 plate); see 'Pop. Sci. Rev.,' iv. (1880) p. 192.

† 'Morphol. Jahrbuch,' vi. (1880) p. 79.

meshwork, and there is a network of interspaces; no signs of any network can be seen in the teeth, for these have for their constituent elements lamellæ, or scales and prisms; the former are chiefly found in the body of the tooth, and the latter in the carina or longitudinal ridge, the face of which is directed towards the enteric tract.

The details of the paper are beyond the limits of any abstract, but their careful study leads the author to some not uninteresting conclusions. He has been led to see that Haeckel was justified in pointing out that, although the sensory organs of these creatures are but very feebly developed, the complicated structure of their hard parts is sufficient to justify their having a somewhat higher place in a zoological classification than is usually assigned to them; at the same time the author reminds his readers that the Rhizopoda also exhibit a considerably complicated structure of their test.

The writer does not point out the bearing which results of this kind have on the doctrine of evolution; it will however naturally suggest itself that the necessary conditions of existence having been in each case complied with, the animal has devoted itself to the complication of its parts in much the same way as a society of human beings at peace becomes daily more complex from the special activity of its individual members.

The tooth is attached to a saccular membrane which appears to be an invagination of the buccal membrane; in this membrane there is no appearance of cell-boundaries, but there are in it structures resembling the nuclei of cells; from it processes are given off which extend through the whole tooth, and surround all the calcareous parts. The presence of such protoplasmic parts is not only spoken to by the mode of growth of the teeth, but also by the fact that there are to be seen, in the larger lacunæ, bodies which are very much like cell-nuclei. The tooth would, in fact, appear to be thus developed: the epidermis of the animal extends inwards, the scales begin to be developed, the interspaces remain filled with living sarcode, and this finally forms a network, in the interspaces of which we find the skeletal parts. When the disks are developed this sarcode begins to disappear, and that only remains which has been already noticed.

Like other hard parts, of no apparent importance at first sight, the form of the skeletal parts of the tooth, and especially of the scales, appears to be constant in different genera, and, so far as observation extends, in different species; the author goes so far as to say that the form of the parts so affects the contours of the whole tooth, that a drawing of the circumference of a transverse section is probably sufficient to determine the species, and certainly the genus. If this be the case, Giesbrecht's observations will be of some assistance to systematists.

New Organ of the Cidaridæ.*—The structure described under this name by Dr. Hubert Ludwig is no other than that to which Mr. C. Stewart has already directed attention;† it is, however, of interest to observe that the German investigator has found, as Mr.

* 'Zeitschr. wiss. Zool.,' xxxiv. (1880) p. 82.
† See this Journal, ii. (1879) p. 888.

Stewart expected that some observer would, an organ of similar character in the Diadematidæ. There can be but little doubt that these organs have the functions of the gills which are found round the actinostome in the rest of the regular Echinida, although Dr. Ludwig feels himself unable to pronounce an opinion on the subject; in any case, his suggestion that living examples should be examined with a view to settle the question, is one deserving publicity.

Asthenosoma varium.*—Dr. Hubert Ludwig gives a careful account of this very interesting Echinothurid; in dealing with its affinities, he points out that it will be of considerable importance to definitely settle whether these creatures have or have not the peristomial branchiæ. Sir Wyville Thomson thought not, but Dr. Ludwig's specimens do certainly possess them, and as their presence is constant enough in all regular Echinida, with the exception of the Cidaridæ, the writer thinks that more careful examination will reveal their presence in the specimens of Professors Thomson and Agassiz. They are found in the peripheral portion of the buccal membrane, between the ambulacral plates, which are continued on to the buccal membrane; but there are no notches in the edges of the interambulacral plates for their reception, and this, together with their delicacy and small size, is probably the cause of their having been hitherto overlooked.

Other points in their organization are not so markedly Cidarid as has been hitherto supposed; and this leads us to a system of classification of the regular Echinida in which the Cidaridæ are marked off from all the rest; thus we have—

I. Echinida with ambulacral and interambulacral plates on the buccal membrane.
Cidaridæ.

II. Echinida with ambulacral plates only on the buccal membrane.
A. More than the two buccal plates for each ambulacrum.
Echinothuridæ.
B. Only two buccal plates for each ambulacrum.
Saleniadæ, Arbaciadæ, Diadematidæ, Echinometradæ, Echinidæ.

As all observers, with the exception of Alex. Agassiz, have failed to detect the presence of gills on the buccal membrane of the Cidaridæ, and as his statement cannot be borne out by his figures, and as the spaces which are taken by Agassiz in the figure of Johannes Müller (who was the first to point out the absence of peristomial gills in the Cidaridæ) to be gill-clefts are probably due to shrinking of the membrane,† Dr. Ludwig proposes to give to group I. the title of Abranchiata, and to group II. that of Branchiata.

As Dr. Ludwig shows, the presence of two genital pores in one of the genital plates is a point of especial interest; similar observations have been made on recent forms by other observers; Baily found in *Archæocidaris Harteiana* six pores in all but the madreporic plate;

* 'Zeitschr. wiss. Zool.,' xxxiv. (1880) p. 70.

† The researches of Stewart and Ludwig confirm Müller's views (cf. the preceding note).

M'Coy noted three in each plate of *Palæechinus elegans;* in other fossil species there have been seen from two to five pores. All these observations seem to show that in this, as in so many other characters, *Asthenosoma* approximates to the palæozoic sea-urchins.

Cœlenterata.

Anatomy and Histology of the Actiniæ.*—An elaborate paper by the brothers Hertwig is especially directed to increasing our knowledge of the nervous system of these creatures. Putting aside the Spongiæ, it is necessary to presuppose from the activity exhibited by the rest of the Zoophyta in the face of stimuli, and the wondrous degree of consentaneousness which their muscles exhibit in contraction, that they are really provided with some kind of nervous system. As to the Hydromedusæ, we have now a certain amount of information; but the remarkable investigations of Kleinenberg and Van Beneden on *Hydra* and *Hydractinia* respectively, far-reaching as they are, require to be repeated; Eimer and Chun are not in accord as to the nervous system of the Ctenophora; but in both these groups more has been done than in the Anthozoa.

The *Actiniæ* were chosen as the subjects of the investigation because of their easy accessibility, their convenient size, and the total absence of any calcareous skeleton. The authors found a nervous system of extreme simplicity; nerves and muscles are distributed throughout the whole of the body; they are very intimately connected with the epithelial layers which cover the surface of the body and line its internal cavity, while, at the same time, they are largely influenced by the characters of the supporting lamellæ of connective tissue. The results are due, the authors think, in large degree to their *method of examination;* little can be done with the fresh tissues which are too opaque and too contractile; using the same mixture of osmic and acetic acids as that which they employed in investigating the *Medusæ*, they were able to isolate not only the nerves, muscles, ganglia, and epithelial cells, but were provided with thin lamellæ of the tissues. Whole animals or pieces were placed for five or ten minutes in a large quantity of the mixture (·2 per cent. acetic and ·04 per cent. osmic acid in sea-water), and then washed for some hours in ·2 per cent. acetic acid; the macerated pieces were then stained with picrocarmine or Beale's carmine; specimens may be preserved in glycerine and water to which a few drops of strong carbolic acid solution are added. The authors enter into further details as to their treatment of the objects, and describe the effect of various poisons on the Actiniæ; the most successful method of killing them appears to be to introduce tobacco smoke by a tube into the bell-jar underneath which they are placed; they may then be treated with chloroform, and so soon as they cease to react to external stimuli they may be safely placed in dilute reagents without any fear of their changing their form. The last point to be borne in mind is that all reagents act very slowly on their tissues.

The first chapter of the "Special Part" deals with the anatomy and

* 'Jen. Zeitschr. Naturw.,' xiii. (1879) p. 457.

histology of *Sagartia parasitica*, *Adamsia diaphana*, *Anthea cereus*, *A. cinerea*, *Actinoloba dianthus*, and *Tealia crassicornis*.

The oral disk and the tentacles: here three layers can be made out, an external and an internal epithelial layer, with between them a supporting layer which is better developed on the oral disk than in the tentacles, and which consists of a transparent fibrous ground-substance with cells embedded in it. When the outer layer or ectoderm is subjected to higher powers it again may be seen to be divisible into three layers; the outermost is the best developed, and is made up of extremely long and fine epithelial cells; between the basal ends of these cells there appears a thin layer consisting chiefly of a special and finely granular substance, and then there follows a single layer of muscular fibres; these three layers are regarded as *epithelial*, *nervous*, and *muscular*.

To the three layers found by Heider in the epithelial, the Hertwigs add a fourth; so that beside stinging, glandular, and ciliated cells, there are also others which are sensory; the simplest are the ciliated, and these are very abundant; they are remarkable for each carrying a number of cilia; the sensory cells are very evenly distributed, but are perhaps a little more abundant towards the tip of the tentacles; they are exceedingly fine and filamentous, and are only continued into a single process. The processes of the integument may be divided into three sets: there are long delicate cilia, which are chiefly connected with the ciliated cells and are distributed over the whole surface; the cnidocils (Heider) are small cones truncated at the free end and seen, when examined with high powers, to be longitudinally striated; these striæ may further be broken up into a number of separate cilia. The third set of processes consists of long filaments, found only on the tentacles, which appear to represent tactile processes, and they are, in fine, cilia modified for a special purpose.

In the nervous layer we find that cells of a special character are associated with the fibres; these are often of a considerable size, either hemispherical or spindle-shaped protoplasmic bodies with a large round nucleus or nucleolus, and occupy a distinctly sub-epithelial position. When this layer is successfully macerated, it is possible to draw out the axis of the tentacle from its epithelial investment; when the ectodermal lamellæ are teased up it is often possible to find the nervous layer remaining attached to a small piece, and so to get a nearer view of the ganglion cells. These are best seen in the oral disk, where the fine granules are found surrounding the large nucleus, and the processes from the body, often of some size and length, become evident. The layer of nerve-fibres is seen to consist of a very thick and regularly well-developed network of fibrillæ, which cross one another at various angles and leave only small interspaces for the supporting cells. The ganglion cells connected with it are bi-, tri-, or multipolar; the first-named are the rarest; varying in size, they have the form of an elongated spindle, and are continued at one end into a nerve fibrilla; The tripolar cells are more common, and generally give off three fibrillæ, the multipolar are the largest and the most common; they often pass by a blunt process into the epithelial layer, and seem to be intimately connected in character with the sensory cells. The authors are of opinion that this indicates that the ganglion cells were primitively situated in the epithelial layer, and only gradually passed from being sensory cells to their later function and position. Successful preparations demonstrate that the nervous layer is connected with these sensory cells. As to the distribution of the ganglion cells, it is shown that the largest and most numerous are found arranged in several circles at the base of the tentacles, and in the intermediate tissue; thence pass off bands of cells slightly separated from one another, which converge radially towards the mouth, becoming rarer as they get nearer to it. In the tentacles the fibrillæ may be seen to have mostly a direction parallel to their axis, while the ganglia are smaller and are far less common than in the disk.

The muscular layer consists of long, very thin, and smooth fibres, closely applied to one another; in the centre of each there is a small collection of protoplasmic matter which surrounds the nucleus (Schwalbe); the longitudinal muscles of the tentacles pass at their base into the muscles of the oral disk; these take a radial direction.

Mesoderm: this is the musculature of Milne-Edwards and the earlier writers. In the tentacles it forms a very thin and easily prepared layer; it is seen, when separated, to have the same thickness in all regions, and to be made up of fibres connected together by a homogeneous intermediate substance; connective-tissue cells, stellate or spindle-shaped, are found in considerable numbers among the fibres. Careful focussing will sometimes reveal the presence of an outer layer in which the fibrillæ are set parallel to the long axis of the tentacles, and of an inner layer in which the constituent parts run at right angles to these. In the oral disk the mesoderm is increased in quantity, and the fibrillæ interlace very closely with one another. The authors direct attention to the higher degree of complexity attained to by the mesoderm of *Tealia*, in which fibres, primarily ectodermal in origin, enter into the composition of the mesoderm.

Endoderm: when this layer is examined in a longitudinal section of a tentacle, it is seen to consist of a muscular layer and of a simple layer of cylindrical epithelial cells; the latter are distinguished from those of the ectoderm by the length and singleness of their ciliary processes; in addition to these elements there are two others which are partly of a nervous and partly of a glandular character; and further there are special bodies which, in the opinion of the authors, are parasitic organisms; these they denominate the yellow cells; found in *Anthea cereus*, *A. cinerea*, and *Adamsia diaphana*, they are rounded bodies with a diameter of from 7–10 μ; they are surrounded by a doubly contoured membrane, and are easily isolated; their contents consists of more or less yellowish granules provided with a nucleus; they are the cause in many cases of the peculiar coloration of the animal.

In support of their view that these yellow bodies are parasitic in origin, the authors point out that (*a*) The yellow cells are also found in the mucus which is so abundantly poured out by the Actiniæ. (*b*) They are found from the tip of the tentacles to the disk in some species, while in others they are never, or at least only sporadically present; in other words, closely allied species may or may not be provided with them. (*c*) They are very similar to the yellow cells found in the Radiolaria, and these, as is known, are regarded by Cienkowsky as very lowly vegetable parasites. (*d*) It seems more than probable that the investing membrane is formed of cellulose.

The authors then pass to a consideration of the structure of the *wall* (Mauerblatt) and of the *disk-like foot:* these, just like the oral disk and the tentacles, are closely allied in anatomical structure; the greater part of the ectoderm consists only of an epithelial layer, and while the stinging and sensory cells decrease, the ciliated and the glandular cells increase in number. The mesoderm is thick, and consists of a number of layers of fibrillæ; in each layer the fibrillæ run parallel to one another, and the separate layers are very closely interwoven; the supporting lamella is continued into inwardly projecting folds of various heights, on some of which smaller folds are again developed. The endoderm has much the same character as before, but at certain points its muscular layer is very greatly developed, and so gives rise to the circular muscle of Rötteken. As seen in *Tealia* this structure has the following characters:—a longitudinal section reveals the presence of a strong process of the body-wall which projects into the cœlenteric cavity and forms, not far below the tentacles, a closed ring or circular welt; the central portion of this is occupied by a cord of connective tissue, and from its surface there are given off delicate laminæ, which are beset with secondary and tertiary lamellæ, and are held together like the leaves of a book. These are covered by circularly set muscular fibres, while the whole is covered by an endodermal epithelium, which, like the other parts, is separated at points for the passage of the septa; the object of this arrangement, which is also to be found in *Actinoloba dianthus*, is evidently to further the drawing of the wall of the body over the more sensitive oral disk and tentacles.

The *marginal saccules* ("bourses marginales") are also found in some few Actiniæ; they form a circle of small spherical projections set just below the outer circlet of tentacles, and in *Actinia mesembryanthemum* they are to be distinguished by their blue colour. These have been by numerous authorities (Schneider and Rötteken, Dana, and Duncan) regarded as eyes; Ludwig looks on them as urticating, and Korotneff as tactile organs. Our authors look on them as nematophores (urticating batteries), and thus describe their structure: the endoderm and mesoderm have the same structure as in the body-wall, but the ectoderm is thickly laden with urticating cells on its surface, and a nervous layer is developed in it. The authors point out the value of the position which they occupy in the animal, and further offer some criticisms on the observations of earlier writers.

The next structure in the body-wall which is described are the *pores* (*cinclides*, Gosse); these appear to be special means, not provided with any sphincters, by which a communication is effected between the interior of the body and the external medium.

Coming now to the *œsophagus* the authors direct attention to the elongated cleft which forms the mouth, and which has on either side a lip-like fold, and to the *œsophageal grooves* which pass downwards from the two angles of the mouth; these are richly ciliated, and as they remain open when the mouth is closed, it would seem that they are the means of conveying a constant current of water into the interior of the body.

In structure the œsophagus agrees very largely with the oral disk, but as the musculature disappears only two ectodermal layers are present in its walls; the epithelium, though thick, is in a single layer; the glandular cells are either coarsely granulated, or form clear spaces club-like in appearance, provided with a delicate membrane, and containing an open protoplasmic meshwork. Further investigations are required to demonstrate the extent of the connection between these two sets of cells. From the nervous layer ganglion cells are almost completely absent. The mesoderm is developed at points into longitudinal ridges, and the endoderm is provided with a circular layer of muscles, but there is not at the lower, any more than at the upper, end of the digestive tube any special sphincter muscle.

The *Septa and the parts appended* are the most complicated parts of the organization of the Actiniæ; they are provided with a supporting tissue of fibrous connective substance, which is invested on either side by a layer of muscular fibres and of epithelium, closely connected with one another; at their free edge they are continued into the mesenterial filaments with their acontia; and, finally, in their interior there are developed the generative organs.

The *fibrous connective substance* is derived from the adjoining regions of the body, strong fibrous bands breaking their way through the endodermal musculature and running along transverse planes which are separated from one another by feebly developed longitudinal fibres.

The *epithelio-muscular layers* present us with two systems of muscles which are separated from one another by the supporting lamella, and are distinguished by taking respectively a transverse and a longitudinal direction; the latter are by far the stronger, and the former are oftentimes so feebly developed as to escape the observation of investigators; in a number of Actiniæ the transverse fibres often form a special parieto-basilar muscle, the presence of which seems to be the cause of the sucker-shape of the foot-disk. In the examination of the elements of the epithelio-muscular layer *Sagartia parasitica* is the form in which it is most easy to make out the characters of the muscular fibres and of the epithelial cells; these two sets of elements combine to form the neuro-muscular, or epithelio-muscular cell, as the authors prefer to call it; each of these cells bears a single flagellum of some size; the cell itself may form a short cylinder, or may be extraordinarily long, and between these two extremes there are all kinds of intermediate conditions. In addition to these there are three other sets of elements in the tissues now under consideration; these are the nettle cells, the gland cells, and the neuro-epithelial cells. The last are those elements which in their external characters completely resemble the sensory cells of the ectoderm; but there still remain nerve-fibres and ganglion cells. If a specimen of *Sagartia* be taken and the epithelio-muscular layer stripped off, lacunæ and clefts will be found in the lamella thus obtained, and between their margins there will be found a number of fine fibrils; these are the nerve-fibres. To see the ganglia it is necessary to wash away part of the epithelium from the septa of specimens which have been hardened (*Anthea* is better than *Sagartia* for this purpose); there will now be seen delicate filaments which take a more or less perpendicular direction to the subjacent muscular fibres, and in the bundles of these nerve-filaments or connected with them by processes we find ganglion cells; some are excessively small, others appear to be well filled with protoplasmic contents; they vary greatly in form, but their distinct nuclei generally contain a large nucleolus.

As to the arrangement of the septa, having lately dealt with this subject,* we must content ourselves with drawing attention to the authors' conclusions; they find that all the septa of the Actiniæ are arranged in pairs, but that the first twelve, which arise from four equidistant points, are somewhat distinguished from the rest; from two opposite points arise successively two pairs, and from the two intermediate points (opposite to one another) only one pair. The other septa (secondary septa) arise in pairs and form cycles, each of which contains the same number of septa as all those which have gone before, and then, if they have any connection with the wall of the œsophagus, have only an incomplete one. They are always provided with

Generative organs. All the species examined had the sexes separate; the organs are placed in that part of the septum which lies internal to the strong fibrous bands of the longitudinal muscles, but the musculature of the septa is, at the points where the genital organs are developed, strong in an inverse proportion to the development of these parts. The male and female organs are both formed on the same type, and consist of follicles set in transverse rows; the mother-cells of the spermatozoa are described as occupying the periphery of the follicles while the matured spermatozoa are aggregated together and form radiating rows which pass backwards towards the periphery from the point at which they will, later on, be extruded. The ovarian cell appears to be attached to the surface of the epithelium by means of a finely striated process; this stalk appears to be the means by which the egg-cell obtains its nutriment, but the surrounding endodermal epithelium is also of importance in this particular; there may be separated from this, very long cells which are filled with highly refractive granules not of a fatty but of, apparently, an albuminous nature. On the interesting question of the origin of the generative organs the authors remark that, in the adult condition, these lie in the mesoderm, while the fact that the ova are enclosed between two endodermal layers and have no connection with the ectoderm, leads to the supposition that they are of endodermal origin; and this derivation appears to be truly

* This Journal, ii. (1879) p. 893.

direct, so that they only pass during development into the supporting lamellæ.

The *mesenterial filaments* are shown not to have the same structure in all their parts, but to consist of a median portion (bands of urticating glands) and of two lateral ciliated bands. Their structure is dealt with in detail; of their function it is thought that the median portion is secretory and that the ciliated bands which are not present on the lower portions of the filaments have a kind of circulatory activity. These organs are very largely supplied with nerves.

The *acontia* form the subject of the last division of this chapter: these protrusible organs are not to be found in all species of Actiniæ; but in *Sagartia parasitica* they form elongated filaments with a worm-like movement which are distinguished by their white or feebly violet colour from the yellowish mesenterial filaments; quickly protruded, they are but slowly retracted; in structure they are much as Heider has represented them to be, but the fact that their cells are modified to form stinging cells and not glandular cells prevents our ascribing to them any secretory function.

Anatomy of Cerianthus.* — Many investigators have, of late, directed their attention to one or other group of the Cœlenterata; among these we have now to number Von Heider, who has investigated the anatomical characters of *C. membranaceus*. Directing attention to the nomenclature of parts, as suggested by himself, the wall (*Mauerblatt*), or column, is by him called the *body-wall;* the disk, or oral plate, the *oral disk;* the stomach (*Gasse*) is named the *œsophageal tube;* and the tentacles may be *marginal* or *oral;* the arrangement of the tentacles is described in some detail.

To examine the internal structure, it is well to make a longitudinal section, and to pin the cut edges; if the creature is kept in sea-water it will long remain in a fresh condition; its longitudinal axis will indeed contract to about half its length, but the breadth will, in consequence of the feeble development of the circular musculature in this family, diminish very slightly. One great practical advantage of this arrangement is that *Cerianthus* does not break away from the needles which hold it, so easily as do most of the Actiniæ. Macroscopic examination now reveals the following arrangement of parts. The œsophagus extends from the oral tentacles about two centimetres downwards, and ends by a free margin in the body cavity. Two white grooves (the gonidial grooves of Gosse) become apparent, and these are looked upon by the author as the signs of the primitively bilateral arrangement of the parts of an Actinian. These two grooves differ considerably in character; one is very distinct, the other seems often to be hardly present. From the inferior edge of the œsophageal tube, which is always more brightly coloured, the inner margins of the now free septa pass downwards as continuations of the parallel grooves seen on the œsophageal tube. These septa may be arranged in three groups:—

(1) *Continuous Septa.* This name is applied to the pair of septa

* 'SB. K. Akad. Wiss.' (Wien), lxxix. 1st sec. (1879) p. 204.

which extend from the œsophageal tube to the porus abdominalis; in external appearance they have a close resemblance to the genital septa, but they enclose a groove which extends from the upper oral angle to the aboral end.

(2) *Genital Septa.*—These are not so broad as the preceding, and are distinguished by the presence of a well-developed ridge at their free edge. The substance of these increases at the generative periods.

(3) *Filamentous Septa.*—Of trapezial form, with their longest side inserted into the body-wall, and their shortest dependent into the "body cavity"; these bear a number of variously coiled and branched filaments. The substance of the septa is excessively thin and transparent, and they contain no specially remarkable elements.

Coming to histological details, the author attaches some importance to the fine network of branched processes from the ectodermal cells, which he calls the interbasal network; this is best shown in osmium or gold chloride preparations. The fibres, which are exceedingly fine, run in parallel lines, and give off at right angles branches which pass either to the ectodermal cells or into the mesoderm. This appears to form a nervous apparatus; the system is best developed in the upper half of the body, and here too we find a large number of urticating capsules, and here the ciliary action of the ectodermal cells is most energetic. So too in the tentacles, which must be regarded as the most sensitive portions of the body, the interbasal network occupies a wider space than it does in the oral disk or at the aboral end of the body; where this structure becomes diminished the glands of the ectoderm are more completely developed.

The sensory character of the urticating cells is spoken to by their structure as well as by the protoplasmic body which encloses the urticating capsule and the cnidocil which projects freely from the ectoderm, and seems so much to resemble the sensory hairs found in other groups of animals. In considering their structure, Von Heider points out that the more we study the various forms under which the urticating capsules or the cnidoblasts are developed, the more are we led to see that the stinging cells, which at first had no other function than that of developing and shooting out projectiles, have in the course of their development become converted into organs of perception, and that in many cases they have lost their primary function. This view is supported by the characters of the so-called chromatophores or marginal bodies, which are, primarily, a collection of cnidoblasts. Similar cases are to be observed in the structures developed on the tentacles, and this being so, the view that the basal processes are means of passage for nervous excitations seems to be supported by the fact that processes of cells are known to have this duty. Nevertheless, the author states that he has not been able to discover any indications of ganglion cells, but he thinks that the presence of one or several nerve-centres is not yet necessary to the Actiniæ. We must only expect to find the earliest or primary arrangements; and centres, such as ganglia are, are secondary developments. When we touch a tentacle of a *Cerianthus* which is in a state of contraction, that tentacle alone contracts; the rest of the creature undergoes no change; if we cut off part of a tentacle the rest of that tentacle contracts, but the neighbouring ones give no indications of being affected.

These considerations are brought into accord with other results, which at first sight would appear to contradict it, by supposing that two systems of fibres, which are connected with one another by numerous transverse branches, can be made out in *Cerianthus;* one is mesodermal and is embedded in the connective substance of that layer, and the other is ectodermal, is embedded in the interbasal network, and gives off, as already said, fibres to the ectodermal and to the mesodermal cells.

In the substance of the mesoderm there are to be observed canalicular spaces, which, as the author thinks, are correlated with the mode of absorption of nutriment in the Actiniæ. The amœboid cells which are found in this layer are looked upon as migratory cells, and they are stated to be much more numerous during the breeding periods.

Testis and Ovary in Campanularia angulata (Hincks).*—The histological study of the three layers, ectoderm, intermediate lamella, and endoderm, of the body in Hydroids, has led M. J. Fraipont to some new and important facts, of which he gives a summary.

The small nematocysts of the ectoderm of the tentacles are surrounded by a slight protoplasmic layer, often nucleolated and individualized, to which a palpocil corresponds. This relation is important from the physiological point of view, and that of the mode of action of the urticant organs.

The endoderm of the stolons in the vicinity of the pedicles of female gonangia (*Campanularia angulata*), and especially in the branches (*C. flexuosa*), contains larger cells, having, on the one hand, the characters of egg-cells, and passing, on the other, into the endodermic cells.

The free extremity of the appendicular organ terminated in a hook is characterized by the development of the ectoderm, by the accumulation in that tissue of corpuscles of special structure, and by the considerable attenuation of the perisarc. These data may perhaps serve to settle the nature of this organ.

In the body and tentacles the intermediate lamella, which elsewhere is amorphous, presents fasciculated fibrils, which insert themselves at definite points, and which the author believes to be muscular.

A *gonangium* is formed by a gonotheca, a central system of canals, and some gonophores. The axial canal, or blastostyle, spreads out into a hammer-head at the upper extremity of the *gonangium*, and furnishes laterally those cæca at the level of which the gonophores are formed. In *C. angulata* and *C. flexuosa* the latter do not become either medusæ or semi-medusæ, as in other *Campanulariæ;* they remain in the condition of diverticula of the wall of the body, and certain of their cellular elements become ovary or testis.

* 'Comptes Rendus,' xc. (1880) p. 43; see 'Ann. and Mag. Nat. Hist.,' v. (1880) p. 265.

The spermatozoids seem to be formed by a small nucleus, or fragment of a small nucleus, surrounded by a little of the protoplasm of the mother-cell, of which the rest serves to form the tail.

The female gonophore contains only one ovum, the germinal vesicle of which, when not fecundated, is analogous to that described by W. Flemming, E. van Beneden, Kleinenberg, O. Hertwig, and Bergh, in various animals. It contains a small clear corpuscle of irregular form (Schrön's corpuscle), from which start from three to six filaments which appear to terminate at the inner surface of the germinal spot; carmine colours it strongly. Segmentation by transverse furrows of unilateral direction produces a ciliated *planula*, showing a cellular ectoderm and an endoderm.

Four opinions are current as to the origin of the sexual organs: Huxley, Keferstein and Ehlers, Claus, Kleinenberg, Schulze, and O. and R. Hertwig, think that the sexual organs originate from the ectoderm. On the other hand, Kölliker, Haeckel, Allman, Claus, and Korotneff, maintain their endodermic origin. E. van Beneden supports a third opinion, namely, the ectodermic origin of the spermatozoids and the endodermic origin of the ova. Van Koch and Bergh confirmed Van Beneden's views. Lastly, Ciamician has maintained the ectodermic origin of the ova and the endodermic origin of the spermatozoids in *Endendrium ramosum*.

In *Campanularia angulata* and *C. flexuosa* the whole development of the sexual organs may be traced by studying a *gonangium* from its base of insertion to its apex.

In the pedicle of the male gonangium, the cœnosarc is constituted as in the stolons and the branches; but at one or two points the ectoderm is more thickened and its cells better defined. Higher up, at a certain point, the cœnosarc is inflated into a small tubercle, into the interior of which penetrates a cœcal diverticulum of the central cavity, bounded by a few endodermic cells. Beyond the latter we see the intermediate lamella, then some well individualized ectodermic cells, larger than the others (these are the *mother-cells of the testis*); and finally the whole is covered by the ordinary ectodermic cells. In the cavity of the gonangium, at its base, are young gonophores, in which we find, from within outwards, a diverticulum of the cavity of the blastostyle, epithelial endodermic cells, the intermediate lamella, a small cellular mass of a horseshoe shape, originating from a few differentiated ectodermic cells, and, lastly, a layer of ectodermic cells. The little mass is the young testicular tissue. The different gonophores have the same constitution, with the exception of the development of the tissue, which gradually acquires a larger and larger volume. In the uppermost gonophores all the elements which surround the mature testis are in process of atrophy. The conclusion is that the spermatozoids originate from the ectoderm.

In the pedicle of a female gonangium we find at the base one or two large endodermic cells projecting into the gastrovascular cavity, having a large nucleus and no vibratile flagellum, in fact, presenting all the characters of young ova of the gonophores. At the upper extremity of the pedicle we see one or two differentiated endodermic cells, but with no direct connection with the gastrovascular cavity, as two or three small endodermic cells cover them. Further up, towards the base of the cavity of the gonangium, the cœnosarc gives origin to lateral diverticula. One of them presents in its interior a small cavity, the cavity of the cæcum of the blastostyle, bounded by a series of endodermic cells. To the outer surface of this layer is attached a young ovum. *The intermediate lamella passes above this ovum;* and further out is the ectodermic lamella. In the upper gonophores the same conditions exist, but the ova become more and more voluminous. When the ovum is mature the tissues surrounding it are in process of atrophy. The endodermic origin of the ova is therefore evident.

Bringing together these observations, and those of E. van Beneden and Bergh, the author concludes that in the family Campanularidæ, the spermatozoids are developed at the cost of the ectoderm, and the ova at the expense of the endoderm.

Lafoëa parasitica — New Species of Campanularian.* — While working at Sertularians at the Trieste Zoological Station, Professor Ciamician obtained specimens of an *Aglaophenia* as yet undescribed, upon which large hydranths of a Campanularian seemed to be growing. These turned out to belong to a new species of *Lafoëa.* The hydrorhiza is threadlike and creeping, the hydrothecæ are large cylindrical cups without operculum, seated on very short two or three-ringed pedicels, and the hydranths are cylindrical with conical hypostome. The species is most nearly allied to *L. parvula* and *L. pygmæa.*

The creeping hydrorhiza of the parasite follows all the windings of that of the *Aglaophenia*, and ascends the hydrocauli of the latter, bearing hydranths disposed alternately at pretty regular intervals. That the ascending processes of the hydrorhiza must not be regarded as hydrocauli is shown by their not terminating in a hydranth at the upper extremity, as is the case in the hydrocauli of all Campanularians. All that correspond to hydrocauli are the short lateral pedicels of the hydranths.

The parasite does not wind around the *Aglaophenia*, but is attached to one side of it. The perisarc of the two hydroids cannot be separated either by maceration or by mechanical means.

Attention is drawn to the fact that gonophores have never been observed among the Lafoëidæ, and suggests that reproduction may take place, as in *Schizocladium ramosum* Allman, by budding only; or, at least, that sexual forms may only occur at rare intervals. The perisarc of the ascending hydrorhiza in *L. parasitica* remains open at the ends, so that a bud from the terminal cœnosarc might easily be set free.

The remarkable development of the hydranths and of the ascending hydrorhiza, and the unusual regularity in disposition of the hydranths, in this as compared with the other species of *Lafoëa*, which grow on stones and algæ, as well as its restriction to a single species of *Aglaophenia*, are finally pointed out.

* 'Zeitschr. wiss. Zool.,' xxxiii. (1880) p. 673.

Internodes in Sertularians.*—Taking *Sertularia pumila* Linn. as the first example in which to show the modifications which these parts may undergo, G. Winther finds that in this species the rule which assigns a joint to the stem between each two pairs of internodes, is liable to many exceptions. This joint is often more or less obliterated, e. g. in the lower part of the stem; a thickening of stem occurring in its place: higher up in the stem the parts are all more slender and the joints more conspicuous than below. Again, instead of having two hydrothecæ only, the internode may bear four, and is then described as an internode of the second order. Typically, the upper third of the hydrotheca is *free*, and makes an angle with the rest, but the younger and more slender is the internode, the more nearly parallel are the two hydrothecæ; while near the root the upper part of the internode between the cells becomes broader, deflecting these to the sides, so that they form a large angle with their bases; this dilatation in time reaches the lower part of the internodes.

The bending and freedom of the upper end of the cell are not due to its growth at this part.

In *Sertularia gracilis* Hassall, the form of the internode is not a fixed one; though in general it is longer and more slender than that of *S. pumila;* but examples high up on the stem may excel thick ones of that species. Here, too, it is the greater or less freedom of the parts composing the joints which affects the slenderness of the internode. The breadth of the joints has no significance as a character, as it varies with the internodes. Variations from the bi-celled arrangement are less frequent than in *S. pumila*. The flexion of the hydrotheca is greater and the stem is thinner than in that species; facts probably due to the slighter build and consequent greater pliability of the parts. It is the amount of projection of the hydrothecæ which distinguishes the species. By way of formulating the differences between the two, it may be stated that the tendency of *S. pumila* is to enclose more hydrothecæ by excessive development of the stem; in *S. gracilis*, for these to remain unaffected by that part.

In *Sertularia cupressina* Linn., an internode carries as a rule six calycles, therefore it is of the third order. But internodes of the second or of the fourth (with eight calycles) order may occur; or in some colonies first order internodes may appear. But this species is fundamentally distinct from the two-celled *S. pumila* in the alternating arrangement of the calycles on the stem; they being opposite each other in that species. Owing to this alternating position the cells are not laterally deflected with age.

S. tenera Sars presents great affinities with the preceding form. There is a considerable distance between the pairs of calycles, and second order internodes are the typical arrangement. They may be preceded by those of the first order, and a parallel branch may show some of the third order; but the thickness and shortness of the stem increase with the number of cells. The thickness of all parts of *S. tenera* is always less than half that of *S. cupressina*. A special feature of the species is the intercalation, chiefly singly, of small bare joints

* 'Nat. Tiddsk.,' xii (1879) p. 303.

at the lower part of the stem. The hydrothecæ may become almost opposite.

An axillary calycle is a peculiar and constant occurrence between the branch and the stem; in position, it is alternate with the cell next below it, and on the same side as that next above it in its own internode. The cells are more free than in *S. cupressina* only in internodes of the first and second order. The inclination to form internodes of a high order is less than in *S. pumila*. *Gonothecæ* have been found in *S. tenera*, but only in colonies much smaller than those of *S. cupressina*—these may be only 30 mm. in height.

The results of M. Winther's observations convince him that the four species are so closely connected together in pairs, that they must be reduced to two; thus *S. pumila* Linn. with *gracilis* as a dwarf variety, and *S. cupressina* Linn. with variety *tenera*, alone remain; and it must be concluded that the tendency to develop the stem at the expense of the internodes is no basis for distinguishing species.

As to the homologies and morphological importance of the internodes in their simple or compound state, the study of young colonies and basal parts shows the compound ones to arise from obliteration of joints between simple ones. The transitions from one order to another are not abrupt. Internodes of the first order appear in *S. cupressina* only as leading up to those of higher orders. Their *form* depends on whether the development is uninterrupted in its completion or not; in the latter case the internode may be finished before a cell is added to the stem; in the former, new cells keep appearing before the next joint is formed. After an active period like this last, exhaustion appears to set in and a joint terminates the internode. The production of cell-less internodes is explained by the independent development of the stem and the cells, the former being developed earliest.

Blastology of Hydra.* — Dr. Haacke commences with a short account of the specific characters of the members of the genus *Hydra*. He says that he has taken great trouble to try and find the specific names for the not-green *Hydræ* which he has had in hand; but the work has been vain. A revision seems to be needed, for the peculiarities on which species have been founded are variable, and this applies to the number and length of the tentacles, to the form of the body, and the position of the buds, as much as to the colour. The author has found one point which he thinks to be of importance; in the buds of one species all the tentacles appear simultaneously, while in the other only two—and those two opposite to one another—appear together, and the rest gradually spring up separately. As he has to give new names to these two, he calls the first *H. Trembleyi*, and the second *H. Roeselii* (after Rösel von Rosenhoff); the third species of the genus is *H. viridis*.

The paper will only be, however, intelligible to those who are acquainted with every term employed by Professor Haeckel, and by those who go even further than he; the rest must be contented to know that Dr. Haacke finds that the remarkable mode of development

* 'Jen. Zeitschr. Naturw.,' xiv. (1880) p. 133.

of the tentacles of *H. Roeselii* is due to the influence of the formation of colonies, just as the bilaterally symmetrical ground-form of the coral person is due to the same cause; * the reason why this symmetrical arrangement is not evident in the adult *Hydra* is that it separates so soon from its parent stock, which is not the case with most corals; in fine, in *H. Roeselii* we only see the bilaterally symmetrical ground-form in a nascent state. The typical number of four, which, as Haeckel has shown, is to be seen in the development of the Hydromedusæ, and in the palæontological history of the Corals, has a reason found for it in the fact that in the developing *Hydra* the number is indefinite; *H. Roeselii* has reached a stage in which two tentacles are the first to appear, and then there appear two others at the points where they are least confined; this gives us the quadrate pyramid. In many adult examples no more appear, and, where they do, the first four can often be easily recognized. The reason why three do not appear is that the first two develop under exactly similar conditions; if they were only succeeded by one tentacle a space would be left which would be equally convenient for the development of another. From these short notes it will be seen that although the paper is almost unreadable on account of its profusion of technical terms, it is exceedingly interesting as being an example of the strict application of the so-called mechanical principles.

Mode in which Hydra swallows its Prey.†—The current idea is that *Hydra* swallows by taking its prey in its tentacles and turning tentacles and all into its stomach. However, the part played by the tentacles ceases as soon as the mouth comes in contact with the food. The *Hydra* then slowly stretches itself over the food in a way that recalls to some extent the manner in which a serpent "gets outside" its prey, or in which an automatic stocking might stretch itself on to the foot and leg. No care seems to be taken, however, to present the easiest point for deglutition, and an Entomostracon may be swallowed sideways, for instance. So far are the tentacles from co-operating in the act, that they are usually reflexed away from the food; occasionally, however, they are swung forward for a moment around the mass, as if to ascertain how much remains to be swallowed. If the prey be at all bulky, immediately after the whole act is completed the body-cavity is everywhere filled and on the stretch, but after a short lapse of time the body contracts forcibly along the long axis, so that the part containing the food is globular, supported on a slender foot, and with a slender apical process bearing the tentacles around the hypostome.

Mr. M. M. Hartog thinks he has found a clue to the false idea referred to. A *Hydra* that had swallowed a morsel larger than itself disgorged, as frequently observed, on his attempting to take it up for examination. On finding it half an hour after, three of its tentacles were turned into its digestive cavity, whence they were successively and slowly withdrawn. As the mouth closes but slowly after

* See this Journal, ii. (1879) p. 892.
† 'Quart. Journ. Micr. Sci.,' xx. (1880) p. 243.

disgorging, he imagines the swallowing them to have been accidental; and a similar phenomenon carelessly observed may well have given rise to a false interpretation.

It seems that here we have the true explanation of the occasional presence of nematocysts in the endoderm; and this explanation Professor T. J. Parker is now inclined to accept. As regards the absence of the interstitial cells from the tentacles of *Hydra fusca*, Mr. Hartog is not able to confirm him; on the contrary, they are present, though in isolated patches, and not forming a continuous network as over the body. The best way to demonstrate these is, having killed a *Hydra* extended on a slide by letting fall a drop of 1 per cent. osmic acid on it, to at once wash away the acid by a flood of absolute alcohol, and then after a few minutes to stain with ammoniacal carmine or picro-carmine. If the *Hydra* is now examined in glycerine under a power sufficiently high to focus successive layers, the presence of interstitial cells can be made out. Owing to their dispersion, the want of them in a section becomes very slight evidence for their absence.

Porifera.

Octoradiate Sponge — Development of Sponge-Buds.*— The sponges here treated of by Professor Selenka are interesting, as coming from a locality—Rio Janeiro—where the sponge-fauna has been little studied hitherto. Two genera, the one belonging to the Ancorinid, the other to the Corticate group of siliceous sponges, are mentioned. Of the one, *Tetilla* O. Schmidt, which the author re-characterizes, he states that it is monozoic and diœcious; both males and females multiply by discontinuous gemmation. One new species, *T. radiata*, was found in mud; it is of a blush-red colour. The single osculum leads into a funnel-shaped cavity, from which radiate four short, wide canals, which each divide into two, and ultimately end in the ciliated chambers. *T. euplocamos* O. Schmidt was also found, and displays the same essential arrangements of the canals, but with less regularity. An *octoradiate* arrangement is the result of the bifurcation of the four primary radial canals. This, however, is not to be regarded as indicating a transition to the Cœlenterata, for it is brought about by the development in this particular case of a root-tuft, and is not manifested in the arrangement of the peripheral ciliated chambers. However, it serves to show how radial symmetry may arise out of asymmetry, and perhaps to mark an outlying section of the Spongida distinguished by a somewhat fixed radial arrangement. It is worthy of notice that the quadriradiate spicules which project from the body serve not only to anchor it, but also to capture minute prey.

Gemmæ are produced in great numbers—forty to one hundred on an average—in almost all individuals. The commencement of the bud is caused by multiplication of mesoderm cells just under the dermis round one or a few spicules, until a globular mass full of cells, and containing twelve to twenty ciliated chambers, is produced; this protrudes from the surface of the sponge, and is eventually projected from it on a bundle of spicules. Meanwhile, double-pointed linear spicules

* 'Zeitschr. wiss. Zool.,' xxxiii. (1879) p. 467 (2 plates).

are being produced, which form a root-tuft to the bud. When the bud leaves the parent it consists of a unilaminar external layer of distinct cells—to which, however, it is undesirable to apply the name of ectoderm—but mainly of closely-packed mesoderm cells without membranes or intermediate substance; a small number of ciliated chambers are present. Further development could not be satisfactorily traced. No ova were found in females between June and August, so there is perhaps an alternation of sexual and asexual reproduction.

Of *Tethya*, a new species is described from the rocks between tide-marks, *T. maza*. It is orange-coloured, has a single osculum, a set of large stellate spicules in the dermis, and of smaller ones occurring with these and also in the parenchyma; there are two sizes of radiating linear spicules, which are said to be either double- or single-pointed or doubly blunt. Gemmation appears to occur only in winter; 300 to 400 buds may be produced without cessation. The stellate or fusiform cells surrounding the spicule bundles at the surface become small, with large nuclei, and multiply; into the masses thus formed, ciliated chambers from the parent penetrate in bundles, losing their connection with the maternal canal system. The exterior part of the bud now consists of mesoderm cells, while the centre is occupied by radially arranged masses of ciliated chambers and their canals; it is extruded by a bundle of spicules from the parent. The subcortical spaces are formed in the mesoderm by separation of its cells, and become clothed with endothelium; the mesoderm cells mostly become stellate or fusiform. Spicules also appear before the bud is set free, but no osculum or subdermal cavities.

Asexual Reproduction of Leucosolenia.*—The species on which M. Vasseur's investigations were made was *L. botryoides* (the *Ascandra variabilis* of Haeckel); the interest of the paper lies in the fact that, hitherto, no mode of asexual reproduction has been observed in the Calcareous Sponges, although it is well known in the Fibrospongiæ. Professor Haeckel goes so far as to say that though he has examined thousands of Calcispongiæ, he has never been able to discover the formation of any gemmules. While at Roscoff, M. Vasseur obtained from the "Ile de Bas" specimens of this sponge, which were provided with singular pyriform prolongations, in which were a number of very long acicular spicules. What was, however, at first most remarkable was the direction which these spicules took; for these, instead of being directed towards the termination of the tube, were turned in the opposite direction; the pyriform prolongations were soon observed to be closed at their free extremity.

These prolongations, or buds, as they may henceforward be called, were by their interior in communication with the cavity of the sponge. After this preliminary examination, some days passed before the sponges were again examined. Now a remarkable arrangement was seen: new prolongations had been formed, while a number had separated from the parent-sponge, and others were on the point of detach-

* 'Arch. Zool. expér. et gén.' (Lacaze-Duthiers), viii. (1880) p. 59.

ing themselves. It is, of course, possible to say that this separation was due to the commencing decomposition of the sponge; on the other hand, it was certain that the parent-sponge was still in full vital activity. When the free buds were studied, it was found that they had broken off at the point at which they were budded off, and that at this point the process was elongated into the ordinary flask-neck shape, so that they now represented young specimens of the species, and had their spicules turned in the ordinary direction. Large specimens of Leucosolenia never present this mode of reproduction. Is it possible that, as the author suggests, we have to do with an alternation of generation, and that the products of sexual reproduction reproduce themselves by gemmation?

Protozoa.

Shepheardella—a new Type of Marine Rhizopoda.* —Mr. J. D. Siddall describes and figures *Shepheardella tæniformis*, a new genus and species of Rhizopods, from Tenby.

The body of the Rhizopod is unicellular, elongated, and abruptly pointed at both ends, flattened and ribbon-like when in a state of activity, rounded and worm-like when at rest. It is furnished with a flexible, transparent, colourless integument of considerable firmness; and the whole tubular cavity is densely filled with yellowish, coarsely granular protoplasm, having a very distinct oval nucleus, and occasionally also a few scattered non-contractile hyaline vesicles. The sarcode rotates in a regular stream around the interior of the integument, and carries the nucleus along with it, the current performing a complete circuit within the cell. The nucleus is seldom carried entirely round the cell, being as a rule intercepted in its course along one stream and passed over into the opposing one before it has travelled far from the centre in either direction. The opposing streams of sarcode thus formed on the two sides of the cell are not separated from each other by any clear line, as in Characeæ, though otherwise much resembling the phenomenon observable in the living vegetable cell. The principal difference between the two is in the direction of the current, that of *Chara* advancing in a spiral direction, while that of *Shepheardella* completes its circuit in one plane, the two currents slightly overlapping each other. The integument is perforated at each end by a minute aperture, through which some of the sarcode passes and collects into a small mass. From this mass a very delicate coating spreads over the whole exterior surface of the integument, and this thin layer occasionally throws out a pseudopodium. But the great network of inosculating and branching pseudopodia are at the two extremities of the organism, extending themselves from the terminal masses of sarcode to a distance considerably exceeding the whole length of the body. The circulation of the finer granular sarcode in the pseudopodia is easily traced. It is very rapid, advancing and returning in single, double, or even triple streams, according to the breadth of the pseudopodium traversed, so that from the rotation of the chief mass of sarcode within the test and the external circulation in the pseudopodia, it

* 'Quart. Journ. Micr. Sci.,' xx. (1880) p. 130 (2 plates).

is evident that every part of the body-contents, the nucleus excepted, is in turn brought in contact with the surrounding water. The combined movements present an evidence of vigorous life rarely exhibited among the Rhizopoda, and the transparency of the "test" permits the internal functions of the organism to be as easily followed as the external.

The specimens observed varied in size between the two extremes of 1·75 and 7·5 mm. in length, and 0·042 and 0·5 mm. in breadth.

The phenomena connected with the life-history and reproduction of this remarkable Rhizopod have not been fully made out, but the author adds some provisional remarks on the subject, as well as histological details regarding the sarcode and nucleus. He considers it premature to assign it any systematic position until the particulars of its life-history are more fully known.

The chief food of the animal appears to consist of infusoria, which are not, as a rule, conveyed into the body, but digested among the pseudopodia outside the test.

New Group of Marine Siliceous Rhizopoda—Phæodaria.*—Professor Haeckel describes the Phæodaria, a new group which he proposes to form of large marine Rhizopods, rich in specific forms and remarkable in many respects, which have hitherto been included in the typical Radiolaria (Sphæridea, Discidea, Cyrtidea, Cricoidea), from which they differ as widely as do the Acanthometrina. Till lately very few forms were known; but the explorations of the 'Challenger' have brought to light a number of new deep-sea species.

Their size is usually very striking in comparison with that of the other Radiolaria, which they greatly surpass in diameter. The greater number are visible to the naked eye, and many are from ½ to 1 mm. or more in diameter. As Murray first showed,† a striking character of all these Rhizopods is the constant presence of large, dark brown pigmented granules, scattered irregularly round the central capsule, and covering the greater part of its outer surface. This extra-capsular mass of dark pigment Professor Haeckel calls the Phæodium (φαιός or φαιώδης = dark brown, dusky). The Phæodella or large brown granules of the Phæodium are not, as Murray supposed,‡ true pigment cells, as a true cell-nucleus cannot be observed in them; and the nature of the peculiar pigment of these pseudo-cells is not precisely known, but the quantity and constancy with which the Phæodium appears in all Phæodaria, while it is wanting in all the typical Radiolaria, gives the Phæodaria a high degree of systematic importance, and it seems to Professor Haeckel at present that the constant presence of the Phæodium and the peculiarly constructed membrane of the central capsule are the only systematically reliable characters which separate all Phæodaria from all other Radiolaria.

The characters of the group may be defined as follows:—

Single-celled Rhizopods, whose larger cell-body, the central capsule (usually round or spheroidal, often, however, egg-shaped or some-

* 'SB. Jen. Gesell. Med. und Naturw.,' 1879, p. 151; see Transl. 'Nature,' xxi. (1880) p. 449.

† 'Proc. Roy. Soc.,' xxiv. (1876). ‡ Loc. cit., p. 536.

what oval, having merely the histological value of a single simple cell), encloses a nucleus or inner vesicle of large size, usually more than half the diameter of the central capsule, and sometimes with one large nucleolus and sometimes several. The cell-membrane is always double, pierced by one or more large openings, through which the intra-capsular protoplasm communicates with the much more abundant extra-capsular protoplasm. In the latter, towards the outside, lies the Phæodium, a peculiar thick mass of dark pigment-granules (or Phæodella), which are usually dun brown or black-brown, often greenish or dun green and like the Phæodium of varying form and size. Sometimes the Phæodium envelopes the greater part of the capsule, sometimes only one side of it. The whole body is enclosed in a thick gelatinous covering, which is often provided with spaces which the numerous pseudopodia traverse in order to radiate freely beyond its outer surface. With very few exceptions (the small division Phæodinideæ) a well-developed, always extra-capsular siliceous skeleton is secreted which forms, as in the different groups of the typical Radiolaria, very varied and delicate structures usually radiating outwards in hollow siliceous tubes.

According to the structure of the siliceous skeleton Professor Haeckel distinguishes in the group four orders and ten families.

Order I. Phæocystia.—The siliceous skeleton is either entirely wanting or it consists of hollow spines, arranged sometimes irregularly, sometimes regularly, outside the central capsule.

Family 1. Phæodinidæ.—Siliceous skeleton entirely wanting. Genera: *Phæodina*, *Phæocolla*.

Family 2. Cannorhaphidæ.—The siliceous skeleton consists of numerous separate hollow spines, or portions of hollow network, which, scattered round the periphery of the extra-capsular soft substance, are usually arranged tangentially. Genera: *Cannorhaphis*, *Thalassoplancta*, *Dictyocha*.

Family 3. Aulacanthidæ.—The siliceous skeleton consists of hollow radial spines, which spring from the outer surface of the central capsule, and traverse the extra-capsular jelly. The outer surface of the jelly is usually covered by a thick mantle of fine hollow siliceous needles, which are arranged tangentially and felted together. Genera: *Aulacantha*, *Aulancora*, *Aulographium*.

Order II. Phæogromia.—The siliceous skeleton consists of a single fenestrated shell which is of different forms, sometimes round, sometimes egg-shaped, often dipleuric, but always furnished with a large principal opening or mouth (more rarely with several openings). Hollow spines with peculiar pore-areas at their bases are often present.

Family 4. Challengeridæ.—The siliceous skeleton consists of a fenestrated shell, uniaxial or dipleuric, often laterally compressed and carinated, often egg-shaped or oval, and furnished with a wide opening at one end of the axis. This mouth is seldom simple, it is usually armed with a hollow tooth, or with one or more often branched hollow tubes. The fenestrated structure of the siliceous shell resembles most closely that of the diatoms; there is a fine pore in the middle of each of the hexagonal facets.* Genera: *Challengeria*, *Tuscarora*, *Gazelletta*, *Porcupinia*, *Entocanula*, *Lithogromia*.

Family 5. Castanellidæ.—The siliceous skeleton consists of a simple round fenestrated shell, which has in one part of its upper surface a wide opening, often surrounded by peculiar processes. The fenestrated shell is usually ornamented with solid or hollow spines. Genera: *Castanella*, *Castanidium*, *Castanissa*, *Castanopsis*, *Castanura*.

Family 6. Circoporidæ.—The siliceous skeleton consists of a subspherical or polyhedral siliceous shell, from which radiate in different directions hollow tubes (simple or branched, often provided with whorls of cilia). The shell has a large opening, as well as scattered pore-facets. The pores usually form circles round the bases of the spines.† Genera: *Circoporus*, *Circospathis*, *Circostephanus*, *Porostephanus*, *Porospathis*.

Order III. Phæosphæria.—The siliceous skeleton consists of numerous hollow tubes which are combined in a peculiar manner into a large, usually round or polyhedral fenestrated body.

Family 7. Aulosphæridæ.—The siliceous shell is a fenestrated ball or a fenestrated polyhedral body whose lattice-work is formed of hollow tubes. Hollow spines usually radiate from the points of connection of the lattice-work.‡ Genera: *Aulosphæra*, *Aulodictyum*, *Auloplegma*.

Family 8. Cannosphæridæ.—The siliceous skeleton consists of a uniaxial globular or oval simple bounding shell, which is connected by means of hollow radial rods with a composite outer encrusting shell. The outer shell consists of hollow tubes which form a wide-meshed latticed sphere; hollow simple or branched radial spines spring from the junctions of the lattice.§ Genera: *Cannacantha*, *Cannosphæra*, *Cœlocantha*.

Order IV. Phæoconchia.—The siliceous skeleton consists of two separate fenestrated shells, like those of a bivalve mollusc. Simple or branched hollow tubes are often found at the junction of the valves.

Family 9. Concharidæ.—The siliceous skeleton consists of two semicircular or lenticular fenestrated shells turned each to each with the concavities inwards; the edges of the shells are usually set with rows of teeth, which lock together like the teeth of a bivalve.|| Genera: *Concharium*, *Conchopsis*, *Conchidium*, *Conchoceras*.

Family 10. Cœlodendridæ.—The siliceous skeleton consists of two semicircular or lenticular fenestrated shells with the concave sides turned towards each other. Simple or tree-like branched hollow spines spring from the two opposite poles of the principal axis, or from the centre of the junction of the hemispheres.¶ Genera: *Cœlodendrum*, *Cœlothamnus*, *Cœlodrymus*, *Cœlothauma*.

Parasitic Acinetæ.**—Mr. W. G. Cocks records the discovery of a branched group of *Epistylis*, to which were attached several *Acinetæ*.

* Cf. Murray, *l. c.*, pl. xxiv. figs. 1, 2, 4. † Ibid., figs. 5, 6.

‡ Haeckel, 'Monogr. d. Radiol.,' 1862, p. 357, taf. x. xi.

§ Hertwig, 'Organ d. Radiol.,' 1879, p. 91, pl. ix.

|| Cf. Murray, *l. c.*, pl. xxiv. fig. 3.

¶ Haeckel, 'Monogr. d. Radiol.,' 1862, p. 360; taf. xiii., figs. 1–4; taf. xxxii., figs. 1–3.

** 'Sci.-Gossip,' 1880, p. 79 (3 figs.).

At first it was supposed to confirm the view of Mr. Gosse that *Acineta* is a stage in the life-history of the Vorticellinæ, but on closer examination it was seen that the stems of the *Acinetæ* were attached to the side of a stem of the *Epistylis* instead of being a continuation of the latter. The *Acinetæ* were also found attached in the same way to a group of *Carchesium polypinum*, and it was seen that when the latter were disturbed and made to contract, the *Acinetæ* remained rigid, showing that their stems formed no part of the contractile stems of the *Carchesium*.

Eozoon Canadense.*—Principal Dawson contributes a further paper on this subject, in which he criticizes in somewhat emphatic terms Professor Möbius's book on *Eozoon*, and more especially his recent reply,† which is, Dr. Dawson considers, written in a manner which "relieves him from any obligation to be reticent as to the Professor's errors and omissions." In reply to Professor Möbius's suggestion that he should be supplied with more and better specimens, the author says that "if he will take the trouble to visit Canada and inspect my collections, he shall have every opportunity to do so."

Dr. Dawson also criticizes at length a contribution by Dr. Otto Hahn ‡ to the literature of *Eozoon*, which he appears to have taken for a serious instead of an ironical production! Dr. Hahn (who in reality is a supporter of the mineral origin of *Eozoon*) is described by Dr. Dawson as now regarding it "as a vegetable production, or rather as a series of such productions, the laminæ being petrified fronds of a seaweed, and the canal systems finer algæ of several genera and species. Not content with this, he describes as plants other forms found in granite, gneiss, basalt, and even meteoric iron, and others found included in the substance of crystals of arragonite, corundum, and beryl. All these are supposed to be algæ of new species, and science is enriched by great numbers of generic and specific names to designate them, while they are illustrated by thirty plates representing the quaint and grotesque forms of these objects, many of which are obviously such as we have been in the habit of regarding as mere dendritic crystallizations, cavities, or impurities included in crystals."

Dr. Dawson cites translated extracts from Hahn's work, and adds that it "seems scarcely necessary to criticize the above statements, as it is probable that very few naturalists will be disposed to accept the supposed plants as veritable species. It may be observed, however, that in regarding the thick plates of serpentine—interrupted, attached to each other at intervals, penetrated by pillars of calcite, and becoming acervuline upward—as fossil algæ, Dr. Hahn disregards all vegetable analogies; while in supposing that the calcite is a filling, and that the delicate fillings of canals contained in it are fine thread-like algæ, he equally asserts what is improbable. Further, no vegetable structure or remains of carbonaceous matter have been discovered in the serpentine. Had he discovered these supposed vegetable forms in the graphite of the Laurentian, this would have been far more credible."

* 'Canad. Nat.,' ix. (1879) p. 228. † This Journal, ii. (1879) p. 902.
‡ 'Die Urzelle' (8vo, Tubingen, 1879).

After discussing some points suggested by Hahn's paper, Dr. Dawson mentions that he recently found in a specimen of *Eozoon* structures which may possibly indicate contemporaneous plants. He previously remarked the occurrence of deep pits or cylindrical cavities in some specimens of *Eozoon*, and supposed that they might be of the nature of oscula. Those now referred to, however, are more definite than any previously observed. They are cylindrical perforations penetrating the whole thickness of the mass and filled with calcite. One of them is simple, another seems to bifurcate. They are about an eighth of an inch in diameter, and present indications of alternate swellings and contractions. In approaching them, the plates of serpentine split into two and then unite, forming a continuous close wall of sarcode. This proves that they are not perforations of any boring animals. They must be either definite canals penetrating the mass while living, or must represent cylindrical stems, algæ, or other perishable organisms, around which the *Eozoon* has grown. As they are only exceptionally seen, the latter supposition is perhaps the more probable. Peculiarities of this kind, to which perhaps heretofore too little attention has been given, are of some importance with reference to the controversies respecting *Eozoon*.

BOTANY.

A. GENERAL, including Embryology and Histology of the Phanerogamia.

Embryo-sac in Angiosperms.*—Mr. H. Marshall Ward continues his researches † on the history of development of the embryo-sac in Angiosperms, the species which he has now made the chief subject of examination being *Butomus umbellatus*. The general result is still further to confirm the conclusions of Strasburger, as opposed to those of Vesque and Warming.

The results which he has attained induce the author to reject the idea that the nuclei in the embryo-sac are homologous with pollen-grains, and are therefore spores, while they encourage the theory that we have, in the repeated bipartition of the nuclei in the embryo-sac, a rudimentary prothallus-formation, as Strasburger believes. The embryo-sac is either a macrospore, or a joint structure formed by two apposed macrospores.

The conclusions arrived at from an examination of *Butomus* are confirmed by observations on *Alisma Plantago*, *Anemone japonica*, *Lupinus venustus*, *Œnothera biennis*, *Pyrethrum balsaminatum*, *Anthemis tinctoria*, *Verbascum phlomoides*, *Lobelia syphilitica*, and other plants.

In order to avoid the ambiguous use of the term "nucleus" for the protoplasmic cell-nucleus, and for the cellular portion of the ovule,

* 'Journ. Linn. Soc.' (Bot.), xvii. (1880) p. 519.
† See this Journal, *ante*, p. 301.

Mr. Ward proposes to substitute in the latter case the convenient term "nucellus."

The general method followed in the preparation of the microscopic specimens was to treat fresh ovaries with absolute alcohol, afterwards adding glycerine, and retaining them in it for some hours.

Development of the Embryo and Endosperm of Lupinus.*—While investigating the embryogeny of the Leguminosæ, Hegelmaier found that the genus *Lupinus* presents important differences from all other Leguminosæ in the structure and position of the fertilizing apparatus in the ovule, as also in the development of the embryo. In the species examined by him, the author was, however, unable to confirm the previous observations of Hofmeister.

While Hofmeister ascribes to all species of *Lupinus*—in contrast to other Leguminosæ—only a single thick integument, and places the embryo-sac in the central region of the nucellus, a portion of the "wart" (Kernwarz) being left behind at the base of the embryo-sac, Hegelmaier finds a single integument in *Lupinus varius*, *mutabilis*, and *polyphyllus*, but a second inner one composed of two layers of cells in *L. luteus*, which disappears immediately after impregnation; a portion of the wart is present before impregnation only in *L. luteus*, being wanting in the other species; the cavity enclosed by the integument, which contains a loosely applied layer of protoplasm, is sharply pointed.

According to Hofmeister there are two germinal vesicles placed immediately beneath the "wart," from the impregnation of which a pro-embryo results bearing the embryo at its apex. Hegelmaier found, on the contrary, in *L. varius*, at the apex of the embryo-sac two nucleated cells, which he regards as analogues of the "synergidæ"; but these shrivel up and disappear when the pollen-tube reaches the endostome. The nucleus of the embryo-sac is united with them by plates of protoplasm. But near the point of greatest convexity of the curvature of the nucellus is a finely granular mass of protoplasm, with about ten nuclei, which indicates the position of the subsequent cells. This compound structure he calls the "*egg-apparatus*," since the cell which lies most backwards towards the chalaza becomes the ovum or oosphere. Immediately after impregnation the remainder constitute the "*secondary apparatus*." No antipodal cells were clearly made out. Of the nine secondary cells, three primordial cells, the "*comites*" ("Begleitzellen"), are separated by a small space, and are then in contact with the anterior side of the protoplasmic layer opposite to the ovum. In addition to the change in form of the ovule resulting from its increase in diameter, impregnation also causes the increase of one of the "comites" to a considerable sized ball, having in its interior a number of well-developed nuclei. The six true secondary cells increase in size; their contents become more coarsely granular, and the nuclei develop into sharply defined balls with shining nucleoli. These parts remain until the seed is ripe. The ovum finally develops into the embryo in an abnormal manner.

* 'Bot. Zeit.,' xxxviii. (1880) p. 65.

Two primary pro-embryo segments are formed; but, notwithstanding Hofmeister's assertion, there cannot be said to be any considerable-sized suspensor; but the division of the terminal cell takes place in quite a different way from what it does in the Cruciferæ, Ranunculaceæ, and Labiatæ.

With the exception of the apparent absence of the "comites," *L. polyphyllus* agrees in essential points with *L. varius; L. mutabilis* has also many points of similarity, and the structure of the ovule before fertilization is essentially the same. After impregnation, on the contrary, a central string of protoplasm is found in the protoplasmic layer of the embryo-sac, which runs to about the middle of the ovule, and then puts out four or five lateral strings. In this system of strings are the nuclei of the secondary cells which are subsequently formed from them by transverse septa, and which may still be recognized in the ripe seed. The ovum lies at one of the points where the system of strings branches. In *Lupinus luteus* the processes differ yet more from the normal ones in Angiosperms.

The formation of the endosperm in *Lupinus* also shows peculiarities which apparently do not occur elsewhere. A distinction must be drawn between the primary general endosperm, the nuclei of which are distributed over the inner wall of the embryo-sac, and the true "endosperm-body," which occupies only a part of the cavity near the embryo. The formation of the numerous nuclei of the general endosperm begins near the micropyle, possibly by division of the primary nucleus of the embryo-sac and not by free cell-formation. The further formation of the endosperm-body results from a small portion developing into several layers accompanied by multiplication of the nuclei. A parenchymatous tissue is then produced by the formation of division-walls within the endosperm. These later processes differ essentially from those observed by the author in the Papaveraceæ, &c., since in the latter a peripheral layer of cells is first of all separated, which then breaks up by division into radial rows of cells.

Embryogeny of the Orchidaceæ.*—The physiological processes which go forward in the embryo have been made the subject of investigation by M. Treub in the case of the Orchidaceæ, which present great facilities for this purpose, from the absence of endosperm and the simple structure of the embryo.

The absorption of nutriment takes place ordinarily through the suspensor (pro-embryo), which is unusually developed, and sometimes presents special adaptations for this purpose. The true embryo is provided with a thick cuticle which prevents the absorption of food-material by the surface. This was proved by experiments with osmic acid.

In many species, as *Orchis latifolia*, *O. pyramidalis*, &c., the suspensor consists of a simple row of cells, is of great length, protrudes beyond the exostome, and becomes applied to the placentæ which abound in starch-grains, oil-drops, and other assimilable

* 'Verh. k. Akad. Wetensch. Amsterdam,' xix.; see 'Bot. Zeit.,' xxxviii. (1880) p. 57.

substances. While the outer wall of the embryo is strongly cuticularized, that of the suspensor consists of pure cellulose.

In *Herminium Monorchis* the cells of the suspensor put out branched filiform appendages which creep over the placentæ. In *Goodyera repens* and *Phajus Wallichii* the suspensor is unicellular, and attains a great length, but does not project beyond the exostome. In these and similar cases the food-material appears to reach the suspensor through the funiculus.

In some species of *Phalænopsis* the suspensor consists of a bundle of slender unicellular filaments which are fixed by their middle to the upper part of the embryo, the free end hanging down and projecting beyond the endostome, rarely beyond the exostome also.

In *Stanhopea* peculiar thick filaments hang above the embryo, the history of whose development has not yet been sufficiently investigated to determine whether they constitute a true suspensor.

The author does not adopt the prevalent view that the embryo of the Orchidaceæ is entirely destitute of a cotyledon. He accepts, on the other hand, that of Pfitzer, that although of exceedingly simple structure, a cotyledon is to be detected in the apical part of the embryo.

Formation of Starch-grains and Composition of the Cell-wall.* —Professor Frommann states that he has detected in growing cells a thread-like reticulated structure, both in the protoplasm and nuclei and in the chlorophyll-bodies, and that these not merely serve to connect the nuclei and chlorophyll-bodies with one another, but that they pass from one cell to the next through minute crevices in the cell-wall. This passage of the threads into the cell-wall can be made out through the whole extent of the primordial utricle, and they pass even into the cuticle. The author suggests that these are connected with the continual fresh formation of cellulose. The starch-grains are formed in the same way, within the chlorophyll-bodies, from a similar network of threads of protoplasm, which are here and there swollen into knots.

The observations were made chiefly on the epidermal and parenchymatous cells of *Dracæna* and of *Rhododendron ponticum*. A magnifying power of 900 is required to make out the structure in question.

Transfusion Tissue.†—This term was first employed by Von Mohl to designate a tissue widely distributed in the Coniferæ, and peculiar to that order. Its special seat is in the leaves, occurring always in connection with the vascular bundles. To this rule there is no exception in those species in which the leaves are free; in those in which they are partially adherent to the stem there is only one, *Cupressus sempervirens*, where the transfusion cells are situated at the base of the leaf, and separated from the vascular bundle by a layer of parenchyma containing chlorophyll. The position of the tissue in relation to the vascular bundle is very various, the most common, as

* 'SB. Jenaische Ges. Med. u. Naturwiss.,' 1879, p. 111.
† 'Flora,' lxiii. (1880) p. 2.

in most species of *Pinus*, being in the form of a cylinder enclosing the bundle.

With respect to the structure of the tissue, the transfusion cells have always, as described by Mohl, lost their primordial utricle, and contain a clear sap, without any special secretion. Their function is, in all probability, the conveyance of this sap, and not of air. Although their appearance resembles that of ducts, they do not contain true bordered pits; and hence the appellation of tracheïdes sometimes given to them is unfortunate, since this term is conveniently confined to those vessels specially concerned in the conveyance of air.

The true transfusion tissue should—according to Zimmermann, who has recently re-examined its structure—be carefully distinguished from the "transverse parenchyma" of Thomas, consisting of strongly thickened bast-like cells with obliquely placed bordered pits, from which it is always separated by a single layer of green parenchymatous cells.

Anatomy and Physiology of Fleshy Roots.*—Dr. J. E. Weiss has investigated this subject in the case of a number of species belonging to various families. The following are the general results arrived at:—

1. In all the roots examined the powerful development of xylem is apparently intended to serve as a reservoir for reserve food-material; it is therefore thin-walled and parenchymatous, and takes the largest share in the thickening. In rhizomes and tigella the pith also serves the same purpose.

2. In all plants which increase very rapidly in thickness and which store up a great quantity of reserve food-material, a rapid means of transport for these materials is essential. Since they are not transported in the parenchyma by means of diffusion, but through the sieve-tube by the open pores, the secondary phloëm and fibro-vascular bundles are of great importance in these plants.

3. The secondary formations are more or less developed in proportion to the longer or shorter length of life of the plant and to the period at which lignification takes place.

4. But the development of these secondary formations depends also on the thickness of the organ.

5. As soon as the plant puts forth a stem above ground, the secondary formations cease, and non-flexible elements take their place.

6. Secondary formations occur not only in those plants the caulome of which has a so-called medullary phloëm, but also in the Cruciferæ, where it is wanting.

7. These secondary formations always decrease towards the apex of the root, and are apparently directly connected with the primary peripheral or medullary phloëm.

Causes of the Curvature of growing Organs.†—The curvatures of the growing parts of plants have been attributed by physiologists to

* 'Flora,' lxiii. (1880) p. 81.
† 'Rev. Internat. Sci.,' iii. (1880) p. 87.

two causes:—viz. (1) external or internal forces acting directly on the increase of the cell-walls, accelerating the growth on the convex, and retarding it on the concave side; (2) an increase of the osmotic tension between the cell-wall and cell-contents on the convex side. In a communication to the Royal Academy of Amsterdam, H. de Vries discusses these two theories, and gives the following as his own conclusions: — When multicellular organs undergo curvature in the course of their growth, the osmotic tension of the cells is first modified, and the change in the rapidity of growth of the cell-walls must be regarded as a secondary phenomenon.

Movements of Air and Sap in the Living Plant.*—Dr. F. R. von Höhnel has been engaged during the past three years on a very extensive series of experiments with a view of determining several still unsettled questions relating to this subject. Among the numerous interesting conclusions at which he has arrived, the following are some of the more important.

In relation to the supposed direct communication between the vessels and the stomata, his results go to show that no such communication exists; and he considers that he has also disproved Hales's theory of a communication between the lenticels and the bark.

With regard to the diffusion of air through plants, and the relation of this to the external pressure, Von Höhnel states that when a negative pressure of air, or suction, takes place in a vessel from which water has been removed, this pressure must not only descend into the vessel, but must also spread laterally in both the radial and tangential directions. Hence it follows that the powerful suction which takes place in the vessels of the youngest annual ring must not only be more or less uniformly distributed within the ring, but must also spread to the older ring next within it. From the second and third rings water must constantly be sucked up into the first, in which it rises and passes away through transpiration. But since the inner rings contain much air in their cells and vessels from the previous year, the negative pressure in them can never attain the possible maximum for the plant by the removal of water, and must therefore always remain considerably less than in the youngest ring. It is, however, clear that in the second ring the negative pressure must be greater than in the third, at least when transpiration is active, since the water must first be removed from it.

Branching of Dorsiventral Shoots.†—Goebel points out that the origin of the prevalent theory of the external conformation of plants rests on two hypotheses: firstly, the spiral theory; and secondly, that of axillary branching.

If the spiral theory were universally true, it would follow as a necessary consequence that the plant would produce shoots uniformly on all sides; and such a mode of branching might be termed *radiar*. It is certain, however, that all modes of branching cannot be referred to the radiar, as in those cases where there is a contrast not only

* 'Jahrb. wiss. Bot.,' xii. (1879) p. 47.
† 'Arbeit. Bot. Inst. Wurzburg,' ii. (1880) p. 353.

between the two ends of a growing organism, but also between an anterior and posterior side, giving rise to a right and left half, whence such a mode of growth may fairly be called *symmetrical* or *bilateral.* The author proposes to restrict the term *dorsiventral* to those cases of bilateral structure where the upper and under, or dorsal and ventral surfaces exhibit organic differences, as where the shoots which proceed from them are of a different nature, or where one surface only produces shoots of any kind.

Observations made chiefly on the Marchantiaceæ, *Zostera*, *Urtica*, *Dorstenia*, and *Hyoscyamus*, have led Professor Goebel to the following general conclusions:—

1. Just as there are radiar and bilaterally symmetrical (or zygomorphic) flowers, and organs of radiar and dorsiventral structure, so a distinction may also be drawn between radiar and dorsiventral branching. Dorsiventral branching is indicated by the different sides of the primary organ (the ventral and dorsal side) behaving differently in relation to the production of lateral branches, as in *Caulerpa* and the Rhizocarpeæ, or by only one side producing lateral branches, as in the inflorescence of the Borragineæ.

2. Organs with dorsiventral branching occur in all forms of plants, from the simplest to the most complicated; the spiral theory propounded in the latter case is incorrect, in relation not only to the history of development, but also to the supposed universality of the radiar type.

3. The mutual relations of leaf and shoot in dorsiventral organs are usually dependent on the total symmetry of the shoot-system.

4. Dorsiventral organs exhibit their dorsiventral structure in relation either to the substratum or to their primary organ.

5. In all cases that have been examined it has been determined that dorsiventral branching does not depend on subsequent displacement or cohesion, but is a peculiarity of the growing point. When displacement, &c., occur, and bring about a dorsiventral position of organs which originated in a radiar manner, this can easily be made out.

6. A distinction must be drawn between apical and intercalary growing points, and between shoots which spring from intercalary growing points and from intercalation. The former arise in progressive order approaching the growing point. The acropetal development of lateral organs is only a special case in which the growing point has an apical position; and the same order of development occurs also when the growing point has a basal position; and the two are therefore comprised in the general term progressive development of organs. Intercalary growing points with progressive development also originate from apical growing points; they occur not only in Algæ, as Ectocarpaceæ, but also in Angiosperms, as in the inflorescence of *Ficus carica*, in the leaf-axils of *Aristolochia*, *Menispermum*, &c., and in flowers.

Leaves of Conifers.*—Dr. M. T. Masters has observed the following correlation between the various characters respectively of the

* 'Journ. Linn. Soc.' (Bot.), xvii. (1880) p. 547.

silver firs (*Abies* of Continental, *Picea* of British writers), and the spruce firs (*Picea* of Continental, *Abies* of British writers). In those silver firs in which the leaves are so crowded as to overlap each other closely, and where their relatively flat surfaces permit only one face at a time to be exposed to the light, not only are the leaves twisted so as to bring them all into nearly the same plane, but they are in many cases, if not in all, endowed with a power of alternate elevation and depression, so that the lower surface may be exposed at times to the light. In spruce firs, as a rule, the leaves are less densely packed than is the case with the silvers, and they are usually more or less four-sided. There is torsion at the base of the leaf, but apparently little or no motion of elevation or depression. The so-called "palisade-cells" are nearly confined to the upper surface of the flat-leaved silver firs, and are apparently connected with their singular power of elevation and depression.

Relationship between Light and Etiolin.*—The term *etiolin* has been given by Pringsheim to the yellow pigment which colours the amorphous or granular protoplasm found in the seedlings of Angiosperms in the dark. Its relationship to light has been investigated by Elfving, who for this purpose exposed etiolated seedlings for a short time to light, comparing the results with others kept in the dark. He states that the yellow colour is produced only by the less refrangible rays of light. It cannot be asserted that absolutely no etiolin is produced by blue and violet light; but it may be stated with certainty that the less refrangible rays are much less efficacious in its formation than the more refrangible; as is indeed also the case with other chemical processes in the plant dependent on light.

Growth of Negatively Heliotropic Roots in the Light and in the Dark.†—The accepted explanation of heliotropic curvature, first proposed by A. P. De Candolle, is that growth in length is promoted by dark and hindered by light, and that in consequence a growing organ such as an internode, exposed to light on one side, will curve towards the source of light. If this theory is correct, negatively heliotropic organs should grow more rapidly in the light than in the dark, a result not in accordance with the observations of Schmitz and Müller (of Thurgau).

F. Darwin has, in order to test the correctness of this hypothesis, watched the growth of the negatively heliotropic roots of seedlings of *Sinapis alba*; and the result of his observations determines with certainty that at all events some negatively heliotropic organs may grow faster in the dark than in light. The author is here led to agree with the conclusion arrived at by Sachs, that heliotropism, like geotropism, is a phenomenon of irritation, and that De Candolle's theory is not supported by facts.

Chlorophyll in the Epidermis of the Leaves of Phanerogams.‡—It has been commonly stated that chlorophyll is absent from the

* 'Arbeit. Bot. Inst. Würzburg,' ii. (1880) p. 495. † Ibid., p. 521.
‡ 'SB. Akad. Wiss.' (Wien), lxxix (1879) 1st Sec., p. 87.

epidermal cells of the leaves of terrestrial Phanerogams and Vascular Cryptogams, with the exception of the guard-cells of the stomata.

M. Stöhr has examined the leaves of 102 species of terrestrial Dicotyledons belonging to a number of different natural orders, and in 94 of them has found chlorophyll in the ordinary cells of the epidermis. Among gymnosperms it was found only in species with very large leaves, and in Monocotyledons not at all. In most cases it occurs in the epidermis of the under side only of the leaf, but also in that of the leaf-stalk and stem. This epidermal chlorophyll appears in some cases to be functionless, no starch being found enclosed in the grains, but in its place strongly refractive particles not coloured by iodine, probably a product of transformation of the original starch. The cause of the normal absence of chlorophyll from the epidermis of the upper sides of leaves appears to be its destruction by too intense light.

M. Stöhr confirms the ordinary statement that chlorophyll is universally present in the epidermis of the submerged leaves of aquatic plants. This again supports the view advocated by Pringsheim that chlorophyll is destroyed by too intense light.

Relationship of Hypochlorin to Chlorophyll.*—In the fourth instalment of his researches on chlorophyll, Pringsheim gives further details of the nature of the *hypochlorin* which he regards as one of its essential constituents.† It can readily be separated from the chlorophyll grains in the living green cell by the action of hydrochloric acid, appearing as a dark reddish-brown or rust-coloured excretion, at first of an oily nature, but subsequently forming ill-defined needle-crystals. The substance has more resemblance to an ethereal than to a fat oil. The hypochlorin can also be separated by other reagents, as picro-nitric acid. It also separates spontaneously from the chlorophyll grains in preparations of green tissues which have been preserved for months in glycerine or calcium chloride. By the application of moist heat, as by warming in water or distilling with aqueous vapour, another substance also separates analogous to hypochlorin, but differing from it in being uncrystallizable. The chlorophyll-grain from which the hypochlorin has been eliminated, has then the form of a spongy porous skeleton, or with somewhat the structure of a sieve-plate.

In this paper the author gives additional reasons for the conclusion at which he had previously arrived, that the hypochlorin is formed independently in the chlorophyll-grain, and that, in angiosperms, light is absolutely necessary to its production. The colouring matter of the chlorophyll, by its absorptive power on light, protects the hypochlorin from oxidation in too intense light.

Gymnosperms exhibit a peculiarity in regard to the formation of hypochlorin, as they have long been known to do with respect to chlorophyll. Just as they are the only phanerogams whose seedlings can form, in an unexplained manner, chlorophyll in the dark, so they are also the only ones in which hypochlorin is also formed under similar circumstances.

* 'MB. K. Preuss. Akad. Wiss.' (Berlin), 1879, p. 860. † See *ante*, p. 117.

The hypochlorin is not itself the colouring matter of chlorophyll, but the menstruum in which the colouring matter is formed.

Relation of the Intramolecular to the Normal Respiration of Plants.*—In an inaugural dissertation delivered at Würzburg, J. Wortmann explains his grounds for arriving at the following conclusions, viz.:—

1. The immersion of plants for some days in an atmosphere devoid of oxygen does not destroy their life.
2. Plants killed by boiling water do not give off carbonic acid into vacuum, provided that care is taken that there is no disturbance by bacteria. The elimination of carbonic acid caused by intramolecular respiration can take place only in connection with living cells.
3. The gas evolved in intramolecular respiration consists of pure carbonic acid.
4. The evolution of carbonic acid takes place both in growing and in mature organs; but is more copious in the former.
5. When oxygen is given off no growth takes place.

The whole of the carbonic acid given off in the process of respiration is stated by the author to be the product of intramolecular processes; the oxygen of the atmosphere therefore takes no part in the production of carbonic acid.

The source of this carbonic acid is a process analogous to fermentation, induced in the molecules of sugar and other carbohydrates by the molecules of albuminoids which are constantly being decomposed and then regenerated by other carbohydrate molecules; the result being the production of carbonic acid and alcohol. Particles of alcohol in the nascent condition dissolved in the cell-sap are now oxidized by the free oxygen, and converted into isomers of acetic acid, the molecules of which are again converted into molecules of sugar. The following equations will represent these consecutive changes.

$$(1)\ 3\,C_6H_{12}O_6 = 6\,C_2H_5OH + 6\,CO_2.$$
$$(2)\ 6\,C_2H_5OH + 12\,O = 2\,C_6H_{12}O_6 + 6\,H_2O.$$

Phenomena of Pressure in Stems.†—Dr. J. Boehm has repeated the previous experiments of Pittra in elucidation of the phenomena known as "weeping" and "bleeding," and has arrived at the conclusion that these processes are not caused, as Pittra believed, by osmose, but by gases which are set free in the submerged branches and roots in consequence of internal respiration and of butyric fermentation. The circumstance that the bleeding is always suspended in cuttings which, in an atmosphere saturated with vapour, dip into the water only at the lower end, and in branches with green bark which are completely submerged in water in broad daylight, appears altogether opposed to the conclusion that the pressure is caused by osmose.

Exudations of Drops and Injection in Leaves.‡—Dr. J. W. Moll gives the following as the general conclusions arrived at from his researches on this subject, viz.:—

* 'Bot. Zeit.,' xxxviii. (1880) p. 25. † Ibid., p. 33. ‡ Ibid., p. 49.

1. In a large number of the plants examined drops exude from the leaves at different spots when water is forced in.

2. In many plants the result of forcing in water is an injection into the intercellular spaces of the leaves, with or without the exudation of drops. This is indicated by the dark green colour of the under side and the transparency of the entire leaf.

3. In those plants which display both injection and exudation of drops, it is frequently the case that only the younger leaves exude water, while older leaves of the same plant exhibit injection only or both phenomena conjointly.

Air as a Germ-carrier.*—After a long and very unfavourable review of the labours of previous aeroscopists, including Pasteur, Lewis, and Douglas Cunningham, Dr. Wernich describes certain experiments on the action of air-currents upon germs. His apparatus is essentially a modification of that previously employed by Nägeli. Filtered air is drawn through or over the germ-containing material, and thence into a vessel containing pabulum, sterilized by boiling.

He finds (*a*) that thoroughly dried compact masses containing germs, e. g. slices of potato bearing crusts of *Micrococci*, and similar incrustations on glass, wire, &c., yield no germs, even to the strongest air-current; (*b*) that coarse and fine dust is easily carried over in the stream of air, and the germs it may contain develop all the more surely if they are accompanied by a small quantity of their former pabulum; (*c*) that porous bodies of different kinds saturated with putrefying fluids and then carefully dried, yield germs to the air-stream, but slight moistening of the porous body is sufficient to prevent this; (*d*) that slimy surfaces bearing germs may be slightly dried by the current of air and germs then taken up; (*e*) that germs are not taken up from a fluid through which air passes if the formation of spray and foam be guarded against.

The author then discusses the bearing of these results upon the ventilation of hospitals, and concludes that while it is doubtless important as much as possible to avoid stirring up the dust of sick rooms, and to ventilate them by as regular and gentle a stream of air as possible, the importance of the air as a vehicle of infectious germs has been much exaggerated.

B. CRYPTOGAMIA.

Cell-nucleus in Thallophytes.†—As a sequel to his discovery of a plurality of nuclei in the cells of the Siphonocladiaceæ,‡ Professor Schmitz, of Bonn, has carried on a series of similar investigations with regard to the cell-structure in other Thallophytes, especially those hitherto considered to be destitute of a nucleus,§ including, according to A. Braun, the Chroococcaceæ, Oscillarieæ, Nostochineæ, Palmellaceæ, Cladophoreæ, and Siphoneæ. The following were the most interesting results attained:—

In the Siphoneæ the species especially examined were *Codium*

* 'Arch. path. Anat. u. Physiol.' (Virchow), lxxix. (1880) p. 424.
† 'SB. Niederrhein. Ges. Natur- u. Heilk.,' Bonn, Aug. 4, 1879.
‡ See p. 493. § See also *ante*, p. 111.

tomentosum, *Vaucheria sessilis*, and *Caulerpa prolifera*. In all these cases a number of nuclei (often very minute) were found embedded in the parietal layer of chlorophyll in the elongated tubular cell, as also in the sexual reproductive cells of *Vaucheria*.

In *Conferva* the structure in this respect was found to be various. The smaller species all contained a single nucleus in each cell; while in some larger kinds there were two, multiplied by bipartition before the division of the cell, so that for a short time before cell-division each cell contained four nuclei.

In *Ulva* the presence of a single very small nucleus was determined in each cell; and the same was the case in *Monostroma bullosum*, in addition to the single large starch-grain.

In *Chlamydomonas* the cell-structure is the same, whether in the resting or in the glœocystic condition. The single oviform cell contains at the anterior end a funnel-shaped vacuole. At the broader posterior end is a moderately large starch-grain. The rest of the protoplasm is apparently of a uniform green colour, and contains a smaller or larger number of protoplasmic corpuscles. Only the anterior end is colourless, and contains a small spherical nucleus, directly beneath the point of insertion of the cilia. A nucleus was also detected in the resting cells of *Euglena*.

In several species of *Chroolepus* and *Glœocapsa* the presence of a nucleus was also substantiated, as also in *Oscillaria princeps*.

In *Saprolegnia* and nearly allied genera, the following is the uniform cell-structure. The cell-wall of the tubular branched thallus is completely clothed by a parietal layer of protoplasm, strings of protoplasm also passing through the cell-cavity. Embedded in the parietal layer are always a number of roundish nuclei. The same structure occurs in species of *Peronospora*, *Mucor*, *Chytridium*, &c.

In *Saccharomyces cerevisiæ*, the reagents employed discovered a single spherical central nucleus in each cell, embedded in the protoplasm near the vacuole. In *Oidium lactis* there are several in each cell.

In the asci of the *Ascosporeæ*, as already observed by De Bary, a single original nucleus divides into two, four, and finally into eight nuclei.

In the *Myxomycetes*, Dr. Schmitz has at present confined his attention to the plasmodia. In these were found nuclei in very large numbers.

The general conclusion arrived at from the large number of observations made by Dr. Schmitz, of which only some have here been referred to, is that in all the Thallophytes the cells invariably contain one or more nuclei, organisms destitute of a nucleus being altogether unknown. It has heretofore been stated that such a condition may occur temporarily in the interval between the absorption of a nucleus and the free-formation of fresh nuclei. This, however, has never been observed by the author; and, from analogy, he considers it probable it never occurs, but that, on the contrary, the presence of a nucleus is absolutely essential to a living cell.

The same he believes also to be the case in all the higher plants, as, for instance, in the guard-cells of the stomata, where it has erroneously been stated that the nucleus may disappear while the cell is still in a living state.

The reagent chiefly employed by Dr. Schmitz for the detection of the cell-nucleus is an aqueous solution of hæmatoxylin, to which in some cases a small quantity of alum was added, and a few drops of the mixture then mixed with the glycerine. This mixture was applied directly to the cell after killing it with alcohol or osmic acid. When properly applied, the interior of the cell-nucleus then assumes an intense blue colour, the mass of the nucleus is more feebly coloured blue, while the rest of the protoplasm remains uncoloured. This preparation is especially useful for detecting the division of the nuclei.

Embryology of the Archegoniatæ.* — K. Goebel gives a brief *résumé* of the present state of our knowledge of the Archegoniatæ, including in this term the Vascular Cryptogams and Muscineæ (Cormophytes). It is based mainly on the published observations of Kienitz-Gerloff, Sadebeck, Leitgeb, Hegelmaier, Pfeffer, of the author himself, and others.

Cryptogamia Vascularia.

Bundle-sheath in Polypodiaceæ.†—In all the Polypodiaceæ the fibrovascular bundles, both of the frond and of the rhizome and roots, are surrounded by a bundle-sheath which differs essentially from that of monocotyledons and dicotyledons. Prantl considers the bundle-sheath of ferns to have its origin in the procambium, while Russow refers it to the fundamental tissue. An examination of a number of species has led Dr. J. E. Weiss to agree rather with the former view, and to regard it as either a product of the procambium or as an independent layer of tissue. The following are his reasons:—

The arrangement and size, as well as the peculiar behaviour of the innermost cells of the fundamental tissue, in contrast to the small size of those of the bundle-sheath, and the position of the radial walls of the latter, do not favour the idea that the two tissues have a common origin; while in the case of monocotyledons and dicotyledons it is easily proved that the bundle-sheath originates from the fundamental tissue.

The bundle-sheath, with the cells which mostly stand in perfectly radial rows, originates from a single cell; but these cells are larger than the phloëm-cells which are irregularly arranged adjacent to them within, but otherwise behave in the same manner.

The bundle-sheath originates at the same time as the procambial fibrovascular bundle, when the cells of the fundamental tissue have already attained a certain size and development.

If the bundle-sheath and its sister cells belonged to the fundamental tissue, they would be formed in centripetal order; but this is not the case, at least in *Pteris aquilina*.

* 'Arbeit. Bot. Inst. Würzburg,' ii. (1880) p. 437.
† 'Flora,' lxiii. (1880) p. 119.

Prothallium of Ferns.*—Leitgeb returns to this subject in a series of investigations carried on chiefly on the prothallium of *Ceratopteris thalictroides;* and confirms his conclusions previously arrived at,† viz.:—(1) The dorsiventral structure of the prothallium of ferns is an effect of light, and is no way affected by gravitation; (2) a reversal of the two sides of the prothallium may be brought about by a change in the direction of the light, and the dorsiventral structure is consequently not inherent in it; and (3) the archegonia and rhizoids are always developed on the shaded side. The position of the antheridia is on the contrary very various in different species. In some species they occur chiefly on the edges, in others almost exclusively on the ventral side.

Affinities of the Carboniferous Sigillariæ.‡—The affinities of the *Sigillariæ* are still in dispute. English palæobotanists regard them as representing the highest modifications of the Lycopodiaceæ. The French and some Americans elevate them to the Gymnosperms. The only plants associated with the *Sigillariæ* in the carboniferous forests, that exhibit any possible affinities with them, are the *Lepidodendra* on the one hand, and the Gymnospermous *Dadoxylons* and *Cordaites* on the other.

The old idea that *Sigillariæ* must have consisted of large branchless stems must be abandoned. The external leaf-scars exhibit nothing distinctive; for some types have the vertical flutings of the stem and the linearly disposed leaf-scars of the *Syringodendra*, whilst others, such as *Sigillaria elegans* and *spinulosa*, exhibit the diagonal arrangement of the leaf-scars characteristic of the *Lepidodendra*. The cortical tissues in the two types of *Lepidodendra* and *Sigillariæ* are absolutely identical, and it is upon supposed distinctions in the vascular axis that French botanists rely. According to them, the *Lepidodendra* have a vascular axis on which the scalariform vessels are not arranged in any radial order, nor increased in bulk by any exogenous mode of growth; in the *Sigillariæ*, whilst the central part of the vascular area is occupied by a cylinder in all respects identical with that of the *Lepidodendra*, it is surrounded by an outer zone in which the vascular wedges are radially disposed, are separated by medullary rays, and have grown exogenously through the operation of a cambium layer.

These supposed differences Professor W. C. Williamson denies to be even generic, much less ordinal, since in several cases they can be shown to be due solely to age, specimens having been found exhibiting transitional stages. When a *Lepidodendron* is about to dichotomize, the vascular cylinder splits into two horseshoe-shaped halves. The same takes place in *Sigillaria*. The invariable dichotomization is in itself a Lycopodiaceous feature. Van Tieghem has shown that the ultimate roots of the Lycopodiaceæ and of the Ophioglossiaceæ have a peculiar structure of their own. In the Cycadeæ, Conifers, and in other Vascular Cryptogams, the centre of each root

* 'SB. k. Akad. Wiss. (Wien),' lxxx. (1880), 1st Sec., p. 201.
† See this Journal, ii. (1879) p. 917.
‡ 'Rep. Brit. Assoc. Adv. Sci.,' 1879, p. 346.

is occupied by a cellular procambium enclosed within a pericambium or special cellular sheath. From this sheath, at points located at measured distances and in varying numbers, several, *but never less than two*, bundles of vessels are developed; but at the free ends of the peripheral portions of the roots, in the case of *Lycopodium*, and throughout the entire length in *Selaginella*, *only one* such procambial bundle makes its appearance. When perfected, this bundle exhibits a triangular form in the transverse section, the apex of the triangle, which always remains adherent to the pericambium, being occupied by the small and first formed vessels, whilst its broad base, composed of larger vessels, projects into the centre of the pericambium. These conditions reappear in the most exact manner in the rootlets of the *Stigmaria ficoides*, now universally admitted to be the roots of *Sigillaria*, as well as of *Lepidodendron*.

This and numerous other facts Professor Williamson holds to be conclusive of at least the ordinal unity of the *Lepidodendra* and the *Sigillariæ*, and of the Cryptogamic character of both.

Muscineæ.

Comparative Anatomy of Marchantiaceæ.*—K. Goebel is able, from his examination of two of the most common native species of Marchantiaceæ, to establish a higher development of tissue than has hitherto been supposed to exist in Thallophytes.

In *Fegatella conica* the central region of the thallus possesses a number of continuous mucilage-passages; in a not specially vigorous specimen as many as ten were counted.

Preissia commutata also has isolated mucilage-cells, and in addition, a skeleton of isolated rudimentary fibrovascular bundles. These latter appear merely to serve for strengthening the thallus, and not to fulfil any other function.

Structure of Anthoceroteæ.†—In the most recent part of his work on the Hepaticæ, Leitgeb discusses the structure and relationship of the small number of genera which make up the group of Anthoceroteæ. He considers the nearest affinity of the group to be with the genus *Riella* of Jungermanniaceæ (Ricciaceæ). The basilar increase of the capsule he regards as equivalent to the growth of the seta of the capsule of *Jungermannia*. To the three genera, *Anthoceros*, *Dendroceros*, and *Notothylos*, he proposes to add a fourth, *Anthocerites*, separated from *Anthoceros* by the absence of stomata in the wall of the capsule, and by having elaters with spiral thickening-band.

Fungi.

Parasitic Fungus of the Mulberry.‡—A. Bertoloni disputes the conclusion arrived at by Piccone, that the fungus-mycelium so destructive to the mulberry trees in Italy is that of *Agaricus melleus*. He maintains, on the other hand, that it belongs to *Polyporus Mori*.

* 'Arbeit Bot. Inst. Würzburg,' ii. (1880) p. 529.

† 'Untersuch. ü. d. Lebermoose,' von Dr. H. Leitgeb. 5 Heft, Anthoceroteen. Graz, 1879; see 'Bot. Zeit.,' xxxviii. (1880) p. 157.

‡ 'Nuov. Giorn. Bot. Ital.,' xii. (1880) p. 19.

He regards fungi as divisible into two classes, true parasites and false parasites (saprophytes), the genus *Polyporus* belonging to the former, *Agaricus* to the latter. There is moreover a difference in the structure of the mycelium of the two fungi, that of the *Agaricus* being unsegmented, while that of the *Polyporus* is segmented, and thickened at the articulations. There are other facts also which, in the opinion of the author, confirm the previous conclusion of G. Bertoloni, that the parasitic fungus of the mulberry is *Polyporus Mori*.

Reversed Polyporus.*—In a partially cleared wood near Müggenburg, S. Schulzer has made the remarkable discovery of a *Polyporus*, belonging to the section *Apus*, with the perforated hymenium occupying the upper side, while the concave under side is barren. It was growing on a prostrate trunk, in considerable quantities, imbricated, and cohering in growth; every specimen exhibiting this unique peculiarity, from the earliest stage of a shapeless tuber to that of perfect development. The somewhat thin pileus was irregularly semicircular or kidney-shaped, always with revolute margin, the upper surface therefore being convex, and the lower surface concave. Growing along with it were *Thelephora hirsuta* and an *Irpex*, all of which exhibited the normal structure. Schulzer proposes for this singular form the name *Polyporus obversus*, and promises a more detailed description.

Fossil Fungi from the Lower Coal Measures.† — Two papers have been read on this subject before the Yorkshire Geological and Polytechnic Society by Messrs. W. Cash and T. Hick. In a previous communication, a list of plants which had been discovered in the lower coal measures near Halifax was given. At that time only one species of fossil fungus had been discovered; since then, however, Mr. Binn has brought to light additional examples of fungoid growth. The specimens, taken from some nodules, were exhibited in three microscopic slides. The first was a transverse section of the petiole of the fern, and a similar section of a branchlet or rootlet of some other plant. The fern (*Zygopteris Lacatii*) evidently lay exposed for some time to the atmosphere before fossilization set in, and during that period it was attacked by the fungi. The vegetative part of the fungus consists of a large number of very delicate hyphæ, not more than $\frac{1}{7000}$ inch in diameter, which are frequently branched. In one respect the hyphæ differ from those of most fungi in exhibiting at different points what appear to be a number of closely approximated constrictions which give the filaments at these points a moniliform character—possibly the constrictions may be transverse septa. The reproductive organs are unfortunately neither abundant nor well-defined, indeed the only structures to which reproductive functions can be assigned are minute spherical bodies, apparently produced at the extremities of the hyphæ, or their branches. They are probably oospores. The fungi, from various characteristics, probably belong to the suborder Peronosporeæ.

* 'Flora,' lxiii. (1880) p. 79. † 'Science-Gossip,' 1880, p. 67.

The second slide exhibited a section cut parallel to the first, from the same species of material, and nearly identical with it. The slide confirms the results obtained from the first, but it does not contain a greater number of the supposed oospores. The third slide was entirely different, having been cut from material obtained from a different pit. It consists of small and disconnected fragments of vegetable tissue, most probably the broken debris of several plants. In and between these fragments are immense numbers of small round bodies, the spores of some fungus, but no trace of mycelium or any filamentous structure has been discovered. In this peculiarity they very much resemble the Myxomycetes. It is just possible that the fossil spores may be of a myxomycetous nature, seeing that they occur in and among tissues that are partially decayed, and in so far resemble the conditions that favour the development of existing forms. The size and appearance of the fossil forms also agree almost exactly with that of existing specimens.

Alcoholic Fermentation.*—To prove the existence of a soluble ferment, Mr. D. Cochin prepared yeast-water from beer-yeast, according to Pasteur's method, by boiling it with water in the proportion of 100 grams per litre, and filtering at once. The filtrate was mixed with beer-wort, at a temperature of 25°–30° C. No fermentation set in, but on sowing some of the residue in beer-wort, fermentation took place with great rapidity. This appears to contradict Berthelot's statement † that a soluble ferment does exist.

M. Berthelot in a subsequent note ‡ points out that a liquid in which yeast is actually growing does not cause alcoholic fermentation, and if a soluble ferment exists at all, it must be sought for under conditions analogous to those in which digestive ferments are formed, viz. under the influence of the food which the ferment is intended to digest.

M. Cochin replies § to M. Berthelot's criticism and states that the ferment he used was stable, contained no organisms in the state of growth, and although capable of inverting sugar, did not induce alcoholic fermentation.

Fungi of Beer-wort and other Fermenting Liquids.‖—M. E. C. Hansen publishes the result of a very extensive series of experiments carried on at the physiological laboratory at Carlsberg (Copenhagen), on the organic substances found in fermenting liquids, and on their presence in the atmosphere. Among a large number of results obtained, the following are some of the most interesting.

The experiments on beer were made on the wort already infused with hop; the objects of experiment were exposed to the air both when there was a free current, and in the neighbourhood of a number of different trees. M. Hansen confirms the statement of Tyndall and Pasteur, that the *Saccharomyces* is not nearly so widely distributed in

* 'Comptes Rendus,' lxxxix. (1879) p. 786; see 'Journ. Chem. Soc.,' Abstr., xxxviii. (1880) pp. 276–7.
† Ibid., lxxxiii. p. 9. ‡ Ibid., lxxxix. p. 806. § Ibid., p. 992.
‖ 'Compte Rendu Trav. Lab. Carlsberg,' ii. (1879). French résumé, p. 49.

the air as bacteria and mould-spores. The neighbourhood of the different trees could not with certainty be stated to have any perceptible effect on the organisms contained in the air.

Observations were also made on the pellicles which appear on the surface of fermenting fluids. The temperature 30°–34° C. was found the most favourable to the production of *Mycoderma aceti* and *Pasteurianum*. At low temperatures *Saccharomyces Mycoderma* prevails almost exclusively; but as the temperature rises it gives place to microbacteria; 15° C. is its optimum temperature; above 26° C. it is unable to thrive. At high temperatures, as above 35° C., *Bacillus subtilis* and *Spirillum tenue* are the prevailing forms; but the former can exist at any temperature above zero.

The author is unable to confirm the statement of the Russian physiologist Horvath that rest promotes, while motion retards the production of ferments in general.

Vital Power of Schizomycetes in Absence of Oxygen.*—J. W. Gunning has previously published an account of his researches, from which he draws the conclusions that substances capable of putrefaction when enclosed in vessels from which nearly all oxygen has been removed, act only for a short time; and when oxygen has been completely removed by means of a solution of grape sugar in caustic soda mixed with indigo, no putrefaction occurs, and the organisms which produce putrefaction are killed.

The present paper is a reply to Nencki's objections, who considered † that Gunning's experiments were inaccurate. Gunning has shown that the apparatus employed to produce what Nencki termed "space freed from oxygen" is insufficient for that purpose, and that it contains enough oxygen to colour ferrous ferrocyanide deep blue. Nencki also supposed that the presence of products of fermentation stopped all action of the organisms. To controvert this statement, Gunning adduces experiments which were already in progress before Nencki had published his objections. These consisted in keeping putrefying matter in tubes in which oxygen, hydrogen, and air were enclosed. As was to be expected, fermentation proceeded furthest in the tubes containing pure oxygen, less far in those containing air, and very much less in those containing hydrogen. The amount of decomposition was ascertained by estimating the carbonic anhydride, ammonia, and volatile acids. Nencki's last objection was that by some chance the liquids affected may have come in contact with only those bacteria which require oxygen for their existence. This objection is shown by Gunning to depend on a misunderstanding of Pasteur's researches, viz. that two such varieties exist. Pasteur believes that such ferments as exist at the surface of a putrefying medium obtain oxygen from the air, and those in the interior of the liquid derive oxygen from the decomposing substance, but does not imagine two varieties to exist. Besides, even were there such different organisms, it is impossible to believe that from some chance a liquid

* 'Journ. prakt. Chem.,' xx. p. 434; see 'Journ. Chem. Soc.,' Abstr., xxxviii. (1880) p. 277.

† See this Journal, iii. (1880) p. 132.

should become infected with only one variety, and that the germs of the other variety, which would be just as likely to be present in air to the same extent, should have no influence.

Effects of Temperature on Bacillus anthracis.*—Professor Frisch has experimented on the effects of abnormally low temperatures on these organisms. The instrument of investigation brought the temperature down to $-111°$, where it remained for half an hour, and then gradually rose; on the whole the test-fluids may be said to have been for about five and a half hours at $-22\cdot5°$ C. Notwithstanding this enormous change in their condition the *Bacilli* were apparently uninjured, for the growth of filaments and the formation of spores went on as before; when, however, they were used for injection purposes, the experiments were found to be in one sense successful, for there were no rods found in the blood of the animals injected, and the spores only once developed their characteristic figure; the latter result shows that against extreme cold, just as against all other adverse circumstances, the spores have a greater power of resistance than the homogeneous rods.

Unfortunately the *Bacteria* of diphtheritis and puerperal fever did not experience any harm from being cooled down to $-87\cdot5°$ C.

Fungus-pests of the Potato.†—The exhaustive work by Reinke and Berthold on this subject is divided into three sections. The first treats of the moist decay of the potato tubers, the authors regarding as the direct cause of this disease the appearance in the plant of bacteria, *Bacillus subtilis* Cohn, and a new form, called by the authors *Bacterium Navicula.* Potatoes weakened by the *Phytophthora* are especially, though not exclusively, predisposed to this form of disease. Other Schizomycetes may also co-operate. The decay is then further promoted by other saprophytic fungi.

The second section of the book treats of the history of development of the most important of these:—*Hypomyces Solani*, a pyrenomycete whose conidial form is known as *Fusisporium Solani; Nectria Solani*, the conidial form of which is known as *Spicaria; Chætomium bostrychodes* and *crispatum*, *Stysanus Stemonitis* and *capitatus*, and *Verticillium* (*Acrostalagmus* Cord.) *cinnabarinum*. The third section is concerned with the crinkling of the leaves of the potato, the cause of which disease is referred by the authors to the attacks of a fungus which they name *Verticillium alboatrum.*

Spirochæte denticola.‡—The organism which is always found in the mucilage of the teeth and tongue, and often in close connection with the epithelium, has been made a subject of investigation by Dr. Rudolf Arndt. In connection with the epithelium are true *Bacteria*, *Bacilli* and *Vibriones.* Among the *zooglœa*-colonies are also traces of colonies of *Bacillus* and *Leptothrix;* and together with these the peculiar *Spirochæte denticola*, consisting of spirally coiled

* 'Zeitschr. gesammt. Naturwiss.' (Giebel), lii. (1879) p. 884.

† 'Die Zersetzung der Kartoffel durch Pilze,' von J. Reinke u. G. Berthold. 9 Taf. Berlin, 1879. See 'Bot. Zeit.,' xxxviii. (1880) p. 44.

‡ 'Arch. path. Anat. u. Phys.' (Virchow), lxxix. (1880) p. 76.

threads about 0·01–0·02 μ in diameter, and having a length of 5 to 15 or 20 μ. The number of coils varies from 1 to 8 or 10. They have a uniform vermiform motion. The complete history of this organism is at present unknown, but the author regards it as probably a stage in the development of true *Bacteria*.

Chemical Composition of Bacteria in Putrefying Liquids.*— Professors Nencki and F. Schaffer have found that on adding a few drops of acid (sulphuric, hydrochloric, or acetic) to a liquid containing *Bacteria*, and boiling it for a few minutes, the *Bacteria* shrivel up and settle; the liquid may then be filtered and the *Bacteria* separated in a "chemically pure" condition. Of course the fluid must contain no substances precipitable by boiling, such as albumen. Ordinary gelatin was therefore chosen as a suitable medium for propagating the growth of *Bacteria*.

The dried mass of *Bacteria* was first exhausted with alcohol, and the alcoholic extract then heated with ether. A slight brownish residue of a substance resembling peptone was left. The ethereal extract contained the fat, the elementary composition of which—72·54 per cent. C, and 11·73 per cent. H—corresponds fairly with that of vegetable and animal fats, but contains 1·5 per cent. too little carbon.

In order to ascertain whether any change in the composition of *Bacteria* occurs in the course of their development, analyses were made of undeveloped granules, of a mixture of granules and rodlike bodies, and of the rodlike bodies after full growth. The results are as follows:—

	Pure Granular Mass (Zooglœa).	Granular Mass with partially developed *Bacteria*.	Perfect *Bacteria*.
Water	84·81	84·26	83·42
Fat (contained in dry substance) ..	7·89	6·41	6·04
Ash (in substance deprived of fat)	4·56	3·25	5·03
Elementary composition of the substances deprived of fat .. C	..	53·07	53·82
H	..	7·09	7·76
N	14·34	13·82	14·02
	a. 14·60	..	*a.* 13·82

An estimation was made of the albuminoid substance contained in the *Bacteria*, by exhausting the mass with very dilute alkali, separating the soluble from the insoluble portion by filtration, neutralization with hydrochloric acid, and precipitation by addition of crystals of salt. The precipitate consists of a new albuminoid, soluble in excess of acetic acid, and has been named by the authors *mycoprotein*. It contains 52·32 per cent. C: 7·55 per cent. H; and 14·75 per cent. N, and corresponds well with the formula $C_{25}H_{42}N_6O_9$. It was proved that neither sulphur nor phosphorus was present. Freshly

* 'Journ. prakt. Chem.,' xx. p. 443; 'Journ. Chem. Soc.,' Abstr., xxxviii. (1880) p. 176.

precipitated mycoprotein is easily soluble in water, alkalies, and acids, but after being dried at 110° it is no longer perfectly soluble in water. It exhibits the usual properties of an albumen, and is lævorotatory, $[\alpha] = -79$. Acids convert it into peptones. The authors believe that this simple form of albumen is obtained from a simple organism; a general law may be deduced, the more complex the organism the more complex its proximate chemical constituents.

The residue left insoluble on treating the *Bacteria* with dilute alkali, consists of cellulose, and amounts to about 5 per cent. of their weight; it contains a little nitrogen. This may point to some albumen not removed, for Loew analyzed similar cell-membranes, and found them to contain a mere trace, or no nitrogen.

Hernia of the Cabbage.*—M. Woronin admits that he was previously in error in attributing all tuberous swellings without exception in the root of the cabbage to the attacks of *Plasmodiophora*.† The true hernia (termed Kropf in Germany, Kapustuaja-kila in Russia) he still maintains to be always due to this parasite, and never to the attacks of insects. There are, however, swellings of a different character, in which not a trace of the *Plasmodiophora* is to be found, which are true galls, produced by insects. These may be distinguished by their resisting decay for a considerable time; while roots attacked by the true hernia very quickly decompose and give out an offensive odour.

Lichenes.

Archil-lichens of California.‡—Hesse has submitted the archil-producing lichens from California to a chemical examination. He gives the 'Neue Freie Presse' of Vienna credit for the statement in 1871 that 300 persons had gone from New York to Lower California to collect these lichens, then lately discovered. They were found on hard, rocky soils, near the coast, and a single person could collect a ton, valued at $300, in four days. In the year 1870, the archil sold in the United States from this source was valued at $14,900, and the extract prepared from it at $4700. The lichens found their way to the London market, and specimens reached him late in 1871. They had been pronounced to be the well-known lichen *Roccella tinctoria*; but doubting the correctness of this view, Hesse sent specimens to Laurer, the lichenologist, who considered it to be new, and proposed for it the name *Roccella fruticosa*, placing it between *R. tinctoria* and *R. fuciformis*, and nearer the latter. Hesse himself placed it as a variety of *R. fuciformis*. The colour was extracted with milk of lime, the lime was thrown down by carbon dioxide gas, and the chromogen was purified by crystallization from hot alcohol. When pure it exhibited all the properties of β-erythrin, and gave on analysis the same formula, $C_{20}H_{22}O_{20}$. It is optically inactive, and yields picroerythrin and orsellinic ether when decomposed by alcohol. Beside erythrin the lichen contains very small quantities of roccellic

* 'Bot. Zeit.,' xxxviii. (1880) p. 54. † See this Journal, ii. (1879) p. 315.
‡ 'Liebig's Ann.,' cxcix. (1879) p. 338; see 'Am. Journ. Sci.,' xix. (1880) p. 229.

acid. The author regards this as confirmatory of his view as to the species.

Algæ.

Cell-division in Algæ.*—In a species of *Conferva* brought from the interior of Greenland, M. Kolderup Rosenvinge observed a peculiar process preceding cell-division, viz. the formation and separation of a very thin interior layer of cellulose; a thickening then makes its appearance in the middle of this interior layer, which grows and divides the cell into two. A similar process was observed in a *Ulothrix* from the marsh of Lyngby, which he proposes to name *U. leverrima* var. *mucosa*.

Reproduction of Bryopsis.†—M. Max Cornu has recently been studying the development of *Bryopsis* at the Wimereux Zoological Station. It was tolerably common at the end of September and in October. At the end of the third week in October the observations were suddenly broken off. They were made on *Bryopsis plumosa*, or a robust form of *Bryopsis hypnoides*. The following are his principal conclusions:—

The orange-coloured *Bryopsis* are not specimens attacked by parasites; the development appeared normal and regular; the transformation of the protoplasm and the escape and disposition of the mobile bodies which it produces show this.

The orange-coloured mobile bodies, whose length is less by one-half that of the others, do not germinate; but a similar capability of alteration shows itself in the green zoospores, a peculiarity rare amongst marine Algæ.

The rare germinations which are effected take place by the formation of spherules of two forms, the development taking a month and a half.

It was natural to consider these two kinds of mobile bodies as the analogues of the sexual corpuscles of *Pandorina*, the red ones being the spermatozoids. M. Cornu brought together under the Microscope small drops of water charged with either kind, and saw no conjunction even whilst waiting for the quiescence of the green zoospores.

M. Cornu noticed some green zoospores with four cilia; but they were rare. It seemed to him that, *à priori*, they ought to be double, and analogous to those of *Botrydium*.

There are no female organs in the form of oogonia. Any near comparison with *Vaucheria* was impossible. *Botrydium* is probably much nearer to *Bryopsis* than to *Sphæroplea*.

In the vegetative or reproductive filaments some short cells lie isolated here and there, whose function is probably that of asexual spores.

Plurality of Nuclei in the Cells of the Siphonocladiaceæ.‡—The group Siphonocladiaceæ has been defined by Schmitz § as including the marine algæ *Valonia*, *Siphonocladus*, *Anadyomene*, *Micro-*

* 'Bot. Tidsskr.,' iii. (1879) p. 2 (Supplement, French résumé).
† 'Comptes Rendus,' lxxxix. (1879) p. 1049.
‡ 'SB. Niederrhein. Ges. Natur- u. Heilk.,' Bonn, May 5, 1879.
§ See this Journal, ii. (1879) p. 606.

dictyon, and *Chætomorpha*, with the one fresh-water genus *Cladophora*. The same writer now gives the following more exact description of the cell-structure, taking as his type *Valonia utricularis*.

The cell-wall is clothed internally with a moderately thin layer of protoplasm, enclosing a large cavity filled with colourless cell-sap. Included in the protoplasm are a number of small, flat, disk-shaped chlorophyll corpuscles, of an irregular form. At the growing apex of the cells, which are always more or less tubular, they are densely aggregated into a dark green layer. Most of the chlorophyll corpuscles contain a single starch-grain.

The great characteristic of these cells is that, in addition to the chlorophyll grains, they contain a number of nuclei embedded in the layer of chlorophyll, and regularly distributed through it at very equal distances. In the larger cells of *Valonia* they may number several hundred.

The division of these nuclei takes place by bipartition in precisely the same way as in the Infusoria and other animals of low organization. The spherical nucleus assumes an ellipsoidal shape, its substance becoming at the same time less dense. The two extremities gradually increase in density, and the intermediate substance becomes more and more absorbed into the two daughter-nuclei, until they are connected only by a thin thread, which is finally ruptured.

The zoospores are produced in great numbers from a single cell. The whole of the protoplasm of the cell collects around the numerous nuclei, and then breaks up into a large number of zoospores, each with a single nucleus. This nucleus is preserved during the whole of the "swarming" of the zoospore, and in the unicellular germ which results from it, becoming then again multiplied by bipartition.

The structure above described is uniform in its main features throughout the Siphonocladiaceæ; but the mode of cell-division varies. The size of the two sister-cells is sometimes nearly the same, sometimes very unequal; the angle of the new division-wall with the old one may be either an acute or a right angle, the wall itself may be either straight or curved.

The Siphonocladiaceæ therefore, instead of being, as hitherto supposed, devoid of a cell-nucleus, exhibit the only instance at present known in the vegetable world of the occurrence of a large number of nuclei in the same cell.*

Crystalloids in Marine Algæ.†—Dr. J. Klein has examined the crystalloids in 20 marine algæ belonging to 12 genera, 5 of the species being green, and 15 belonging to the Florideæ; some were examined in the living, others in the dry state. A strong resemblance existed between all the crystalloids examined. Their physiological function appears to be that of temporary reservoirs of reserve material; when, under certain circumstances, albuminous substances are formed, a portion separates in the form of crystalloids, afterwards possibly to be utilized in the formation of the spores. This is the case probably

* See also p. 482. † 'Flora,' lxiii. (1880) p. 65.

in *Acetabularia*, where crystalloids are found only before the spores are formed.

Acetabularia mediterranea has colourless, usually very regular hexahedral crystalloids in the chambers of the pileus; *Bryopsis Balbisiana* comparatively large quadratic or rhombic octahedra, often congregated in large quantities. *Cladophora prolifera* has regular hexahedra, the smaller ones colourless, the larger brown. The hexahedra of *Dasycladus clavæformis* are colourless, or more often brown, and exhibit obvious parallel stratification. The crystalloids of *Callithamnion griffithsioides*, *Griffithsia heteromorpha*, and *G. parvula* resemble very acute hexahedra or pyramids, but show a six-sided transverse section, or have the form of thin, not very regular, six-sided plates. Those of *G. setacea* and *G. Schousbœi* resemble octahedra, while those of *Laurencia* sp., *Polysiphonia purpurea*, and *P. funebris* are clearly octahedra, and those of *P. sanguinea* very acute elongated rhombs, probably pyramidal.

The author was unable to determine with certainty from algæ preserved in alcohol or dilute glycerine the crystalloid red substance termed by Cramer rhodospermin. Only in *Peysonnelia* he found red bodies, which could not be more closely examined in consequence of their small size; and in two dried Florideæ irregular angular bodies of various size, of a bright carmine-red colour, which behaved with reagents like crystalloids, and might possibly be imperfectly formed rhodospermin.

MICROSCOPY, &c.

Haris and Power's Physiological Manual.—Dr. Haris and Mr. D'Arcy Power, the Demonstrator and Assistant-Demonstrator of Physiology at St. Bartholomew's Hospital, have just published* a small Manual for the Physiological Laboratory which should be of considerable service, as it contains very useful practical information. "An epitome of histology" accompanies the practical directions, of which the following are samples:—

"*Preparing for Mounting.*—Specimens may be mounted at once in glycerin after cutting, staining, and washing in distilled water; but if it be desired to preserve in Canada balsam or dammar, the sections must pass, after staining, through—

(*a*) Methylated spirit }
(*b*) Absolute alcohol } to remove the water.

(*c*) Clove oil, oil of turpentine, or benzol } to render them transparent.

They must remain in alcohol for five to ten minutes, and in clove oil for the same time."

"*Elastic Tissue.*—Preparation—Tease out a small piece of the ligamentum nuchæ of an ox in glycerin, and examine.

"Structure.—Elastic fibres are *thick* and well defined; they do not form bundles; they *branch* dichotomously and *anastomose* with each

* 8vo, Baillière, Tindal, & Cox, London, 1880, 113 pp.

other to form a real network; when torn they *curl up* at the ends. They do not swell up when treated with acids, and they yield elastin."

Part I. is entitled Practical Histology, and Part II. Physiological Chemistry; some more difficult subjects are dealt with in the Appendix, which concludes with Mr. Groves' valuable classification of staining fluids, and a copy of Messrs. Parkes's table of the magnifying powers of Microscopes.

Collecting and Mounting Spiders' Webs.*—Mr. J. Fenner, referring to Mr. Hind's paper on this subject (*ante*, p. 320), thinks that not so much has been made of the subject as it is capable of, and gives his own experience. It occurred to him that he would endeavour to view a web with a light in front to answer for direct sunlight, and another behind to represent sunlight reflected back from the surface of green foliage. To imitate these conditions, the lamp is placed in front and on one side of the stage of the Microscope, using the bull's-eye condenser to focus on to the web. Then take a piece of stout millboard, covered with a bright green paper, bent into a semicircular form to back the lamp, so placed that the green light from its surface shall fall on the mirror beneath the stage, and be thrown back from it through the web. There is no slide, or covering glass, or mounting medium of any kind; but as the webs are entirely exposed, it is, of course, necessary to keep them free from dust, &c. As the threads of a web are, in their natural form, at some considerable distance apart, you can, in the ordinary way, only get one or two lines into the field of view at one time; the web should therefore be doubled and quadrupled. In order to accomplish this, take a piece of thin board, such as cigar-boxes are made of, about 10 inches by 6 inches, and cut out the middle part, leaving a margin $\frac{1}{2}$ inch wide, which smear on one side with thick gum. Then, placing the frame behind a clean, newly-formed web, and bringing it forward gently, and cutting away all round, transfer the web bodily on to the frame. In order to double the web cut another frame, about $8\frac{1}{2}$ inches by $4\frac{1}{2}$ inches, and take a second web. Then placing the smaller frame on a table, bring down the larger one so as to cover and include the other, and then cutting away between the two, a doubled web is obtained. If this is not sufficient a still smaller frame should be made and the operation repeated. When a web is thus obtained with as many lines close together as is required, take some small disks of thin cardboard with $\frac{1}{2}$-inch centres punched out, and having gummed them, place them both before and behind the web, and in this way obtain small portions of the most suitable parts of the web which can be placed on the stage of the Microscope.

Koch's Method of Preparing Sections of Corals.†—Mr. H. N. Moseley testifies to the great success of this method, which was described in a previous volume.‡ In some sections of corals sent him

* 'Engl. Mech.,' xxxi. (1880) p. 135.
† 'Quart. Journ. Micr. Sci.,' xx. (1880) p. 245.
‡ This Journal, i. (1878) p. 274.

by Dr. von Koch, the hard and soft tissues were maintained in their exact relations to one another, and both were reduced to a sufficient thinness to exhibit the minute structure in all essential details. Mr. Moseley considers the method will yield valuable results, not only in the case of corals, but also in all other problems of minute anatomy in which the relations of hard and soft parts have to be determined. It might perhaps be employed with advantage in the examination of the structure of Corti's organ. Sections could thus be prepared of the undecalcified cochlea, in which the components of the organ of Corti would be seen in situ and unaltered by the action of acids. Sections of injected bone showing the relations of the blood-vessels to the Haversian system, sections across the arms of undecalcified Crinoids and starfish, and many similar preparations suggest themselves as likely to yield valuable results.

Localities for Marine Foraminifera.—With regard to localities for marine Foraminifera along coast regions, Professor Leidy remarks* that sea-sands contain as an important constituent the dead shells of recent Foraminifera, though in very variable proportions. They are generally most abundant in the sands of warmer latitudes, and especially on shores profusely furnished with sea-weeds. Plancus,† who, according to D'Orbigny, was the first to describe and figure the shells of Foraminifera, counted 6000 individuals in an ounce of sand from the Adriatic. D'Orbigny estimated that there were 160,000 in a gram of selected sand from the Antilles. Schultze gives 1,500,000 as the number he found in fifteen grams of sand from Gaeta, on the coast of Sicily.

Even on the comparatively barren shores of New Jersey, consisting of quartz sand, foraminiferous shells occur in notable quantity. In a portion scraped from the surface between tides, at Atlantic City, he estimated that there were 18,700 shells to the ounce avoirdupois, all of a single species of *Nonionina*. In another sample, from Cape May, he obtained 38,400 shells to the ounce, likewise of the one species. In sand collected by scraping up the long white lines on the bathing beach at Newport, Rhode Island, occupying an indenture of the rocky coast, covered with sea-weeds, foraminiferous shells were found to be much more numerous, but, excepting in the case of some samples of *Miliola*, of smaller size. In an ounce of the sand, there were about 280,000 shells, of several genera and species.

Separating Foraminifera from Sand.‡—Mr. C. M. Vorce finds that if dried sponge sand is thrown into water slowly, all the foraminifers sink, and sand floats on the water. A slide dipped under the floating film will bring up only sand. All that does not sink with a little stirring may be safely skimmed off and thrown away. Then the sunken part should be dipped out, about a dessert-spoonful at a time, into a small saucer, and water enough to just fairly cover them put

* See this Journal, *ante*, p. 288.
† 'Ariminensis de conchis minus notis,' Venice, 1739.
‡ 'Am. Nat.,' xiv. (1880) p. 118.

in, and all floating grains stirred down. Then by a circling movement of the hand the foraminifers will be got to the top, and by gradually tipping the saucer and slowing up the movement they can be worked to one edge of the little pile of sand, and thence carefully dipped up with a rubber bulb pipette. In this way they are got almost pure. Only a little sand must be washed at a time, or not all the foraminifers will be got out, and very little water must be used or sand will get mixed with them. Much water moves the light sand, but a shallow wave seems not to stir it, but yet rolls the shells along.

Continuous Measurement of the Intensity of Daylight, and its Application to Botanical Researches.*—M. Kreusler describes an instrument whereby the intensity of daylight can be estimated for any hour; it consists of a hollow drum in which is cut a slit parallel to the terrestrial axis; behind this slit is a strip of sensitized paper, across whose surface the slit is caused to pass by means of clockwork. To be able to compare the shades of colour, several tints are produced also on sensitized paper, by causing the direct rays of the sun to fall on the paper at various angles for twenty seconds, this being the length of exposure for each part of the registering paper. An inclination of 60° produces half tint, &c., the tints being numbered 1, 2, 3–10, 10 representing full sunshine.

In the second portion of his paper the author states that brightness of light is accompanied by increased assimilation on the part of the plant; but this regularity of increase continues only up to the point when the intensity of light is one-eighth that of the full sunshine, and after that assimilation goes on less rapidly, not keeping pace with the increased intensity. Now, as increased intensity of light is accompanied by increased chemical intensity, the former may be used as an indicator of the latter, as regards plant physiology, as it was found that assimilation increased as chemical intensity increased, at first rapidly, but afterwards in a less degree. Sub-aquatic plants are not of value in determining assimilation, as they are not sensitive enough to small changes of light; an apparatus has therefore been devised in which it is possible to expose whole plants to the light, and is on the principle of an aspirator.

Collecting Marine Diatomaceæ.†—According to Mr. K. M. Cunningham, a quick way of getting marine forms of Diatomaceæ is to take a peck of fresh oyster-shells, and brush the back of each one into a basin of water; some cotton should be cut up into tufts and immersed in the fluid, which will make the product suitable to be dried and ignited, as it will take fire at a red-heat and entirely burn; it will, however, take a stronger heat to destroy the particles of animal matter of the oyster—the young spawn which will naturally be brushed into the water. This oyster-shell process will give *Pleurosigma* and *Coscinodiscus* in abundance.

* 'Bied. Centr.,' 1879, p. 117; see 'Journ. Chem. Soc.,' Abstr., xxxviii. (1880) p. 188.

† 'Am. M. Micr. Journ.,' i. (1880) p. 66.

Arranged Diatoms for Test Slides.—Diatoms arranged in stars and other patterns have hitherto been regarded as beneath the notice of right-thinking microscopists. Recently it has been pointed out * that slides with six or eight diatoms arranged radially from a common centre will be found useful as test objects to those whose Microscopes have not a rotating stage, saving much time in manipulation, as one or other of the specimens will be sure to be in the position required for resolution with reference to the direction of the illumination.

Preparations of Crystals for the Polariscope.†—After preparing crystals, dry, in Canada balsam, and in castor oil, it occurred to Mr. M. A. Veeder to attempt to preserve them in their own mother-liquor. To do this, paint on a slide a thin ring of gold size, whose entire diameter shall equal that of the cover-glass. The edges of the ring may be made smooth and true by holding the flat edge of a small chisel against them, whilst the turntable is whirled. As soon as the ring is finished heat it over the flame of a lamp until it become brown. Put into a test tube a little salycine, tartaric acid, prussiate of potash, or other substance adapted for examination with the polariscope, add water and apply heat until the solution is of such strength that crystals will form in it only when quite cold. Coat the ring, already hardened, with a little fresh size, and likewise the edge of the cover-glass. Put the slide and cover-glass thus prepared on the hot plate for a few minutes and then pour a few drops of the boiling solution from the test tube into the cell and apply the cover-glass immediately, pressing it down gently with a dry cloth which will absorb the superfluous liquid. Touch the edge of the cover-glass with gold size and then transfer to the turntable and finish. If the above directions have been followed correctly the cell will contain a clear liquid which begins to deposit crystals as it cools. Without the aid of the polariscope it is of interest, but with that accessory the spectacle presented is exceedingly beautiful. After standing for some time, the crystals appear to lose their sharpness and perfection of form. They may be restored by a fresh application of heat sufficient to cause them to dissolve and enter upon new forms of combination.

It should be noted that the quantity and strength of the solution employed will modify the results obtained, also agitation of the fluid whilst evaporating will in some instances introduce crystals of an entirely different form from those obtained when it is permitted to remain undisturbed.

Preparation of Thin Rock Sections in the Field.‡—Mr. A. A. Julien thinks that when a party who may be exploring in portions of country where the more refined apparatus for section grinding and preparing cannot be procured, or where one is obliged to travel by mule train, where but little luggage can be transported, the following will answer the purpose very well, viz. a tin box about $2\frac{1}{2} \times 5$ inches, containing a small box of flour emery (or, as a substitute, garnet may

* 'Engl. Mech.,' xxxi. (1880) p. 181.
† 'Am. Nat.,' xiv. (1880) p. 116.
‡ 'Am. Journ. Micr.,' iv. (1879) p. 231.

be picked up in many places and powdered in the field), a small bottle of common balsam, made very hard, a few corks, some pieces of broken window glass, a few thin covers, or, if they are omitted, pick up mica from some of the rocks, and use thin sheets of that instead (except in some cases where it would interfere with the use of polarized light upon some rocks); in addition to these, a small piece of iron plate for grinding upon completes the outfit, all of which will fit into the tin box.

The processes are simply as follows: Break off very thin flakes from the rock to be examined, a piece one-eighth of an inch in diameter is large enough; take the small piece of smooth flat iron (a stove lid will do), place a little flour emery with water upon it, then, with the flake of rock upon the iron plate, press upon the section with a cork for a holder, and rub one side by grinding with the emery until that side has been made smooth and flat; take a small piece of the window glass, and by melting some of the balsam cement the smooth side of the section to the glass. Now take the glass in hand, and with the other side of the section *down to the plate*, with emery, grind as before, until *newspaper print* can be clearly seen through it. This will answer well for ordinary examination, but with care many rocks may be polished finer and thinner than this. Now take one of the cover-glasses or laminæ of mica, and with the melted balsam place upon the uncovered side, and the section is ready for microscopic examination. All of this can be done in ten minutes anywhere in the field.

Test for Amyloid Substances.*—Safranine, one of the red aniline dyes, is recommended for the detection of amyloid matter. It is soluble in water and alcohol. Sections immersed in a watery solution of safranine (one or two grains to the ounce), are stained rapidly, the amyloid substance showing a beautiful orange colour, while the rest of the section is of a rose colour. Epithelial cells are more deeply tinted than connective tissue. Thick tissues colour well; tissues which have been hardened in alcohol stain well; but not those which have hardened in chromic acid or the bichromates. Acetic acid destroys the value of the test, the entire specimen being stained of a uniform rose tint in the presence of this acid.

Picrocarmine Staining in Inflammation-Studies.†—Professor Neumann in describing his method states that the mixture adopted by Schweigger-Seidel of one part muriatic acid and 200 parts glycerine is very useful; instead of this, one or two drops of acid may be added to ten cubic centimetres of glycerine, and the moment carefully watched for, under the Microscope, at which the solution has completed its action; this method may be adopted for specimens preserved in alcohol as well as for those that have been in Müller's fluid or in chromic acid. This solution is applied after the sections have in Ranvier's solution taken on a more or less distinct orange-red coloration.

The author enters into a detailed account of the value of this

* 'Med. Herald' (Louisville, U.S.A.), i. (1880) p. 523.
† 'Arch. Mikr. Anat.,' xviii. (1880) p. 130.

method in elucidating the characters of various inflamed membranes, and into the pathological questions connected therewith, which are beyond our province.

Preparation of Ranvier's Picrocarmine.*—The preparation of this staining agent is, Mr. S. H. Gage says, somewhat difficult, owing to the fact that the right proportions and the precise operations for its manufacture have not been definitely determined. Ranvier's directions are, to add an ammoniacal solution of carmine to a saturated solution of picric acid, until saturation. Four-fifths of this mixture is then evaporated in an oven, allowed to cool, then well filtered and the filtrate evaporated to dryness. When wanted for use the dry powder is dissolved in water, in the proportion of one part by weight of picrocarmine to 100 parts by weight of water. It is very difficult to decide when the mixture of carmine and picric acid solutions becomes saturated, and the simple watery solution soon becomes mouldy.

Some experiments were made in the anatomical laboratory of the Cornell University, U.S., to determine definitely, if possible, the process of making a solution that would keep for any length of time.

1. It was found that equal parts by weight of picric acid and carmine gave the best results.
2. The picric acid should be dissolved in one hundred times its weight of water, using heat if necessary.
3. The carmine should be dissolved in fifty times its weight of strong ammonia.
4. Mix the two solutions. It seems to make no difference in the result which solution is poured into the other.
5. Use porcelain evaporators and glass funnels.

The best results were obtained when the solutions were made at the ordinary temperature of the laboratory, 17° C., and then evaporated three-fourths at a temperature of 40°–45° C. The solution should be allowed to cool, and filtered through two thicknesses of filter paper. The filtered liquid is then evaporated to dryness at 40° C., or at the ordinary temperature.

If the preparation has been successful the residue dissolved in one hundred times its weight of water should give a clear solution, after filtering. Make 50 c.c. of such a solution and filter it through two thicknesses of filter paper and a fine cotton filter moistened well and crowded into the neck of the funnel. Filter the solution four or five times through the same filter, and a clear solution will probably be obtained. In case a clear solution cannot be obtained by repeated filtering, the whole of the powder may be dissolved in the proportion given above and allowed to stand a few days in a tall narrow vessel. If the finely suspended particles settle, the top will be clear and may be decanted; but if the fluid remains cloudy, a quantity of ammonia equal to that originally used should be added to it, and the evaporation of three-fourths should be repeated with the subsequent filtration and evaporation to dryness. Usually, however, if the method given

* 'Am. M. Micr. Journ.,' i. (1880) p. 22.

above be followed, one will succeed the first time. In case the third evaporation should not give a clear solution it is advisable to begin again with new materials.

When a clear solution is obtained there should be added to every 100 c.c. of the picrocarmine, 25 c.c. of strong glycerine, and 10 c.c. of 95 per cent. alcohol; there will thus be formed a permanent solution that may be kept perfectly clear by filtering once in five or six months.*

Glycerine-Gelatine for Mounting.†—Herr Otto Brandt, F.R.M.S. and Secretary of the Berlin Microscopical Society, points out that glycerine-gelatine, though known, is not properly appreciated. No other medium offers so many advantages for mounting; Canada balsam requires a tedious treatment of the object after it comes from the water in which it has been rinsed, such as desiccation, soaking in oil of cloves, and even after three to four months, if handled incautiously, the cover-glass may be displaced; on the other hand, objects intended for mounting in glycerine-gelatine need no further preparation after being washed, and in a few hours the preparation may be permanently sealed up.

The little use that has been made of this substance may be accounted for, first, from the method of preparing being little known, and secondly, because the glycerine-gelatine of commerce contains small threads which are difficult to get rid of. Herr Brandt therefore describes his method of preparing and using.

A quantity of the best white gelatine should be cut up coarsely with the scissors, and laid overnight in a vessel with distilled water, so that it may swell up during the night. In the morning it is taken out, squeezed in the hand, and placed to melt (without adding fresh water) in a glass cup in the water bath; as soon as the mass has become fluid add to it (stirring continuously) about one and a half times as much glycerine as was taken of the gelatine.

As the gelatine of commerce is always mixed with particles of dust and minute threads, the filtering of it is a point of vital importance, and this is where many have failed. Swedish filtering paper does not allow the fluid to pass through sufficiently, and flannel produces more threads than before. The following simple apparatus is found effective: A wide-necked bottle is broken in two, and the upper part taken. The neck is stopped with a cork having two holes bored in it. In the first hole a glass tube about 20 cm. long is inserted so as to project a little into the inside of the bottle, and on the outside it is bent sharply to one side and drawn out into a point of about $1\frac{1}{2}$ to 2 mm. diameter. In the second hole a funnel-shaped filter is inserted so that the conical part is inside the bottle and the tube projects a few centimetres beyond the cork and the neck of the bottle. The apparatus is then placed so that the wide opening of the bottle and of the

* For three methods of preparing hitherto described see Ranvier's 'Traité technique de Histologie,' p. 100; C. Baber in 'Quart. Journ. Micr. Sci.,' 1874, p. 251; Rutherford's 'Practical Histology,' p. 173.

† 'Zeitschr. f. Mikr.,' ii. (1880) p. 69.

funnel is uppermost, and some spun glass is pressed into the lower conical part of the filter.

In using the apparatus the funnel is filled with glycerine-gelatine, and the bottle with hot water, which runs off slowly through the tube in the first hole and is constantly replenished. The glycerine-gelatine is thus kept fluid, and drops in a clear condition into a vessel placed below to receive it. Some drops of carbolic acid should be added to the fluid product of the filtering.

The method of using it given by Herr Bachmann* is as follows:—

"A piece of the glycerine-gelatine of sufficient size is taken with a scalpel and placed in the middle of the slide, and the whole of the middle part of the slide is warmed uniformly. It is thereby melted, and spreads. The object is then put in the fluid, and a small piece of glycerine-gelatine added; it is again warmed slightly, so that the fluid may thoroughly penetrate the object. The slide is then laid on something black, whereby the air-bubbles present become plainly visible. By the blade of a scalpel these are drawn out of the fluid, and at the opposite side the cover-glass, *slightly warmed*, is placed in a slanting position, and gradually brought horizontal. By this means any remaining air-bubbles are all driven in one direction, and by a slight pressure on the loose cover-glass may be pushed from under it. An essential point for the success of the whole manipulation consists in using more glycerine-gelatine on the slide than is required for the mounting, the circle formed by it being larger than the cover-glass, so that the air-bubbles may be pushed from under the cover into the liquid outside it. If any air-bubbles remain notwithstanding under the cover, the slide should be warmed again, the cover-glass raised again with a fine needle, so that a little of the mounting material can get under, and the cover-glass repeatedly pressed at the side opposite to the air-bubbles until they are pushed from under the glass. The slower and more uniformly the slide is warmed, the fewer air-bubbles will be formed.

It may happen that from the object not being properly penetrated by the embedding substance, small air-bubbles, or water or glycerine globules may be formed in the preparation after it has set. Before the slide is varnished, these should be carefully looked for under the Microscope."

Herr Brandt further says that it is very difficult, by merely placing the object in the glycerine-gelatine on the slide, to be sure that it will be thoroughly penetrated. It should therefore be placed first in a small wide-mouthed bottle of glycerine-gelatine, of the same consistency as that used for the mounting, which has been melted on the hot-plate described by Donnadieu,† particular care being taken that it is heated only a little beyond the melting point of the glycerine-gelatine. When the object appears to be sufficiently penetrated, it is taken out and placed on the slide, and is then ready for mounting in the manner above described.

"After a few hours (continuing Herr Bachmann's description), the

* 'Leitfaden z. Anfertigung Mikr. Dauerpräparate,' 8vo, Munich, 1879.

† 'Zeitschr. f. Mikr.,' i. p. 86.

preparation will be sufficiently hardened to allow of the slide being cleaned. For this purpose the parts of the surface of the slide and cover-glass to which the gelatine adheres should be scraped off with a knife, and rubbed over with fine powdered chalk by an ordinary brush, and then cleaned with a dry rag."

Dr. E. Kaiser also describes * a process for preparing a chemically and "microscopically" pure glycerine-gelatine as follows:—One part by weight of the finest French gelatine is left for about two hours in six parts by weight of distilled water, seven parts of chemically pure glycerine are added, and for every 100 grams of the mixture 1 gram of concentrated carbolic acid. The whole is warmed for ten to fifteen minutes, stirring all the while until the whole of the flakes produced by the carbolic acid have disappeared. Finally, it is filtered while still warm through the finest spun glass which has been previously washed in distilled water and laid whilst still wet in the filter. When cold the preparation may be used like Canada balsam.

Glycerine-Gelatine as an Embedding Substance.—Dr. Kaiser in the same paper points out that the above forms also an excellent embedding substance for making sections. For this purpose the objects are placed in the glycerine-gelatine after it has been again warmed. When sections of objects have to be made so delicate that there is danger of their falling to pieces after being cut, the object must be left in the warmed glycerine-gelatine until it is *thoroughly* penetrated by the latter. The gelatine may be removed from the tissues by a fine jet of warm water after the section is made and placed on the slide.

For embedding harder objects glycerine-gelatine is an excellent medium, for after it is set, any degree of hardness may be imparted to it by treating it with absolute alcohol, the time required for this being from ten to thirty minutes.

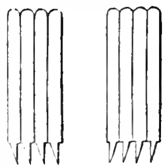
A special recommendation of this substance for embedding is its transparency, which enables the operator to see at any moment what the position of the object is.

Brandt's Microtome.†—Herr Brandt has devised a modification of the Rivet microtome (in wood). The body of the microtome is cut through the middle longitudinally, and the two halves movably attached behind by a hinge, so that they can be made to diverge at any angle, and be fixed by means of a clamping screw in any position. By this arrangement the idea suggested and carried out by Dr. Long, of Breslau, of making the right and left grooves not parallel but diverging towards the front, is still further extended, as it lies in the power of the operator to increase the angle of divergence at pleasure, and make the knife take a greater or less lateral motion. Herr Brandt has succeeded by this means in making good sections of objects of most delicate structure which he failed to do to such perfection in any other way.

* 'Bot. Centralb.,' i. (1880) p. 25.
† 'Zeitschr. f. Mikr.,' ii. (1880) p. 172.

Improvements in Cell-cutting.*—Cells cut from thin sheet wax or lead are rapidly coming into use in America. They can be built up one upon another to form deeper cells, but are most applicable where great thickness is not required, and have the great advantage that they can be prepared, as wanted, by anybody, of any required size, with very little trouble, and almost without expense. The elegant preparations of Mr. Merriman at the Buffalo meeting of the American Society of Microscopists were mounted in cells of wax cut by Streeter's punches.

FIG. 29.



These instruments, as subsequently improved and as now made, are represented in section by Fig. 29. There is a set of four concentric tubes of iron or hard brass, of equal length, fitting smoothly within each other, and turned to a cutting edge at the lower end. When using the punches, the cutting edges are to be moistened with water to prevent sticking to the wax, and the wax laid on some book-leaves or writing-paper to form a firm, smooth cushion. The smallest punch is then pushed through the wax sheet with a slightly rotating motion, and then the next one is placed over it and pushed down in the same manner, and so on, to the largest. The

FIG. 31.

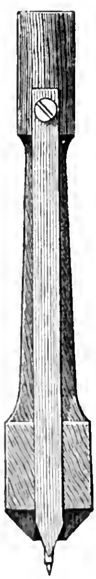


FIG. 30

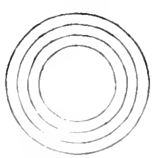
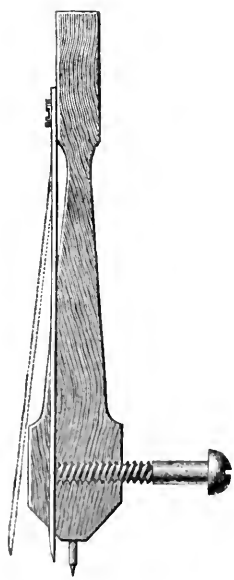


FIG. 32.



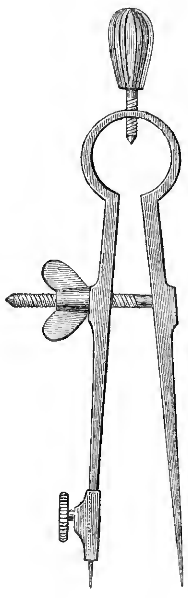
inner punch is next withdrawn by a wooden peg or pencil thrust into it, and the others drawn out one after the other by the little finger. Each ring of wax is then pushed out of its punch with the top of

* 'Am. Nat.,' xiv. (1880) p. 65.

the next smaller punch, leaving it flat and true. The three rings (Fig. 30) thus prepared are suitable for use with cover-glasses of one-half inch, five-eighths inch, and three-quarters inch diameter. They may be fastened to the slide by a little warmth and pressure only, or by some kind of cement, which will not only form a coating to the wax, but also secure it to the slide.

Of instruments adapted to cutting both wax and sheet-lead cells, two very convenient forms were brought forward by Dr. R. H. Ward, at a recent meeting of the Troy Scientific Association. The first was designed by Mr. C. M. Vorce, of Cleveland, O., and is represented in front view and in section in Figs. 31 and 32. It can be readily made by amateurs for their own use. It consists of a wooden body of such size as to be easily held and twirled between the fingers, with a short needle point inserted in the centre of the lower end. On one side a longitudinal slot or groove is cut through the wood deep enough to allow the cutting edge to approach nearly to the needle. The cutter should be ground to a triangular point, and ground only on the outside, leaving its inner face flat and smooth. A screw passes through the body of the instrument, and bears against the spring, regulating its distance from the needle point. Greater firmness might be secured by changing the form of the body so as to support at its two edges the cutter when forced out to its farthest limit.

Fig. 33.



The other instrument, shown in Fig. 33, was suggested by the Vorce instrument, and was contrived by Mr. F. Ritchie, of Troy. It possesses greater power and precision than the other, but is not so easily made by an amateur. It consists of a pair of spring dividers about three and a quarter inches long, from one leg of which half an inch of its length has been cut off and replaced by a brass socket with a binding screw to hold a small knife-blade. A knob is also added at the top for convenience in manipulation.

The method of working these two forms of apparatus is precisely the same. A sheet of wax may be laid on a sheet of heavy white paper, and both together tacked to a piece of smooth hard wood. The instrument, with its legs set three-sixteenths inch apart, is used to cut out a series of disks of three-eighths inch diameter. How near together these can be safely cut will soon be learned by experience. The legs are then set one-quarter inch apart, and using the same centres as before, a series of rings can be cut suitable for one-half inch covers. By successively spreading the legs one-sixteenth inch further each time, rings may be cut around the same centres for five-eighths and three-quarters inch covers, and larger if desired. The concentric rings around each centre are cut out without waste, as shown in Fig. 30. Not only wax, but also sheet lead, cardboard, and guttapercha can be cut with facility in this manner. The various tools sold by hardware dealers for cutting washers of leather, &c., have often been employed for this work, but they have proved too clumsy to be useful.

How to make the new Wax Cell.*—Dr. F. M. Hamlin uses for making the wax cell, "which has so suddenly come into favour," only a turntable and a penknife. Placing the slide upon the turntable, a square or circular piece of sheet wax (such as is used in making artificial flowers) is put upon the slide and carefully centered. The outer edge should then be pressed firmly upon the glass with the thumb or fingers. Having determined the exact size of the cell, turn the slide very slowly and hold the knife with the blade slightly moistened so that the point will cut from the upper surface of the wax downward and outward, gradually pressing the point of the knife down upon the glass. This manner of holding it causes it to serve as a wedge, the outer shaving of wax being generally thrown up and entirely off the glass. If a circular piece of wax from a punch is used, its outer edge should be trimmed off to make it perfectly circular, the pressure of the fingers being likely to distort it somewhat. Any superfluous wax that may remain may be removed by means of a bit of cloth held over the end of the finger or on a stick.

The next operation is to cut out the centre, and is done in the same way, only that the knife is held so as to cut from the top of the wax downward and inward, toward the centre of the cell, so that the bottom of the wax ring shall be wider than the top, which should be about one-tenth of an inch in width. As the point of the knife goes down it throws up the different thicknesses of wax till the last is reached, which it removes, leaving the glass inside the ring almost perfectly clean, unless too much pressure has been used in fastening the wax to the slide.

These wax cells possess certain advantages over others, among which is the slight cost of the necessary apparatus for making them. It might be thought that wax alone is too soft for durable mounts, but this is not the case. Being made and fastened upon the slide at one operation, they are not liable to that distortion which removal from the punches is likely to cause. They can also be made of any size.

According to Mr. C. C. Merriman the wax must be carefully covered with some cement. whether used for fluid or dry mounts; as it is said that certain volatile portions will ultimately collect upon the glass cover of dry mounts or mingle with the preservative media in liquid mounts, and thus spoil the work in either case. His experience is, that the best cement to cover the wax with is Müller's liquid marine-glue. After coating the ring with this it is used in the ordinary way.

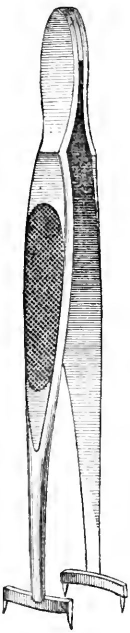
Device for Mounting.†—Mr. A. L. Woodward applies to a Cox turntable a slender arm of brass which is attached at one end to the hand-rest of the turntable by a milled-head screw. The other end extends over the centre of the turntable at a suitable height above it. A pointed screw comes down through the end of the arm exactly over the central dot. In mounting in glycerine, for example, after

* 'Am. M. Micr. Journ.,' i (1880) p. 16. † Ibid., p. 57.

the cover is applied to the object, the slide is transferred to the turntable, the cover is brought to the centre, and the pointed screw is turned down upon the cover, compressing the object and expelling the superfluous fluid. After a rough cleaning a ring of gelatine-solution may be applied, as directed in Marsh's treatise on Section-cutting, p. 41. After a couple of applications of the gelatine and time allowed for it to set, the screw may be loosened and the slide removed from the turntable.

Chase's Mounting Forceps.*—Having experienced the inconvenience attendant upon the use of the ordinary methods of placing glass covers upon objects, Dr. R. H. Chase devised the forceps shown in Fig. 34, consisting of an ordinary pair of surgeon's spring forceps, either straight or curved, having attached to each blade a circular strip of metal, which carries a short pin-shaped foot. The feet being attached to the outer sides of the circular cross pieces, leave a ledge upon which the glass cover rests.

Fig. 34.



The method of mounting with the forceps is as follows:—Having placed the slide upon a self-centering turntable, and the object carefully arranged upon it in the balsam, place with a clean pair of forceps the thin glass cover (which has previously been cleansed and set aside for use) in the jaws of the mounting forceps. Put a drop of balsam upon the side of the cover that is to come in contact with the object, and invert it over the object on the slide. Allow the feet of the forceps to rest upon the slide, and adjust them by the rings upon the turntable that are seen through the glass.

When the cover is thus carefully centered over the object, relax the grasp of the fingers upon the forceps, and the cover falls in place, causing a wave of balsam to radiate from the centre in every direction. The result is that the cover is accurately centered, and "the object peers up at you—gratifying sight—from the centre of the cover."

In this manner delicate tissues can be mounted that would be inevitably washed to the edge of the cover by the old method; and which are too delicate to be moved back in safety to their proper positions. Those also who have occasion to mount groups of two or more objects under one cover, will find this method of great advantage, as the objects retain their relative positions as arranged upon the slide.

Cleaning Slides and Thin Covers.†—Dr. C. Seiler describes an easy method which he employs of effecting this object. He places new *slides* for a few hours in the following solution:—

Bichromate of potash,	2 oz.
Sulphuric acid,	3 fl. oz.
Water,	25 fl. oz.

* 'Am. Journ. Micr.' v. (1880), p. 64. † Ibid., p. 50.

in such a manner that the brown liquid covers them completely; then rinses them under the tap, and stands them on edge on several thicknesses of blotting paper. When dry, they are chemically clean and require no further rubbing. Before mounting on them, the dust should be brushed off with a camel's hair brush.

With new *covers*, an ounce or so of them are placed in a wide-mouthed vial, and covered with the cleaning solution, shaking them up occasionally, so that they become separated. After three or four hours, pour off the acid solution and wash the covers in the bottle with water, pouring it on and off until the water remains colourless, after continued shaking of the bottle. When wanted for mounting, a cover can be taken out of the bottle with a pair of forceps, and wiped dry with a linen rag. Cleaning covers in this way gets them thoroughly clean, and breaks very few of even the thinnest.

When it is desired to clean off specimens which have been mounted, either in balsam or in a watery medium, so as to save both the cover and the slide, slightly warm the specimen over a spirit lamp, and push the cover with a pair of forceps into a vessel containing alcohol and hydrochloric acid in equal proportions. After having scraped off the balsam or cement with a knife, drop the slides into the bichromate of potash solution, in which they must remain several days, when they can be washed under the tap and dried on blotting paper like new ones. The covers also should be left a few days in the acid solution, and are then transferred to the bichromate of potash solution, and treated like new ones.

Conditions of Aplanatism of Systems of Lenses.*—Prof. Abbe publishes an interesting paper under this title.

As hitherto defined, aplanatism is simply the "elimination of spherical aberration for a pair of conjugate points on the axis;" the word, however, as practically applied is used with a wider meaning, denoting the capacity of a system of lenses to produce a well-defined image of an object by a cone of rays of appreciable (i.e. not infinitesimal) divergence; and by object is meant, not a *point* on the axis, but a *surface* perpendicular to the axis.

On analyzing the conditions under which an image is produced with large angles of divergence, it appears that even when spherical aberration is perfectly corrected for the axis, images of unequal linear amplification may be formed by the various portions of the available aperture of the lens-system. The image of an axial element (or minute portion) of an object, which is formed by a pencil of rays inclined to the axis (through any excentric part of the aperture), has a different linear amplification to that which an image has which originates simultaneously from the rays nearer the axis (through the central part of the aperture). In fact, the image produced by a cone of rays of wide aperture is the result of the superposition of the innumerable images which the various elements of the free aperture would produce *singly*, and these may be shown isolated by the aid of diaphragms. If the linear amplification of these "partial"

* 'SB. Jen. Gesell. Med. und Naturw.,' 1879, p. 129. Revised by Professor Abbe, with diagrams (Figs. 35, 36, and 37).

images of which the whole image is composed be different, they may still coincide in the axial point of the image-field, if the spherical aberration is completely corrected, but at a distance from the axis, and in proportion to that distance, they will separate from one another more and more. The image of a point at some distance from the axis resolves itself into a circle of confusion, whose diameter bears a finite—in some cases a large—ratio to its distance from the axis, and consequently to the dimensions of the portion of surface viewed, however small that may be. When, for example, the linear amplification through the central portion of the aperture is 10 diameters, while the amplification through a marginal portion is 12 diameters, the overlapping of the image produced by the latter over that produced by the former would introduce circles of confusion whose diameter is one-fifth of their distance from the centre at every part of the field. Hence a system, to be aplanatic, besides having its spherical aberration corrected for a pair of conjugate points, must satisfy the further condition of uniform amplification through all parts of the available aperture, that is, for rays in every direction which the angle of aperture embraces.

By a geometrical analysis it may be demonstrated that the required identity of amplification through different parts of the available aperture only subsists when there is a definite ratio between the convergence of the two conjugate pencils of rays whose centres are the axial points of the object and of its image; the *sines* of the angles of inclination of mutually corresponding rays towards the axis must have a constant ratio throughout the whole range of both pencils. By this property aplanatic points are contrasted with a second kind of characteristic points which are important in the formation of images by rays of appreciable divergence, viz. those points on the axis in which the *tangents* of the angles of inclination of conjugate rays are in a constant ratio. These may very properly be called *orthoscopic* points, as on them depends the possibility of forming orthogonal, or similar, images of extended (i. e. not infinitesimal) objects.

The amended definition which Professor Abbe gives is therefore as follows:—"Aplanatic points in a lens-system are those conjugate points on the axis, the spherical aberration of which has been corrected for a cone of rays of appreciable angular aperture, the sines of the angles of inclination of conjugate rays being also proportional."

The essential part of this definition was published by Professor Abbe in 1873.* Professor Helmholtz independently established the same principle, and showed † that the constant ratio of the sines was the condition required if the quantity of light proceeding from the object was to reach the image without loss or gain. Since "quantity of light," according to the undulatory theory, is the energy of an oscillatory movement, this mode of deriving the above theorem connects the action of optical apparatus with the most universal principle in modern physics.

In microscopical objectives of large angular aperture the aplana-

* 'Arch. f. Mikr. Anat.' ix. (1873) p. 420.
† 'Poggend. Annalen, Jubelband,' p. 566.

tism which has just been defined, becomes a matter of vital importance. When the error in the convergence is considerable and affects the whole aperture, the defects arising from ordinary aberration, curvature of the field, and other causes, sink into insignificance—the image of a flat object appears then not merely as a curved surface, but rather as the apex of a cone viewed from the axis.

In the case of large angles of aperture the second condition of aplanatism cannot be so completely satisfied, either theoretically or practically, but that evident traces of the error in divergence are left in the image even when the best means of construction are employed. Microscopists have given to this the very unsuitable name of "curvature" or "unevenness of the field of view," by which it is commonly known. It may, however, be easily shown by experiment that the defects in the image thus described increase in amount, not with the second, but with the first power of the distance from the axis, and therefore in the main have nothing to do with the actual curvature of the image surface.

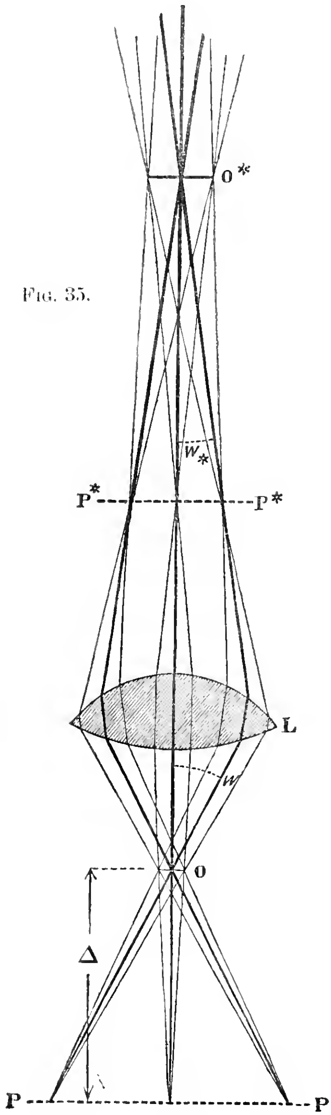
By the simple experiment about to be described, the characteristic relation of convergence of rays at aplanatic points may be observed, and the fact that it persists universally becomes confirmed in a striking manner. This experiment is founded on the contrast between the *aplanatic* points and the *orthoscopic* points of the lens-system, and is deduced from the following considerations.

If an optical system is to produce a correct image of an object extended in a plane, the principal rays proceeding from points of the object and crossing at a point on the axis, and the corresponding principal rays of the image-forming pencils which cross in the conjugate point on the axis and proceed to points of the image, must maintain a constant ratio between the *tangents* of their angles of inclination. It is only when a lens-system satisfies this condition for a pair of conjugate points on the axis (as e. g. a properly constructed eye-piece should do for the place of the objective-opening and the point of vision conjugate to it) that it is orthoscopic, and can produce images which are orthogonal and free from distortion when the object or the image, or both, are shown under a large angle. But aplanatic points, by virtue of the condition of aplanatism, are in antagonism with this property of orthoscopic points, and consequently an aplanatic system, from its peculiar relation of convergence, must give a distortion of the images, *which can be determined beforehand*, when we produce the image of a plane *distant* from the aplanatic point while the principal rays of the image-forming pencils cross in this aplanatic point.

It will be enough if we determine the form which parallel lines assume under these circumstances, or *vice versâ*, find what curves will appear as straight lines in the resultant image.

By a simple calculation it is found that a set of parallel lines in a plane perpendicular to the optical axis, will, with an aplanatic system, form a number of ellipses having the same major axis, but different minor axes (the line at infinity forming a circumscribing semicircle). On the other hand, a set of hyperbolas (of determinate

Fig. 35.



form to be described later on), with the same centre and conjugate axis but with different transverse axes, will be reproduced in the image as a system of parallel straight lines. It is here assumed that the pencils of rays which form the image, cross on entering the lens-system in the aplanatic point which is situate on the side next the object, and for the sake of simplicity the angle of convergence of the rays in the conjugate aplanatic point on the side next the image is assumed to be so small that sine and tangent may be regarded as equal.

These conditions are fulfilled if with an objective of large aperture, the pupil of the observer's eye—or whatever opening admits the rays to the eye—is brought to the axis of the system, and at the spot where the conjugate aplanatic focus on the side next the image is; because in this case no ray can reach the eye which has not passed, on its entrance into the system, through that element in the object which is on the axis conjugate to the pupil or other opening. The assumption as to the angle of convergence in the aplanatic point next the image is evidently satisfied sufficiently in microscopic objectives.

The hyperbolas above referred to are constructed from the equation

$$y = \frac{\Delta}{a} \sqrt{x^2 - a^2},$$

where Δ (the common conjugate axis for both sets of hyperbolas) represents the distance of the plane of the object from the correspond-

[L is a system of lenses which is aplanatic for the conjugate points O and O*; the condition of convergence being fulfilled,

$$\frac{\sin W^*}{\sin W} = \text{const. for any two conjugate rays through O and O*}.$$

P P is a plane perpendicular to the axis, at a distance Δ below the aplanatic focus O; P* P* is the image of this plane, depicted by pencils whose principal rays cross at O and O*—under these conditions the image P* P* shows the distortion described above. The thicker lines indicate the principal rays.]

ing aplanatic focus; and the value of a in both the sets is taken from the formula

$$a = \frac{\Delta \cdot u}{\sqrt{1 - u^2}},$$

the increments of u being equal; e.g. the values of $u = 0 \ldots . 0 \cdot 2 \ldots . 0 \cdot 4 \ldots . 0 \cdot 6 \ldots . 0 \cdot 8$. Provided the common centre of all the curves in the diagram Fig. 36 is adjusted to lie on the axis, and its plane is perpendicular to the axis and at the proper distance Δ

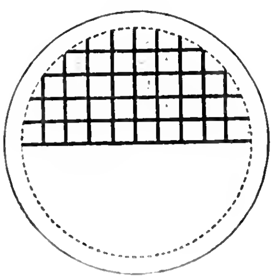
FIG. 36.

(Δ = 12 mm.)

from the aplanatic focus, the diagram appears in the image as two sets of equidistant parallel lines intersecting at right angles.* The parts of the diagram bounded by curved lines and increasing continually towards the extremities in size and distortion appear as equal squares; the intersections of the hyperbolas (forming angles which towards the outside become increasingly acute and obtuse) are repro-

* Image of the hyperbolic curves, as depicted by a wide-angled aplanatic system, under the conditions named above—the dotted circle indicates the limit of the telescopic field corresponding to an air-angle of 180°.

FIG. 37.



duced as right angles; even the more distant curves of both systems of hyperbolas whose branches do not intersect in the figure but evidently diverge from each other (e.g. those for $u = 0 \cdot 8$), intersect at right angles in the image, though their point of intersection—corresponding to an imaginary point in mathematics—is at a distance from the centre of the image which no rays of light emerging from air can reach, outside the circle on the plane of the image which corresponds with the boundary of a cone of rays of 180° in air.

With objectives whose focal distance is not very short—down to about 3 mm.—the appearance described may be seen with the naked eye by removing the eye-piece from the tube of the Microscope and looking down the open end, keeping the eye as much as possible in the centre, and near the spot where the real image would be formed when the Microscope is used in the ordinary way, and viewing the air-image floating above the objective.

With objectives of very small focal distance, an auxiliary Microscope of low power must be inserted in the tube, and a diaphragm placed in a position conjugate to the aplanatic focus.

This method converts the whole optical system into a telescope with a terrestrial eye-piece through which the drawing which serves as the object is viewed. The microscopic objective which is being tested acts as a telescopic objective, its aperture angle gives the angle of the field of view of the telescope, and what in the ordinary use of the Microscope is the field of the object, the element of surface in its aplanatic focus, acts as entrance aperture when thus used like a telescope.

Numerous trials have been made by Professor Abbe with objectives of various construction and by different makers, and the results have invariably confirmed the theory above laid down. With the exception of the objectives manufactured by Zeiss, there are probably none that have been constructed with this principle avowedly in view. If in spite of this the objectives of all opticians on the Continent, in England, and America satisfy this condition, the fact shows more convincingly than any theory could do, that this peculiar convergence of the rays is undoubtedly an essential constituent of aplanatism in a lens-system.

The above experiment is instructive in many other respects. It illustrates practically some theoretical deductions regarding the image produced by a cone of rays of large angle, as for example, the influence of the angle of aperture on microscopic vision. The portions of field between the hyperbolic curves which are so extremely dissimilar, (the area of those on the outside being many times the area of those in the interior,) appear as squares of equal dimensions, and when the diagram is uniformly illuminated no difference in the brightness can be discerned, although in the squares on the margin the rays are compressed which proceed from an illuminating surface many times larger than that corresponding to the middle squares. This fact shows plainly the great inequality in value of the different parts of the angular aperture with respect to their share of the quantity of light which the system receives.

It is obvious, in fact, that the peripheral portion of the aperture conducts very much fewer rays of light into the objective in proportion to the central parts than would correspond with the measure of their angles, and that consequently the *angle* of aperture cannot be a correct expression of the real aperture—that is, of the capacity of the optical system to receive light. This leads us empirically to the conclusion which results from theory, viz. that "numerical aperture" is the rational measure of aperture, and the only one from which an estimate of its practical effects can be formed.

Systematic Examination of Objectives for the Microscope.—Dr. G. E. Blackham, of Dunkirk (N.Y.), U.S.A., in a paper read at the last (Buffalo) meeting of the American Society of Microscopists, says that the microscopist dealing with minute quantities, is peculiarly liable to be aided or hindered by slight differences in the quality of his instruments; for while it is doubtless true that an expert can do very fair work with instruments of only moderate quality, and the tyro cannot do first-class work with instruments even of the most superlative excellence, it is also true that, other things being equal, the better the instrument the more reliable the results obtained, and that the *best* work cannot be done even by the most expert worker except with the best instruments. The comparison of instruments must therefore always, if properly and skilfully done, be of value to the worker, who may thus be enabled to select the most fitted for his work.

The most important optical part of the Microscope, and that most subject to variation of quality, is the objective; but the ordinary methods of describing these seem to the author to lack precision. For instance, we often see the recommendation to beginners to purchase a stand and a 1-inch and a $\frac{1}{5}$-inch objective. On referring to the catalogue of some makers we may find the latter thus described:—Student's series, $\frac{1}{5}$-inch, ap. 100°, non-adj., price $15; in another, Student's series, $\frac{1}{5}$, ap. 85°, non-adj., price $12. How is the student to choose between them?

The descriptions are insufficient to enable him to compare them. Which glass has the greatest resolving power, which the flattest field, which the longest working distance, and which the greatest amplifying power? Of course if objectives were all truly named the last question would be answered, as all $\frac{1}{5}$'s would have the same amplifying power, viz. × 50 at 10 inches from optical centre of the objective, but such is not the case.

In order to meet this requirement and answer these questions, Dr. Blackham has elaborated a system of examination and prepared a form for recording the results, which gives at a glance most, if not all, the points necessary to the comparison of objectives.

The first column gives the record number for convenience of reference, the second the owner's name, and the third the maker's and the year in which made. This latter is important, as in these days of rapid improvement in construction, it would be obviously unfair to compare an objective made five or even three years ago with one of same nominal grade made this year, without stating the fact.

Record No.	Owner.	Maker, and When Made.	Price.	Maker's Description. Designation.	Cover Adjustment.	Dry or Immersion.	Equivalent Focal Length.	Angle of Aperture. Air.	Water.	Balsam or Crown Glass 1·525.
			$ c.	in.			in.			
1	G. E. Blackham ..	R. B. Tolles, 1876	30 00	1	None	D	1	30°	—	—
*2	,, ,, ..	,, ,,	70 00	Duplex 1/8	Collar moving back.	I	1/8	180°	—	95°
3	R. B. Tolles ..	,, ,,	15 00	Student 1/4	Front lens.	D	1/4	110°	—	—
4	Bausch & Lomb Optical Co.	Bausch & Lomb Optical Co., 1878.	15 00	Student 1/5	None	,,	1/5	108°	—	—
5	,, ,,	,, ,,	20 00	1	,,	,,	1	36°	—	—
6	,, ,,	,, ,,	20 00	4/10	,,	,,	4/10	110°	—	—
7	J. W. Queen & Co.	Carl Zeiss, 1878 ..	15 00	3/5	,,	,,	3/5	—	—	—
8	,, ,,	,, ,,	19 00	C.C.	,,	,,	1/4	90°	—	—
9	,, ,,	,, ,,	40 00	G.	Collar moving back.	I	1/8	—	108°	—
10	,, ,,	,, ,,	47 50	H.	,,	,,	1/11	—	108°	—
11	Edward Pennock	C. H. Spencer & Sons, 1878.	15 00	Professional 1	None	D	1	30°	—	—
12	,, ,,	,, ,,	20 00	Professional 1/2	,,	,,	1/2	65°	—	—
†13	Bausch & Lomb Optical Co.	Bausch & Lomb Optical Co., 1879.	18 00	Student glycerine 1/4	Front lens.	,,	1/4	105°	—	—
14	,, ,,	,, ,,	28 00	Professional 1/8	Collar moving back.	,,	1/8	170°	—	—
15	,, ,,	,, ,,	25 00	1/2	None	,,	1/2	85°	—	—
16	G. E. Blackham ..	,, ,,	25 00	1/2	Front lens.	,,	1/2	85°	—	—
17	J. W. Sidle	J. W. Sidle, 1879	10 00	2/3	None	,,	2/3	34°	—	—
18	,, ...	,, ,,	18 00	3/10	,,	,,	3/10	110°	—	—
19	,, ...	,, ,,	Not stated.	1/5	,,	,,	1/5	Not given.	—	—
20	Prof. A. H. Tuttle	Chas. A. Spencer & Sons.	,,	1	,,	,,	1	50°	—	—
21	R. & J. Beck ..	R. & J. Beck, 1878	27 50	3	,,	,,	3	12°	—	—
22	,, ,, ..	,, ,,	27 50	1½	,,	,,	1½	23°	—	—
23	,, ,, ..	,, ,,	25 00	2/3	,,	,,	2/3	32°	—	—
24	,, ,, ..	,, ,,	60 00	4/10	Collar moving front lens.	,,	4/10	90°	—	—
25	,, ,, ..	,, ,,	50 00	1/10	,,	I	1/10	160°	—	—
‡26	,, ,, ..	,, ,,	8 00	1	None	D	1	19°	—	—
‡27	,, ,, ..	,, ,,	10 00	1/2	,,	,,	1/2	38°	—	—
‡28	,, ,, ..	,, ,,	12 00	1/4	,,	,,	1/4	75°	—	—
‡29	,, ,, ..	,, ,,	20 00	1/8	,,	,,	1/8	95°	—	—
‡30	,, ,, ..	,, ,,	30 00	1/16	,,	,,	1/16	110°	—	—
31	James W. Queen & Co.	H. Crouch	12 00	2	,,	,,	2	15°	—	—
32	,, ,,	,, ...	12 00	1½	,,	,,	1½	20°	—	—
33	,, ,,	,, ...	12 00	2/3	,,	,,	2/3	30°	—	—
34	,, ,,	,, ...	7 25	1	,,	,,	1	16°	—	—
35	,, ,,	,, ...	12 00	1	,,	,,	1	25°	—	—
36	,, ,,	,, ...	18 00	1/2	,,	,,	1/2	40°	—	—
37	,, ,,	,, ...	13 50	1/4	,,	,,	1/4	100°	—	—
38	,, ,,	,, ...	28 00	1/4	Collar moving back lens.	,,	1/4	100°	—	—
39	Bausch & Lomb Optical Co.	Bausch & Lomb Optical Co., 1879.	18 00	2	None	,,	2	20°	—	—
40	R. B. Tolles ..	R. B. Tolles, 1879	80 00	1/8	Collar moving back lenses.	§I	—	—	—	—
						‖,,	1/8	—	—	120°

* Glycerine immersion. † Compensation adjustment by varying thickness of *internal* film of glycerine.
‡ National Series. § With glycerine immersion. ‖ With cedar oil immersion.

RESULTS OF MEASUREMENTS AND TESTS.

Extreme Angle for Admission of Light.			True Aperture. Extreme Angle for Good Definition.			Nominal Amplifying Power.	Actual Amplifying Power.	Frontal Distance.	Working Distance.	Clear Aperture, Front Lens.	Diameter of Field.	Flatness of Field.	Chromatic Correction.	No. resolved on Probe-platte.	Lines per 1/1000 in. on ditto.	No. glimpsed on ditto.	Lines per 1/1000 in. on ditto.
Air.	Water.	Balsam or Crown Glass 1·525.	Air.	Water.	Balsam or Crown Glass 1·525.												
30°	—	—	30°	—	—	10	10	·309	·307	·360	·034	5½	Slightly under.	4	24·5	5	26
180°	114° 35′	95°	180°	114° 35′	95°	60	54 to 75	·017	·015	·031	·006	5¼	,,	20	95·2	—	—
108°	—	—	108°	—	—	40	45	·015	·013	·077	·007	4½	,,	11	47	13	53·5
108°	—	—	100°	—	—	50	50	·012	·010	·080	·006	5½	,,	13	53·5	14	62
36°	—	—	36°	—	—	10	8·33	·416	·414	·400	·040	5	,,	3	16	4	24·5
110°	—	—	100°	—	—	25	25	·021	·019	·200	·013	4½	,,	11	47	13	53·5
36°	—	—	36°	—	—	16⅔	14	·281	·279	·210	·025	5½	,,	4	24·5	5	26
90°	—	—	80°	—	—	40	36	·018	·016	·105	·010	5½	,,	11	47	12	61·6
180°	108°	90°	180°	99° 38′	84°	80	85 to 90	·015	·013	·075	·004	5	,,	14 & 15	62 58	18	86·2
180°	108°	90°	180°	102° 13′	86°	110	100 to 112	·012	·010	·055	·003	5	,,	14 & 15	62 58	18	86·2
33°	—	—	33°	—	—	10	10	·308	·306	·240	·033	4¾	Slightly over.	3	16	4	24·5
65°	—	—	65°	—	—	20	22	·050	·048	·260	·015	4	,,	9	46·4	10	49·2
100°	—	—	100°	—	—	40	35	·016	·014	·108	·009	5	Slightly under.	13	53·5	14	62
140°	—	—	120°	—	—	60	60	·008	·006	·044	·006	4¾	,,	16	67	17	63
85°	—	—	85°	—	—	20	18½	·036	·034	·260	·018	5	,,	11	47	13	53·5
98°	—	—	92°	—	—	20	20 to 22	·026	·024	·240	·015	5	,,	13	53·5	14	62
32°	—	—	32°	—	—	15	15	·199	·197	·200	·022	5¼	,,	4	24·5	5	26
120°	—	—	102°	—	—	33·3	33·5	·030	·028	·160	·009	5	,,	13	53·5	14	62
115°	—	—	81°	—	—	50	50	·022	·020	·100	·007	5	,,	14	62	15	58
50°	—	—	50°	—	—	10	10	·137	·135	·300	·034	5¼	,,	8	33·1	9	46·4
12°	—	—	12°	—	—	3·33	3	2·442	2·440	·520	·120	4¾	,,	1	3·7	2	13
23°	—	—	23°	—	—	6·67	6·67	·652	·650	·460	·051	5	,,	2	13	3	16
32°	—	—	32°	—	—	15	15	·325	·323	·260	·022	5½	,,	3	16	4	24·5
90°	—	—	80°	—	—	25	30 to 32	·052	·050	·130	·011	5¼	,,	10	49·2	13	53·5
152°	93° 1′	—	140°	89° 24′	—	100	95 to 100	·031	·029	·024	·003	5	,,	11	62	16	67
16°	—	—	16°	—	—	10	10	·291	·289	·300	·031	5¼	,,	2	13	3	16
38°	—	—	38°	—	—	20	22	·163	·161	·200	·015	5	,,	4	24·5	5	26
74°	—	—	70°	—	—	40	45	·028	·026	·086	·008	4½	,,	10	49·2	11	47
90°	—	—	80°	—	—	80	90	·026	·024	·037	·004	4½	,,	11	47	12	61·6
108°	—	—	95°	—	—	160	170	·010	·008	·020	·002	4½	,,	14	62	15	58
17°	—	—	17°	—	—	5	5⅓	1·173	1·171	·440	·062	5¼	,,	2	13	3	16
23°	—	—	23°	—	—	6·67	7	·737	·735	·400	·047	5¼	,,	3	16	4	24·5
25°	—	—	25°	—	—	15	15	·395	·393	·220	·025	5	,,	3	16	4	24·5
14°	—	—	14°	—	—	10	11	·780	·779	·300	·032	5⅓	,,	1	3·7	2	13
20°	—	—	20°	—	—	10	10	·415	·413	·280	·032	5½	,,	2	13	3	16
50°	—	—	40°	—	—	20	22·5	·102	·100	·240	·015	5½	,,	8	33·1	9	46·4
100°	—	—	90°	—	—	40	50	·015	·013	·070	·006	5½	,,	11	47	12	61·6
110°	—	—	80°	—	—	40	45 to 55	·024	·022	·062	·006	5½	,,	11	47	12	61·6
22°	—	—	22°	—	—	5	5	·870	·868	·440	·067	5⅓	,,	2	13	3	16
180°	—	105°	180°	—	105°	80	82 to 100	·012	·010	·020	·0035	5⅓	,,	20	95·2	—	—
180°	—	110	180	—	110	80	80 to 100	·015	·013	·020	·0035	5⅓	,,	20	95·2	—	—

The next eight columns give the description of the objective as obtained from the maker; viz. its price,* designation, adjustment for cover (if any), dry or immersion, equivalent focal length, and its aperture in air, water, or balsam. The remaining columns show the results of examination. The first group shows the extreme angle for the admission of light from the centre of the field, measured in air, water, or balsam; the next group the extreme angle for *best definition*, also measured in air, water, or balsam. This latter value is usually, though not always, less than the extreme angle for admission of light; and the difference between them, which is sometimes very considerable, shows the extent to which the nominal aperture of the lens could be profitably reduced by diaphragms as proposed by Dr. Royston-Pigott. The next column gives the nominal amplifying power, that is the amplifying power of the objective alone at 10 inches from the optical centre of the objective. Providing its nominal equivalent focal length were correctly given, this would be for a $\frac{1}{2}$-inch $\times$ 20, &c. The next column shows the actual amplifying power, measured at 10 inches from front surface of front lens, of the objective. It would have been more absolutely accurate to measure from the optical centre, but the exact position of this point could not be ascertained without a knowledge of the formula on which the objective was constructed, and in lenses possessing adjustment the position of the optical centre varies with every movement of the adjustment. The front surface of front lens being a fixed and easily determined position, and the results obtained by using it differing but slightly from those obtained by using the true optical centre, it was selected as, on the whole, the best position from which to measure the 10 inches. The method of measurement has been to compare the image of a Rogers' stage micrometer with that of an eye-piece micrometer placed exactly 10 inches from front lens, both micrometers being magnified by means of a Bausch and Lomb (Gundlach) periscopic eye-piece, in which the field lens is placed within the focus of the eye lens, and the eye-piece micrometer placed below the field lens and in the focus of the eye-piece, as a whole. The ordinary Huyghenian eye-piece will not answer for this kind of work. The actual and nominal amplifying powers of objectives are often very closely identical, and where variations occur, the actual will sometimes be found in excess of the nominal, and *vice versâ*. The next column gives the frontal distance of the objective, that is, the distance from front of front lens or of brass setting to the object; and the next column, the "working distance," which is frontal distance minus thickness of cover-glass (in all cases here being ·002 inch, the same cover being used with all objectives). The next column gives the clear aperture of front lens, that is the diameter of the light-spot seen when the objective is reversed—held with front lens towards the eye and the posterior combinations pointed at a brightly illuminated white surface, such as a sheet of

* The price is given as a matter of justice to makers whose cheap objectives appear in the list, as it would be unjust to compare the work of a cheap objective with one of same nominal power costing twice or three times as much, without making the fact apparent.

paper. The clear aperture of front lens is always much less than the diameter of exposed front surface which is free of the setting.

The next column gives the diameter of field, which often varies considerably with objectives of same nominal power. The next column shows the flatness of field, indicated by an arbitrary standard of 1 to 6; the latter representing an *absolutely* flat field, not yet found in any objective examined. The next column shows the chromatic correction, in regard to which Dr. Blackham says he has been unable to devise any numerical method which would fairly represent this quality, and has been forced to content himself with such vague notes as "slightly under," "slightly over," &c.

The next two columns give the number of the diatom on Möller's balsam-mounted probe-platte clearly and fully resolved by the lens with light from lamp and mirror, and the number of lines per ·001 inch, as per Professor Morley's measurements. The next two columns, the number of the diatom on same platte which could be just glimpsed under same conditions, and the number of its striæ per ·001 of an inch. The last column is for remarks.

It is of course understood that many of the results given would vary with different eye-pieces; but all except the actual amplifying power have been obtained with Tolles' $\frac{1}{2}$-inch solid eye-piece, the field of which is small enough not to be affected by the size of the tube of the Microscope.

The annexed Table shows the results of the examination of forty objectives of various makers. It was intended that this table should be as complete as possible, but at least two important omissions were discovered as the work progressed.

1st. The diameter of the exposed face of front lens should have been given.

2nd. The number of the diatom on the Möller platte resolved with direct *central* light, should also have been recorded.

There are probably other points which have been overlooked; but the table is submitted as an earnest and honest endeavour to remove the examination of objectives from the domain of mere opinion to that of carefully ascertained and accurately recorded *fact*. The attempt has been to ascertain and record the details of the best performance of each objective for itself, rather than to express an opinion as to its excellence or defects as compared with some standard, ideal or actual, and it is hoped that not only these records, but more especially the *method* may prove of interest, and possibly of service, to users and makers of objectives.

Unit of Micrometry.*—At the Buffalo Meeting of the American Society of Microscopists, the Committee on this subject (representing a large number of the American Microscopical Societies), presented the following report:—

"This Committee, as a result of individual consideration of the subject, and correspondence with Microscopical Societies and students, would respectfully and unanimously tender a report of progress to the

* See this Journal, ii. (1879) p. 154.

American Society, and respectfully request this Society to rescind its approval of the one-hundredth millimetre as a unit for Micrometry, and to refer that question, together with those of securing precision and international uniformity, to the Committee for further action."

This report was accepted.*

Micrometre or Micromillimetre. — Referring to the note on page 327, the adoption of the term "micro-metre" is objected to † on the ground that independently of the extreme similarity of the word to "micrometer," which is evident at a glance, the terms already in vogue in our popular treatises on arithmetic meet the case. For example, in Hensly's 'Scholar's Arithmetic,' published in the Clarendon Press Series (p. 174), an example is cited, and it is stated that, "if there were more decimal places in this case, they would be tenths, hundredths, and thousandths; then ten-thousandths, hundred-thousandths, millionths of a millimetre." This terminology seems simple enough, and cannot fail to be understood.

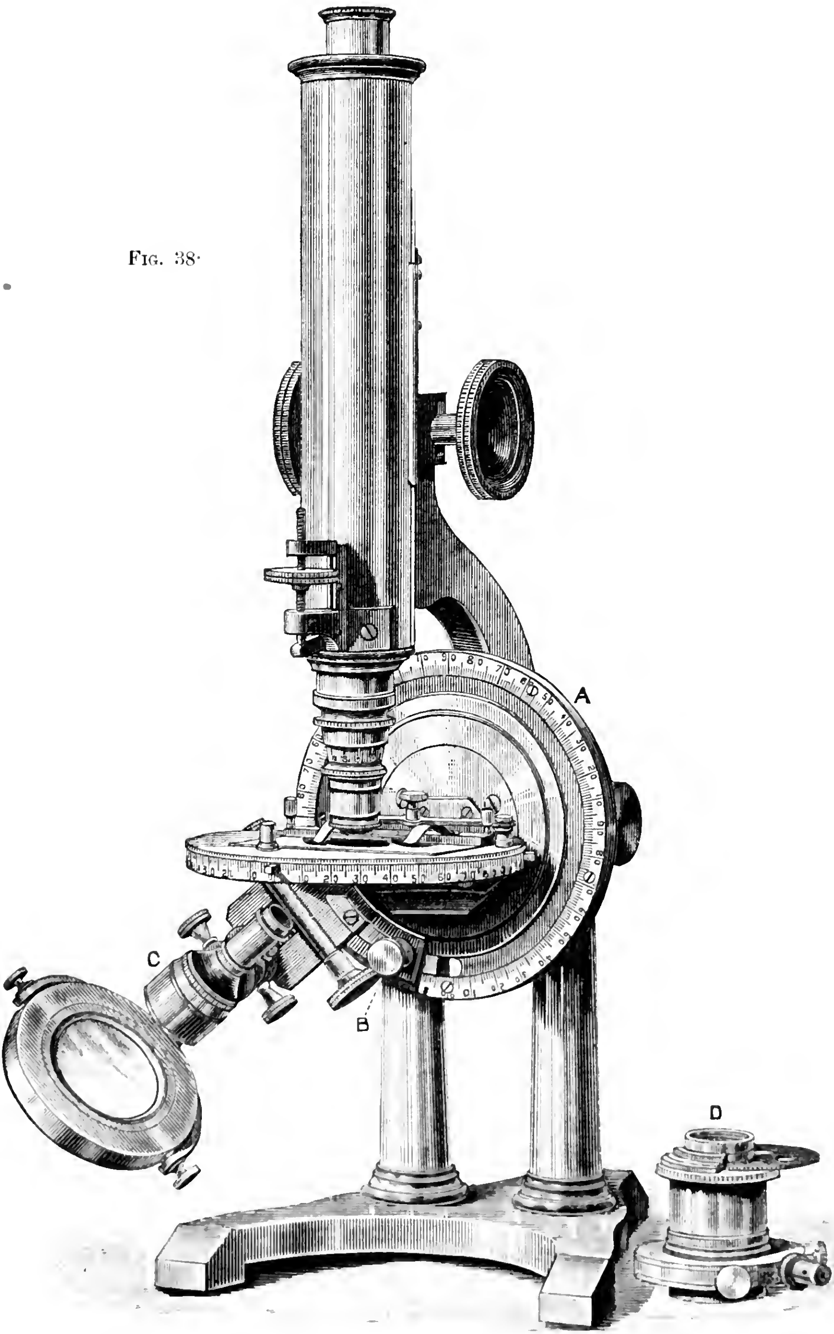
Tolles-Blackham Microscope-Stand.‡—A writer in the 'English Mechanic' compares this stand (which was made some two or three years ago by Mr. Tolles, of Boston, U.S.A., for Dr. Blackham §) with the Beck form.‖ The stand is shown in Fig. 38. Its speciality consists in the vertical disk A fixed rigidly to the main limb of the Microscope. The substage C is fitted to the zone carrier near the edge of the disk, and is moved circularly by means of the milled head B. When central light is required the extra substage D, with centering adjustments, is used. The stage is fixed to the centre of the vertical disk.

The main differences between the two stands are (1) that the vertical disk in Beck's is *not* fixed to the main limb, but is provided with a vertical sliding motion to allow for different thicknesses of object-slide, so that the swinging motion of the substage may be made strictly concentric with the object examined. This requires the manipulator to make the vertical centering adjustment with accuracy. (2) The stage itself can be turned laterally (or inverted) with rack and pinion, and thus enables the observer to obtain different views of the object. The cost is necessarily augmented by the extra difficulties in overcoming errors of centering and parallelism, and in producing steadiness and freedom from flexure.

Referring to the preceding communication, Mr. J. Beck says that, during extensive travels amid scientific men in the United States he has never seen one of these stands, and was ignorant of its existence. He has never claimed as a novelty the disk carrying the illuminating apparatus; this was virtually designed and carried out by Mr. Grubb, in 1854. What he does claim as a novelty is, that this disk is *not* fixed to the main limb, which he considers is a great improvement. In all the plans hitherto contrived, if the manipulator wishes to

* 'Am. Journ. Micr.,' iv. (1879) p. 210.
† "Cypher" in 'Engl. Mech.,' xxxi. (1880) p. 212.
‡ 'Engl. Mech.,' xxxi. (1880) p. 134.
§ See this Journal, i. (1878) p. 392. ‖ See *ante*, p. 329.

FIG. 38.



raise or lower the beam of light under oblique illumination, he moves this beam out of the optical axis of the instrument to either one side or the other; whereas by the new plan the beam is raised and lowered *in the axis of the instrument.* Any one who will work with oblique light on the one system or the other, will at once perceive the advantage and practical utility of it. Instead of the character of the illuminator being changed by the increased or decreased proportion from the one side or the other, it remains perfectly the same. The only value of these contrivances for the use of oblique light rests in their perfect accuracy; and anything that leads thereto is a step in advance. If there is any advantage in accuracy, as it must be considered that there is, the Grubb, the Zentmayer, and the Tolles-Blackham plans are only accurate for viewing an object on a slide of a definite thickness; any variation throws them out at once, whereas, by the new plan, the rotation can readily be made exact for an object mounted on glass of any thickness.

Jaubert's Microscopes.*—It may be new to many microscopists to learn that, some years ago, M. Jaubert, optician, of Paris, proposed to mount—and did actually mount—the Microscope limb, carrying the optical body, on a joint that permitted its inclination to either side. If a suitable object were placed some distance above the level of the stage, the optical body could be inclined so as to view it from one side of its horizon to the other, or even beyond. The side-inclination of the stage can only be regarded as a tentative process of examining the object from side to side, when compared with M. Jaubert's method. Not that the general adoption of M. Jaubert's idea is to be approved, but when we are seeking the best means of making a special examination, we must take cognizance of apparatus that has already been designed for that purpose.

M. Jaubert is also said to have made and published, and provisionally patented in England, a practical binocular Microscope, before either Professor Riddell's or Mr. Wenham's, or even Sir Charles Wheatstone's binocular projects were published.

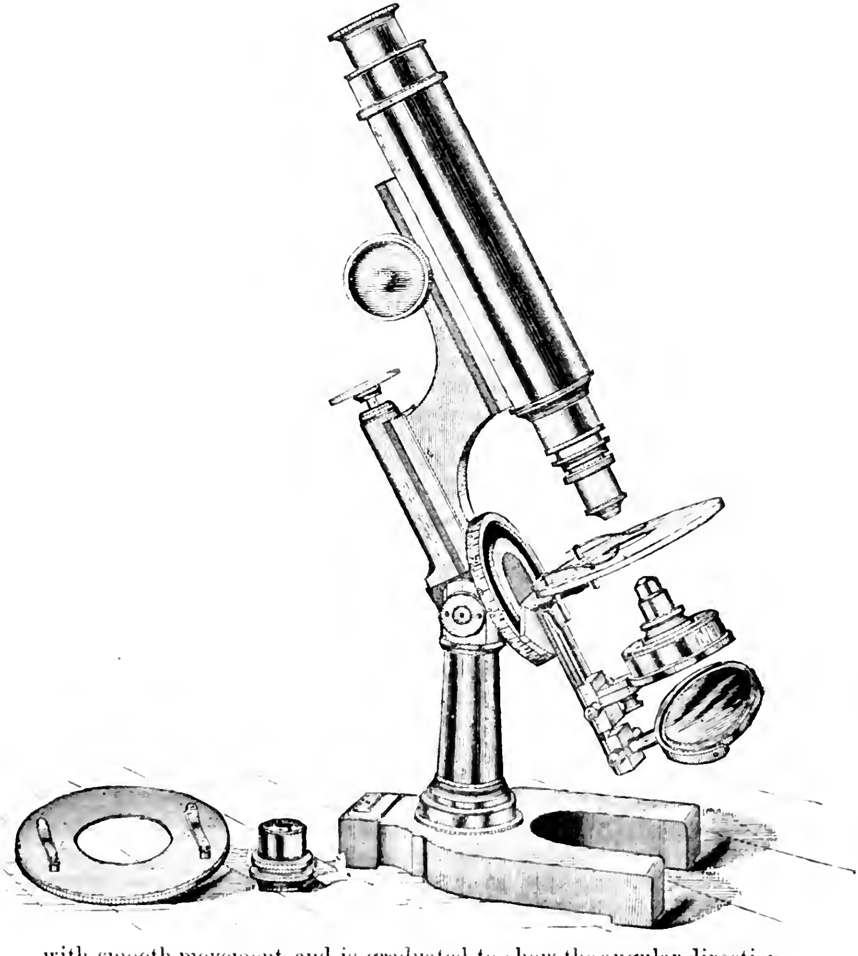
Sidle and Poalk's Acme Microscope.†—This Microscope, shown in Fig. 39, is the first cheap instrument that we have seen with a swinging substage.

The general form of the instrument hardly needs any description, but it may be mentioned that the *stage* is made of two thin, circular brass plates, the upper one (shown in the lower left-hand corner) fitted to turn upon the lower, so that the object can be rotated in the field of view. The stage can be centered. The upper plate can be removed, and two spring clips attached to the lower one, either above or below, thus making a stage for use with oblique light. The aperture in the stage has a standard-screw thread, to receive various accessories for illumination when it is desired to have the mirror move independently of them, and also to afford a means of mounting the selenite so that it can be revolved without turning the Nicol prism.

* 'Engl. Mech.,' xxxi. (1880) p. 135.
† 'Am. M. Micr. Journ.,' i. (1880) p. 8 (1 fig.).

The *mirror and substage* are both attached by sliding fittings to the same bar, which carries them around the object as a centre. The circular piece at right angles to the stage, gives steadiness to the bar,

Fig. 39.



with smooth movement, and is graduated to show the angular direction of the illuminating pencil.

The horseshoe *base* is reversible, so that greater steadiness can be ensured when the stand is used in a horizontal position.

Powell and Lealand's new $\frac{1}{8}$ Water-immersion and $\frac{1}{25}$ Oil-immersion.—At the Conversazione of the Royal Society, on April 28, Messrs. Powell and Lealand exhibited their *new formula* $\frac{1}{8}$ water-immersion on *Amphipleura pellucida* (dry) illuminated with oblique light from their oil-immersion condenser. The new objective has an aperture, measured in crown glass, of 112° (= 1·27 numerical aperture, nearly), which is stated to be the highest aperture hitherto produced in Europe for a water-immersion. It is understood that these opticians have also produced $\frac{1}{4}$ and $\frac{1}{16}$ objectives on similar formulæ, and of nearly equivalent apertures.

At the last scientific evening of this Society, Messrs. Powell and Lealand also exhibited their new $\frac{1}{25}$ oil-immersion on *Podura* and *P. angulatum* with central light from their achromatic condenser. The aperture of the new objective, measured in crown glass of mean index 1·525, is 110° (= 1·26 numerical aperture, nearly); the covering-glass used was stated to be ·004 inch, and the working distance also ·004 inch, giving a clear object-distance of ·008 inch from the plane surface of the front lens. In consequence of this increased working distance the objective will be found far more convenient to use than the $\frac{1}{25}$ on earlier formulæ by these opticians.

Zeiss's Adjustable Objectives.—These objectives, in which the magnifying power can be varied from that of a 5-inch to a 2-inch lens, have been further improved. In the original form the adjusting screw pushed the *back* combination upwards, which necessitated an alteration in the diaphragm usually placed at the objective end of the tube. In the improved plan the screw pushes the *front* combination forward so that the objectives can be used with any stand.

Durability of Homogeneous-Immersion Objectives.*—Professor Abbe writes that Dr. Woodward's homogeneous-immersion and the few others returned to Zeiss for repairs were "not damaged at all," the oil it would seem having entered at the screw at the lower part of the setting, and *not* at the edge of the front lens. Only two instances are known in which the setting of the front lens became leaky, the objectives being some of Zeiss's earliest productions. No homogeneous-immersions now leave the works until the tightness of the front lens has been ascertained by several prolonged exposures to oil.

Professor Abbe considers that the durability of homogeneous-immersion objectives is in no way inferior to that of other objectives, and remarks that the cedar oil supplied by Zeiss does no injury to the varnish of stands, or other brasswork, as shellac is not dissolved by it.

Wenham's Dry Paraboloid and Amphipleura pellucida.—Mr. George Williams has succeeded in satisfactorily resolving, on bright ground, the transverse *striæ* of *A. pellucida* with Zeiss's water-immersion objectives (G $\frac{1}{8}$ and K $\frac{1}{20}$), using as a condenser only Wenham's ordinary dry paraboloid, having a diaphragm at its base, or a stop in its cup, such diaphragm and stop having respectively an eccentric aperture. Both diaphragm and stop are made of sheet metal, Figs. 40 and 41 being forms of the diaphragm; Fig. 42, of a shutter laid over the apertures (of Fig. 40) not intended to be used; and Figs. 43 and 44, of the cup stop. The figures are drawn to full size.

The diaphragm and stop are not used in combination, but separately; and the forms figured have been adopted as giving the best

* 'Engl. Mech.,' xxxi. (1880) p. 135.

results, one being the more effective upon certain frustules, or with a particular paraboloid, or a given objective.

The diaphragm is a circle of the exact diameter of the tube in which the paraboloid is mounted, and rests upon the ring in which the lens is set, and is therefore in close contact with its base, excluding all light except such as may enter through the aperture. It is supported by a slight inner tube sliding conveniently tight within that holding the paraboloid. The stop fits the cup accurately, dips into it, and completely lines its inner surface, admitting rays only perpendicularly through the eccentric opening. The stop is thus substituted for that usually supplied with a paraboloid (which has to be removed), and a flat-headed pin passed through its central hole into the perforation in the paraboloid (fitting moderately tight), suffices to maintain it steadily in position. No stop is needed with the diaphragm.

Fig. 40.

Fig. 41.

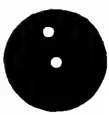


Fig. 44.

Fig. 42.

Fig. 43.

A slide of *A. pellucida* being placed upon the stage, the paraboloid, carrying its diaphragm and shutter, or stop, is inserted in the substage and racked up to focus, and the concave mirror manipulated in the axis of the Microscope until the light is thoroughly introduced through the eccentric aperture, the due accomplishment of which causes a brilliant but narrow luminous streak to appear across the slide. This arrangement effected, objective focussed, and valve found (isolated, and appearing to be otherwise well placed), the stage is rotated until the diatom under observation lies exactly lengthwise in the direction of the beam of light; which is made evident by the bluish colour, and equally illuminated and undistorted form, of the outline and midrib of the frustule, the objective being carefully corrected. A few moments' gazing prepares the eye to perceive the fine striæ which are then distinctly resolved, and, if the diatom be favourably placed, over its entire surface. The light is managed to avoid glare, and modified to suit the eye-piece, a somewhat dusky hue being preferable and most conducive to distinctness. The beam admitted through an aperture of any of the sizes figured is found sufficient to amply illuminate the field of the G objective with the fourth eye-piece—(× 1150)—an important consideration, as many valves will scarcely yield to less amplification.

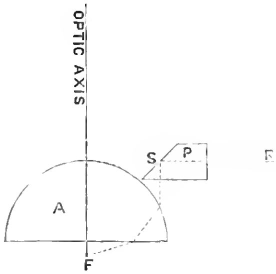
One of the dry strewed slides, at present supplied by Wheeler, is used by Mr. Williams, the specimens in which he is advised are of fair average difficulty. Equally satisfactory results are, however, obtained with slides by Hardman (Baker's), and other mounters; no valve resolved was in any instance specially selected, or "picked."

But very few trials have as yet been made with specimens mounted in balsam. Striæ have, however, been certainly discerned on some valves so mounted; and observations will be continued as appearances would seem to justify the anticipation of completely successful resolution.

It is not pretended that there is any novelty in the use of a diaphragm with the dry paraboloid; but it is believed that a stop as above described and figured has not been before applied to its cup. Diaphragm or stop, however, resolves *A. pellucida*, a little experience of their action demonstrating that in some respects the latter is occasionally preferable to the former. It is further believed that there is no previously published record of the resolution of *A. pellucida* by means of the dry paraboloid, and the result exemplifies yet another use (among the many) to which the Wenham dry paraboloid can be applied, and its consequent great efficiency as an accessory to the Microscope.

Tolles's Opaque Illuminator.* —One of the most ingenious methods of illuminating objects by means of light incident upon the surface under examination with high powers has been devised by Mr. Tolles for Professor W. A. Rogers, F.R.M.S., of Harvard College Observatory, U.S.A. Professor Rogers has given much attention to micrometry and the preparation of diffraction rulings, and in the examination of specimens of his own rulings on steel, &c., he found the need of "opaque illumination," which led to the adoption of the following plan, which he considers to be superior to any other he has tried.

Fig. 45.



In Fig. 45, A represents the front lens of a ½-inch objective (not to scale). P is a small and narrow prism made to side into the brass mount of the front lens to about the position shown. Parallel rays can be projected throughout the prism in the

* 'Engl. Mech.,' xxxi. (1880) p. 135.

direction of the ray R, and will be totally reflected at the internal surface S, whence they will fall upon the spherical surface of the lens A, and be refracted nearly to its focus F.

Spencer and Tolles Camera Lucida.—Mr. Stodder, of Boston (U.S.), sends us a description of a camera lucida, which he says is largely used in America, and although very old has not hitherto been described.

The original form was the design of Spencer, and its construction is shown in the diagram Fig. 46, where A A is the axis of the Microscope, B the lens of the eye-piece, and C a prism, mounted in front of B. The ray D from the pencil and paper passes through the prism and reaches the eye at E, the ray from the eye-piece being reflected at the upper surface of the prism, and also reaching the eye at E.

Fig. 46.

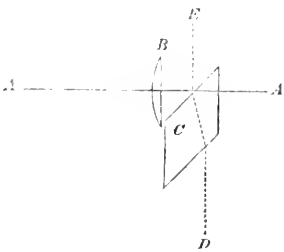


Fig. 47.

Fig. 48.

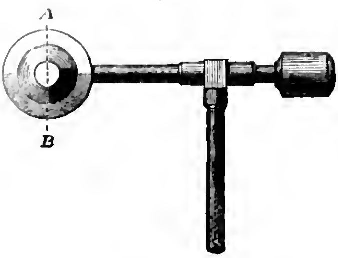
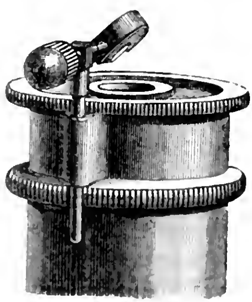


Fig. 49.



The principle of this apparatus is obviously identical with that of Dr. Beale's "Neutral Tint Reflector," but it is claimed to be an advantage that whilst the thin plate is liable to give reflections from both surfaces, the second surface in the Spencer form is so distant that the internal reflection does not reach the eye. The head does not require to be held immovable, but one may leave off work and begin again as often as desired. It can, moreover, be used with high as well as low power objectives.

Mr. Tolles subsequently devised a modification of this camera.

It consists simply of a circular piece of glass, of the form and mounted in the manner shown in Figs. 47 and 48 (Fig. 47 being a section, on the line A B, of Fig. 48), and placed with the plane side in front of the centre of the eye-piece, as in Fig. 49. This plan enables the camera to be placed closer to a deep eye-piece. The effect is, however, precisely the same as in the Spencer form, but a little more trouble is required to get the reflecting surface into the right position, which is however compensated for by the greater economy of construction.

Reflecting Plates for Microscopical Investigations. * — Herr Hilgendorf points out that it is often difficult or impracticable with flat objects to bring the sides (or with elongated objects, the ends) into the proper position for observation. The author uses, in such cases, a small strip of reflecting plate (silver-leaf, such as can be detached from ordinary looking-glass or silvered cover-glass), which is attached to a piece of glass from about ½–1 mm. in thickness. The short side of the latter is ground to an angle of 45°, and the facet thus obtained carries the little reflecting plate. This, turned upwards, is put close to the surface to be examined, which is in a perpendicular position; by looking from above into the reflector, the reflected image can be observed in a position somewhat sideways from the original, and at a lower level. The nearer the object is to the reflecting plate, the sharper and higher the image appears. Direct application to the reflecting surface would therefore be the most advantageous; but in this case transmitted light, or at least central light, must be dispensed with in the examination. Transverse sections of hairs lying horizontally have been shown by the author by this method. The extent of amplification with which the reflector can be used depends not only on the nature of the object, but on the perfection of the reflector. With imperfectly arranged contrivances, the use of an amplification of about a hundred times has been found possible. Considering the cheapness of the reflectors, their application is much to be recommended for preparations whose sides would otherwise be invisible. The author suggests that the same reflectors reversed, that is, with the reflecting surface turned downwards, could be made available for illuminating laterally an object placed close beside them.

Parkes's Microscope Lamp with Cooling Evaporator.—This lamp (designed by Messrs. Parkes, of Birmingham) is shown in Figs. 50 and 51. A is a lacquered brass stand, with heavy foot; B the brass lamp, capable of holding paraffin for eight hours' consumption. This may be raised or lowered on the sliding upright from 4 to 12 inches; that is, the burner is 4 inches from the level of the table, when at its lowest point. C is a bronzed copper cylindrical shade, 3¼ inches diameter, with hood at front to prevent the upward reflection of light. At the back is a parabolic reflector transmitting nearly parallel rays, which will slide out for cleaning; when desirable a disk of cardboard may be placed over this reflector, for "white cloud" illumination. At the front is a tinted glass "light modifier," which is secured by a bayonet joint, and may also be removed when necessary.

* 'SB. Gesell. Naturf. Freunde zu Berlin,' 1879, p. 2.

D is the *cooling evaporator*, constructed of thin bronzed copper, and covered with a lid of perforated copper. A layer of thick felt is placed inside for *saturation*. This vessel, filled with water and placed over the shade as soon as the lamp is lighted, at once prevents the radiation of heat upon the observer's head, and its use, during a long evening, "prevents an annoyance which has long been felt by every microscopist." The felt only requires remoistening once in every five or six hours. If a thermometer is placed say 8 inches from the lamp when it is first lighted, and on a *level with the top of shade* (which is the usual position of an observer's head when using the Microscope), it will be found that after the lamp has been burning an hour, the thermometer will only indicate a rise of three or four degrees, whereas with lamps having a terra-cotta or metallic shade the temperature would be raised from twelve to fifteen degrees.

FIG. 50.

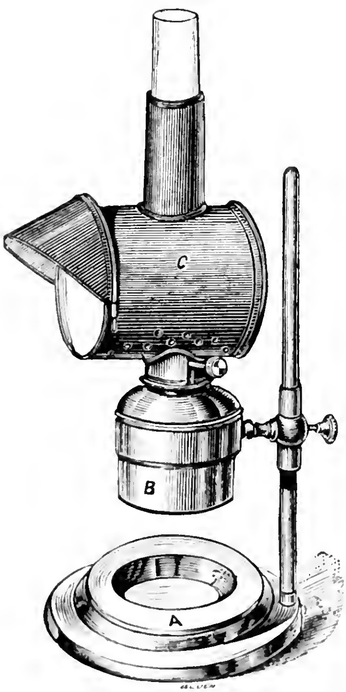
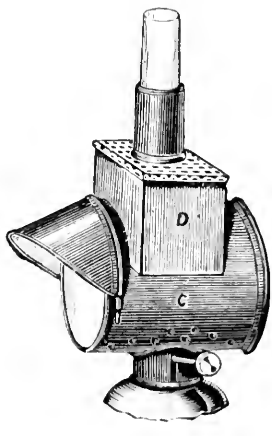


FIG. 51.



It is claimed for this lamp that, independently of the cooling arrangement, it fulfils all the conditions of the most approved lamps hitherto constructed for Microscopic use, with the addition of a more effective shade and reflector. In consequence of more perfect combustion, resulting from the shape of the chimney and arrangement for the ingress of air, an abundance of light is supplied for the higher powers.

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„ „ Priority of the Generic Name *Gaillonella* (Bory) over that of *Melosira* (Ag.). *Brebissonia*, II., pp. 106–7.

Richter, P. — New Bacillariaceæ. [*Homœcladia germanica; H. conferta.*] [*Transl.* from 'Hedwigia,' XVII.] *Brebissonia*, II., pp. 1–3.

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WOLLE, F.—Notes on Fresh-water Algæ. V. (*Cylindrocapsa*), 1 fig. *Am. M. Micr. Journ.*, I., pp. 83–4.

MICROSCOPY, &c.

A., M.—*See* Carr, E.

AKAKIA.—Angular Aperture of Immersion Object-glasses. *Engl. Mech.*, XXXI., p. 119.

„ Aperture of Powell and Lealand's new Formula $\frac{1}{8}$ Immersion. *Engl. Mech.*, XXXI., pp. 158, 211–12.

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ATWOOD, H. F.—[Coloured Glass Balls used for trap shooting as Aquaria for Entomostraca.] *Am. M. Micr. Journ.*, I., p. 78.

B., R., jun.—Cover-glasses. „ „ p. 68.

BARKER, A. H.—[Smith's] Microscopical Illumination. *Engl. Mech.*, XXXI., p. 183 [see also "Fellow," &c.].

BAUSCH, E.—The Microscope and its Parts. *Am. Journ. Micr.*, V., pp. 58–64.

BECK's Improved Large Best Microscope-stand. 2 figs. *Engl. Mech.*, XXXI., pp. 104–5, 131–5, 159, 181.

BECK, J.—The Tolles-Blackham and Beck's Microscope-stands. *Engl. Mech.*, XXXI., p. 159.

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BRAGDON, A. A.—The Objectives which afford the most accurate knowledge of Histology. *Am. M. Micr. Journ.*, I., pp. 89–93.

BRANDT, O.—On Glycerine-gelatine. *Zeitschr. Mikr.*, II., pp. 69–72.

„ „ A new Microscope specially intended for the Examination of Flesh. 1 fig. *Zeitschr. Mikr.*, II., pp. 72–80.

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[*Wien. Med. Wochenschr.*, XXIX., p. 1261.]

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" " Cleaning Foraminifera. *Am. M. Micr. Journ.*, I., p. 88.

Cutter, E.—Microphotography with the $\frac{1}{75}$ Objective of R. B. Tolles. 2 figs.
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Dallinger's Lamp.—*See* "Fellow," &c.

Diatom Test-slides. *Engl. Mech.*, XXXI., p. 181.

Diatoms, about. *Am. M. Micr. Journ.*, I., p. 84.

Dippel, L.—Some further Fluids for Homogeneous Immersion.
Zeitschr. Mikr., II., pp. 57–8.

Dunning, C. G.—Description of an Improved Microscopical Turntable (1 fig.).
Journ. Quek. Micr. Club, VI., pp. 81–2.

Edmunds, J., F.R.A.S.—*See* Carr, E.

"Fellow of the R. Micr. Soc."—[Management of Illumination; Homogeneous-Immersion Objectives; Illumination of Opaque Objects under High Powers (1 fig.); Centring Glass; High-power Objectives and the Binocular Prism; Mercury Test for Objectives; Advantage of High Angles of Aperture.]
Engl. Mech., XXXI., pp. 85–6.

" " [Tolles-Blackham's (1 fig.), Beck's, Jaubert's, Grubb's, Zentmayer's, and Ross's Microscope-stands: Rogers's Opaque Illumination (1 fig.); Parkes's Microscope Lamp; Dr. Beale's 'How to work with the Microscope.'] *Engl. Mech.*, XXXI., pp. 134–5.

" " [R. Micr. Society's Second Scientific Evening; —Powell and Lealand's new Oil-Immersion $\frac{1}{25}$; Beck's new Microscope; Diatom Test-slides; Zeiss's Adjustable Low-power Objective (improved form); Objectives as Eye-pieces; Zeiss's Oil-immersion Objectives; &c.]
Engl. Mech., XXXI., p. 181.

" " [Powell and Lealand's new Objectives at the Royal Society; [Smith's] "Microscopical Illumination"; Mr. Dallinger's Lamp; Alleged Chromatization of Light by a Parallel-sided Microscope Slide; Achromatism.] *Engl. Mech.*, XXXI., pp. 228–9.

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Fieldwick, A.—On a Method of Centring Slides. 1 fig.
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[Reprint from *Am. Journ. Insan.*, 1879.]

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Engl. Mech., XXXI., pp. 181-2.

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[*Med. Herald* (*Louisville*), I., p. 523.]

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" The Binocular Microscope. *Engl. Mech.*, XXXI., p. 158 [*see* also p. 181].

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PROCEEDINGS OF THE SOCIETY.

Meeting of 14th April, 1880, at King's College, Strand, W.C.
The President (Dr. Beale, F.R.S.) in the Chair.

The Minutes of the meeting of 10th March last were read and confirmed, and were signed by the President.

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

	From
Ormerod, Miss E. A.—Notes of Observations of Injurious Insects. 44 pp., 28 figs. (8vo. London, 1880)	*The Author.*
Traill, G. W.—The Algæ of the Firth of Forth. 20 pp. (8vo. Edinburgh, 1880)	*Ditto.*
79 numbers of the 'Monthly Microscopical Journal,' 13 of the Society's 'Journal,' and 67 of 'Science-Gossip' ..	*Executors of the late M. C. Hardy, Esq.*
Smith, Sir J. E. and J. Sowerby.—English Botany. (1st edition.) 41 vols., including Index vol. and 4 vols. Supplement. (8vo. London, 1790–1814, 1831–49) ..	*Mr. Crisp.*

The President said that they must feel greatly indebted to Mr. Crisp for the very valuable further donation which he had just made to the Library—that of 'Sowerby's Botany.' Though during the interval which had elapsed since the first publication of the work very much had been added to the general knowledge of the plants, he was afraid that the progress made in the art of illustration had not been at all in proportion.

The President said the next duty he had to perform was not so pleasant a one, as it was to announce that they had since their last meeting received notice of the death of two Fellows of the Society. Professor Bell, formerly a President of the Society, and one who had so largely advanced our knowledge of the British fauna, had died, full of years and honours, at the age of 87. The other death was that of a gentleman who, though not so long associated with them, was but a few meetings ago present in that room—Dr. Fripp, a President of the Bristol Naturalists' Society—who had done much to render accessible to English microscopists the views of German writers. He proposed a vote of condolence to the nearest relatives of the deceased gentlemen, which was carried unanimously.

Mr. Crisp described by means of drawings on the black-board the Spencer-Tolles Camera Lucida (see p. 527), and also exhibited Spengel's Improved Rivet-Leiser Microtome (see p. 334).

Dr. Matthews referred to the use of objectives in place of eye-pieces, in regard to which he had recently been experimenting. An objective so used not only gave very excellent definition but also sufficient field of view. The only fitting required was an adapter sliding into the tube and into which the objective would screw. It was of no consequence what was the length of the tube, because whether placed close to the lower objective or at ten or more inches from it, the arrangement performed equally well; the field was also very fairly flat.

Mr. Ingpen in reply to a question said he could add nothing to what Dr. Matthews had said upon the subject. He had used objectives in the manner described, because he saw them suggested by Sir John Herschell, and he obtained very good results.

Mr. Curties called attention to some excellent photographs of microscopical objects, the production of one of the Fellows of the Society, Mr. Burton, of Nottingham. They had been prepared specially for illustrating lectures on natural history by means of the magic lantern.

Dr. M. C. Cooke's paper "The Genus *Ravenelia*" was read by Mr. Stewart, the figures in illustration being shown upon the blackboard (see p. 384).

Dr. Geo. Hoggan gave a résumé of a paper by himself and Mrs. Hoggan, M.D., "On the Development and Retrogression of Blood-vessels," illustrating the chief points in his remarks by drawings on the board as he proceeded.

Herr A. Grunow's paper "On some New Species of *Nitzschia*" was taken as read (see p. 394).

Mr. Webb's paper "On a New Finder" was briefly explained by Mr. Crisp, who thought that generally the idea was a good one, the doubtful points being the cost and the possibility of accurate execution.

Mr. Curties said that Mr. Webb had recently brought the matter to his notice. He believed also that Dr. Royston-Pigot had a similar matter under consideration.

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

Mr. Bolton:—Spawn of perch.

Mr. Burton:—Photographs of Microscopical Objects.

Mr. Crisp: Spengel's Improved Rivet-Leiser Microtome (see p. 334).

Dr. Hoggan:—Specimens to illustrate the paper "On the Development and Retrogression of Blood-vessels.

(1) *From omentum of newly-born kitten.* Showing development and retrogression of blood-vessels in the same field.

(2) *From mesentery of rat dead of old age and starvation.* Show-

ing portion of capillary broken off from the circulation and enclosing blood-corpuscles.

(3) *From mesentery of rat dead of old age and starvation.* Showing loop of blood-vessel about to separate, and enclosing blood-corpuscles.

(4) *From broad ligament of rat dead of old age.* Showing contraction and thickening of walls of smaller blood-vessels.

(5) *From broad ligament of pregnant mouse.* Formation of new capillary loop; the already-formed loop is being joined at both ends to the circulation.

(6) *From broad ligament of pregnant mouse.* Showing typical forms of splicing or cell-junction with strengthening-cell placed against the original joint in developing capillary.

Mr. E. T. Newton:—Improved Microtome.

New Fellows.—The following were elected *Ordinary Fellows*:—Messrs. W. Carruthers, F.R.S., G. Devron, M.D., D. W. Greenhough, J. C. Havers, W. A. Rogers, E. M. Stone, and H. Woodward, LL.D., F.R.S.

Scientific Evening.

The second Scientific Evening of the Session was held in the Libraries of King's College, on the evening of Wednesday the 21st April, 1880, and was very numerously attended, nearly 150 Fellows and Visitors being present.

The following were the objects, &c., exhibited:—

Mr. Chas. Baker:

Stephenson's binocular dissecting and other Microscopes, Parkes' Microscope lamp with cooling chamber (see p. 528), Teasdale's safety stage (see p. 332), improved mounting for Wenham's disk-illuminator, Newton's improved microtome, &c.

Messrs. R. and J. Beck:

Improved Microscope-stand with swinging substage (see p. 329).

Mr. W. A. Bevington:

Griffithsia sp., from Australia.

Mr. Thos. Bolton:

Medusa from the gonophore of a Marine Hydrozoon, *Obelia dichotoma*, perch spawn and young fry, *Asplanchna Brightwellii*, &c.

Mr. Thos. Curties:

Zeiss' objective adjusting 2″ to 4″, flea of ferret with *Hippopus* (Acarellus) *pulicis*.

Mr. W. G. Cocks:

A form of *Epistylis* with a number of *Acinetæ* attached (see p. 470); a gigantic Floscule.

Mr. A. C. Cole:

A set of Mr. Shrubsole's diatoms from the London clay.

Mr. F. Enock:
Trypeta reticulata (net-wing fly) found for the first time in Great Britain, by Mr. Enock last August; *Nycteribia Hopei*, a parasite of one of the Indian bats (prepared without pressure).

Mr. A. Fieldwick, jun.:
Scales of *Morpho menelaus*, &c.

Dr. Gibbes:
Tail of rat, scalp of child, and tongue of dog, all treble stained, and epithelium from skin of embryo salamander—shown with $\frac{1}{12}$ oil-immersion and Wenham's ordinary binocular prism with both fields illuminated.

Messrs. W. H. Gilburt:
Nymph of *Tegeocranus latus.*

Mr. A. de Souza Guimaraens:
Sections of *Petromyzon fluviatilis* and *Triton cristatus*, fossil wood, agates, and various rocks, &c. Prepared by H. Boecher.

Messrs. How and Company:
Sections of dolerite and pseudomorphs in serpentine.

Mr. F. Hailes:
Foraminifera.

Mr. W. Joshua:
Polysiphonia fastigiata with antheridia, *Codiolum gregarium*, an alga new to Great Britain, from the sea wall at Teignmouth, *Lemania fucina*, and *Chantransia violacea*.

Mr. R. T. Lewis:
Hoyne's patent lamp for burning paraffin oils without a chimney, the quantity of air required to maintain perfect combustion being supplied to the wick by means of a small clockwork fan rapidly rotating inside the pedestal of the stand, and running for sixteen hours with once winding.

The results obtained were an intensely brilliant, white, steady, and smokeless flame, entirely free from smell whether turned high or low, whilst the constant upward current of air kept the whole of the parts contiguous to the burner at so low a temperature as to render explosion impossible, a maximum of light being produced at a minimum of heat and expense.

Dr. Maddox:
"Aëroconiscope" for collecting dust, &c., from the air.*

Mr. F. W. Millett:
A series of fifteen drawings of the eggs of insects.

Dr. Millar:
A section of *Parkeria* showing tubes in centre.

Dr. Matthews:
Association of corals with sponges.

Mr. A. D. Michael:
Young hexapod larva of *Leiosoma palmicincta* nov. sp.

Messrs. Powell and Lealand:
Pleurosigma angulatum and *Podura* scales, with $\frac{1}{25}$ oil-immersion object-glass.

* See 'M. M. J.,' June 1, 1870.

Mr. W. Priest:
A section of sponge, *Raphiodesma lingua*.

Mr. H. J. Roper:
Moschatel cluster-cups, *Æcidium albescens*.

Mr. Walter W. Reeves:
One of the Crystalworts, *Ricciocarpus natans*.

Mr. James Smith:
Pleurosigma angulatum and *P. formosum* with $\frac{1}{16}$ immersion object-glass and his new mode of illumination (see p. 398).

Mr. Charles Stewart:
Section of Calcareous sponge (*Grantia compressa*) showing soft parts.

Mr. A. Topping:
A collection of various grouped diatoms.

Mr. George Williams:
Some forms of diaphragms and stops, with eccentric apertures, to be applied to the cup or base of a Wenham's dry paraboloid; resolving *Amphipleura pellucida*, on bright ground, with Zeiss' water-immersion objectives (see p. 524).

Mr. Thos. C. White:
Urceolaria parasitic on *Hydra*, and one of the *Medusæ* alive.

Mr. Ed. Wheeler:
Lung and ovipositor of spider, *Volvox globator* with resting spores, section of the eye of *Eristalis tenax*.

Dr. Whittell:
Fang and poison-duct of South Australian centipede, head of ditto, and fang of an unnamed poisonous spider from South Australia.

Mr. F. H. Ward:
Section of mistletoe and apple, thorn and stem of rose, and various other stems of plants, double stained.

Rev. J. E. Vize:
Tetraphis pellucida, with gemmæ germinating.

Meeting of 12th May, 1880, at King's College, Strand, W.C.
The President (Dr. Beale, F.R.S.) in the Chair.

The Minutes of the meeting of 14th April last were read and confirmed, and were signed by the President.

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

Thomé, Prof. O. W.—Text-book of Structural and Physiological Botany. Translated and edited by A. W. Bennett, M.A., B.Sc., F.L.S. 479 pp., 546 figs., and one map. 3rd ed. (8vo. London, 1879)	*Mr. A. W. Bennett.*
Molesworth, C.—The Cobham Journals. 178 pp. (8vo. London, 1880)	*Miss E. E. Ormerod.*
Two Slides of Micro-fungi (*Arthroderma* [?])	*Mr. G. E. Davis.*

The President gave notice that the next meeting would be made special to consider an alteration in the Bye-laws as to the payment of the first year's subscription by new Fellows.

Mr. Crisp explained that under the existing regulations new Fellows elected in January to June paid the full year's subscription, while those elected in the months of October, November, and December did not pay for that year at all. It was thought to be preferable to divide the year into two or four parts so far as the *first* year's subscription was concerned, so that new Fellows would pay a proportionate part of the first year's subscription according to the time of their election.

Mr. Beck suggested that the amount to be paid by new Fellows should be proportionate to the months remaining of the year in which they were elected.

Messrs. Ross's improved Microscope stand was exhibited and described by Mr. Crisp.

Mr. G. E. Davis's letter relating to two slides of micro-fungi which he sent was read.

Professor Abbe's Note "On the Origin of Homogeneous Immersion" was read by Mr. Crisp, and a further Note describing the proper use of his Immersion Condenser.

Mr. George Williams' Note on "Wenham's Dry Paraboloid and *Amphipleura pellucida*" was read by Mr. Crisp (see p. 524).

Mr. Beck said he thought it right to say that the dry paraboloid had been used before for resolving diatoms; in fact, if the light were thrown upon it in an oblique position, it was one of the easiest methods of resolving test-objects.

Mr. Curties said that Mr. Williams merely claimed as a novelty the arrangement of the stops described in his Note.

Mr. Crisp described the Tolles-Rogers Illuminator for opaque objects (see p. 526).

The Rev. H. Higgins' Note "On the Plasmodia of Myxomycetes" was read by Mr. Stewart, the drawings in illustration being enlarged upon the board.

Dr. Maddox's illustrations of the life-history of the Diatomaceæ were exhibited, and the President called attention to the admirable character of the drawings.

Herr Brandt's improved Rivet-Leiser Microtome was described by Mr. Crisp (see p. 504).

Mr. Crisp gave some further explanations as to the Wickersheimer preservative process (see p. 325), which continued to be in great favour in Germany for zoological preparations, but had not been found so effective in the case of plants.

Mr. Stewart said that as regarded pathological preparations the process was hardly a complete success, inasmuch as it entirely removed all colour which was due to blood, apparently dissolving the colouring matter.

The President said the fluid was much the same as "Goadby" and glycerine.

Mr. Stewart read a note "On the Histology of *Grantia compressa*," illustrated by drawings on the board and by preparations exhibited under the Microscope.

Mr. Spicer asked what reagents Mr. Stewart had made use of in demonstrating the nucleus of the flagellate cells.

Mr. Stewart said, in the first instance he put the living sponge into a 1 per cent. solution of osmic acid, and then for preservation in weak spirit and water. On returning to London some days afterwards, he put it into syrup for twenty-four hours, and then into gum-water for twenty-four hours; the sections were cut by the ordinary freezing process. Not being however altogether satisfied that the appearance of a nucleus in the neck of the cell might not be due to other causes, he afterwards stained some of the sections with logwood and found his previous observations confirmed.

Mr. Crisp explained a process for making pure "glycerine-gelatine" (see p. 502), and the suggestion of Herr Hilgendorf for using thin reflecting plates (see p. 528).

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

Mr. Bolton :—Young Eel.

Mr. Crisp :—Schöbl's Dissecting Microscope (see p. 956).

Mr. Curties :—Zeiss's Microscope with Abbe's Immersion Condenser and Amplifier.

Mr. G. E. Davis :—Two slides of Micro-fungi (*Arthroderma ?*)

Mr. Ross :—Improved Microscope-stand.

Mr. Stewart :—Slides showing structure of *Grantia compressa*, with "palpocils."

New Fellows.—The following were elected *Ordinary Fellows :—* Messrs. J. C. Shenstone and W. Morris, jun.

WALTER W. REEVES,
Assist.-Secretary.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY,

CONTAINING ITS

Transactions and Proceedings,

AND OTHER INFORMATION AS TO

INVERTEBRATA AND CRYPTOGAMIA, EMBRYOLOGY, HISTOLOGY, MICROSCOPY, &c.

Edited, under the direction of the Publication Committee, by
FRANK CRISP, LL.B., B.A., F.L.S.,
one of the Secretaries of the Society.

THIS Journal is published bi-monthly, at the beginning of the months of February, April, June, August, October, and December. It varies in size, according to convenience, but does not contain less than 5 sheets (80 pp.) and 4 Plates, with Woodcuts as required. The uniform price to non-Fellows is 3*s*. per Number.

The great development that has taken place in modern times in periodical Scientific Literature, however satisfactory from one point of view, cannot but be regarded with regret by the Biologist, involving as it does so great an extension of the field to be explored—many even of the minor and more inaccessible Transactions often containing the results of original observations with which any writer upon the subject must make himself acquainted.

With the object of providing a record, brought down to a recent date, of the principal observations and investigations published in this country and abroad, relating to the Invertebrata and the Cryptogamia (including also Embryology, Histology, and Microscopy), the Journal contains as a special feature, under the head of BIBLIOGRAPHY, a classified list of the contents of the principal English and Foreign Journals, Proceedings, and Transactions (so far as they relate to the above subjects), and also, under the head of NOTES AND MEMORANDA, abstracts of or extracts from the more important of the articles and papers from time to time noted in the Bibliography.

In addition, the Journal contains the TRANSACTIONS and PROCEEDINGS of the Society, being the Papers read at the Meetings, and Reports of the business transacted, including any observations or discussions on the papers read or subjects brought forward.

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All Communications as to Papers or Advertisements should be addressed to the Assistant-Secretary, Royal Microscopical Society, King's College, Strand, W.C.; other Communications as to the Journal to the Editor, at the same address.

THE

ROYAL MICROSCOPICAL SOCIETY.

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

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

It consists of Fellows, and *Ex-officio*, Honorary, and Corresponding Fellows.

The Council is elected annually, and is composed of the President, four Vice-Presidents, Treasurer, two Secretaries, and twelve other Fellows.

Candidates for Fellowship must be proposed by three Fellows, who must sign a Certificate of Recommendation stating the names, residence, description, &c., of the Candidate, of whom one of the proposers must have personal knowledge. This Certificate is read at the next Monthly Meeting, and the Candidate is balloted for at the succeeding Meeting.

The Annual Subscription is 2*l.* 2*s.*, payable in advance on election, and subsequently on 1st January annually, with an Entrance Fee of 2*l.* 2*s.* Future payments of the former may be compounded for at any time by a payment of 31*l.* 10*s.* Fellows elected in October, November, or December will not be called upon for a subscription during the succeeding year, and Fellows absent from the United Kingdom for a year, or permanently residing abroad, are exempt from one-half the subscription during absence.

Ex-officio Fellows consist of the Presidents for the time being of such Societies at home or abroad as the Council may recommend and a Monthly Meeting approve. They are entitled to receive the Society's Publications, and to exercise all other privileges of Fellows, except voting, but are not required to pay any Entrance Fee or Annual Subscription.

The Meetings commence on the second Wednesday in October, and are continued on the second Wednesday in each month until June. They are held in the Society's Library at King's College, Strand, W.C., and commence at 8 P.M. Visitors are admitted by the introduction of Fellows.

In each Session two additional evenings ("Scientific Evenings") are devoted to the exhibition of 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, with other Microscopical and Biological Information, is published bi-monthly, and is forwarded *gratis* to all Fellows.

The Library, with the Instruments, Apparatus, and Cabinet of Objects, is open for the use of Fellows on Mondays, Tuesdays, Thursdays, and Fridays, from 11 A.M. to 4 P.M., and on Wednesdays from 7 to 10 P.M. It is closed during August.

Forms of proposal for Fellowship, and any further information, may be obtained by application to the Secretaries, or Assistant-Secretary, at the Library of the Society, King's College, Strand, W.C.

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